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Enterprise Information Systems

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1 INTRODUCTION

An **enterprise information system** (**EIS**) is any kind of information system which improves the functions of enterprise business processes by integration. This means typically offering high quality of service, dealing with large volumes of data and capable of supporting some large and possibly complex organization or enterprise. An EIS must be able to be used by all parts and all levels of an enterprise (Wikipedia 2019).

Enterprise information systems provide a technology platform that enables organizations to integrate and coordinate their business processes on a robust foundation. An EIS is currently used in conjunction with customer relationship management and supply chain management to automate business processes. An enterprise information system provides a single system that is central to the organization that ensures information can be shared across all functional levels and management hierarchies (Wikipedia 2019).

An EIS can be used to increase business productivity and reduce service cycles, product development cycles and marketing life cycles. It may be used to amalgamate existing applications. Other outcomes include higher operational efficiency and cost savings (Wikipedia 2019).

For the structure and learning background of subject "Enterprise Information Systems" were used taken over derivated chapters of the books Enterprise information systems: the enterprise in the information society (Basl, J. , Blažíček, R., 2012), Business informatics (Gála, Pour, & Šedivá, 2009), Information systems in entrepreneurial practice (Sodomka, P. , Klčová, H., 2010) and Application of Modern Information Technology in Corporate Management (Tvrdíková, 2008).

2 INFORMATION SOCIETY, INTRODUCTION TO INFORMATION SYSTEMS, THE LEARNING ORGANISATION, HISTORICAL STAGES OF IS DEVELOPMENT

2.1.1 Modern network learning organisations

At present, there are many would-be networking organisations that have all sorts of entrepreneurial visions and goals. Some, for instance, cooperate as an alliance with the objective to cover the largest portion of the market, and others cooperate purely on a supplier-customer basis. However, only the networks that entirely cover their value generating chain and have the flexibility and adaptive capability to cover and expand it through the resilient transformation of their own relationships can prosper in the long term. These dynamic networks can then compete even with the supra-national corporations that control the global market.

Yet, prosperity can be understood in two ways. We can achieve it by force in the network environment in the form of dictatorship toward the subcontractors, sucking of primary resources or treatment of people as a mobile tool to generate profit. Unfortunately, this is the case of many "dynamic networks" in the modern global world. We can also opt for a more difficult, but generally far much more beneficial approach to business with a strong social aspect.

2.1.2 Decisive paradigms

According to the book titled "The Fifth Discipline Fieldbook" (Senge, 1994), a learning organisation that wants to maintain its competitiveness long-term must fulfil five basic conditions.

1. It is necessary to apply systemic thinking in the organisation. However this assumes deeper insight and knowledge of the internal relations in the company rather than only monitoring the causes and consequences of individual incidents. An important precondition is also the monitoring of the process of changes rather than recording and solution of individual incidents.
2. It is necessary to achieve so-called personal mastery. It is the discipline of continuous clarification and deepening of personal visions, focusing of the corporate management efforts on the patient search for objective reality. The difference between reality and vision should then increase creative tension, which should lead to the implementation or verification of this vision.
3. It is necessary to analyse and achieve changes in the established models of thinking. This concerns the deep-rooted ideas, generalisations, or even the impressions that influence the comprehension of reality and decision-making of the corporate management. People should learn to see their own thoughts in the context of other opinions within the organisation.
4. It is necessary to be capable of creating and sharing visions. In practice, this means the involvement of the employees in the implementation of these visions and support for their internal involvement instead of only the implementation of the ideas of the management.
5. Teamwork must be focused on dialogue between the team members and suppression of the ambitions of individuals to the benefit of common thinking about problems. Overcoming of the barriers that are caused by the deep-rooted behaviour patterns in teamwork means the "acceleration of learning", and its preservation on the contrary means "impeding of learning" (Senge, 1994).

The social aspect of the business is included in these conditions, but still lacks the answer to the fundamental question. How can the given conditions be implemented in practice? How can the strong social aspect be implemented to uphold the competitiveness level? Which strategic approach will be successful in the building of the learning organisation?

Let us try to apply the five fundamental paradigms of human activity to answer these questions. After all the essence of the learning organisation are the people themselves, their capability to communicate and strike agreements with other people, regardless of whether this is in the supplier chains, sale of goods and provision of services or directly within the organisation itself.

Informatics, just like the computers themselves, has undergone its own historical development. Just as informatics has

developed, its concept has also developed, including its comprehension, definitions and interpretations. Currently, many definitions of informatics as a science discipline exist and this issue is also addressed by many specialised publications. It is clear that the opinions on its definitions and interpretations often also substantially differ. However, the purpose of this publication it not to solve the definition of informatics itself, but to provide a picture of its application options and technologies. For this reason, we shall define informatics only as follows:

Informatics utilises other sciences in its studies. This applies, for instance, to philosophy, natural sciences (Mathematics, Physics, Chemistry and Biology), computer science, cognitive sciences and artificial intelligence sciences. The principles formulated by Informatics are then applied to other science disciplines and fields. Application of the informatics specialisation in a given field is usually expressed as informatics in combination with the name of the given discipline or field. We can encounter medical (healthcare, bio) informatics, agricultural informatics, chemical (molecular) informatics, etc.

Many combinations are also used in the field of economics, for instance, economic informatics, managerial informatics, informatics in the economy, informatics in enterprise, etc. In this publication, we shall make an attempt to express the designation of this application using the words **enterprise informatics**. By this, we want to express the fact that we shall focus on the enterprise as the representation of institutionalised enterprise. But since some activities of entrepreneurial subjects (procurement, human resources management, financial management, etc.) are also performed by the State and its territorial units (region, municipality), represented by the executive bodies and state organisations, the principles of enterprise informatics can also be applied to these bodies and organisations.

To comprehend the content of enterprise informatics, we must first define a few basic concepts - information, information system, information system resources and processes.

We intuitively use the term "**information**" throughout our lives. It is not without interest that we historically encounter this term already in the Middle Ages - always in the most important spheres: in trade, in the judiciary and in church life (i.e. in ideology).

At present, we encounter various comprehensions of the term information. In the concept of this publication, it is significant that information is a **link of the processing chain** "real world - data - information - knowledge". In this context, data are defined as a "raw material" for preparation of information. And the information together with the defined rules becomes knowledge. Use of the term information in the sense of a message, data, statement or advice, became widespread only up to the 1950s. At the time, with the development of the transmission of signals, theory of telecommunications, cybernetics and electronic computers, new separate fields have spun off with their own subjects of research, methodologies and terminology. One of them was and continues to be the "**theory of information**". Shannon, Bell, Ashby, Wiener, Kolmogorov, Gabor, Szilard and Brillouin were at its birth.

Initially, the interest of the experts was focused on **technical information**. The scientists based their actions on the requirements of communication technology - transmission of the maximum volume of reports within the shortest time and as securely as possible. A further area of research was provision of the essential information for management of machinery. **Biological information** is reviewed in connection with memory, genetic codes, thinking and other related phenomena. **Social information** forms the most extensive area. It comprises economic, regulatory, scientific, social, artistic, political and other information. At present, we can monitor the following interpretations of information particularly in **economics**:

- in the general sense - statements, messages,
- distributed impact on the company (or on its individual) - mass communication resources in the broader sense of the word (radio, print, TV, advertisements, etc.),
- in terms of general cyber significance - management and communication in the living organisms and machines (including economic systems).

Each piece of information may be subjected to three different viewpoint levels in terms of corresponding arrangement, interpretation and use of characters:

- The **syntax** level is concerned with the internal structure of the message consisting of the characters of the given alphabet, i.e. it investigates the relationships between the characters. At the same time, it assumes the analysis of information regardless of its relationship to the object, which it reflects. Thus, independent of the significance of the information and the recipient, who will use it. An example of this are the rules for compilation of messages in a specific (natural or artificial) language.
- The **semantic** level is concerned with the relationship of the character to the object, process or phenomenon, which this character reflects, regardless of the recipient. An example is comprehension of written text.

- The **pragmatic** level is concerned with the relationship of the information to the recipient, its usage, practical impact on the given, for instance, economic system. It is the most important aspect for us, but also the most difficult level to formalise. For example: the "practical importance" of the message to the recipient.

We can summarise the information concept under the following working definition: **Information** is a message of a phenomenon that has occurred and reduces the level of ignorance of this phenomenon on our part (the recipients).

2.2 The position of ICT in supranational corporations

Globalisation in the entrepreneurial sphere is manifest mainly in the continuously increasing share of supranational corporations. The establishment of new subsidiary companies or acquisition of existing companies outside the boundaries of the parent company can be seen both coming into the Czech Republic and also in the opposite direction.

The development of telecommunications with the opportunities to build extensive corporate networks and also the development of the Internet have made it possible to inter-link companies within the supranational corporations. The creators of the enterprise IS also responded to this. The advanced systems support applications for inter-linking of companies that fall under the international concerns not only within a single country, but also internationally.

Within the scope of the big supranational corporations, uniform information systems are often used within the entire group. International standards are used within the financial processes. A uniform method in the area of management accounting offers uniform and comparable reporting within the entire international concern. Implementation of these applications is not easy because the user encounters not only a new application but mostly also the fact that such implementation is accompanied by changes in the accounting procedures. The uniform controlling models make it possible to compare the enterprises within the group at international level.

2.3 Information System

Just like in other fields, informatics also makes an effort to suitably arrange its own area. We consider the concept of the system as one of its fundamental principles. Many definitions of this term exist and for our current purposes, we shall use the definition according to (Molnár, 2007).

A **system** is an arbitrarily defined non-empty set of elements and a plurality of links between them, whereby the properties of the elements and the links between them determine the properties (behaviour) of the complex.

For such an identified system (which is the subject matter of our interest), we mainly identify the following:

- **purpose of the system**, i.e. objective, respectively, target behaviour of the system;
- **structure of the system**, i.e. the system elements and the relationships between them;
- **properties of the elements** of the system that are significant for overall system behaviour;
- **properties of the relationships** between the system elements, which are significant for overall system behaviour;
- **system environment**, i.e. definition of the elements which are not parts of the system, but whose properties and system link to the surrounding elements significantly impacts the behaviour of the system;
- **any subsystems**, if the review of the system as a whole is too complicated and it is necessary (and mainly possible) to divide the system into smaller relatively independent (closed) units within the system.

In informatics, such a system is designated as an **information system**. Its purpose is to ensure the suitable expression of information, its processing and transfer within some system. It generally comprises people, suitable tools and methods, which are grouped into three basic components:

- **Input** - includes the elements which allow the capture of information and other inputs, which should be the subject-matter of processing, or mutually inter-link the inputs;
- **Processing** - includes elements which ensure the transformation of inputs to the required output;
- **Output** - elements which are capable of carrying information and other outputs to the recipient (user).

The **information system** is the consistent arrangement of a set of cooperating components for the purpose of creation, collection, processing, transfer and distribution of information. The information system elements are people, respectively, users of the information, and informatics resources. A component comprises one or more elements.

2.4 Corporate information system

So as we have already stated on the general plane in chapter 2.3, enterprise informatics also formulates an information

system. Since enterprise informatics focuses on the enterprise, we then designate this system as the information system within the enterprise or the enterprise information system.

Information and communication technology is a broad scale of technical resources and program resources. The term technical resources (hardware - HW) was created due to the need to separate the physical aspect of the computers, communication resources and other technical equipment from the programs which are loaded into these devices and are used to manipulate them. The total number of all programs is designated as **program resources (software - SW)**.

Technical resources include all computers, computer peripheries, separate data carriers, office equipment, communication resources (telecommunications and computer networks, including end-user devices) and other specialised equipment (for instance, letter packing devices, electric power generator, etc.).

The complex **program resources** are broken down into three basic groups:

- **Basic software (BSW)**, which includes software that allows operation of the programs from other program groups, ensures the communication of the programs, which run on various computers connected in a network, and also resources that allow effective integration of the programs into larger units.
- **Application software (ASW)**, which processes information and supports the enterprise processes. In this enterprise, the following ASW categories are concerned:
    - transaction type application software, which is focused on information support and automation of business transactions, such as e-commerce applications, production management, etc.;
    - application software for support of decision-making at all management levels (strategic, tactical and operative);
    - application software for support of the development and innovation of products and services in the enterprise;
    - infrastructural application software products, which include support for the activities across the organisation (or are components of the above-stated ASW) and that also include, for instance, document and content management, team management, etc.
- **Software for support of ASW development, implementation and monitoring of IS/ICT operations.**

2.5 Enterprise informatics

Based on the above-stated information, it is possible to formulate the content of enterprise informatics. It can be comprehended as an application, a process and a system.

In a case where we comprehend enterprise informatics as an application, its content is then identical to the content of informatics that we stated at the beginning of this chapter, with the difference that it is limited to the environment of the enterprise as a system. The definition of enterprise informatics is then as follows:

Enterprise informatics "studies" the expression and form of information, its processing and transfer within the enterprise.

The "study", respectively its systematism as formulated by Kotler (Kotler & Keller, 2007) can be seen as a process in the field of marketing. Then:

Enterprise informatics is the comprehensive process of securing the information needs related to the performance and management of enterprise activities (processes).

2.6 The information society as the next development stage

There is no doubt about the role of ICT in the society and the issue is only when the given community's entry into the development phase known as the information society occurs. A clear historic "milestone", which is usually characteristic of the end and beginning of other important epochs in the history of mankind does not exist here.

One of the potential aspects may be the share of the company's production created in connection with the application of new technologies. In the information society, the share of the gross domestic product (GDP) created in connection with the ICT increases and gradually becomes dominant. This historically results in a shift from primary use of the initially agricultural and subsequently industrial resources toward the information resources. This shift was already registered by the sociologists and economists from the 1950s in the advanced industrial societies although the explanation many a time remained within the traditional industrial concept and the society was termed post-industrial on the basis of these changes.

In the information society, the source of increasing GDP share value continues to be those branches which resulted in a direct link to ICT or strongly use the ICT results. The quick deployment of new ICT tools logically results in that the current business paradigms differ from what was applicable in the near past. This changing environment must adequately respond to both practice and particularly the corporate managers and also in the area of education and research.

It can be said that we are beginning to live in an information society, whereas this expression contains an extensive complex of quantitatively and qualitatively new phenomena. From the general viewpoint, each more extensive change, which is undoubtedly the case of the shift to the information society, is usually clarified, categorised or identified by comparison with the current state. This is, among other things, the reason why some authors sometimes use the more "technological" term "third industrial revolution" for the information society era.

2.7 Basic classification of information systems

Every organisation has several organisational levels, which require a specific method for processing of information or a specific type of information. At the same time, the strategic, management, knowledge and operational levels are most frequently differentiated. None of these levels in itself cannot provide all the information that the management needs. Similarly none of these levels is a separate complete entity which could reflect the practical need for deployment of an independent information system (software application). For this reason, the frequently used classification (Laudon & Laudon, 2006), which differentiates the operating, knowledge, management and strategic information systems, exclusively reflects the theoretical viewpoint of the functioning of the enterprise. Its task is to **characterise the value of the automated processing of information for the staff at individual organisational levels**, such that such a viewpoint undoubtedly makes sense. It is however not too fortunate to talk about the information systems directly in this context as this incessantly complicates the already so difficult understanding of many mutually overlapping concepts - Figure 1 Information pyramid according to the enterprise organisational levels .

Operational level - requires the processing of information concerning the routine business agenda, such as the fulfilment of production orders, procurement and sales, receiving and making of payments, etc. The information systems that cover the operational level respond to the fulfilment of daily activities and monitor the flow of transactions across the organisation (for which reason we also often talk about transaction or operating systems). They answer the following questions: Do we have adequate component warehouse stocks for assembly of the order? Has the last financial transaction with our main supplier been executed? Were all the finished orders delivered to the final destinations? It is clear from the questions stated above that the information systems at the operations level must provide precise, current and easily accessible information. The typical user of such information is the accountant, operations staff member or the dispatching operator working with the client workstation that provides interfaces with the enterprise information system.

Knowledge level - this includes not only the client applications of the enterprise information system (ERP, CRM, etc.), but also the personal informatics resources such as office applications, groupware, etc. These applications support the growth of the organisation's knowledge level and mainly manage the document flow. They answer the following questions: How do the customers respond to the quality of our products in the corporate correspondence? What are the results of recent meetings with our suppliers? What are the current data on the business operations of the enterprise? The information provided by the cited applications entails potential knowledge. The information is the basis for co-creation of the experience of the enterprise's operations workers. The typical users of the applications at the knowledge level are the managers and technical-administrative staff at all levels.

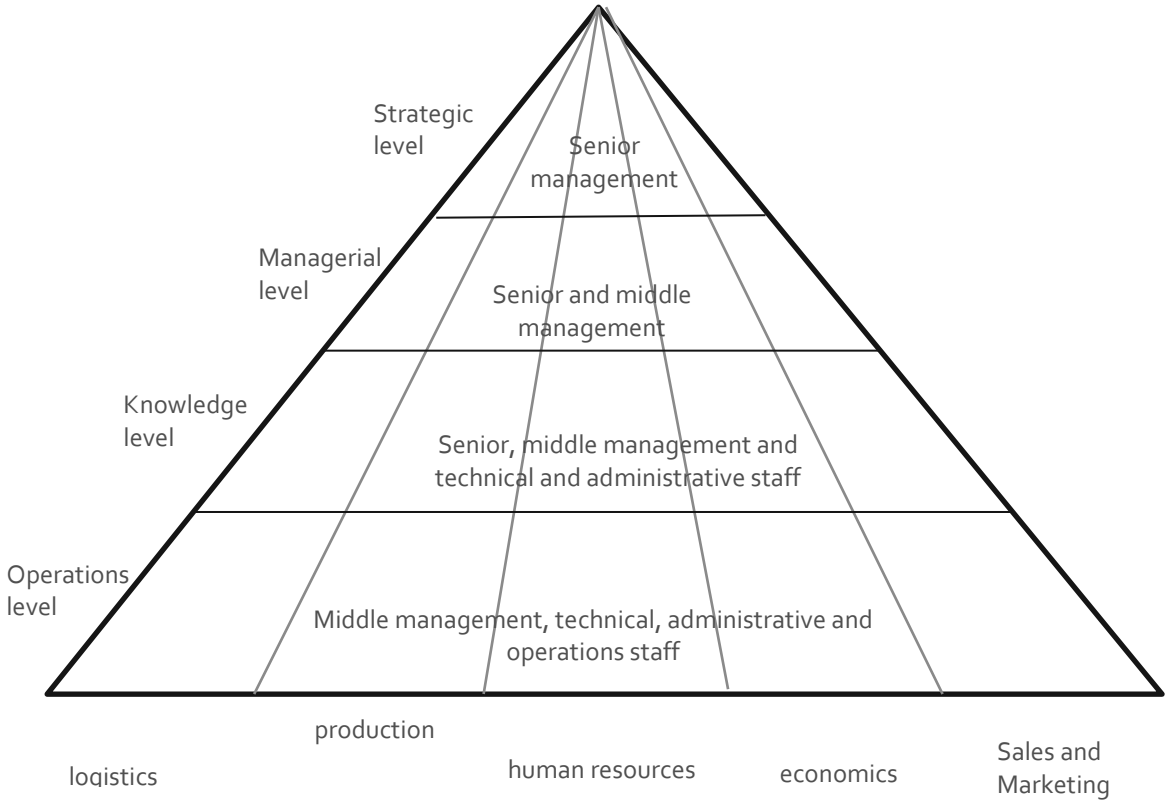


Figure 1 Information pyramid according to the enterprise organisational levels (Laudon & Laudon, 2006)

Management level - requires information necessary for fulfilment of administrative tasks and support of decision-making, particularly in the case of the middle and senior management. The information system used at the management level provides an answer to the fundamental question: Are things working the way they should? The answer in this case is provided in the form of so-called reporting, that is generation of output reports containing summary results from the required area. Support of structured decision-making through reports most often takes place at regular intervals (for instance, at the end of the week). An example may be reporting of the economic results of trading operations.

An integral part of the managerial level is also the need for reports for use in non-routine decision-making, where the requirements of the inquirer are not always quite clear. A typical example are analyses that take the form of "what happens when". The managers thus get answers to the following questions: How should we schedule production capacity if we wanted to increase the sales volume by 30% by the end of the fiscal year? How will the return on investments in production equipment progress if the delivery of the orders is delayed by two months?

Strategic level - information systems covering the strategic area are usually helpful to the senior management in the identification of long-term trends, both within and outside the organisation. Their main role is to help uncover the expected changes and determine whether and how the enterprise could respond to the change. The typical questions to which the information systems provide answers at strategic level include: What are the long-term trends in the development of sector production costs and how do the costs of our organisation correspond with this trend? What performance of the corporate processes will be required by the supplier-customer relations in two years' time?

The information for management and strategic analyses mostly comes not only from the organisation's operating system, but also from external resources.

The **technological viewpoint of the enterprise information systems** is closer to practice. It concerns classification based on layers, which are data transformed into information that is comprehensible to the user.

An integral part of the enterprise information system is the hardware and software infrastructure, which makes effective automated data processing through software applications and its conversion to interpretable and comprehensible form conditional.

The quality of the complex IS/ICT solutions then determines the technological platform that shall be used for operations.

According to the holistic-process classification, the components of the enterprise information system are as follows:

ERP core focused on the management of internal enterprise processes,

CRM - system for management of processes focused on the customers (customer relationship management),

SCM supplier chain management, whose integral part is usually **APS** used for advanced planning and scheduling of production,

MIS - management information system, which collects data from the ERP, CRM and APS/SCM system (and naturally also from external resources) and that is the basis for providing information for the corporate management decision-making process.

System Integration then provides resources for creation and permanent maintenance of the enterprise information system at the technological as well as management, project and strategic level.

An integral part of the enterprise information system are the so-called **infrastructure applications** (portal solutions, applications for support of the administration of documents and content, for workflow management, for cooperation support), which are used across the entire organisation. They are usually grouped into larger units, which are designated as **ECM - Enterprise Content Management**.

3 EIS CLASSIFICATION, CONCEPT, TERMINOLOGY AND ARCHITECTURE

3.1 Essence of the enterprise informatics applications

The enterprise informatics applications are used for its deployment, i.e. they are focused on the needs of the users (managers, traders, accountants, production workers, etc.). One of the key properties of the applications are therefore the functions and processes, which they support in the enterprise.

The **enterprise informatics applications** mean the solution of the management, financial, trading, manufacturing and other processes and functions of the enterprise through the use of the information and communication technology **resources**, i.e. application and basic software, technical and communication resources and the related **services**, provided to their users.

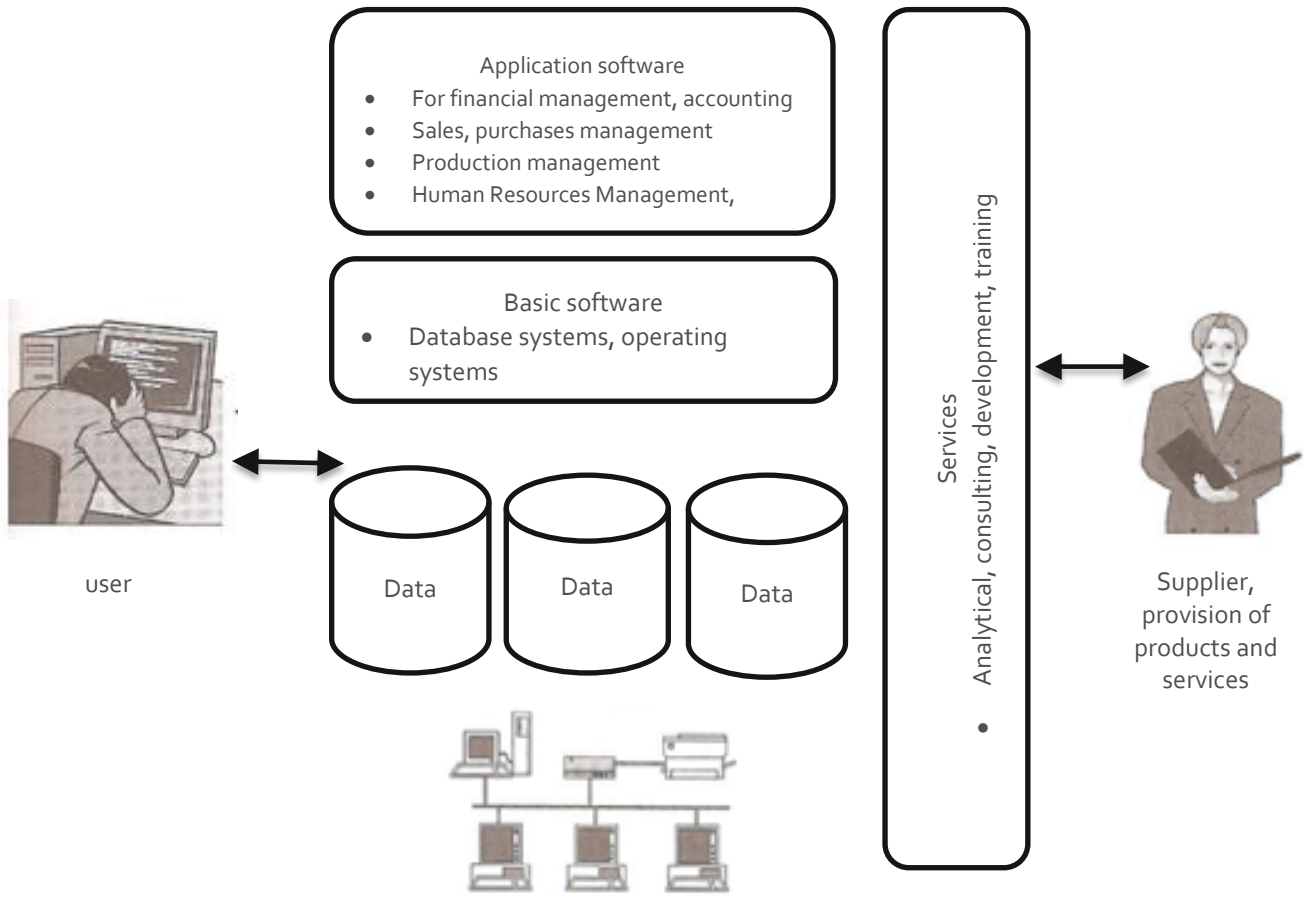


Figure 2 Content of the corporate information system (Gála, Pour, & Šedivá, 2009)

The core of any application is **application software (ASW)**, i.e. software intended for use by the end-user (for instance, accounting software, business software, etc.). The application is also based on a full complex of information and communication technologies and data, respectively, databases. These technologies and data may be designated for and used only by a certain application (for instance, the database of customers, goods, etc.) or are common for multiple applications, which is a significantly more common situation in practice.

Components of the application are also the services that the providers of the applications, i.e. the internal informatics staff or external provider companies provide to the users. These are consulting, analytical, development, training, or other services. In connection with the increase in the volume, and mainly the complexity of the solved and operated applications, the significance of services is strongly increasing and the successfulness and effectiveness of the use of the applications is increasingly being impacted significantly by the quality of the services provided. Even the best application software may be debased by poor services regardless of whether this is at the stage of its implementation in the enterprise or during its normal operation. The content definition of the applications is documented in Figure 2.

3.2 Classification of enterprise informatics applications

In enterprise informatics practice, a broad spectrum of all sorts of applications exist that continue to expand and which differ not only in terms of functionality, but also in many other aspects, including the technological aspects. The information systems are thus characterised by high heterogeneity and the associated continuously increasing management demands. For this reason, it is purposeful to formulate the necessary classification aspects, which shall at least basically contribute to orientation in the current offer on the applications market and also allow enterprise informatics to develop systematically. These **aspects** mainly include:

- determination - the target circle of application users, for instance, electronic trading: trader -> and customers, analytical applications for the managers, etc.;
- data - the data they work with and use, for instance, structured data in the relational databases, non-structured

data in the documents;
- functionality - what transaction, analytical, eventually special functions they provide
- enterprise processes (eventually, areas of management) - the processes supported by the applications, for instance, manufacturing, trading, human resources, etc.;
- technologies used - the information and communication technologies used to develop and run the applications (database, communication, etc.).

If we considered all the aspects, then we would create several classifications, respectively, enterprise application structures. For simplification, we use the practice proven classification of applications, i.e. we shall examine the individual **types of applications**, which differ in all the above-stated aspects.

Enterprise informatics as a whole produces a huge amount of data in various databases, documents, files, websites, etc., structured and otherwise. This creates the need to coordinate and manage the content of all sorts of data resources. For work mainly with non-structured data (letters, messages, etc.) applications and tools are used that are not directly linked to specific enterprise processes or areas of management. This means that they are used across the entire information system, have the character of infrastructure and are designated as **infrastructure applications**. This includes, for instance, the applications for management of documents, web content, workflows, etc. For the full complex of these applications, we use the term **ECM - Enterprise Content Management**.

3.3 Definition of the approach to the corporate IS

For the last ten to fifteen years enterprises have been implementing comprehensive information systems in the ERP (*Enterprise Resource Planning*) category. Without exaggeration, these enterprise applications can be considered as the ones with the highest impact on current corporate business. And not only because of the number of implementations, but due to their importance. ERP is used by more than 90% of the enterprises ranked by us in the TOP 100 and ERP generally impacts decision-making in the enterprises with a significant share of the exports, employment and generation of Czech GDP. If we additionally consider the financial, time and human complexity of the implementation and operation of the ERP, their economic and social significance cannot be doubted.

In the enterprise, the information systems are not present only in connection with ICT, but can be perceived in the broader framework with regard to the degree of formalisation of the data, share of the human factor and, for instance, with regard to the type of information "carriers":

- Information recorded and processed most often through a relay database and targeted at the elimination of the direct involvement of human labour through automation of certain operations and used to support his decision-making (standard corporate software solutions).
- Information stored on other, often still "classic carriers" - documents, forms, reports and regulations, newly supported, for instance, by ICT content management applications. Such information is often stored in non-structured format, for instance, text or graphic form and is usually more difficult to access.
- Information that has not been recorded in a database to date, in a different electronic format and is not even on any form. This may concern the experience that is kept in the heads of the staff (traders, engineers, designers, but also the manufacturing workers and the managers), which is used operatively at the moment of need and is the subject-matter of *Knowledge Management*.

3.3.1 The beginnings of the enterprise IS were accompanied by terminological non-uniformity

One more fact is however interesting in the historical development of the enterprise IS, which is the terminology used and its development. The already mentioned Automated Management System used created uniform terminology. After which the full group of software applications represented by the CAx abbreviations were accepted in the technical practice of the enterprises and its English names were generally established. Unfortunately, this was not the case of software support for planning and management for which both of the above-stated foreign abbreviations were used at the beginning of the nineties (i.e. according to the place of origin, it is either MRP – *Material Requirements Planning*, respectively, MRP II – *Manufacturing Resource Planning*, or also PPS – *Produktionsplanung und-steuerung*), which are moreover supplemented with their translations. Other designations of the software applications for the enterprise IS are also frequent, for instance:

- information system,

- integrated information system,
- integrated management system,
- comprehensive production management system.

3.3.2 The ERP systems built on the MRP II, respectively, PPS solutions

The solution of the MAP II or PPS type registered the biggest change in the enterprise IS in our country after 1990 - refer to Table 1 Changes in the integration and functional orientation of software in the last decade. At the same time, they were accompanied by very strong development of software support for financial management tasks, particularly accounts, and the merging of these two major functional lines resulted in the formation of the solution designated as EAP.

Table 1 Changes in the integration and functional orientation of software in the last decade

Changes in orientation	After 1990	After 2000
Integration of SW tools in the enterprises	• integration within the enterprise between the individuals and the departments • integration of financial and logistics business processes	• integration outside the enterprise within the network of customers and suppliers (partners) • integration in corporate networks and societies • integration within the framework of e-business
Functionality of the SW tools	• management of production orders in the enterprise • management of internal logistics	• management of the deliveries of products and services within the framework of the complex logistics chain • customer relationship management • production management

After merging the financial and logistics tasks into the EAP solution, the expansion of these applications toward support of activities related to trading and generally to the customer and the enterprise environment continues. This is also the reason why EAP could be comprehended at present in two basic planes:

- In the narrower sense of the word, EAP includes the integration of the above-stated intra-company areas, such as production (including product data), logistics, finance and human resources.
- In the broader sense of the word, the *extended* EAP includes other applications, such as managerial superstructures of type BI (*Business Intelligence*) and applications that support the relationship of the enterprise with its surroundings, for instance, supply chain management in the form of SCM (*Supply Chain Management*) and customer relationship management in the form of applications designated as CRM (*Customer Relationship Management*). An integral part of the integrated all-enterprise solutions of type ERP has also become components for the execution of electronic trading - B2B (*Business to Business*), B2C (*Business to Customer*) and supply (*e-procurement*).

When looking at the current offer of enterprise IS, it is possible to encounter two types of applications, differentiated by type of specialisation on one hand and complexity on the other hand:

- *All-in-One*. These applications cover all, respectively, most of the key enterprise processes. On one hand, a high level of integration is characteristic for them, while on the other hand, they may offer lower functionality detail.
- *Best-of-Breed*. These applications focus on coverage of selected processes and their specialisation. High functionality detail is characteristic for them, which is on the contrary combined with more complicated integration.

Apart from this, there was an earlier effort of the suppliers to offer certain simpler "lite" versions of their solutions for the enterprise IS. Further, the gradual expansion of the deployment of tools that support the enterprise IS is clear also in the non-business sphere, which includes, for instance, the public administration, hospitals or education.

3.3.3 From independent software to integrated applications

But for the entire period, the ERP, respectively, MRP applications accompany the focus on the common database, i.e. gradual integration of initially partial applications into single common data. The path to the integrated enterprise information system thus runs through certain development stages:

- individual independent software (developed, for instance, in 4th generation languages, but also in Excel or Word applications);
- separate applications that support a certain selected functionality in the enterprise (for instance, accounting, warehouse management, sales, etc.);
- applications that support a selected functionality are becoming integrable (for instance, the already mentioned warehouse management can exchange data with accounting);
- integrated system with a common database for all important enterprise functions (to be described in detail in the next text).

The two main areas already mentioned were historically dominant for the development of the enterprise information systems. In consequence of this, some initially dominant financial systems were subsequently integrated with warehouse management, production planning, etc. On the other hand, some systems for production planning and management added accounting functions. In some cases, these historically older and often also stronger aspects can still be seen in the deployed systems, which is more true in the area of production where it is also possible to observe the type, respectively, production branch which the system historically started supporting at the beginning of its establishment.

In spite of the fact that the enterprise IS themselves in the form of ERP appeared on the market only after 1990, their history is older. As is clear from Table 2 Basic development generations of the ERP systems, it is possible to identify different development systems in them and it is also possible in this case to talk about certain generations - predecessors of software solutions of type ERP - Table 2 Basic development generations of the ERP systems.

Table 2 Basic development generations of the ERP systems (Basl, J. , Blažíček, R., 2012)

	1st generation 1975	2nd generation 1985	3rd generation 1992	4th generation 1996	5th generation after 2000
Processing method	Batch Processing	Processing in a dialogue	Processing in a dialogue and a batch	Processing options	Processing via the Internet
Portability	Linked to a specific computer - HW link	Link to a specific operating system	Portability between operating systems - for instance, UNIX, OS400, etc.	Three-tier applications (database, custom applications, user presentations)	Integration of SOA applications
Software	Lower programming languages	Higher programming languages - for instance, COBOL	SQL relationship databases and programming tools - for instance, Oracle, Informix	JAVA programming environment and object database	XML resources
User conditions	non-interactive	Standard screens - text mode	Freely configurable user screens - Windows	Multimedia applications, Internet environment	Access through mobile devices, tendency to services

			environment	and websites	
Functionality	Planning of mainly material requirements	Material and capacity planning and management of production orders	Enterprise management integrated information system	Supplier-customer chain	e-business, CRM, BI, PLM, APS

4 BUILDING OF ENTERPRISE INFORMATION SYSTEMS, LIFE-CYCLE, METHODS FOR PROCUREMENT OF EIS, ECONOMIC ASSESSMENT OF EIS PROCUREMENT

Building of EIS is determined by **two major approaches** that we can encounter in the Czech enterprises. The **first,** which is in principle applied in most of the organisations, **comprehends the enterprise information system as a management support tool**. The major requirements for such a system are:

- Support for the automation of everyday routine agenda
- Availability of decision-making information
- Uniform version of the truth present in all system outputs

Since we are now acquainted with the specifics of IT projects, we move on to the characteristics of the individual life-cycle stages of the enterprise information system.

1. **Performance of analytical works and choice of decision** - immediately at the beginning, it is necessary for the managers to ask whether they need a new information system or whether it suffices to innovate the existing system. At the same time, they should base their judgement on the business and information strategy of the company. It does not make sense to innovate an information system, for instance, in a situation where it is clear that the company is probably awaiting a merger or is not successful in its market and will have to re-assess its overall strategy.
   It is further necessary to carefully consider the condition of IS/ICT, particularly in the big organisations or companies with branches, where many different partial information systems or quantitatively different operation of the business processes may exist in parallel.
   This analytical and decision-making stage should include the definition of system requirements, characteristics of its objectives, benefits and analysis of the impact of this decision on the level of business and the organisations.
   Important aspects of this stage: The world of business information systems is moving forward very quickly and the business environment is also changing likewise. This instability is characterised by the changing IS/ICT requirements. These are developing according to the needs of the organisation and the individual user groups. The dynamically developing capabilities of the IT products also have a significant impact on the generation of these changes. But the company executives are often incapable of discerning and appreciating their benefits.
   Implementation of information systems is a very complex process characterised by the promotion of many, often contradictory requirements, difficult controllability of a non-homogeneous team of people (consultants of the provider company, programmers, key users, managers) with different characteristics and abilities.
   Important aspects of this stage: When choosing a system and supplier, commendations in the field and often also the personal contacts of the managers play a significant role in practice. Furthermore, the level of functionality, price, service quality are usually assessed.
2. **Selection of the system and implementation partner** - this life-cycle stage includes the choice of product (hardware, software, infrastructure, services), which best suits the requirements of the organisation. At the same time, the basic requirement should be the minimal customisation aspects of the system because they result in time delays and additional high cost.
   Apart from the IT solutions, it is necessary to address the selection of a suitable implementation partner (system provider, system integrator). In the implementation of extensive projects, the user organisations also utilise the services of some consulting companies, especially in the phase of selection and implementation.
3. **Conclusion of the contractual relationship** - this life-cycle stage is one of the most underestimated and also most

critical points. The supplier presents a set of contracts to the customer for signature (licence, implementation and service support agreements), which are characterised by specific terminology and need not be regulated under the law (innominate) and may be very complicated for assessment from the legal and content viewpoints.
Important aspects of this stage: The main points of the contractual agreement include the agreement of both parties to meet the specification price for ordered products and services, establishing the principles of cooperation in the implementation of the project and sanctions. Given the complexity of the issue, it is suitable to take advantage of the counselling services of a reputable law firm or external consultants who have experience not only with the relevant legislation, but also the content aspect of performance during implementation of the projects.

4. **Implementation** - includes adaptation (customisation) of the information system or its parametrisation (adaptation - if a One-to-Many solution is involved) in such a manner as to best fulfil the requirements of the organisation. The most costly activities during the implementation phase include information system customisation and user training. The training itself then also intervenes in further development stages.
   Important aspects of this stage: During implementation, high demands are placed on compliance with the work schedule, the investment plan and organisation of the work teams. It is therefore necessary to have a fixed investment limit and a detailed project schedule, and in the case of serious and reputable suppliers it is possible to take advantage of the repayment of investments over a longer period.
   During the solution of operational tasks, unexpected additional costs usually arise from errors and time losses. A key role is thus played by the personnel composition of the implementation team, its management and organisation of work.
5. **Use and maintenance** - includes productive operation of the IT solution in a manner that allows the implementation of the expected benefits.
   Important aspects of this stage: The determinant factor is mainly full functionality of the system and achievement of the expected benefits from its deployment. For this reason, its administration and maintenance is quite fundamental. Every instance of downtime may have a negative (sometimes up to critical) impact on the operations of the enterprise (for instance, non-compliance with the order dispatch deadline).
   The provider's service terms are included in the service agreement or at least some of them (for instance, service intervention response time) and are the subject-matter of the **Service Level Agreement (SLA)**. It defines the measurable level of the services provided for fulfilment of the concluded contract. In case of a drop below the given level, sanctions against the provider follow. The measured indicators may be, for instance, the system downtime, volume of transactions, etc.
6. **Development, innovation and "retirement"** - within this stage, which may follows shortly after implementation of the system core itself, additional applications are integrated into the enterprise system. They are designed to cover the key processes in detail in order to obtain additional benefits. They can also be deployed because the original information system cannot provide the functionality that is necessary in this area.
   The information system is developed either vertically, i.e. focusing on analytical functionality (Business Intelligence), or horizontally, focusing on cooperation in supply chain management (SCM) or customer relationship management (CRM). During expansion of the information system, the individual elements are often combined according to the specific requirements (for instance, deployment of CRM functionality including extensive analytical support). The information system is usually supplemented with the functionalities that require acquisition of user experience with the operations (management of workflows and configuration of the approval processes, closer integration of warehouse management in the system, for instance, implementation of the managed warehouse).

4.1 Life-cycle of the enterprise informatics applications

In practice, informatics undergoes permanent development almost in all enterprises and organisations. This is due to the development of new information and communication technologies, their new versions, development of legislation and new user requirements. Enterprise informatics is developing in its various fields, but the application area is key and most significant for the user. The **purpose** of this chapter is to characterise the development of the application of informatics in the individual stages, which form a spiral and are designated as the application life-cycle.

The development of the enterprise informatics applications is solved on the basis of various methods and procedures, which differ according to whether the application is custom-developed, or solved on the basis of type software; it differs according to the types of applications, which we stated in Part II, and also according to the individual companies and their products. The recommended solution procedures for applications or full information systems are designated as **methodologies**. This means that most of the ICT companies have their own methodologies, or use standard methodologies, which they may also modify according to their own needs.

We shall now focus on the clarification of the content of the development of one application in its individual stages. We shall **base our judgement** on the de facto global standard for enterprise informatics management, the **ITIL** - Information Technology Infrastructure Library. The application development management process in this case is comprehended as the life-cycle of the applications. This includes the complex activities that should be performed within the framework of the individual phases of this process. The application life-cycle phases are classified as follows:

1. Application planning and preparation
2. Application analysis and design
3. Application implementation
4. Commissioning, migration
5. Application operation and use
6. Application development and optimisation

The term 'application life-cycle' is used because from the beginning, the application is undergoing its development stages and after a certain period of operation and development, it returns to its beginning where a higher level of the application is prepared for the given area of application, which is based on new modern technologies and correspond with the completely new needs of the users.

At this point, we are looking at the solution of the individual applications, which is always **a component of the management of the development and operation of the entire information system**, which is a substantially more comprehensive issue. On the other hand, it is logical that activities which fall under the application life-cycle phase must necessarily create a component of the entire informatics management, for instance, in the planning of the projects, planning and analysis of the costs and effects of the individual applications, etc. The activities that comprise the content of each of the stages are always grouped into several tasks for better orientation. We shall state the basic content and principles of each of the subsequent stages and tasks.

4.1.1 Application planning and preparation

Every new application in enterprise informatics is based on the **information strategy** of corporate development and from the users' considered application requirements.

Initial analysis

The purpose of the analysis is to assess the intended application project from the viewpoint of the overall IS/ICT concept, respectively, the **information strategy** of the enterprise, and from the viewpoint of the **user's actual application requirements**. The information strategy should be used to make the assessment of the degree to which the proposed appreciation covers the company objectives and its informatics, its position in the application architecture, how it is linked to the other applications, or if any of them replaces what falls under the overall development schedule of the entire information system. In connection with the evaluation of the application within the framework of the information strategy, analysis of the specific user requirements for the application shall be done at the next step.

Planning of the application project

Application project planning should respect the following major principles:

- The project plan includes all the fundamental characteristics of the designed application, for instance, reasons for solution of the project, objectives and expected costs and effects of the project, end-user target groups, their basic functionality and others that are contained in the basic document – **Project idea**.
- Design of the plan for solution of the given application **is assessed** from several aspects, mainly the needs of the company and the available financial and human resources. An integral part of this process is also the evaluation of the ICT market conditions in relation to the application, which means the finished application software and other technologies that are available and that the company is implementing, and the nature of the financial and organisational complexity of such solutions.
- Based on the project idea and the information ascertained about the offer on the market, **decisions** are made on acceptance or rejection of the project. In connection with it, the solution **method** is also determined, i.e. whether the project shall be solved using own capacities or supply method, where the use of the type application software is assumed or if the project shall be solved individually according to the specific needs of the user.

Selection of the application provider

In the event that a provider solution is considered, then the company management must decide whether it shall be implemented on the basis of a tender or other form, for instance, direct selection of supplier on the basis of own market research. (In the case of the public administration organisations, a tender is always concerned). The basic procedure of the tender for supply of enterprise applications documents.

- Processing of the **enquiry document** is based mainly on the project idea. The purpose of the enquiry document is to relatively precisely define the application requirements, define the procedure and organisation of the tender and simultaneously also specify the requirements for supplier bids.
- In connection with the previous point, the suppliers prepare the **bids** in the structure stipulated by the contracting authority. During the preparation of the bids, the contracting authority must often ensure professional consultation with the provider on the tender document and the solution requirements.
- The supplier's **reference installations** are already finished application projects that are already in operation at a given customer, which the supplier has already realised and is similar to the enquired project.
- **Comprehensive evaluation** includes the final assessment and evaluation of the submitted bids, the supplier's reference installations and presentations.

Initial study

Processing of the initial study is purposeful in the case of a provider project solution and a solution using own means. Its purpose is to **determine the overall solution concept** in the context of overall IS/ICT development. This means that this concept must be defined precisely already in the project target and must deploy the project in the IS/ICT application architecture, the project site must be defined precisely in this architecture (for instance, the functions covered and not covered by the project). This concept is then the basis of the project demands for personnel, technological and financial resources.

The initial study also contains the basic specification of the organisation of project activities - determination of the steering committee (SC), members of the analytical, respectively, application teams, basic principles of project planning and management, determination of the rules for communication with the work teams, specification of documentation, determination of the access rights of the individual team members to the applications and documents.

The initial study is usually subjected to opponency in the company management, and becomes an input for formulation of the contract for the whole project and organisation of its organisation after acceptance. In some cases, the contract for the full project is concluded already after completion of the tender. For larger projects it is more convenient to prepare and conclude an agreement on the project only after the initial study, because it is only on this basis that it is possible to set the more realistic time and financial demands of the project, or other conditions of the solution. Contractual management, i.e. the preparation and negotiation of individual parts of the contract until its conclusion and signature is labour intensive and time-consuming process, and can even take several months in some cases. Many specialists from the fields of informatics and law as well as the managements of both parties - the customer and supplier - participate in its progress.

In conclusion, it is essential to emphasise that in all of them, the very close **co-operation of the users and informatics staff** is essential particularly the internal informatics staff. The decision-making role and actual selection of products and services are mostly logically in the competency of the company management and owners. For these reasons, it is essential that the staff working in these roles should be ready to get a full picture of the offered products and services and systematically evaluate them.

4.1.2 Application analysis and design

The next phase in the solution of the application must include complex activities associated with the analysis of needs and the current condition of the company and the subsequent solution design applications primarily from the content point of view, i.e., it must specify what functions should be provided, the data to be processed and the business processes to be supported in a substantially greater level of detail. In practice, this complex activity is structured differently in relation to the different projection methodologies and the different types of applications. In this phase of the cycle, we will therefore focus only on two basic groups of tasks.

The tasks cover the analysis and design point of view of the main solution area, i.e. business processes, databases, content, respectively, functionality of applications.

Analysis of business processes

The development and changes in the business processes are implemented either completely within the project of process reengineering covering the entire enterprise, or in relation to the applications being solved.

The purpose of the analysis of business processes is to determine the current state of corporate governance in the areas (sales, purchase, production etc.), which the planned implementation of the applications should solve, where there are problems in the management and the requirements for its further development. **Scope of analysis differs according to the solved situation** - from the sub-area, e.g. sales management and customer relationship management (CRM) to the analysis of the entire enterprise management, especially the appropriate enterprise-wide applications (ERP).

Analysis of the current databases

Analysis of existing databases includes the evaluation of their content, scope, quality and method of use. For instance, in the case of ERP solutions, virtually all data sources and databases are analysed due to their enterprise-scale nature. During the deployment of the ERP, most of the enterprise databases are replaced or newly created. The purpose of the database analysis is to assess their condition and quality for estimation and planning of their migration to new database structures. Data migration from old to new databases is one of the most challenging tasks in terms of labour-intensity and time consumption in the phase of preparation for operational deployment of the application.

When solving business intelligence applications, the analysis of the analysis of the condition and quality of the source databases, i.e. the databases that contain the data, which shall be fed to the data warehouses, data markets and subsequently the OLAP database through the data pumps (ETL) play a major role. The analysis thus includes the anticipated demands for transformation of data from these applications. The next step is carried out by detailed analysis of the quality, i.e. error rate, integrity and availability of the necessary data resources.

Analysis of existing applications

The need to assess the current application, which is already operational in business informatics, is due to the fact that the vast majority of business informatics application is not isolated, but must be integrated into the entire information system. The solutions to their data and functional links to other applications are therefore a highly significant component of the solution.

Design of changes in the enterprise processes

The proposed changes to business processes, respectively, newly defined business processes that the application should support are based on prior analysis. Even at this point, we must emphasise that the roles of process reengineering are often implemented as enterprise-wide projects with no direct ties to any of the solved applications. The modifications of processes in connection with a certain application (e.g. CRM or e-business) then have the character of partial and complementary solutions or the necessary modifications. For the enterprise-wide projects and the modifications mentioned in connection with a particular application, the process-modelling methods are used.

Database design

The design of the data, databases, their content and organisation using data modelling methods differ substantially depending on whether the application, respectively, application software is custom-developed, or type application software. Type ASW has already clearly defined databases that mostly permit only minor changes, for instance, the definition of individual items. This is also reflected in the individual types of applications.

Application design

The target application solutions should be divided into two basic levels - logical, defining its substance, and physical that already represents its technological demands.

4.1.3 Application implementation

Right at the beginning of this stage, it is advisable to include a note on terminology. The term **implementation** is in practice often understood not only as the mentioned technological implementation stages of the application, but also as the whole process of application solution, de facto throughout its life-cycle.

The implementation includes the precise specification of the individual software modules, creation of so-called prototypes and subsequently a specific solution of the variant **customisation** of the functions of the typical application software, or development or final development of specialised, i.e. non-standard software modules. This already

represents the technological implementation of the proposed solutions.

4.1.4 Preparation for commissioning, migration

Based on the approved acceptance protocols, the so-called **migration plan** is prepared, i.e. the process of project implementation. The migration and preparation of project implementation is an organisationally demanding and labour-intensive activity. Application operation and use

This stage includes the routine maintenance operations, operational service and permanent consulting services - the so called, help-desk. Another essential moment is the processing of operational statistics, operational intervention in the operation of the application and formulation of new application requirements.

The application is initiated by its one-off transfer for live operation, while the subsequent tasks are already being implemented continuously and must be provided continuously.

4.1.5 Further application development and optimisation

The development of the application and its optimisation has the character of continuous adjustments, or conversely the nature of a fundamental change of the whole solution, i.e. the assignment of a completely new project.

4.2 ERP project implementation stages

Figure 3 thus captures a specific model situation in such a manner as to allow focus of attention on the selected aspects of the entire IS Implementation process. It symbolically demonstrates this on the example of ERP implementation in a style which could be further characterised as the approach of building "on a green field" - Figure 3 Major activities in the selection and implementation on the example of the ERP.

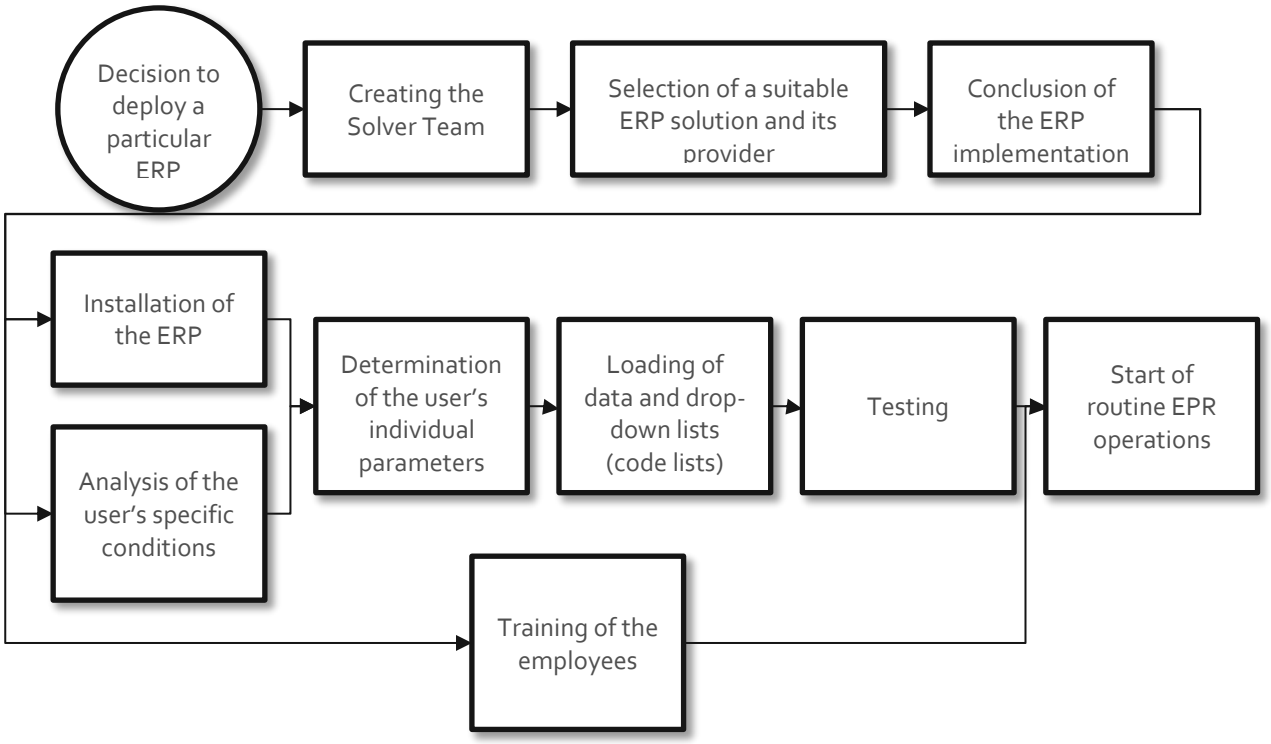


Figure 3 Major activities in the selection and implementation on the example of the ERP (Basl, J. , Blažíček, R., 2012)

In specific cases, the start is not from scratch and it is necessary to respect the other existing IS components and overall business environment. In consequence of this, all the described steps need not be implemented and, for example, the introduction of a new IS may be the decision of the parent undertaking and may be due to the influence of a strong buyer of the company's products. This eliminates the selection and many a time also the detailed analysis of needs and the IS configuration from the parent company is deployed.

5 ERP – ENTERPRISE RESOURCE PLANNING - THE ESSENCE OF THE ERP SYSTEM AND THE ACTIVITIES IT SUPPORTS, SIGNIFICANT ERP SYSTEM PRODUCERS, ECONOMIC PROCESS MANAGEMENT, HRM, ASSET MANAGEMENT AND ADMINISTRATION OF CRITICAL ASSETS

5.1 Classification of ERP systems

We divide the ERP systems according to their ability to cover and integrate all four aforementioned internal processes. We then designate the systems that are capable of this as All-in-One systems. This category also includes some universal ERP solutions (mostly of foreign production), but which do not cover one of the key processes - human resources management. In the implementation projects, this process is usually secured by a subcontract with a different, specialised supplier. Given the relatively easy integration of this functionality into the ERP solution, the organisation does not face the problem of solving a further complex integration project. The supplier usually guarantees the entire work including this subcontract and its integration. For the company, the choice of the All-in-One system would entail the implementation of only one project - Table 3 Classification of ERP systems according to the field and functional focus.

The All-in-One ERP systems segment thus includes substitutes, whose number of implementations, or if you want, a share of the market, can be compared. The typical representatives of this category are Helios Green, Microsoft Dynamics NAV, and many others.

The ERP category also includes the information systems that need not necessarily cover and integrate all four internal processes. But it is capable of providing the customer with detailed superior functionality or are focused exclusively on certain business sectors. These, so called, best-of-breed systems (best of breed, individuals with excellent characteristics) thus in practice have a tendency to be deployed, either separately (in particular sectoral Best-of-Breed), or form a component of the corporate ERP concept (process-oriented Best-of-Breed) together with other information systems.

We are capable of precisely defining the Best-of-Breed systems category, but it cannot be measured seriously. For instance, implementation of the information system in the field of human resources management and economics cannot be compared with the projects in the automotive industry.

Table 3 Classification of ERP systems according to the field and functional focus (Sodomka, P. , Klčová, H., 2010)

ERP system	Characteristics	Advantages	Disadvantages
All-in-One	The capability to cover all the key internal business processes (human resources management, production, logistics, economics)	High level of integration, which suffices for most of the organisations	Lower functionality detail, costly customisation
Best-of-Breed	Focus on specific processes or fields, it need not cover all the key processes	Top detailed functionality, or industry-specific solutions	More difficult co-ordination of processes, inconsistency of information, necessity to solve multiple IT

			projects
Lite ERP	Lite versions of the standard ERP focused on the SMEs	Lower price, focus on quick implementation	Limited functionality, number of users, expansion options, etc.

An ERP category information system is an effective tool, which is capable of covering the planning and management of the major internal enterprise processes (resources and their transformation into outputs) at all management levels, from operative to strategic (Sodomka P. , 2006). They mostly represent the core of the application part of the Information systems and cover many of their functions and key processes. The key internal processes are production, (internal) logistics, human resources management and economics.

The objective of this chapter is to acquaint the users with the reasons for the development and use of ERP systems, their basic components and basic division. It further highlights the trends in their development and the reasons that may lead to innovation of the ERP system in a given enterprise or institution.

The most important properties of the ERP system include:

- automation and integrate of business processes;
- sharing of data, procedures and their standardisation in the whole enterprise;
- creation and provision of information in the whole enterprise;
- capability to process historical data;
- complex approach to the ERP solution.

The basic components of ERP are (Figure 4**):**

- application modules;
- administration modules for the whole application;
- system modules (operating systems, modules for treatment of the interfaces of the database systems).

However, ERP systems also contain **additional modules**, which have an operational or supportive character:

- Modules for adaptation of software to modifications according to the needs of the given enterprise or institution.
- Modules of the development environment itself (programming resources or languages).
- Integration modules - that ease the creation of the interface with other types of applications and technologies.
- Implementation modules - supporting the deployment of the ERP in the given corporate environment (optimisation of corporate processes, definition of functionality, determination of the types of users and their roles).
- Technological and administration modules - modules for setting of operating rules, communication structure, access authorisations of the users to the data, as well as the functions, ERP modules for evidence and analysis of operations executed in the system.
- Documentation modules - on-line documentation to the application modules and functions.

Examples of potential application modules - the most commonly required ERP modules are:

- economics
  - accounting - general ledger, receivables, payables
  - asset management
- production
  - production planning
  - workshop management
  - production management

- business
  - procurement
  - sales
  - warehouse management (stock management)
- marketing
- human resources (human resources management)
- Project Management

The stated modules are not an exhaustive list of the provided modules, but are only the most frequently demanded, and thus also offered application modules. The systems may contain many other modules depending on the focus and size of the given enterprise. The expansion of the ERP system, however, requires the proactive cooperation of key users because they best know the processes that are running in their enterprise and their information needs.

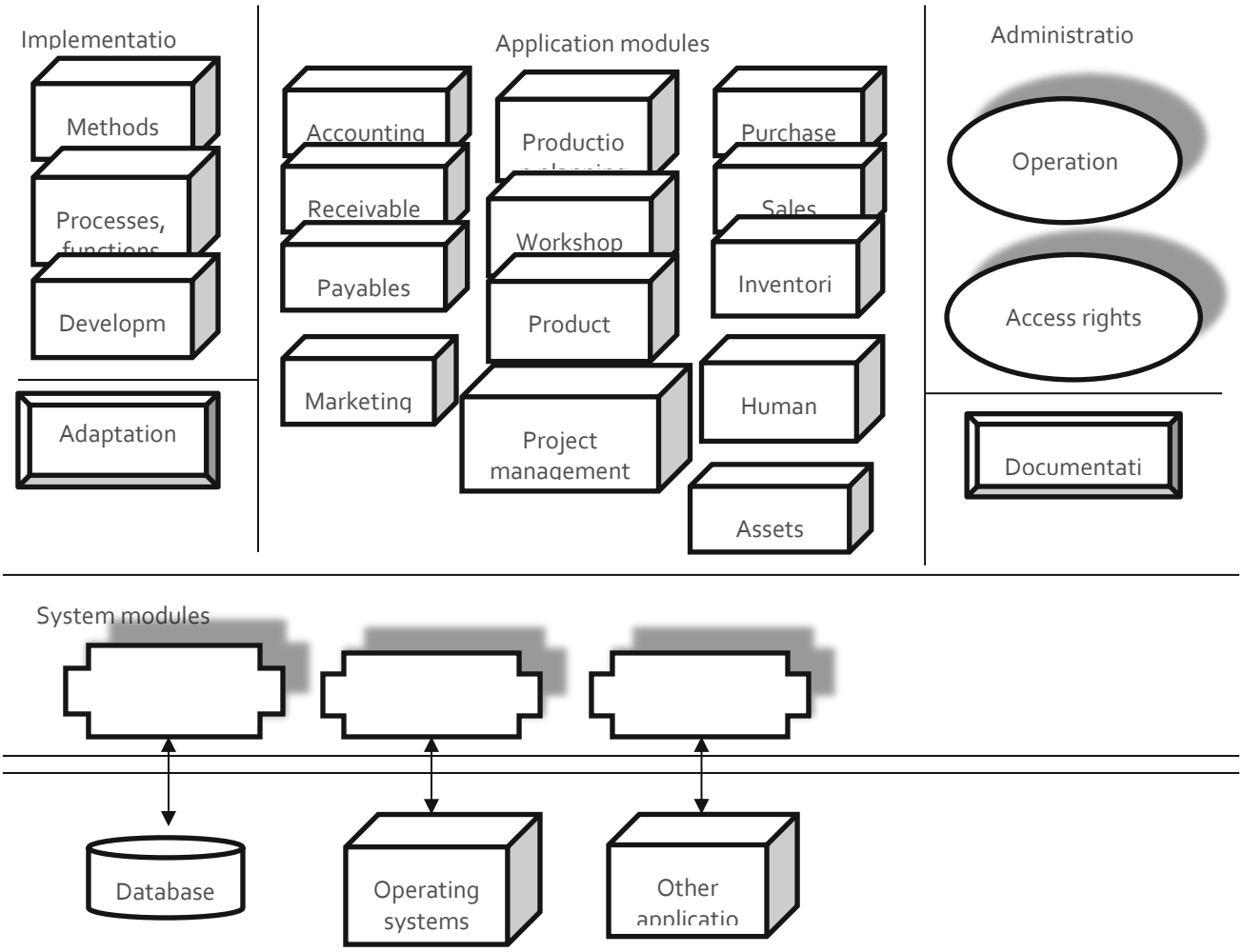


Figure 4 Basic components of ERP system (Tvrdíková, 2008)

5.2 ERP solution principles

The term ERP and applications of this type were preceded by several development stages characterised by the trend towards increasingly stronger interdependence of functions and the corresponding software modules. ERP software covers the decision-making part of enterprise management, particularly at the tactical and operative management level. In practice, the ERP applications were deployed from the beginning of the 1990s century and have become substantially widespread in entrepreneurial practice.

ERP (Enterprise Resource Planning) - is a type of application, respectively, application software, which facilitates the management and co-ordination of all available corporate resources and activities. The major ERP properties include the capability to automate and **integrate** key corporate processes, functions and data within the whole company.

5.3 ERP functionality

The ERP applications provide a broad spectrum of functions and are the most comprehensive from this viewpoint in relation to the other types of applications. If we compare the functionality of the ERP applications from various providers, it is good to draw attention to the following bottlenecks:

- ERP functionality is very extensive, and for this reason, more detailed comparative analysis is relatively complicated and time intensive;
- the structure of the functions and hence also the communication structure in the menu substantially differ between the different ERP applications;
- different ERP application providers use partially different terminology, thus different names for similar functions, which is often also due to the differences in the Czech localisation of the original software, i.e. localisation differences.

This situation is due to the very strong dynamism of this segment of the ICT market, creation of new products in the market, rapid development of the provided functionality of already existing products, and on the other hand, the minimum standards applicable to this area of application software.

5.3.1 Financial management

The *Financial Management* module must provide a comprehensive view of the financial data in the whole organisation and effective execution of financial operations. Among other things, the *Financial Management* module also provides the following functions:

- **general ledger** - accounting to multiple accounting books, processing of accounting statements, closing statements, record of the transactions between the branches and elimination of the inter-company transactions for the requirements of consolidation of accounting statements, processing of cash flow forecasts;
- **management of receivables** - specification of the parameters of credits and flexible payment terms, processing of prepayments, pre-authorisation and authorisation of card payments for sales orders, calculation of interest, processing of dunning letters;
- **management of payables** - support for flexible payment terms, advanced payment calendars, multiple payments, option for separate processing of approved and unapproved invoices, pairing of invoices with the physical deliveries;
- **management of relations with the banks** - evaluation of the deposits, payments, bills of exchange, bank account balances, support for electronic payments to and revenues from customers and suppliers;
- **management of fixed assets** - ordering and receiving of fixed asset items, update of the reproduction costs and insured value of fixed assets, management of the life-cycles of the individual fixed asset items;
- **cost accounting** - allocation of the cost accounts to the cost categories, allocation of costs, cost planning according to the utilisation of capacities, comparison of the target and real costs.

5.3.2 Sales and marketing

The *Sales and Marketing* module mainly contains integrated support for administration of customers, management of sales operations and marketing.

The Sales and Marketing Module offers the traders and marketing specialists particularly the following functions:

- **visualisation of relationships** - between the customers, interested parties, suppliers, staff and the competitors;
- **administration of opportunities** - evaluation of business opportunities, identification of the realistic and unrealistic business opportunities, support for creation of business offers;
- **sales management** - support for basic sales activities, creation of sales documents, monitoring of the fulfilment of sales targets, evaluation of the performance of traders and sales representatives, evaluation of the activities according to the customers, planning of future sales income;

- **marketing management** - support for creation and management of marketing campaigns and evaluation of their results, analyses of the return of investments in marketing activities;
- **telemarketing** - creation of telemarketing documents and lists, recording and evaluation of a telemarketing conversation.

5.3.3 Procurement and warehouse management

Procurement and warehouse management provides support for processing of the requirements for procurement, evaluation of the warehouse stocks and actual supply operations. Ingredients:

- **supplier management** - evidence and analyses of suppliers, analyses of supplier prices;
- **procurement management** - evidence of the material requirements for the individual production and other centres and cumulation of the requirements for procurement, blocking of material, i.e. blocking of the required quantity of items, processing of enquiries (for potential and permanent suppliers), evidence of the offers, processing of orders, evidence of deliveries and creation of the basis for receiving of materials to the warehouse, evaluation of deliveries - from the viewpoint of completeness, deadlines and quality;
- **management of warehouse stocks** - evidence of inventories, receiving and issue of goods in the warehouse, solution of changes in the storage locations of material in the warehouses, processing of stock-taking (inventories), monthly warehouse closing reports, warehouse reports, for instance, monthly changes in the warehouse stocks according to the type of movement, inventory turnover lists, disposal of incessant inventories.

5.3.4 Human resources management

The *Human Resources Management* module provides the personal records and mainly supports the management of the qualification development of company personnel, their effective deployment, recruitment of new employees.

The *Human Resources Management* modules includes the following selected functions:

- **personnel records** - centralised records of the employees, their qualifications, assigned working functions, evidence of absence;
- **management of the organisation** - creation and update of the working functions and positions, evidence and update of the organisational structures, organisational documentation, preparation of the template for new working functions;
- **management of the performance and development of the staff** - evidence of the assessment of the employee, preparation of the career maps and plan of the qualification development, preparation of the documents for definition of the rules of remuneration for performances, solution of the links of the personal targets of the employees and strategic targets of the enterprise;
- **management of qualifications** - evidence of the qualification requirements according to the enterprise needs, analysis of missing employee qualifications, support for selection of staff according to the qualification requirements;

5.3.5 Production

The *Production* module is particularly focused on the planning of production, respectively, production orders, monitoring of their fulfilment levels with regard to the deadlines, monitoring and evaluation of the warehouse stocks, production management at the operative and workshop management level.

The *Production* module offers the following main functions:

- **bills of material** - evidence and administration of bill of material items and their individual characteristics (normal item, subcontract, derived production, etc.), allocation of the appropriate bill of material to the production order;
- **product configurator** - option to configure selected products, determination of price data according to the variables in the models of the individual products, setting of delivery deadlines;

- **administration of production orders** - visualisation and monitoring of sales orders, creation of production orders, for instance, from sales orders, management of the procurement of services from subcontractors, planning of individual production orders;
- **production prognosis and planning** - optimisation of production planning respecting the limited capacities and availability of materials, determination of the earliest possible deadline for delivery of the production orders according to the demandingness of the production procedures;
- **operative production planning and management** - operative planning of production operations, re-scheduling of production operations in case of required changes, evaluation of the bottlenecks in production, planning of the use of alternative production centres with regard to the load of the capacities;
- **management of production procedures** - definition and planning of technological procedures, planning of production capacities, calculation of waste from the production operation, definition of resources and procedures for specialised production procedures;
- **workshop production management** - evidence of products, production resources according to the orders in the workshop and production operations, preparation of the schedule for feed of materials to the workshop, planning of manufacturing jigs, evidence of the working time and salary slips, evidence of the production done;
- **monitoring of the production situation** - evidence of work-in-progress, current condition of products, real production costs;
- **monitoring of production tasks** - monitoring of various types of tasks, for instance, preparatory, partial, etc., monitoring of the consumption of production resources according to the tasks (material, working, etc.), analysis of the use of production capacities and re-scheduling of production procedures in relation to their load;
- **monitoring of production costs** - monitoring and evaluation of the costs of production resources, cost analysis according to the production centres.

5.4 Supply chain management

Significance of supply chains

The basis of ERP application and generally IS integration in the enterprise was often focused on material flow support. It is a platform for optimisation steps in the enterprises targeting the achievement of flexible and high availability of products on one hand and low costs on the other.

Thanks to ICT, the management of the whole supply chain is becoming one of the competitive advantages of the enterprises. *Supply Chain Management (SCM*) results in the shortening of processing time and simultaneous increase of the reliability of product delivery to the customer or generally to the market.

In principle, the classic supply chain could be linear and consisted in the realisation of the basic link:

supplier➔ producer➔ distributor➔ seller➔ customer

Goods flow from the supplier to the final consumer and the main flow of information and financial resources, i.e. payments for the products and services sold flow in the opposite direction. Currently, these two flows are also monitored separately - optimisation of the financial flow is usually not synchronised with optimisation of the material flow.

Thanks to the Internet and its resources, the modern enterprises are merging into more complicated structures and forming mutually networked companies. Their common main target is to offer the required competitive product with adequate speed at low cost. Many activities are beginning to be outsourced and the opportunities of the specialised enterprises, which have effectively applicable technologies or know-how are being utilised.

5.5 Human resources management

Human Resources Management (**HRM**) is an integral part of the support processes of every organisation. The scope of its coverage using the information system substantially differs according to the type and size of the user companies, business sectors and the capability to use IS/ICT effectively in this area. For instance, the domestic SME production and trading companies are often satisfied only with basic payroll processing, simple personnel evidence, or applications for management of some important operative activities, such as calculations and business trip reports.

The counter-pole to these companies are the supranational concerns or advanced IT corporations, which place not only

great emphasis on the implementation of all important HRM sub-processes, but also their incorporation into the information system. The enterprises for which systematic work with their own staff is necessary to maintain competitiveness are mainly gradually shifting to the highest level of HR management.

Figure 5 illustrates the major HRM processes integrated in the applications that comprise the **standard** Human Resources Information System (**HRIS**).

The HRIS in the organisation is created in two ways. The first is delivery of an All-in-One ERP system, whose component is functionality for HRM. Usually this concerns the modules of an external provider - specialist for HR applications, which are often adapted as a subcontract for integration with a specific ERP system that is deployed and guaranteed just by the implementer partner for the whole solution. For this purpose, the partners provide their ERP products and services to the providers, for instance, KS – program, Elanor or Kvasar.

As stated by Jaroslav Šmajda, one of the leading Czech experts in HRIS, the organisations are globally rather opting for the Best-of-Breed applications from specialised providers capable of covering the required functionality, and with all necessary specifics (Šmajda, 2010).

Let us now take a closer look at HRM from the viewpoint of the ERP concept. We briefly describe the major HRM processes and principles of their automation in the HR information systems, which can be classified as a **standard HRIS**.

5.6 HR Management

Due to the fact that the HR area is very diversely understood not only by organisations that use IS/ICT, but also provider-specialists, we have defined its sub-processes, agenda and activities as follows:

1. HRM in the narrower sense provides evidence of the basic personnel data and labour-law documents. The specimens of the documents are usually pre-defined and regularly reviewed according to the applicable legislation.
2. In the broader sense, apart from evidence of employees' data and the applicable documents, HRM also includes the agenda for occupational health and safety, systematisation of workplaces, education and management of career growth, assessment of employees, social programmes, job candidates and tenders.

In the following text, we select some important areas of personnel management and use examples to describe the significance of their incorporation into the information system.

5.7 Education and training of employees

Staff education, training and on the job training form one of the most important and also often underestimated components of human resources management. The HR information systems are used, among other things, for the following purposes:

1. Monitoring of the fulfilment of qualification requirements
2. Planning of educational events
3. Evidence and evaluation of educational programs including their costs
4. Evidence of the validity of licences, certificates and other qualification documents
5. Administration of tutors
6. Administration of self-study courses

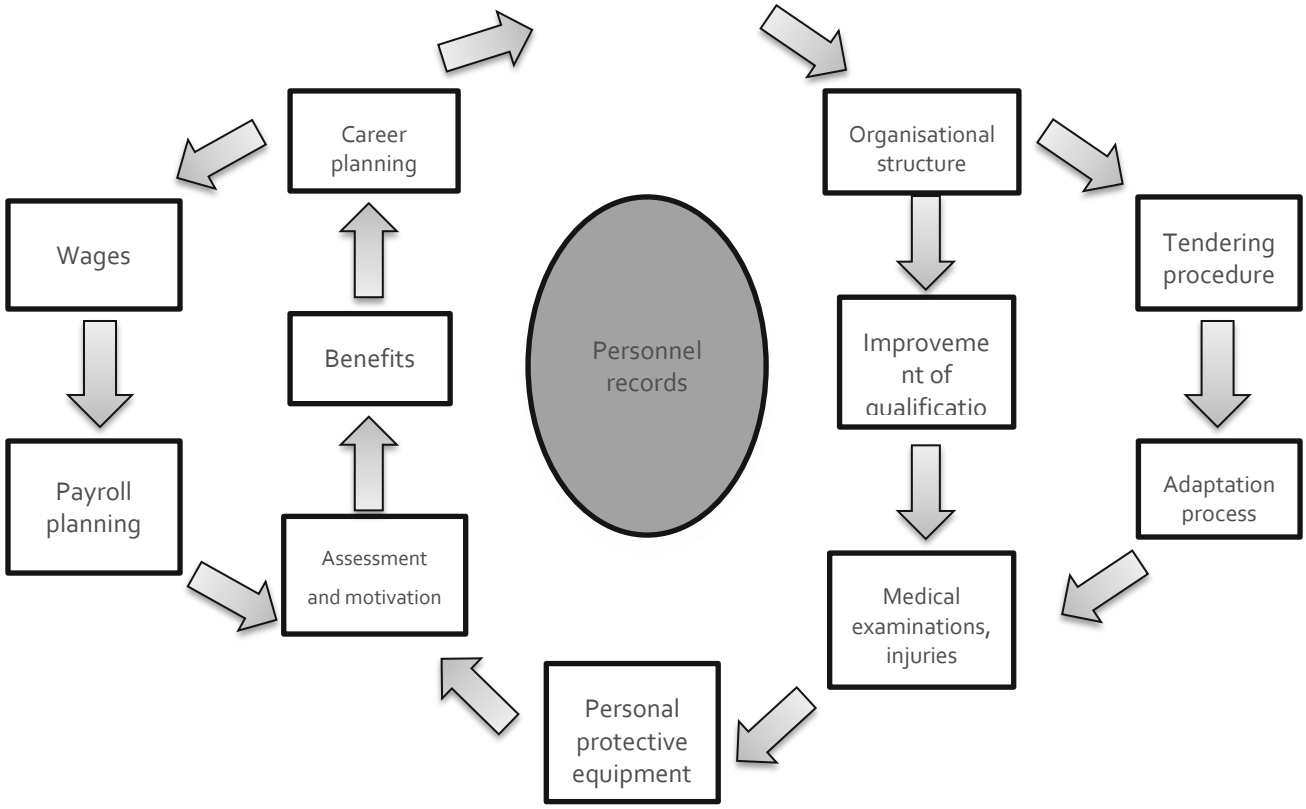


Figure 5 Coverage of HRM processes (Sodomka, P. , Klčová, H., 2010)

5.8 Asset management and administration of critical assets

The term **Enterprise Asset Management** is not one of the most frequently used in the area of enterprise informatics. But it hides a very important functional component of the information system that contains the tools for asset management, production and other important corporate facilities.

Enterprise Asset Management is used for asset management. Its functional support in the information system makes it possible to monitor all the costs and activities related with the critical material resources of the organisation.

The assets and equipment of the organisation may be recorded in many ways in various places of the enterprise agenda. Usually the asset data can be obtained in the financial department (fixed or leased assets). The information about the elements or works, for instance, production equipment may be components of the warehouse items or maintenance items.

Enterprise Asset Management is capable of merging the given viewpoints of assets and equipment into a single unit and also makes it possible to manage these resources in a complex manner. EAM functionality is provided by either **ERP system** modules or **specialised EAM applications**.

By acquisition of the EAM application, the company management gets control over the use of assets within the whole enterprise, may monitor its operating costs, depreciation, manage its maintenance, etc. By use of the EAM system the management achieves reduction of the overall operating costs of all enterprise equipment and increases its usability. Last but not least, the deployment of EAM improves the decision-making process for the owner or manager responsible for critical assets.

6 ERP - ENTERPRISE RESOURCE PLANNING, LOGISTICS, SALES, SCM (SUPPLY CHAIN MANAGEMENT)

Currently, the chain is no longer linear, it includes multiple subjects, uses all sorts of e-business forms and can be illustrated as shown in Figure 6 Diagram of the Internet based supplier chain.

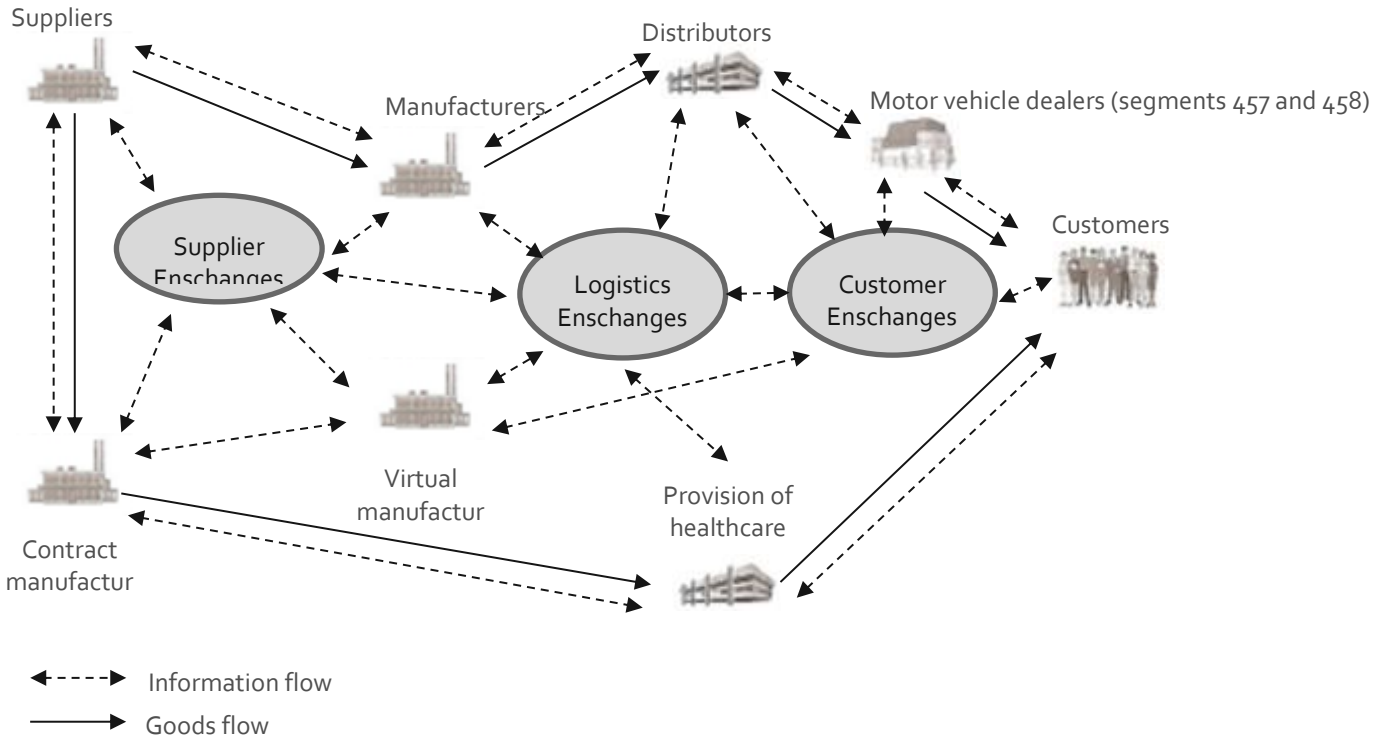


Figure 6 Diagram of the Internet based supplier chain (Basl, J. , Blažíček, R., 2012)

Definition of SCM (Supply Chain Management)

Just like in the case of the ERP, SCM also has multiple definitions. One of them, for instance, states that:

SCM (Supply Chain Management) - supplier chain management, or network management, is a set of tools and processes, which are used to optimise management and maximise the efficiency of the operation of all elements (links) of the whole supply chain with regard to the final customer. SCM is a specific example of the mutual interlink of suppliers and customers on the basis of the information and communication technologies. Through this interlink and exchange of information, the partners in the chain (network) can co-operate, share information, plan and co-ordinate the overall procedure in such a manner as to increase the agility of the whole chain.

6.1.1 Functionality of current SCM applications

The current SCM solutions also focus on increase of customer satisfaction and, for instance, offer the following:

- the customer's share of the resulting product configuration;
- permanent information to the customer about the status of his order;
- reduction of the probability of delay or incomplete deliveries;
- solution of unexpected situations during solution of the order within the framework of the whole supply chain.

For partners within the framework of the chain, these solutions are also interesting thanks to the possibility to cut costs and shorten the time required for clearance of the customer request and also because of the following:

- improvement of management within the whole process, including the responses to changes or arising problems;
- elimination of "blind spots" within the framework of this process;
- possibilities for automation of the procurement operations;
- possibility for all partners to share information about the actual status of the order;
- enhancement of cooperation and confidence between partners.

A very important functionality of SCM consists in its capability and support for scheduled operations, which include:

- planning of requirements in the chain on the basis of historical data with regard to the overall opportunities for procurement, production, distribution and transport;
- support for determination of the optimal locality and form of the supply chain in the given case;
- the necessary material requirements are connected to the option of e-procurement or procurement through the electronic marketplace with the objective to receive a bid from multiple suppliers.

Separate functional support of supply relationships and support of the strategic procurement decisions is provided in the enterprise information systems by modules designated as Supplier Relationship Management (*SCM*). These applications offer:

- securing of the quality of the supplier data;
- cost analysis;
- procurement strategies;
- purchase measurement and evaluation.

Management methods applied within the framework of SCM

Prior to the deployment of the Internet, the efforts at deployment of SW applications for support of supplier chains were restricted to the capability to forecast customer demand, and hence ensure that the whole chain functioned as smoothly as possible. The advantages of the Internet, consisting in its prevalence, low price and offer of universally acceptable standards opened new possibilities for the chains. They include the rapid development of e-commerce between the enterprises themselves - i.e. B2B (*Business to Business*).

These efforts were also reflected in the individual methods applied in the supply chains:

- **CRP (*Continuous Replenishment Planning*)** - system for maintenance of the customer's stock levels by the supplier.
- **VMI (*Vendor Managed Inventory*)** - where the buyer provides certain information to the vendor who assumes full responsibility for the agreed inventory level from the buyer's warehouse.
- **ECR (*Efficient Customer Response*)** - effective response to customer requirements. Allows the communication and cooperation of the vendor with the manufacturer with the objective to respond more effectively to the customer requirements and cut the costs in the supply chain.
- **CPFR (*Collaborative Planning, Forecasting and Replenishment*)** - joint planning and forecasting in the supply chain. CPFR is a concept for increase of integration in the supply chain that supports the current practises, increase of cooperative management and visualisation as well as placement of products in the whole chain on the basis of shared information.

The above-stated methods are the basis for joint planning within the supply chain. Two principles are used - ATP (*Available to Promise*) and CTP (*Capable to Promise*). These characterise the capability to deliver products to the customer at the level of the individual participants in the chain. This means that the given SCM system is capable in the calculation of the potential order completion deadline to take into consideration the available CTP on the basis of the production plans or do the calculation only on the basis of the available finished products inventories and fixed continuous production period (which is ATP).

6.1.2 IS for support of the production systems

Advanced Planning and Scheduling - APS

An integral part of SCM is a strong link with the production planning down to the level of detailed workshop scheduling.

This area of special applications within the Enterprise IS is designated as APS (*Advanced Planning and Scheduling*). Often, this group of applications is designated using the common abbreviation APS/SCM. APS systems have a similar role within the enterprise like the one solved by the SCM (*Supply Chain Management*) systems outwards.

APS is characterised by the simultaneously synchronised planning of all resources while respecting all the known limits. The input conditions and output parameters are defined in the system and the APS system subsequently has the task of identifying an optimal solution variant. Change of input parameters can also change the resulting system recommendations. Optimisation algorithms work on the basis of the criterial functions, where each request is evaluated.

Manufacturing Execution System - MES

The area of corporate logistics is really rich in applications, which form the mosaic of the enterprise IS, and for this reason, another important group should not be omitted, which after APS is even closer to the actual production system because it directly realises its management. This application group is designated as MES (Manufacturing Execution System) (Sodomka P. , 2006).

The MES according to the MESA (Manufacturing Enterprise Solutions Association) support the following areas:

- resource management and allocation,
- operative planning and scheduling of production,
- dispatch production control.

6.2 Logistics and supply chain management

In terms of defining the concept of ERP, we talk about the internal logistics process, which is further divided into **procurement, sales** and **production logistics**.

Production logistics consists in the internal transformation of material flows. Its mission is to create and operate an efficient structure for their management. This includes cross-cutting processes and activities in the areas of handling, storage and transportation of materials, semi-finished products, parts and other components necessary for the implementation of the production process.

Purchase logistics consists in the procurement of materials, semi-finished products, parts, commercial goods or services in order to implement the production, sale or provision of services. It includes the order cycle, transportation, inventory maintenance, inventory management and is closely linked to the management of supporting processes (accounting, billing, price lists), workflows and documents.

6.2.1 How to consider the supply chain

As we explained in the introductory definition, the supply chain is best considered as a system composed of the business processes of organisations involved in satisfying the customer. This procedural viewpoint may at the same time be dual:

1. We view the processes in the chain as a series of cycles, each of which functions at the interface between two successive levels of the chain.
2. The processes in the chain are divided according to whether they are realised on the pull or push principle. We term the processes that are activated by a customer order as pull processes, while the processes carried out before the expected order are characterised as push processes.

Let us look at the Supply Chain first as a series of cycles. In principle, all the chain processes may be broken down in the following process cycles (Chopra & Meindl, 2004):

- Order cycle
- Top-up cycle
- Production cycle
- Delivery cycle

The **Order Cycle** takes place between the customer and the retailer and includes all the processes directly related to the receiving and clearance of the order. It specifically concerns the **contact management processes** with the objective to fulfil the order, **record** and **clear the order,** and its final **acceptance** by the customer.

From the chain viewpoint, it is a key step in the arrival of a customer. **Contact management** is then used to transform the arrival of the customer into the assignment of his order. For this purpose, many procedures and options are used within the framework of the information systems.

The **order recording** process follows in which the customer notifies the vendor of intent to purchase goods and specifies the type and quantity. The objective of this process is to ensure the precise specification of the order, expediency of its delivery and to make contact with the follow-up processes in the chain.

During the **order clearing** process, all the important steps toward the customer are secured, and the order is also secured and sent to the customer. However, the clearance of the order may be done in several ways. It depends of the number of levels in the given chain. This process can thus take place in the vendor's warehouse, directly at the end of the manufacturer's production line (custom production) or also be realised by the customer himself (in the supermarket). The objective of this process is to deliver the required order to the customer within the promised deadline at the lowest possible cost. It is further necessary to update the inventory position, which is followed by start of the replenishment cycle.

The order cycle is completed by **takeover of the order** by the customer, including the property title. The details of the order are updated in the information system; the payment is also completed if not realised beforehand.

The **Replenishment Cycle** takes place between the retailer and the distributor and includes all the processes in the vendor's replenishment of the inventory. The replenishment cycle starts at the moment when the vendor issues the order for replenishment of the inventory to cover future demand. This cycle is similar to the customer order - in this case, however, the vendor becomes the customer. The vendor's objective is to replenish its own stocks at the lowest possible cost, while trying to ensure high availability of the products offered to the final customers. The result should be a balance between the availability of the required goods in the warehouse that gives the vendor a competitive advantage and the inventory levels in terms of generation of costs. It is a critical point in chain management as it requires the reconciliation of two conflicting requirements.

The **Manufacturing Cycle** runs between the producer and the distributor (retailer) and includes all the processes concerning replenishment of the distributor's or store's stocks. This cycle is initiated by the customer's order, supplementary order from the store or distributor or forecast of customer demand and current availability of the product in the manufacturer's finished-goods warehouse.

The manufacturing cycle issue is very broad. It may, for instance, concern the steel industry, which is focused on mass production. For this purpose, it collects very similar orders and thus responds to the customer demand. A completely opposite example are enterprises that manufacture in response to expected demand (for instance, small series manufacture, job-order manufacture). In this case, the production cycle assumes the customer demand and includes the arrival of the order, planning and scheduling of production, actual production, assembly and delivery of the product to the customer.

The **Delivery Cycle** takes place between the producer and the supplier, and includes all of the processes necessary to ensure the availability of materials for production according to its scheduling. During the delivery cycle, the manufacturer orders components to replenish the existing stocks. It is a situation similar to what occurs between the distributor and the manufacturer. It differs only in one fundamental thing. While the store order is initiated at the distributor by unspecific customer demand, the manufacturer's order for materials and components is accurately defined at the moment when the decision was made to schedule production. For this reason, the interlink of suppliers in the manufacturing schedule is also important.

If the delivery periods are too long, it is then clear that the supplier must manufacture according to a preliminary plan. The plan of the manufacturer himself cannot thus be fixed long-term.

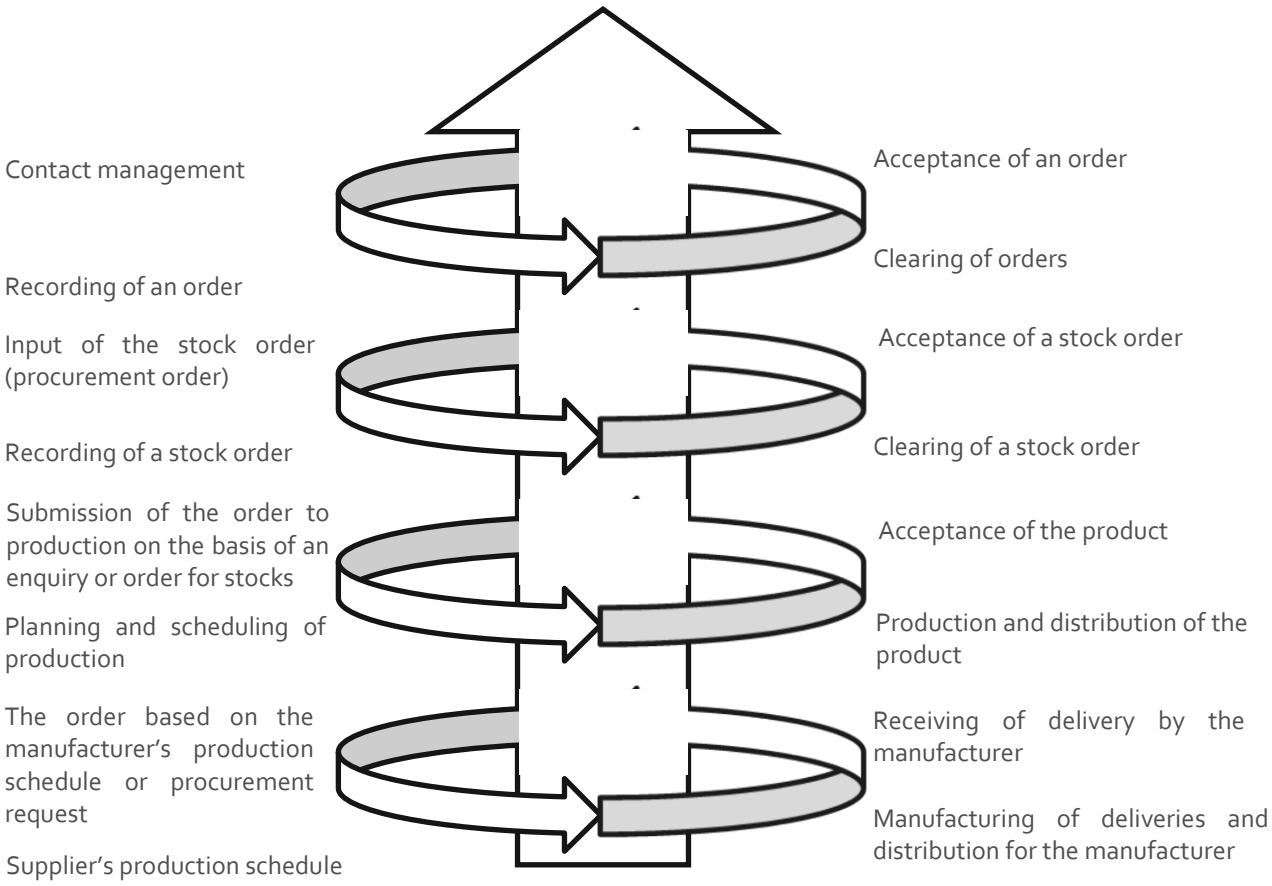


Figure 7 The supply chain in terms of the process cycles (Sodomka, P. , Klčová, H., 2010)

If we look at the supply chain as a cycle, then we clearly define the integrated processes and owners of these processes. This view is very useful for consideration of the operational decisions because it specifies the roles and responsibilities of each link in the chain and the desired outcome of each process – Figure 7.

6.2.2 Modern technologies in the supplier chain

With the coming of the Internet and the mobile networks, multi-channel communication started playing a dominant role in the supplier chains. When used, SCM systems share some important processes, for instance, with CRM applications (in the area of contact centres or automation of sales activities). In the case of the CRM, the reconciliation of communication through all channels by means of a basic strategic rule. EDI (Electronic Data Interchange) systems are directly implemented in the SCM. These are capable not only of replacing, and hence reconciling communication (telephone, fax, post) in a standardised document, but also bring other benefits.

EDI is a modern way of communication between two independent entities, in which the exchange of standard structured documents is done electronically, directly between their information systems.

Electronic identification of stocks is the technology most commonly used for acquisition and transfer of information in supply chains. The most widespread variant, however, is still barcodes. From 2005, the more massive deployment of **Radio Frequency Identification** (**RFID**) in the Czech enterprises is also beginning.

Talk of the RFID technology started already during the 1940s. But it is only now that it is ready for real use, mainly due to the parallel development of three additional technologies. In the first place, a way has been found in which to significantly reduce the production cost of chips that are at the core of the RFID solutions. Secondly, there has been a significant expansion in the use of the Internet through which you can easily share data in real-time on a global scale. And thirdly, there was a massive development of mobile technologies that enable data capture at any location and their wireless transmission to the information system.

The RFID is a system of small electronic chips (i.e. tags composed of a small tag chip and an aerial) transmitting radio signals, transducers of such radio signals and the corresponding hardware and software infrastructure. Electronic chips (tags) can be placed on any goods that require tracking. These include, for instance, transport containers, pallets, boxes, individual pieces of merchandise, but also people and animals. At the moment when the object with an attached tag comes close to the sensor, the radio signal is captured and sent to other systems for processing. What happens to the captured data subsequently only depends on the particular software application.

In general we can say that RFID technology delivers a revolution in the truest sense of the word in the areas of production and logistics processes, helping to significantly reduce costs and improve operational efficiency. Potential RFID applications can be almost of any type because the technology can be used in all organisations that have something to do with manufacturing, logistics, transportation and sale of goods. This therefore includes trading companies, distributors, logistics companies, manufacturers and all their suppliers.

The RFID technology has the potential to increase efficiency and transparency, reduce costs, improve resource utilisation, improve the quality of goods and services, reduce excess inventory, increase sales and ultimately reduce the risks associated with counterfeit goods, particularly in the food and pharmaceutical industries.

The key to achieving the above advantages is the cost. A Canadian manufacturer of consumer goods calculated that the turning point for truly effective use of RFID technology comes at a time when the price of RFID chip drops below 15 cents per piece (i.e. about three crowns). Then it will be realistic to start thinking about the replacement of barcodes directly with the RFID chips. The current barcode price is now essentially zero. The manufacturers should therefore get the price of the RFID chip way below one crown. It is only when it shall pay off to put the chips on each can of beer or other small goods that it will be time for their wide-scale use.

6.3 Procurement and warehouse management

Procurement and warehouse management provides support for processing of the requirements for procurement, evaluation of the warehouse stocks and actual supply operations. Ingredients:

- **supplier management** - evidence and analyses of suppliers, analyses of supplier prices;
- **procurement management** - evidence of the material requirements for the individual production and other centres and cumulation of the requirements for procurement, blocking of material, i.e. blocking of the required quantity of items, processing of enquiries (for potential and permanent suppliers), evidence of the offers, processing of orders, evidence of deliveries and creation of the basis for receiving of materials to the warehouse, evaluation of deliveries - from the viewpoint of completeness, deadlines and quality;
- **management of warehouse stocks** - evidence of inventories, receiving and issue of goods in the warehouse, solution of changes in the storage locations of material in the warehouses, processing of stock-taking (inventories), monthly warehouse closing reports, warehouse reports, for instance, monthly changes in the warehouse stocks according to the type of movement, inventory turnover lists, the end of incessant inventories.

7 ERP II - ENTERPRISE RESOURCE PLANNING, CRM

7.1 Customer relationship management

7.1.1 From marketing systems to the modern CRM concept

CRM systems comprise one of the most popular areas of business informatics. They address both user organisations, which they should help to make money, and suppliers, who see a great business opportunity in this area.

The Internet, mobile phones, wireless data transmission and other digital technology have completely changed the traditional marketing concept. They have made it possible to improve the classic and create entirely new business models. New markets have emerged and new opportunities for business have been created in almost all fields of human activity.

However, the change is not solely the outcome of modern technologies. Sales and marketing in themselves have undergone dynamic development, which can be summarised in the following stages:

1. Orientation on the broad availability of a cheap product (Ford, beginning of the 20th century)
2. The product focus, which delivers high product quality (Lux, mid-1920s - whose name, just Xerox, was later considered by the people as a synonym for the operation performed using the product)
3. Concept focused on sales, marketing and the market
4. Focus on the needs and profitability of the customers with regard to the fact that the organisation is a component of the supply chain.

The latter phase probably most accurately describes the conditions for successful business in the global economy of the 21st century, in which a learning organisation networks or even their entire network structures mutually compete.

And it is just the focus on customer needs and profitability that generates demand for the automation of external processes (sales, marketing, service and contact management), and thus also for the implementation of the CRM system. But it assumes that:

1. We understand the customers' needs.
2. We are capable of suitably segmenting them into groups.
3. We shall adapt to these groups with a product offer and accompanying services.
4. We are capable of deciding on the priorities during automation of external processes.
5. We understand the functioning of the supply chain, which means that:
   a. we are capable of correctly defining the strategic position of the organisation within the chain,
   b. we can define processes that are under the direct control of our organisation and the processes that we share with other entities in the chain,
   c. we can determine which of these processes function on the push and the pull principle,
   d. we understand how the order cycle between the organisation and the customer works, and the factors that influence this cycle (process).

The vast majority of authors writing about CRM above all emphasise the need to **satisfy customer needs**, so it is necessary to once more emphasise another key factor of the CRM application, which is the **management of customer profitability**.

The growing interest in CRM systems is a logical response to the changes brought about by the development of multi-channel communication and focus on the needs of businesses and customer profitability.

Process aspect of CRM

We collectively designate CRM processes as those external processes that are part of the business cycle. The business cycle is a significantly broader concept than the order cycle, which takes place between the customer and the seller with the objective to receive and clear orders. The **Business Cycle** includes the following key CRM processes:

- **Management of contacts** - consists in the management of the multi-channel communication with customers within and outside the organisation. It is therefore a **cross-cutting process**, which affects all other CRM processes. The automation of contact management is done through the **contact centre** (**Contact Centre**) technology.
- **Business Management** - includes the **order cycle** (management of contacts, recording and clearance of orders and their acceptance by the customer) and overlaps with two further CRM processes, which are **marketing management** (particularly in the pre-sale phase) and **services** (particularly in connection with the already fulfilled order). The **SFA** (**Sales Force Automation**) is intended to automate business activities.
- **Marketing Management** - consists in the management of marketing resources, planning, implementation and evaluation of **marketing campaigns** and the use of appropriate communication channels for all activities. The aim of the implementation of the marketing process is to identify potential customers and create new business opportunities. The automation of the marketing process is done using the functionality known as **EMA** (**Enterprise Marketing Automation**).

Service - used to provide guarantee and post-guarantee service, offer complementary products and services with the objective to strengthen customer satisfaction and loyalty. They hit all the stages of the business cycle and for this reason, we divide them into **pre-sale**, **sales** and **pre-sale**. Services are managed within the CRM functionality that we designate as the **CSS** (**Customer Service and Support**).

7.1.2 CRM concepts and strategic rules

If we want to automate CRM processes, then we should consider how to best support the competitive strategy of the company and help in the acquisition of the information relevant to the implementation of corporate strategies throughout their hierarchy. It is additionally necessary to count on the fact that it is a dynamically evolving relationship. The market conditions and the internal conditions of the organisation or supply chain within which it operates may change.

7.1.3 Customer Relationship Management (CRM)

Customer Relationship Management (CRM) is complex application and basic software, technical resources, business processes and human resources for management and continuous management of customer relations with the company in areas of trade promotion, especially sales, marketing and customer care services.

The main task of CRM is to support the business processes, and in this sense, the creation of long-term and successful relationships with customers, increasing their so-called loyalty. The major **functions** include:

continuous monitoring of customer needs and behaviour, registration and assessment of current business contacts,

- creation of new business opportunities using the cited customer information,
- activities leading to the creation of long-term and economically valuable relationships with customers,
- sophisticated analysis of the customers according to all sorts of criteria,
- management of marketing campaigns using the results of customer analyses and their requirements.

In terms of the internal **CRM solution concept** it can be stated that it is a comprehensive combination of transaction and analytical applications. Three basic CRM solution areas are differentiated, i.e. the operational, cooperative and analytical areas.

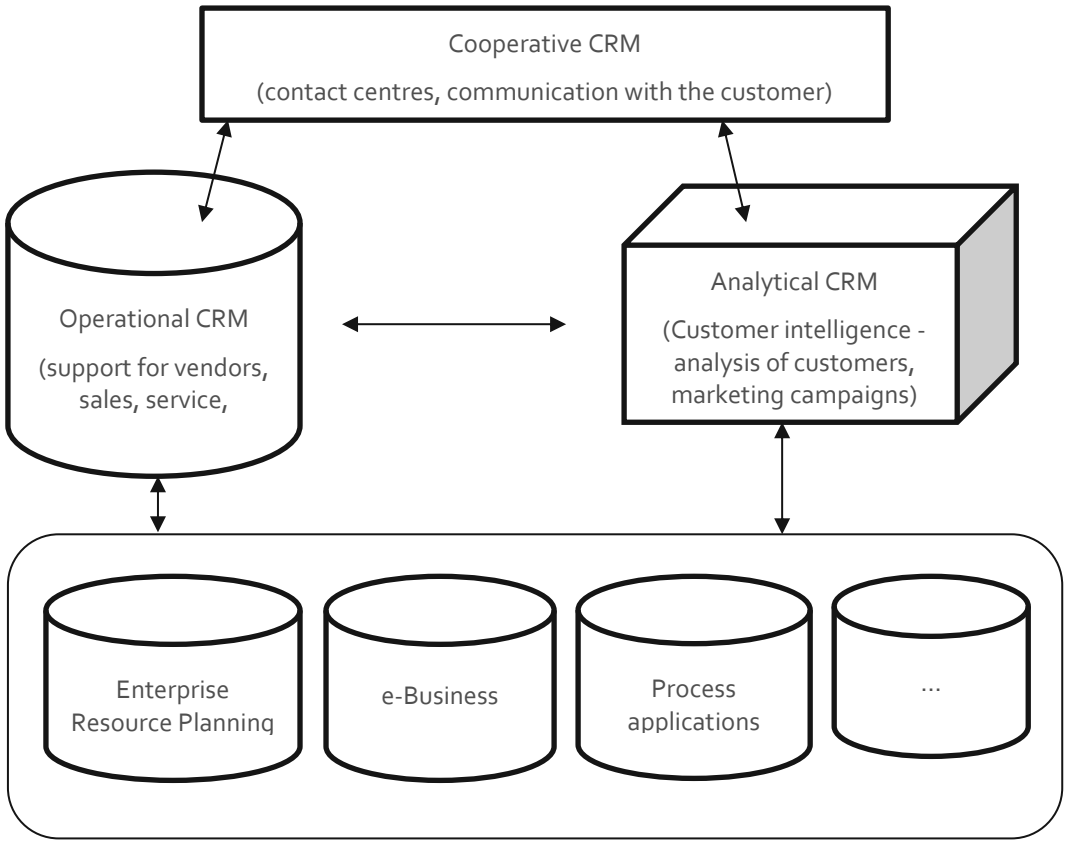


Figure 8 CRM Architecture (Gála, Pour, & Šedivá, 2009)

Let us take a further look at the basic characteristics of all the three major components of CRM - Figure 8 CRM Architecture.

The **operational part of CRM** covers all the software applications, which solve operative issues and the contacts in cooperation with the customer. This area includes, for instance, the functions that support the management of business contacts, management of individual business transactions, creation of marketing plans and campaigns, monitoring of competitors, functions for specifying the requirements for customer service, their evaluation, etc.

Cooperative CRM expands the methods used earlier for contact with the customers, such as post, fax, telephone contacts and personal meetings (1: 1) and adds the Internet, electronic mail, mobile communication, and particularly the interactive web applications. All this is coordinated and managed through the **contact centres** (respectively, call centres), which are applications and technologies within CRM that are based on the central approach of the customer to the company. The contact centre is the site for storage and regular update of information about any contact with customers (complaints, information transfer and bidding, sending of marketing materials, information on contract signature). Thus, the contact centres provide features such as support for customer communication based on the integration of different communication channels, automated interactive voice response, e-mail processing, voice communication over the web, conducting of marketing campaigns and others.

Analytical CRM already includes aggregation and application of customer knowledge and provides functions, for instance, segmentation of customer, analysis of marketing campaigns, forecasting of customer behaviour, etc. The Analytical part of CRM is usually realised in such a manner that the customer data acquired from the operational and cooperative CRM, eventually other applications (ERP, e-Business) is used for processing of analyses in the BI technologies and applications. Such a CRM and BI combination is designated as **Customer Intelligence** and is mostly already comprehended as a synonym for analytical CRM. Customer Intelligence (CI) thus represents functionality focused on customer knowledge, values, preferences, risk or likelihood of opting for the competition.

CI is thus primarily focused on the collection and analysis of data from interactions with customers using processes and resources, such as records of business contacts, documentation centres, data from e-Business applications, enterprise portals, captured by the so-called, click stream, i.e. the approaches and practices for using the web applications functions by the customer. The CI analytical capabilities also allow business analysts to focus on customer value, and based on this value, act on the quality of support for individual customer segments. The **Customer Value** (**CV**) concept consists in the quantification of the customer's past and future benefits and costs, and therefore works with such indicators as customer profitability (calculated as the difference between revenues from the customer and the sum of the direct and indirect costs for the previous period) the risk of losing the customer and others.

7.1.4 CRM functionality

CRM provides four basic methods of application that the enterprise can deploy separately (prepared according to www.wikipedie.org):

- *Active* CRM,
- *Operationall* CRM,
- *Collaborative* CRM,
- *Analyticall* CRM.

The basis of CRM is an active centralised database, which, like ERP, supports process automation.

Operational CRM provides support for business processes of the so-called "*front office*" and includes sales, marketing and services. Every interaction with the customer is added to the contact history and every worker can draw on this database if he requires suitable information.

Cooperative CRM includes direct interaction with customers. This includes various communication channels, not only the Internet, but also, for instance, *Interactive Voice Response* (IVR). Its objectives may also be broader and may include cutting of costs and improvement of services rendered. This communication does not include the sales representatives (so-called "*self-service*").

Analytical CRM analyses customer data from different perspectives, such as:

- design and implementation of targeted marketing campaigns leading to their higher efficiency;
- design and implementation of targeted marketing campaigns, including *cross-selling* or *up-selling*,
- customer behaviour analysis used to support decisions on products and services (e.g. setting of appropriate pricing, new product development, etc.);

- management decisions such as financial forecasting and analyses of customer profitability.

The goal of CRM is also improved communication with customers, and in particular its coordination within the company. The point is that it was not necessary during the enquiry, complaint about the product or failure to gradually and repeatedly explain the facts and details that had already been announced to other company employees or that the company only once promised to tackle.

Thanks to CRM, the customer can actively communicate with multiple suppliers of the desired product, customise his requirement and compare the best bid in terms of price, time and method of delivery. But this on the other hand reduces the customer's loyalty to a specific manufacturer or service supplier, which would be an important factor for a lasting relationship and sales.

However, CRM does not mean that the current channels and links to the customer have been abandoned completely. Otherwise the enterprise could face the fate of companies that at the close of the nineties extremely applied the principles of the so-called, "new economy" and addressed the customer only through the Internet. Although this allowed them to reach a wider range of customers and gain a bigger market share thanks to the implementation at lower transaction costs. Unfortunately, entry of these "dot.com" companies into the new millennium in many cases meant a big drop in sales, among others, for reasons of communication with the customers. Among other things, precisely because they failed to also comprehensively integrate standard communication channels. On the contrary, the companies that successfully expanded communication with the customers via new channels did very well and thus got back their former customers.

7.1.5 Structure of CRM

The CRM systems are usually divided into the operational, collaborative and analytical parts:

- The analytical part of CRM concerns analytical work with all data and use of the data warehouses. The analytical part of CRM includes, for instance, segmentation of clients, identification of groups of profitable customers, analyses of customer behaviour, analyses of marketing campaigns. It thus concerns the optimisation of current business processes and definition of new processes that support the corporate strategy.
- The operational part of CRM implements predefined business processes. It is part of CRM solutions designed to support customer interactions across different types of channels, from telephone customer service centres through electronic channels to the handling of mail and management of traditional outlets. The operational part of CRM includes the Back Office (support applications), and in particular the Front Office (applications used during contact with the customer):
    - by mobile phones;
    - Contact Centre (application used to manage calls at HQ);
    - Sales Force Automation (application for support of the salesman);
    - Enterprise Marketing Automation;
    - Customer Service and Support (all sorts of customer service and support applications).
- The cooperative part of CRM builds on the Front Office and represents the technologies used according to the type contacts with the customers:
    - personal contact at the company branch - the contact and its content are entered directly in the CRM;
    - written correspondence - EDMS (Electronic Document Management System) used;
    - electronic mail - EDMS technology used and the e-mail server (incoming e-mail can directly and automatically trigger defined actions and processes in the CRM);
    - fax communication - EDMS technology used and the fax server;
    - contact (mobile, fixed). Technologies used:
        - PaBX (Private Branch Exchange);
        - IVR (Interactive Voice Response);
        - Dialer (automatic dialling service);
        - CTI (Computer Technology Integration);
        - SMS centre (Short Message Service);
        - WAP (Wireless Application Protocol - access to the Internet via a mobile phone - corporate WAP portal);

- communication over the Internet - the customer in a classical way accesses the website that offers him the following:
  - self service (to present requirements to the company);
  - clarification queries via on-line chat;
  - Call Back Button and the queries are subsequently solved over the phone.

Everything is automatically recorded in the CRM.

The basic principle of this solution is that the customer request is recorded as an object, which is further processed using the built-in workflow (flow predefined objects within the business process). CRM technology is based on the fact that all modules share a single database. The module is comprehended, for instance, as marketing, sales, customer care, customer information and behaviour, etc.

The success rate of CRM projects is based primarily on the cooperation of all its parts. Without appropriate data, the analysis will not yield good results and without analysis the operational part of the CRM will not yield expected results. For this reason, everything must be integrated into a coherent system Figure 9 CRM Architecture.

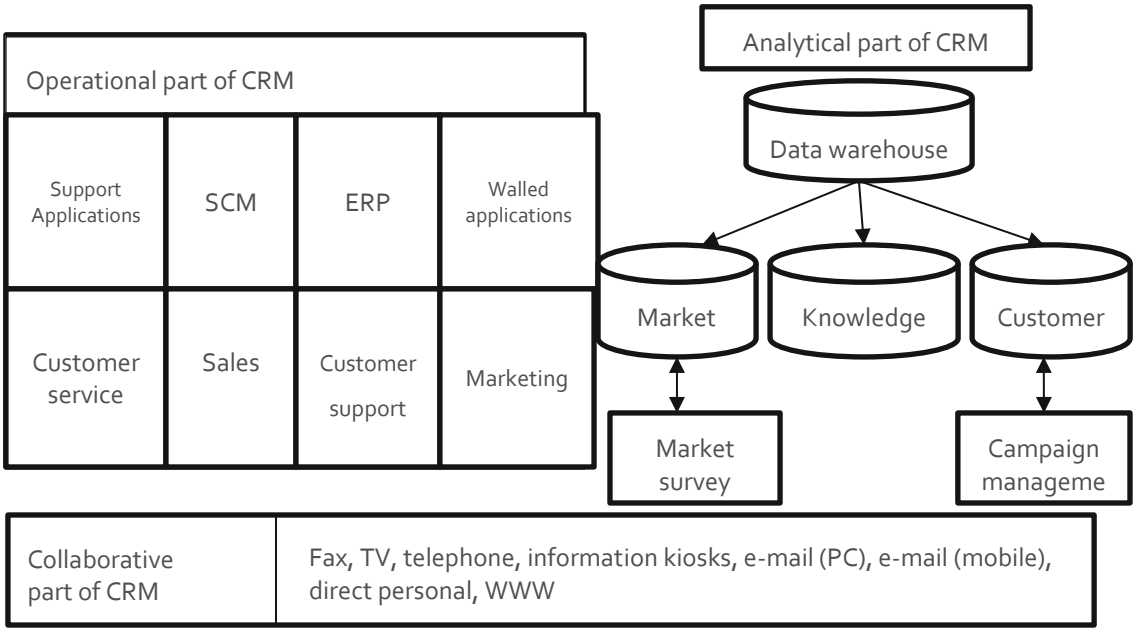


Figure 9 CRM Architecture (Tvrdíková, 2008)

7.1.6 CRM implementation

Implementation of the CRM system must respect the plan of the company and its priorities. It depends on whether the company needs to focus on attracting new clients or strengthening the loyalty of old clients and prevention of their departure. CRM makes the senior management and informatics management cooperate because the effective implementation of CRM primarily requires the knowledge of all strategic plans and visions of the company, but also contemporary information technologies and their possibilities.

The implementation of the CRM project is impacted by **four elements** Figure 10 Preconditions for a successful project,:

- **Planning** - the vision of a well-prepared plan (2-3 years beforehand), setting measurable project success criteria (KPI - Key Performance Indicators), and both in terms of items and in time.
- **People** - employee involvement in the creation of the vision and in the creation of design solutions, employee communication and training in working with the system, strong management support and reward system according to set success criteria (KPI).
- **Processes** - a consistent description of all processes (including client communications and information flows), creation of process maps and diagrams. The employees must be involved in the description of the processes.

- **Technology** - when deploying technologies, it is necessary to start with a simple solution that has minimal modifications, so that implementation is followed by quick manifestation of (at least a little) improvement and the system is capable of start-up within 4 months.

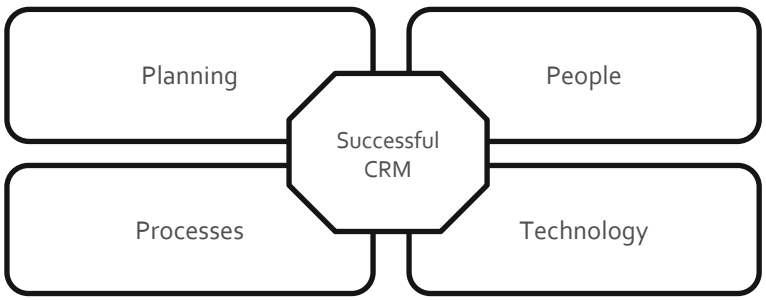


Figure 10 Preconditions for a successful project (Tvrdíková, 2008)

8 ERP II, BI - BUSINESS INTELLIGENCE, MIS - MANAGER INFORMATION SYSTEM, EIS - EXECUTION INFORMATION SYSTEM, DW - DATA WAREHOUSE

Business Intelligence represents a set of tools enabling users to use integrated access to data in enterprise information systems and their analysis to better understand the business and customers.

The BI applications are products for improvement of quality and performance of enterprise management and increasing the competitiveness of the enterprise. They are designed for senior and middle management as well as for analysts and planning specialists. This means that their users are not users of business processes within the basic functional modules as in the case of transactional systems.

BI applications are applications with available multidimensional information. They support real-time management and integrate factually or locally independent information resources.

BI software products during deployment provide their users with the following:

- **current information** - about the state of suppliers, buyers, sales, warehouses, work in progress, etc., without waiting for processing of the relevant periodical closing accounts in the transaction systems;
- **Independence** - because they eliminated the need to search for information across multiple management levels, which can lead to unwanted "hum" and where processing can be unnecessarily lengthy and possibly can be drawn simultaneously from multiple data resources;
- **flexibility** - when we ask for information that cannot be specified in advance or would be less effective.

The basic options for deployment of software support for decision-making can be found in the following areas:

- **reporting** - includes provision of the necessary reports including values, their analyses and trends;
- **analyses** - i.e. the possibility to process more detailed and multidimensional data analysis, including the implementation of ad hoc queries;
- **query** - constitutes ad hoc querying tools including the ability to predefine different queries.

The outputs of BI applications may be available in printed or electronic form in the office or on a laptop during negotiations with business partners or with own employees and are available through mobile devices anywhere, any time.

It is suitable at this point to sound the reminder that the quality of the individual enterprise IS is closely related to the quality of the data used and this applies two-fold to BI. This must always be ensured because the data are entered manually by many users with different "literacy levels", and also come from various applications, respectively, sources, which may cause their different interpretation. Errors also occur in consequence of conversion, or possibly unauthorised

interference or unsuitable tests.

BI applications often become part of the offers of standard ERP application suppliers and trends of these platforms in 2011 within the Magic Quadrant confirms their significant potential.

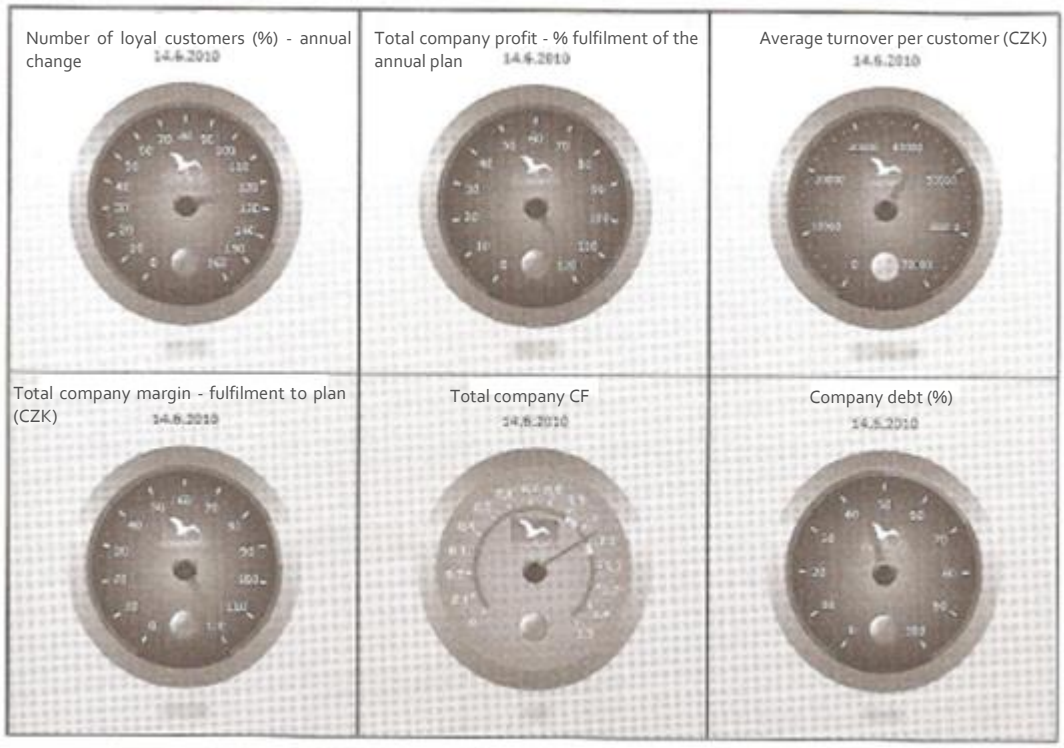


Figure 11 System of evaluation indicators in the Adler information system (Sodomka, P. , Klčová, H., 2010)

8.1 Essence of business intelligence

To understand the essence of business intelligence, it is useful to start from the differences between transactional and analytical tasks in business management. If we compare the basic concept of the work of the user (merchant, financial, officer) working mainly in a **transactional manner** and the user (manager, financial, marketing or other analytics) utilising data for **business analysis and reporting**, then we can find disparities. While in the case of transactional tasks, there is a significant survey of detailed information, for example, to the individual goods items, in the case of analytical tasks it is the assessment of certain indicators, in our case, the volume of goods sales, according to different dimensions (customers, products etc.), including the time dimension.

If we look in greater detail at the nature and demands of transactional and analytical tasks, the following differences are revealed. **During transactional tasks** (accounting, working with business documents) the user mainly has the following demands:

- to ensure the fastest possible access to the individual detailed data (orders, invoices, individual customers, etc.) and allow effective implementation of all required operations,
- realise the update of individual data on the basis of event data, for example, update of customer data on the basis of new facts, update of account status according to the invoices received, etc.,
- on the basis of existing or new data, create the relevant business and other documents with all the substantive and formal requirements (orders, delivery notes, invoices).

When dealing with business analyses, developing plans, in decision-making activities, informatics must fulfil the following user demands:

- to ensure the evaluation of the monitored business characteristics, e.g. sales volume, for a defined (often the

maximum possible) scope of enterprise data,
- provide an opportunity to analyse these indicators by various criteria, respectively, dimensions and their various combinations, e.g. by volume of sales to the individual customers, products, territories, types of contracts, vendors, sales channels and others, and do so within an acceptable response time,
- enable the monitoring of the development of business indicators and their fluctuations in time, i.e. creating time series, various types of indexes, etc.,
- offer the possibility of implementation of the above analyses and evaluation indicators at different levels of detail, respectively, aggregation of monitored values.

While the transactional applications access and update the detailed data in their databases, and allow creation of all sorts of reports and documents on their basis, the analytical applications de facto do not create new data, but use the already existing database of transactional applications, transform them and, according to requirements, allow the aforementioned analysis. In practice, these basic principles have many forms, modifications and options offered. It is just the specific demands of the users for support of their decision-making, analysis and planning activities that are the foundation of the current extremely rapid development of business intelligence.

Business intelligence (BI) is a set of processes, know-how, applications and technologies designed to effectively and efficiently support the management activities in the business. They support the analysis, planning and decision-making of the organisation at all levels and in all areas of business management, i.e. sales, procurement, marketing, financial management, controlling, asset management, human resources, manufacturing and others.

Business intelligence is thus focused on their use of information in management and decision-making, rather than on the basic data processing and implementation of common business, financial and other transactions. How the BI capabilities are used today largely affects **the performance and corporate management quality** and in relation to this, in the end it also affects its overall success and competitiveness. BI is closely linked to other IS/ICT applications, draws on these input data and more frequently returns these data to other applications. The quality of BI solution is therefore closely dependent on the quality of other (transactional) applications, in particular the quality of their production databases.

8.1.1 Multidimensionality of data in the OLAP technology environment

Multidimensional databases are optimised for storing and interactive usage of multidimensional data. The advantages of multidimensionality, respectively, deployment of OLAP (On-Line Analytical Processing) technology is the processing speed and efficient analysis of multidimensional data (*drilling, slice and dice*, etc.). OLAP technologies thus offer efficient access to data in a simple structure suitable for the analytical work of business managers and support for their decisions. With the introduction of the BI concept, and with the development of tools and technologies for broad support of analytical activities in the organisation, however, the term OLAP has become somewhat narrowed.

The narrower meaning defines OLAP in a purely technological manner, i.e. as "information technology based primarily on the concept of multidimensional databases". Its main principle is the multidimensional table that allows quick and flexible modification of the individual dimensions and thus changes the user's views of the modelled economic reality.

The basic **principle** of OLAP technology is **a multidimensional table** that makes it possible to change the **individual dimensions** very quickly and resiliently and thus offers various viewpoints of the modelled economic reality to the user; the table also offers the *drill down*, *drill up* or *slice and dice* options for selection ("slicing") of data from the OLAP dice, as documented in Figure 12 Principle of the OLAP-based multidimensional database. The OLAP cubes thus include preprocessed data aggregation according to the above-stated hierarchical structures of the dimensions and their combinations. It is thus essentially the principle of the n-dimensional cube filled with the most important business data.

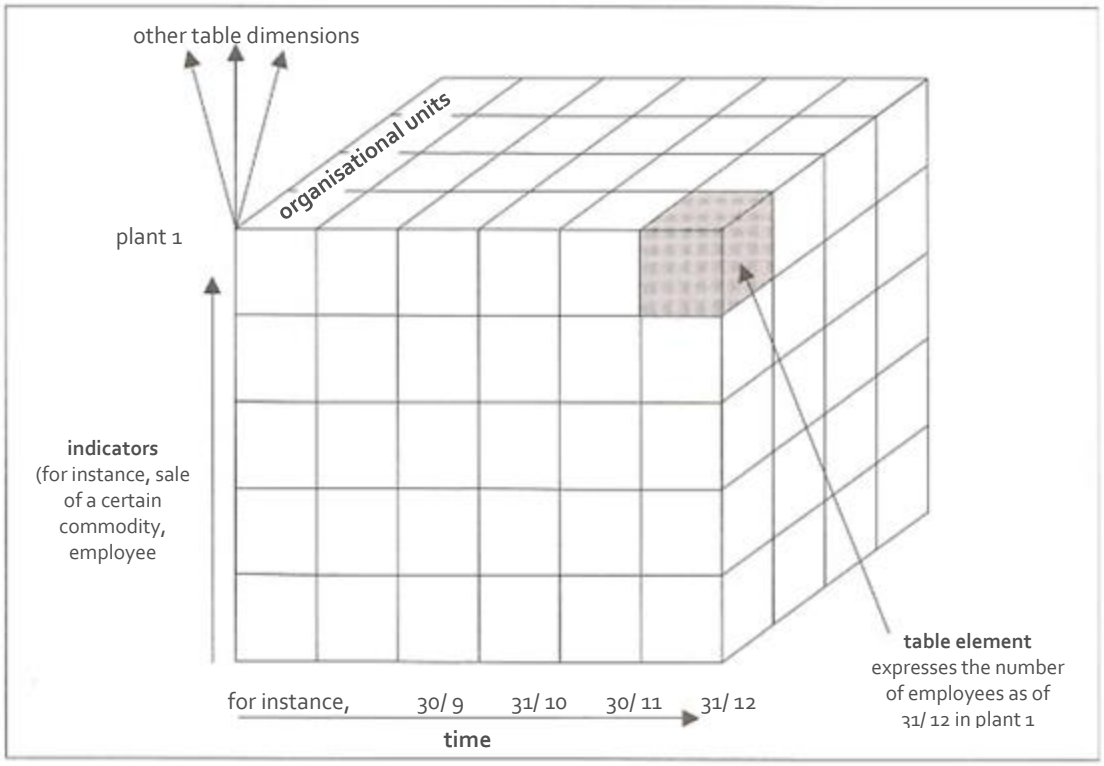


Figure 12 Principle of the OLAP-based multidimensional database (Gála, Pour, & Šedivá, 2009)

This figure shows that the standard two dimensions here are indicators (economic variable) and time. Other dimensions are defined for the individual models according to the needs, e.g. an organisational unit, products, customers, suppliers, territories, competitor, etc. The content dimension is composed of the **dimensional elements**, i.e. concrete factories, plants or customers, suppliers, commodities, etc. The projection of all dimensions to one point constitutes **an element of the OLAP cube**. The OLAP technology is the basis for so-called **OLAP databases**, which comprise one or several related OLAP cubes.

For the analytical systems to provide the required analytical functions and decision-making support, it is necessary for us to be able to view their data simultaneously from various perspectives, which is a problem in the case of transaction application data. Moreover, it is necessary to browse through a large volume of data, calculate aggregation, and this has a negative impact on the response time. The multidimensional databases in the OLAP environment are therefore optimised for storage and interactive use of multidimensional data and their advantage is mainly processing speed, respectively, short response time.

8.2 Major components of the business intelligence solution

The general concept of BI architecture is illustrated in Figure 13 General architecture of the BI solutions.

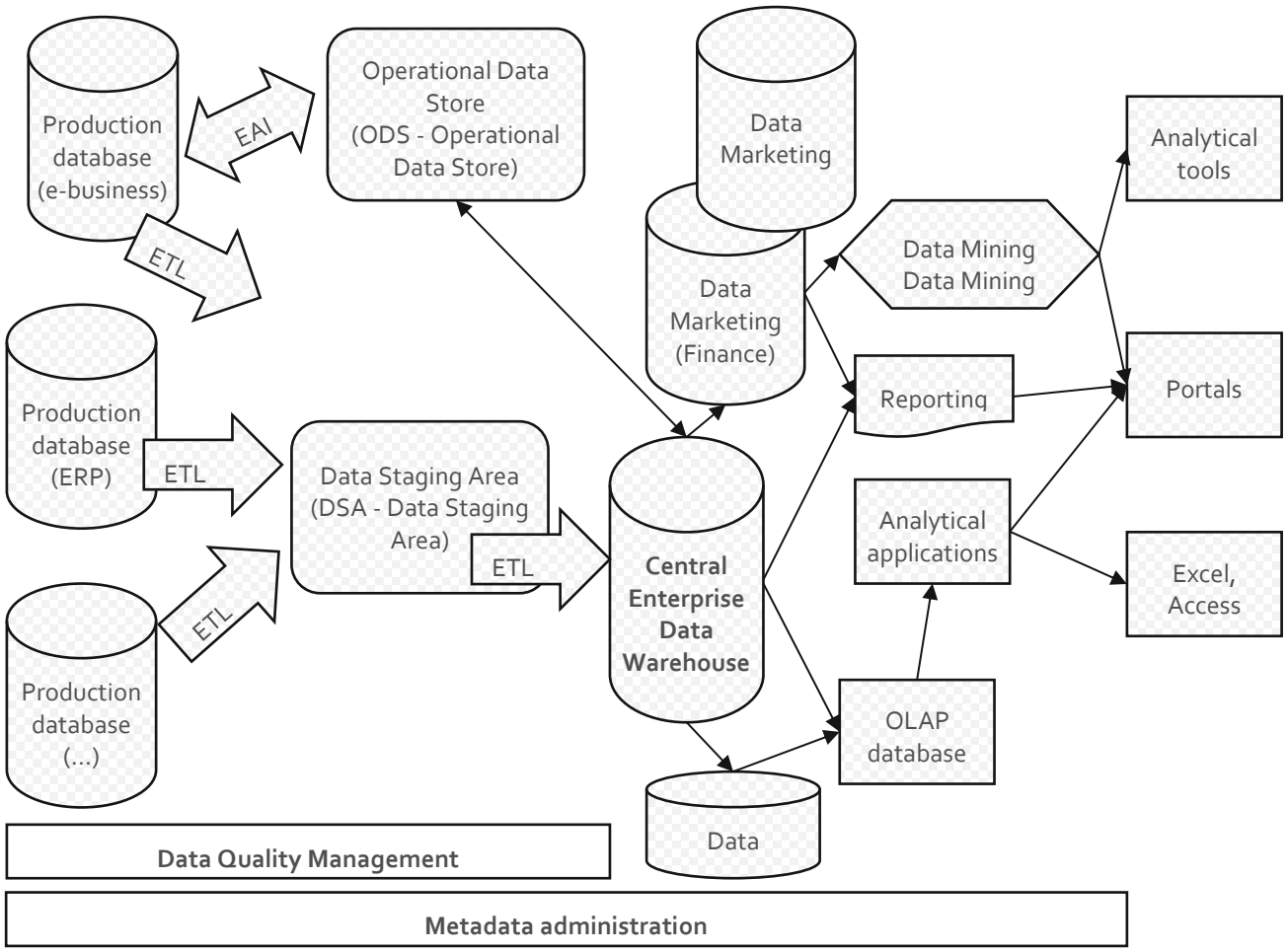


Figure 13 General architecture of the BI solutions (Gála, Pour, & Šedivá, 2009)

At the outset it must be emphasised that the particular arrangement of the components of a BI solution can vary significantly depending on the situation and the needs of the customer or the company. This means that it is in the range from the simplest solutions to the solution of the most complex in terms of technology, financing and labour-intensity. During the period of development in this area, the general concept of BI solution architecture has been established. The variety of problems solved using BI tools as well as a variety of instruments themselves, however, leads to the fact that the general architecture has several development branches, and its concrete applications in real situations differ substantially.

In subsequent text, we shall state the summary characteristics of the individual components of the solutions illustrated in Figure 13 General architecture of the BI solutions.

8.2.1 Production (source) databases

Production (source) databases are database applications (also sometimes referred to as primary LOB - Line of Business, transaction, or legacy OLTP), from which business intelligence applications get data, and do not belong to the group of BI applications. Unlike the BI applications, these systems are not designed for analytical tasks. Examples include database applications, ERP, SCM, CRM, as well as regular files in spreadsheets (Excel) or files in text format with delimited or fixed sentence structure (so-called *flat files*). The source for BI solutions need not be the only database of internal enterprise applications as well as external (e.g. database of business entities, directories, outputs statistical offices or government institutions, etc.).

The production database is the main, and often, the input to the BI. In practice, the spectrum is mostly highly diverse and heterogeneous in terms of both content and technology. Thus, the task of the BI solutions is to ensure analysis of these resources for the needs of the company management and ensure the collection of relevant data for management and consequently their mutual integration.

8.2.2 ETL - Extract, Transform and Load

ETL (Extract, Transform and Load) is one of the most important components of the whole BI complex. A common name for ETL resources is also the **data pump**. Its task is to obtain and select data from the source system (***extract***), convert them to the desired format, clean (***transform***) and load them into specific data structures, respectively, data schema of the data warehouse (***load***). These tools can thus be used for data transfer between two (or more) arbitrary applications and databases. Just like in the case of the tools for ensuring data quality and meta data management, ETL tools gained importance only with the development of analytical applications, i.e. the explicit need for secure data transfer between different application systems within a heterogeneous database environment. ETL tools work in batch mode, data is transferred at once at certain intervals, e.g. daily, weekly, monthly, etc.

8.2.3 EAI - Enterprise Application Integration

EAI tools (Enterprise Application Integration) were created and in the majority of cases they are currently used in the layer of source applications. Their objective is to integrate primary enterprise systems and reduce the number of their mutual interfaces. These tools principally work at two levels:

- at the data integration level where the EAI platforms are used for data integration and distribution;
- at the level of application integration, EAI platforms which are used not only for the integration and distribution of data, but also to share some functions of selected applications.

Unlike ETL tools, the EAI platforms work in **real time**. They find their use in business intelligence solutions mainly in the transformation layer where the EAI tools are used to transfer data to storage in real time, in particular, to the operational data stores. The EAI thus add batch transfer and enable the creation of data warehouses in real time, respectively, Real-time Data Warehouse.

8.2.4 Data Staging Area (DSA)

The purpose of the Data Staging Area (**DSA**) is temporary storage of the data extracted from the production systems and its main task is to support quick and effective extraction (selection) of data. Data Staging Area is thus described here as the first component of BI solutions used for data storage. DSA is used for initial storage of untransformed data from the source systems. It is a non-mandatory component of the BI solution, which finds its application in the following cases:

- in permanently loaded production systems, where there is a need to transfer data with a minimum impact on their performance;
- in systems whose data must be converted to database format prior to processing (for instance, systems that use text files, etc.);
- in the case of a short time interval for extraction of data from the source.

The data staging area (DSA) - thus contains data with the following characteristics:

- detailed - data is not aggregated;
- inconsistent - the data are not controlled against external code lists or other data in the data warehouse;
- do not contain history - only the current data are transferred from the source system;
- changing - usually only the data that have not been processed yet are picked from each image; such data are removed from the DSA after processing and transfer to other BI solution components;
- in precisely the same structure in which they are stored in the source systems.

8.2.5 Operational Data Store (ODS)

The Operational Data Store (ODS) is a further component of the layer, which we need not find in all business intelligence solutions. There are two basic approaches to the definition of ODS:

- The first approach defines ODS as a uniform place for data integration of the current data from the primary systems. It is a source for monitoring aggregated consolidated data with minimal latency after processing (i.e. monitoring in near real time). In many cases, such an ODS serves as a central database of basic code lists

(customer, product) or for support of interactive communication with the customer (for instance, support of workers at the contact centres where the ODS provides the current consolidated customer data, its profile, products used, etc.). The so defined databases support the input and modification of data in real time and are typically connected to the EAI platform.

- The second approach defines the operational data store as a database designed to support relatively simple queries over a small amount of current analytical data. Unlike the first approach, the ODS is created as a derivation of an already existing data warehouse and contains only the current records from the selected quantity of data.

Just like DSA, ODS also contains data without history (only current data) that changes after each download. Unlike DSA, ODS (thanks to the transformation operations) already contains consolidated data, which is consistent, subjectively oriented and also supplemented with aggregation in some cases. The difference between DSA and ODS is in their uses. While the DSA is used only as a temporary data storage prior to its processing in the data warehouse (whereas these data are erased after processing), ODS serves as a database that supports the analytical process. The ODS are created with the objective to provide the users or other systems with access to data for analyses or queries with a minimum delay as compared with their procurement. A typical example of the use of the operational data store is a reference database of products or customers. This reference database is used as a uniform consolidated source of relevant data for all systems or enterprise users.

8.2.6 Data Warehouse (DWH)

The data warehousing technology currently represents one of the most important trends in the development of enterprise information systems. The Data Warehouse (**DWH**) can be defined in many ways. However, we consider the basis as the definition of one of the founders of DWH, William Inmon (Inmon, 2002): "The **Data warehouse** is an integrated, subjectively oriented, permanent and timed data compilation, arranged for support of management needs." These terms can be interpreted as follows:

- **Subject oriented** - data are distributed by type, not by the applications in which they are formed. It is therefore a case where the data of the employees are stored only once, in a single database, a data warehouse, while in the production system the data are usually scattered in different files depending on which application they should be used.
- **Integrated** - the data are stored across the enterprise, and not only within individual departments.
- **Permanent** - data warehouses are designed primarily as a "*read only*," meaning that no data are created and the user cannot change them using the user tools. Data are loaded into the DWH from the production databases or other external sources exists here throughout the life of the data warehouse.
- **Time differentiated** - in order to perform analyses for certain time periods, is required to be stored and to DWH data history. The loaded data must also carry information about the time dimension.

8.2.7 Data market (DMA)

The principle is similar to the data marts, as in the case of the data warehouses. The difference is that the Data Marts (**DMA**) are intended for a limited number of users (department, division, branch or plant). The essence is thus decentralised data storage, which will be gradually integrated into the enterprise-wide solutions. In some cases, the DMA after the creation of an enterprise-wide data warehouse also serves as an intermediate step in the transformation of data from production databases.

The Data Mart is thus a problem-oriented data warehouse, which is designed to cover the specific problems of the circle of users and allow flexible "ad hoc" analysis. The result of DMA creation is shortening of the payback period, reduced costs and a significant reduction in their implementation risk.

8.2.8 OLAP database

The OLAP databases comprise one or more associated OLAP cubes. Unlike the data warehouses, they usually already contain preprocessed aggregated data according to the defined hierarchical structures of dimensions and their combinations (see text above).

8.2.9 Reporting

The client applications can be distinguished in BI basically on two levels, firstly at the level of reporting, i.e. the analytical tables and surveys implemented based on the queries to the data warehouse databases, or to multidimensional databases, and secondly the analytical applications, where their greater flexibility is assumed with respect to the current requirements of the user. We shall continue to comprehend **Reporting** as activities related to querying the databases through the standard interfaces of these databases (for instance, SQL commands). In the context of reporting, it is possible to identify the so-called:

- Standard reporting, where pre-set queries run in certain time periods;
- Ad hoc reporting, where the queries to the databases are (mostly) single-purposely formulated and explicitly created by the user.

8.2.10 Analytical applications

Analytical applications are a type of BI client applications for which it is important that:

- they are designed specifically to provide "management" information - enabling the monitoring of business processes, fulfilment of objectives of the organisation, etc.
- they are capable of accessing specific data as well as creating aggregated data;
- they provide tools for on-line analysis that mainly includes analysis of trends, *drill up*, *drill down*, *slice and dice* and identification of exemptions;
- they are easily operated (on a standard basis using a mouse or *touchscreen* technology and provide a high predictive value of the outputs through the graphic user interface.

The analytical applications may run in different technological environments. With regard to the cited required flexibility, however, client applications are mostly implemented above the OLAP databases. They are created and operated using various resources, either **specialised products** for these applications, for instance, ProClarity, Oracle Discover, etc., or using **office software**, for instance, Excel, Access, or applications developed in specialised programming languages.

The analytical applications in the BI thus need not be solved only by means of specialised tools, but very effectively by using the resources of office software, most often Excel or Access. It has a great advantage in the easy availability of these resources, in particular the minimum cost and the knowledge of the users who normally work with these resources. The implementation of BI functions is typically done using Excel contingent spreadsheets that allow flexibility to change the content of the spreadsheet rows and columns.

8.2.11 Data Mining

Data mining allows the identification of strategic information in data using special algorithms. It is an analytical technique closely related to the data warehouses as a high quality data resource for these special analyses. **Data mining** can be characterised as the **process of extracting** relevant, previously unknown or undefined information from very large databases. An important feature of data mining is that it is derived from analysis of the data content rather than the analyses pre-specified by the user, and it mainly concerns derived predictive, not only descriptive information. Data mining is used by managers to discover new facts, which help focus attention on the essential factors of the business, allow testing of the hypothesis, reveal the hidden correlations between economic variables and the like in the ever-accelerating and increasingly complex business environment.

Various types of tools exist for data mining. Some of them are designed for specialists with knowledge of statistics, some for the management staff. The **final destination** of the data mining tasks is, however, similar to most of the business intelligence tasks that are designed to provide strategic information to a wide range of managers in the organisation. What distinguishes data mining from other statistical tools is just its focus on different users. Statistical data mining tasks are performed automatically according to specific algorithms, so the target user can be a manager without special knowledge of statistics, not just a specialist who subsequently prepares reports for the manager.

Data mining is based on a number of mathematical and statistical techniques. Examples are the **decision-making trees**, which is a predictive model that displays data in the form of a tree, where each root determines the criterion for subsequent distribution of the data to the individual leaves of the **neural network**, which is also used for creation of

predictive models. Other examples include clustering and classification. **Clustering** is a technique used to divide the data into groups with similar characteristics, **classification** defines the essential attributes of the groups in the form of classification criteria. It is evident that data mining techniques would require far more space, but in this case we only refer to specialised literature, for example, (Rud, 2001).

9 ERP II, MES - MANUFACTURING EXECUTION SYSTEM, APS - ADVANCED PLANNING SYSTEM, MRP - MATERIAL REQUIREMENTS PLANNING, MRP II - MATERIAL RESOURCE PLANNING

9.1 Operative production management

During automation it is necessary to ensure not only the link to the logistics processes, but also to the production process itself. Acquisition of operational data in real time is usually done according to so-called **Manufacturing Execution Systems** (**MES**). In the hierarchy of the enterprise information systems, it comprises the layer between the technological level of production and the ERP systems. MES is thus concerned with the detailed collection of data and their processing for the purposes of evaluation of production from many various angles of view and operative management Figure 14 Position of MES in corporate architecture.

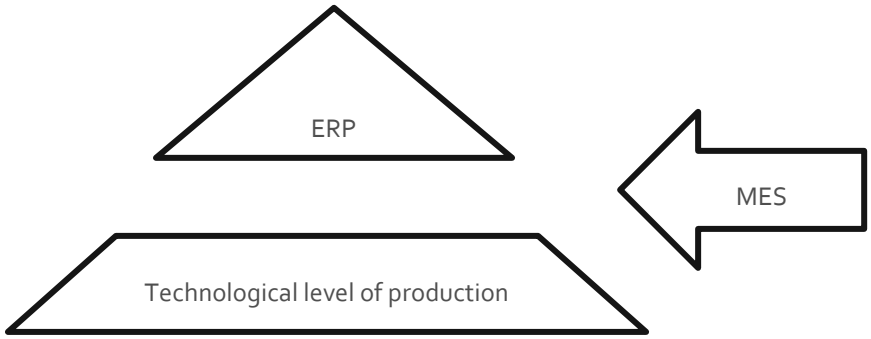


Figure 14 Position of MES in corporate architecture (Sodomka, P. , Klčová, H., 2010)

9.2 Overview of the basic management methods and principles

Modern information systems provide their users with standard and less conventional management methods, which affect not only production, but also other related processes. These methods have evolved gradually and many of them are already known for decades. The development of enterprise informatics in recent years led to their full integration into algorithms of software applications and thus also offered hitherto unprecedented opportunities of advanced production planning and management also to the smaller organisations.

Production management based on minimum inventories is one of the first methods applied in the information systems. The method is based on the decoupling of the production process and its division into several stages. The inventories stocks between the individual stages are controlled. If the supply drops below the scheduled threshold, it is replenished and the production flow will continue to run relatively smoothly. The static management method, however, is difficult to adapt to changes and thus tied unnecessary costs to the necessary inventories.

Material Requirements Planning (**MRP**) as compared to management based on minimum stocks is characterised by close links to the logistics chain (supply, storage, transport). MRP creates a balance between the customer requirements and their fulfilment. MRP keeps only the necessary inventory and fulfils unplanned requirements based on time priorities.

Combination of MRP and inventory management according to the minimum inventory, makes it possible to manage the particular part of the material for which it is advantageous. The delivery dates for customers then set the limit for the sequence of delivery periods of the individual material items and processing times, which are set out in the production technological process.

The MRP method automatically counts on unlimited capacities. But this is practically only a rarely useful prerequisite. Therefore, the concept was extended to **Manufacturing Resource Planning** (**MRP II**) so as to include the precise control of procurement planning in relation to manufacturing and sales. Material consumption is determined based on the requirements derived from individual production orders. The subsequent material requirements were defined according to the consumption of resources required to manufacture these orders.

The MRP II method is thus capable of providing a time and quantitative link between procurement and sales. It is essentially an iterative process in which the inputs are the material and capacity requirements together with the manufacturing start or end date. The system will then schedule manufacturing according to the specified requirements, either from the initial deadline onwards or backwards from the final deadline.

If you cannot make a final schedule, then the schedule is repeated, but this time with modified parameters - changed deadlines, increased capacities, etc. This situation may occur, for example, when the final manufacturing deadline has been set in such a manner that the deadlines for delivery of materials have long since expired. MRP II is one of those methods that require the relatively large computational capacity of the information system.

The MRP II method represents the push control principle according to which the product is manufactured according to a schedule and gradually "pushed through" the business processes to the final customer. The manufacturing plan is created on the basis of the sales forecast.

The MRP II concept is suitable mainly in the area of utilisation of manufacturing capacities. The main advantage is the low level of production in process and manufacturing inventories, good knowledge of the individual material needs, opportunity to generate various solutions for the main manufacturing schedule and monitoring of the running manufacturing times.

However, MRP II responds to the change management requirements with difficulty, for instance, in relation to construction. It is not possible to continuously change the plan after every change of input requirements. Repetition must be stopped and further changes are then solved operatively or using other, often visualisation methods (planning board). Modern information systems are, for instance, capable of offering on-line visual simulation. If the simulation is not available, you can use a Gantt chart that clearly shows each operation and allows intuitive changes to the plan while respecting the limited capacities.

The MRP II method is currently used by the vast majority of ERP systems available on the Czech market. Some products are exclusively focused on just consistent application of algorithms MRP II, for example, **Infor ERP MAX+**, others enrich this push method with the advanced TOC (Theory of Constraints) elements, for instance, **Infor ERP SyteLine**, **QAD Enterprise Applications** or **IFS Applications**.

In the management of the manufacturing and logistics processes together with the push methods, the methods on the push principle are also applied. We then collectively designate them as **JIT** (**Just-in-Time**).

JIT is a pull control principle, according to which manufacturing is initiated by the customer. All the essential components are pulled "just-in-time" by the corporate processes up to the final assembly of the product and handed over to the customer.

It is possible to view the JIT principle from two perspectives. The traditional, narrower concept talks about the use of JIT management at various stages of production and between individual plants. "Just-in-time" production requires delivery of materials, products or services within the deadlines required to activate the production sub-processes that directly respond to customer demand. The result is mainly a cut in the inventory storage costs and time losses.

The broader JIT concept comprehends it as a method of linked processes within the supply chain.

9.3 Production

The *Production* module is particularly focused on the planning of production, respectively, production orders, monitoring of their fulfilment levels with regard to the deadlines, monitoring and evaluation of the warehouse stocks, production management at the operative and workshop management level.

The *Production* module offers the following main functions:

- **bills of material** - evidence and administration of bill of material items and their individual characteristics (normal item, subcontract, derived production, etc.), allocation of the appropriate bill of material to the production order;

- **product configurator** - option to configure selected products, determination of price data according to the variables in the models of the individual products, setting of delivery deadlines;
- **administration of production orders** - visualisation and monitoring of sales orders, creation of production orders, for instance, from sales orders, management of the procurement of services from subcontractors, planning of individual production orders;
- **production prognosis and planning** - optimisation of production planning respecting the limited capacities and availability of materials, determination of the earliest possible deadline for delivery of the production orders according to the demandingness of the production procedures;
- **operative production planning and management** - operative planning of production operations, re-scheduling of production operations in case of required changes, evaluation of the bottlenecks in production, planning of the use of alternative production centres with regard to the load of the capacities;
- **management of production procedures** - definition and planning of technological procedures, planning of production capacities, calculation of waste from the production operation, definition of resources and procedures for specialised production procedures;
- **workshop production management** - evidence of products, production resources according to the orders in the workshop and production operations, preparation of the schedule for feed of materials to the workshop, planning of manufacturing jigs, evidence of the working time and salary slips, evidence of the production done;
- **monitoring of the production situation** - evidence of work-in-progress, current condition of products, real production costs;
- **monitoring of production tasks** - monitoring of various types of tasks, for instance, preparatory, partial, etc., monitoring of the consumption of production resources according to the tasks (material, working, etc.), analysis of the use of production capacities and re-scheduling of production procedures in relation to their load;
- **monitoring of production costs** - monitoring and evaluation of the costs of production resources, cost analysis according to the production centres.

The *Manufacturing* module thus provides an opportunity for forecasting and planning of production, quick restriction to new or changed customer requirements, option to optimise the manufacturing procedures and the evaluation and restriction of production constraints.

9.4 IS for support of the production systems

9.4.1 Advanced Planning and Scheduling - APS

An integral part of SCM is a strong link with the production planning down to the level of detailed workshop scheduling. This area of special applications within the Enterprise IS is designated as APS (*Advanced Planning and Scheduling*). Often, this group of applications is designated using the common abbreviation APS/SCM. APS systems have a similar role within the enterprise like the one solved by the SCM (*Supply Chain Management*) systems outwards.

APS is characterised by the simultaneously synchronised planning of all resources while respecting all the known limits. The input conditions and output parameters are defined in the system and the APS system subsequently has the task of identifying an optimal solution variant. Change of input parameters can also change the resulting system recommendations. Optimisation algorithms work on the basis of the criterial functions, where each requirement is evaluated.

9.4.2 Manufacturing Execution System - MES

The area of corporate logistics is really rich in applications, which form the mosaic of the enterprise IS, and for this reason, another important group should not be omitted, which after APS is even closer to the actual production system because it directly realises its management. This application group is designated as MES (Manufacturing Execution System) (Sodomka P. , 2006).

The MES according to the MESA (*Manufacturing Enterprise Solutions Association*) support the following areas:

- resource management and allocation,

- operative planning and scheduling of production,
- dispatch production control.

10 ERP II, ECM - ENTERPRISE CONTENT MANAGEMENT, DMS - DOCUMENT MANAGEMENT SYSTEM, CMS - CONTENT MANAGEMENT SYSTEM

10.1 Document and content management

Document and content management is focused on non-structured and semi-structured data. These are text documents (contracts, offers, but also output spreadsheets, e-mail messages, etc.), graphical data (images, photographs, CAD system outputs, etc.), multimedia data (video, audio, animations).

Document and content management includes a complex of tools and approaches that allow suitable capturing of the set of non-structured and semi-structured data and offer them to the user in the required form.

The subject-matter of the processing using document management tools is the document, which is a set of non-structured or semi-structured data of various types and forms. Documents can be broken down into:

- hard copy or electronic documents,
- documents that are outputs of other systems (for instance, output spreadsheets, invoices, etc.),
- internal documents (for instance, guidelines, quality documents, product documents, etc.),
- documents from data exchanges with partners or other subjects from the corporate environment (for instance, e-mail messages, downloaded websites, etc.).

The document is the basic data unit, which we record as a complete unit. A document may be a text, image, video, that it may be of various type. Of course, the document may also be composed of other documents. For instance, a tender bid may be a document, which contains text, but also contains other embedded documents (output accounting spreadsheets, organisational structure diagram, etc.). In principle, the document can be likened to an object. The content shall be comprehended as the semantics of the document, i.e. the significance of its individual parts. Everything is targeted at facilitating the automated processing of the documents themselves and their content. For instance, in a case where an accounting fact changes prior to submission of the given bid, it should be possible to either amend the bid automatically or send a call to the bid processor to amend the data.

10.1.1 Document life-cycle

Comprehension of the life-cycle of the document makes it possible to define the performance of the systems, which shall improve the efficiency of the administration of data-related processes. It is generally possible to characterise the life-cycle of the document in four basic phases:

1. procurement of an electronic document,
2. allocation of the document to the system,
3. document processing,
4. document archiving.

Procurement of an electronic document

The documents come to the organisation in hard copy or electronic format or are created in electronic format within the organisation. In the case of hard copy documents, it is necessary to ensure their transformation to electronic format (digitalisation). The activities related to the digitalisation of the documents are designated differently in different systems and in this case we encounter terms like "imaging", "digitalisation of data", "data capture", or the designation "Fixed/Final = Form Management". Figure 15 schematically shows the activities related to the digitalisation of hard copy documents.

In the area of document digitalisation, we encounter the following technologies:

- OCR (Optical Character Recognition) - technology for recognition of machine printed and typewritten text,

- ICR (Intelligent Character Recognition) - technology for recognition of handwritten text,
- OMR (Optical Mark Reading) - technology for recognition of checked items and their conversion to values; the technology is also often designated as Mark Sense Recognition,
- BarCode Recognition - technology for identification, recognition and conversion of barcodes to characters.

Digitalisation of documents includes the activities of extraction of data from free forms. A free form may be a digitalised document (for instance, digitalised invoice received). Such documents contain a lot of partial information, which should suitably be automatically processed in other systems. In order to obtain such information, it is necessary to analyse the document and search for the specific data. In the document, they are often identified by a label, for instance, the maturity date, account number, etc. After the search, it is necessary to mark, mine and store the data for further processing - Figure 15 Diagram of the digitalisation of documents.

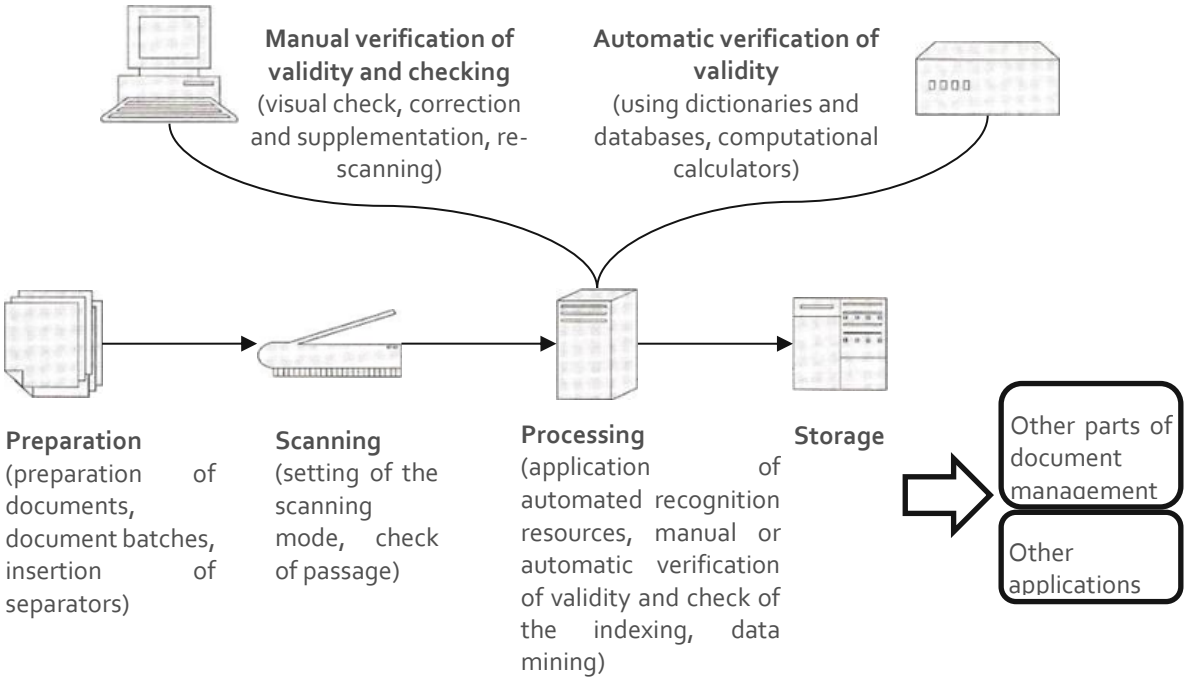


Figure 15 Diagram of the digitalisation of documents (Gála, Pour, & Šedivá, 2009)

Further documents are already created or come into the organisation in electronic format as:

- Electronic messages and documents from other systems. These are messages and documents that come from the surroundings of the organisation, for instance, e-mails or downloaded websites, but this category also includes data from other enterprise systems, for instance, output reports, structured data obtained from other systems and added to the documents (price table embedded in an offer, profit and loss account embedded in the annual report, etc.).
- Documents created directly and data created by various authoring tools, i.e. documents and data in all sorts of formats (text, image, video, audio) created using all sorts of editors directly in the ECM.

Allocation of the document to the system

At the moment when an electronic document is available to us, it is possible to allocate it to the system. Within the framework of this stage, it is necessary to allocate a unique identifier to the document, classify and supplement it with other descriptive attributes, i.e. perform taxonomy of the document. The given functions then facilitate the efficient processing of the document or a search for it. The classification is often associated only with the solution of security, i.e. with the mechanisms for distribution of data according to the required level of protection (known, confidential, secret, etc.). In the broader sense of the word, this concerns the mechanisms for addition of meta data that allow the description of non-structured data using structured data. The scope of data classification and taxonomy depends on the approach of the given organisation and specific type of data. Different meta data shall be used, for instance, for graphic objects, others for contracts and others for product documentation.

Document processing

It is only the processing of a small quantity of documents (for instance, collection of laws) that ends in allocation to a system or submission to some other system (for instance, data mined from digitalised forms and documents, which are submitted to the ERP or other systems for further processing). In this stage of the life-cycle, we encounter the necessity:

- to deliver the document to the given person for processing, whereas the processing may also be done by several persons in sequence or simultaneously;
- to modify the content of the document while ensuring retention of the original versions;
- to ensure the publishing of the document. Depending on the final output format, it is possible to divide this part into data, which remain in electronic format at the output (for instance, websites, e-mail, PDF documents, etc.), and data, which are printed. Depending on the extent of printing and the volumes of data, various robust solutions are created, which include technical resources ranging from standard printers to special lines that allow compilation, for instance, of printed letters. We shall still recourse to the area of electronic data publishing in relation to the editorial and publishing systems. Apart from evidence of the outputs from the system, it makes it possible trace the subject to whom the data was provided, when and by what communication channel (by publishing on the Web, delivery by electronic mail, classic post, etc.). For some types of documents (guidelines, procedures) this part also includes the so-called familiarisation processes with support for provable recording that the worker has acquainted himself with the document.

Document archiving

The last stage of the document life-cycle is its archiving. The rules applied here depend mainly on the type and character of the document and laws. In the case of hard copy documents, they are archived and shredded upon lapse of a certain period of time. In the case of electronic documents, they are logically marked by the creator that they are intended for archiving. In case of storage in the electronic archives, specific devices are used to ensure secure storage on large capacity media, the documents are compressed (packed) and collaborate with the "jukeboxes" that contain the individual archiving media.

10.1.2 Document management

The tools that are used to support the activities related to the life -cycle of the document are characterised as document management tools (DMS - Document Management System). The significant functions that differentiate the DMS from bare storage of documents in the computer are mainly:

- **Document versioning** - most of the documents are not permanent after creation because they are often modified and supplemented in the course of time. The logging of the document history including marking of the changes made (reviews), just like the option to mark the currently valid version of the document and the option to simply return to the previous version is a significant feature of the DMS.
- Support for **definition of the document life-cycle** - includes the option to use the workflow tools or the principle of document classification in containers to which operators are allocated to pick-up, process or transfer the documents to other subjects. A further function is marking of the documents (for instance, reviewed, approved, published, archived and withdrawn from circulation).
- Strong support for **searching**, both by attributes (author, date of creation, ...) as well as full text search. Besides the actual search for a document, a strong property of the DMS system is considered to be the search for or detection of changes in the document and its versions (i.e. by comparison of the documents). The resources that support document search functions are either directly DMS functions or more often a component that is shared by different applications across the organisation.
- Support for **personalisation**, which guarantees direct "delivery" of only those documents that are relevant to a particular user, which reduces its "information saturation".
- Support for **customisation**, which ensures that the user can customise the document environment according to own requirements, i.e. create own bookmarks, pre-set selected values, etc.

10.2 Knowledge Management

Knowledge Management (KM) is one of the areas to which the organisations are devoting increasing attention. Its objective (in simple terms) is:

- to connect those who know with those who need to know,
- to transform the personal knowledge of the individuals into the knowledge of the organisation (enterprise).

On the one hand, such systems exist separately, but now have strong ties to the ECM integration, or are more often direct components of the ECM. These solutions work with **specific knowledge** that can be found in the documents of the organisation, and with so-called, **implicit (tacit) knowledge** that is "in the heads" of the employees. Within the framework of KM, the following groups of persons are defined - Figure 16 Activities of subjects:

- **Knowledge broker** - responsible for defining the overall scope of the enterprise knowledge. He is capable of identifying potential conflicts, which can cause information overload caused by outdated, redundant or poorly organised information. He is responsible for setting strategy discovery, cleansing the knowledge and for planning appropriate ways of knowledge transfer between the suppliers and the users.
- The **Knowledge Supplier** - is responsible for content creation and transformation of the users' personal knowledge to corporate knowledge or for content management, creation, maintenance, testing, and delivery of knowledge to the user.
- The **Knowledge Consumer** - obtains and uses the knowledge and provides feedback, which leads to improvement or modification of the knowledge.

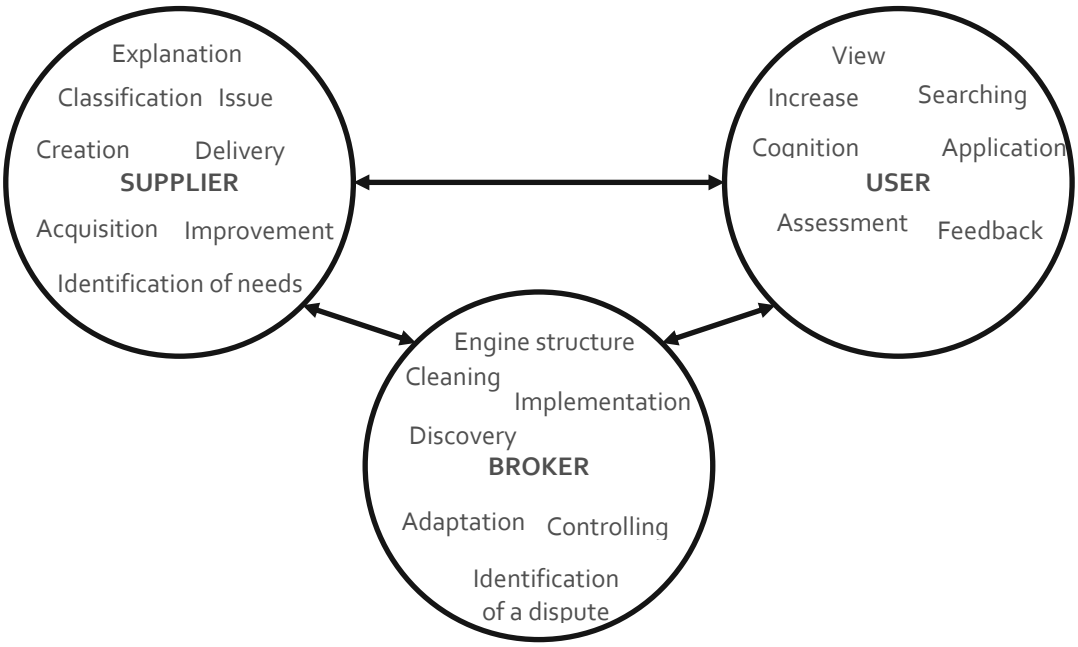


Figure 16 Activities of subjects (Gála, Pour, & Šedivá, 2009)

KM systems support a variety of activities and allow:

- **Interlink of the knowledge of the suppliers with the knowledge of users** - the information stored by the suppliers is made provided according to the immediate needs of the users. For instance, at the moment when the user interacts with the application selected within the given process and is not capable of solving the problem, all the information stored in the system is visualised to him. Of course, access rights also exist at this level, so the user can only obtain the contact of the knowledge owner instead of the knowledge.
- **Interlink of individuals** because it often applies that finding the right information in fact means finding the right person who has the knowledge. The KM system allows the user to get information about who is in possession of the relevant knowledge, including where the person is (e.g. by displaying the organisational structure), his working program (by visualisation of the calendar), etc.

The KM systems cooperate with ECM and BI in the creation of qualitatively new content that would be more suitable for the organisation

10.3 Basic components of the document management systems

A fundamental breakdown can be made on the basis of the document life-cycle:

- capture;
- management;
- collaboration;
- storage;
- preservation;
- delivery;
- workflow;
- security.

Commercially available solutions of document management systems at present do not generally include all the components described below. These solutions are usually accompanied by other commercial solutions and solutions are integrated together - Figure 17 Basics of document management system components.

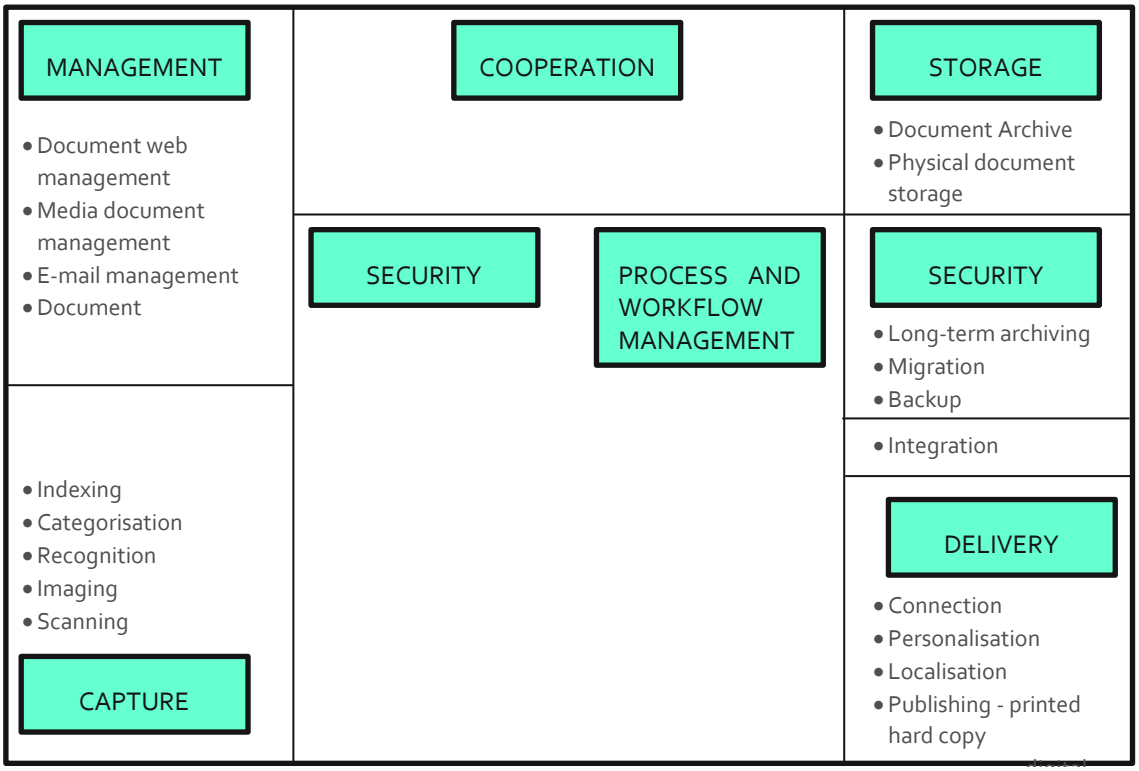


Figure 17 Basics of document management system components (Tvrdíková, 2008)

Workflow

Workflow is the automation of the entire business process during which documents, information or tasks are transferred from one party to the process to another, according to a set of procedural rules, possibly by automating part of this process. The process is at the same time defined as a set of one or more related activities that jointly contribute to the achievement of the corporate goal.

The workflow system is therefore a tool for automation of the corporate, in particular the business processes (e.g. payment of invoices, mortgage approvals, quantifying the growth of the company costs, the turnover development plan) and the management processes.

Workflow management is done by a workflow management system that defines, creates and manages the process, is

able to communicate with workflow participants and, if necessary, also run other applications.

The workflow management system utilises existing communication resources to transmit the necessary information, increasing the efficiency of the whole process.

When using the workflow system, we can always trace the document processing stage, who created it, who reviewed it and who approved it, which ensures control over the documents.

11 ERP II, ERP BRANCH SOLUTION, EXTERNAL RELATIONS MANAGEMENT APPLICATION, E-BUSINESS SUPPORT

Vertical solutions in ERP systems

Typical industrial (sectoral or also vertical) solutions are usually prepared by the manufacturers and their development partners according to the requirements of the industrial sectors. They include predefined operation and functionality of the system corresponding to the field of activities, which are then further adjusted according to the customer requirements. Such industry solutions that include extensive know-how from implemented projects in a specific vertical axis are very beneficial for a user organisation. They bring:

1. Standard procedures from the given business field.
2. Best practices for the implementation of specific business agendas (e.g. in the management of packaging materials in the food enterprises or technical preparation of in primary mechanical engineering and assembly).
3. Easier and cheaper modifications for the client according to his requirements.

However, not every industry solution is created on the basis of broad knowledge with the objective to prepare a pre-defined framework of standard procedures for further modification. Some producers of ERP systems create an "industry solution" on the basis of a single implementation and customisation of a business and then offer the same to other companies in the same industry.

Without years of knowledge gained through the implementation of a series of projects with multiple organisations and world leaders in the given business sector, a specific modified project based on the requirements of one, actually won client is created that has many inherent pitfalls for it to be "repeated several times successfully" with other customers. Although it can bring some knowledge of the processes and procedures from a similar organisation, it mostly does not constitute a predefined standard which can be the basis for economic and easy creation of the necessary user customisation. It also may not provide all of the important best practices, on the contrary, it can include very specific practices and procedures that are unsuitable for other organisations, which the client shall eliminate sooner or later or unsuitably adjust to. Such solutions are too expensive and inefficient for clients other than those for whom they were developed. Reputable suppliers (e.g. Siemens) designate them as customer, not industrial or sectoral.

We can encounter incorrectly classified professional solutions (created according to one client) particularly among the suppliers who lack an adequate number of quality workers and a corresponding knowledge base for the development of standardised sectoral functionalities.

World ERP suppliers have the opportunity to offer the best standards and practices established for each sector based on the projects and the experience gained in many European and global enterprises to their customers. It's obviously not the rule for all suppliers. Some are facing very long vertical solutions transfer time, while others leave too much free rein to their partners, who then develop a customised solution that they then purport to be a vertical solution.

AXIOM SW is one of the successful suppliers, who managed to transfer the vertical solution for car importers and dealers from the Czech Republic directly to the global market. To focus on this speciality, the company during more than a decade of development has come up with customisations based on Microsoft Dynamics NAV. For such vertical solutions to compete on a global scale, Axiom SW has come up with the idea to apply for its international certification. For Microsoft partners the highest level of certification is the opportunity to get the so-called Certified for Microsoft Dynamics rating. Currently Several hundreds of solutions have this rating worldwide. One of them is offered by Axiom SW under the trade name Automotive Business Solutions.

A good model example of how the creation of a vertical solution can do good service for the entry of a company is IFS. It creates them for some industries on joint-venture basis with major global customers, for instance, the implementation of the IFS Defense solution, which was created in collaboration with the industry-leading defence industry company BAE

Systems.

Offer of global ERP systems for industry

The typical global ERP solutions competing in the segment of medium-sized manufacturing companies include SAP Business All-in-One, SAP Business One, Microsoft Dynamics AX, Microsoft Dynamics NAV, Infor ERP SyteLine, QAD Enterprise Applications and IFS Applications.

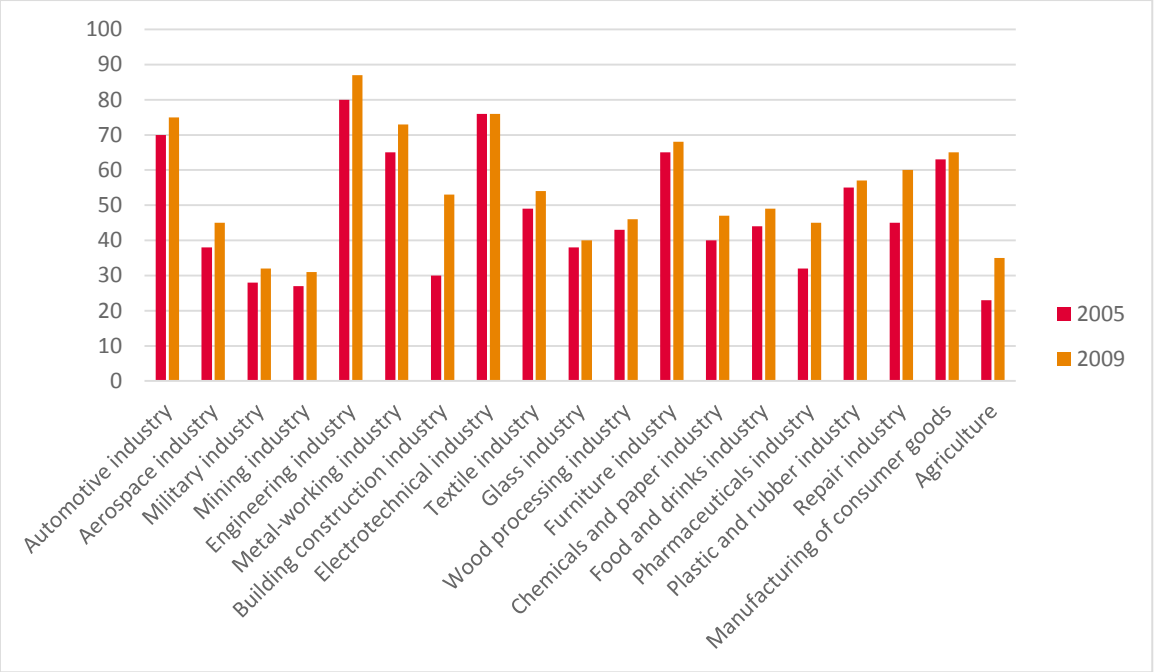


Figure 18 Vertical solutions in ERP systems - Part One (Sodomka, P. , Klčová, H., 2010)

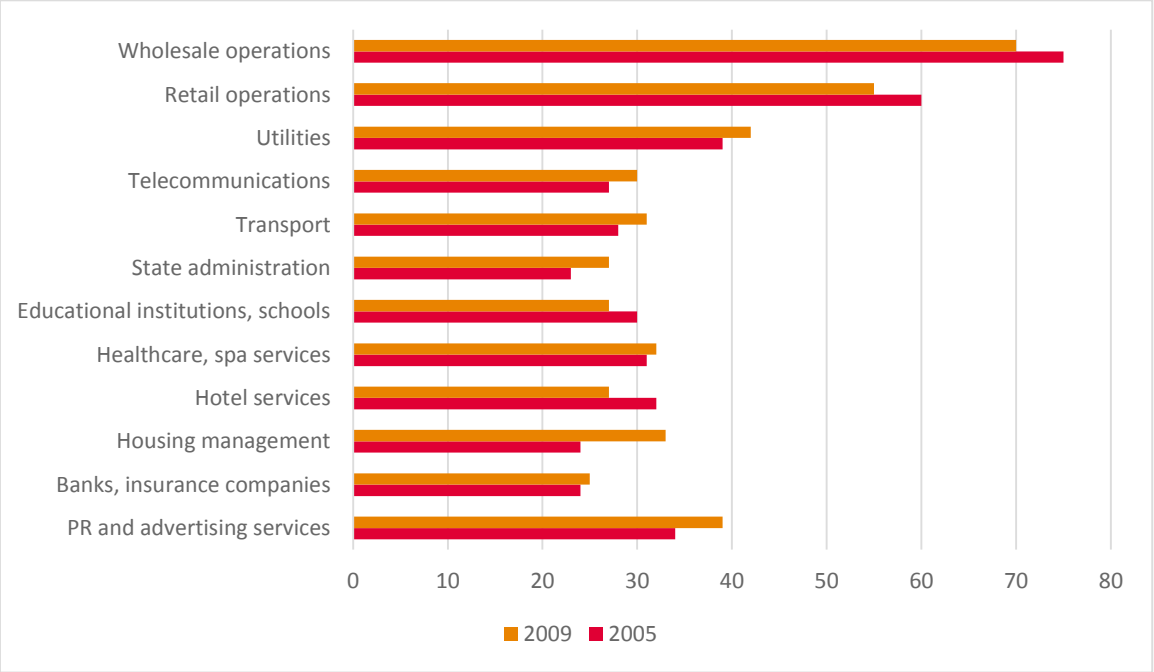


Figure 19 Vertical solutions in ERP systems - Part Two (Sodomka, P. , Klčová, H., 2010)

11.1.1 Service administration

The Service Management Module is focused on support for the management of service operations and evaluation of

their economic aspects, i.e. costs and revenues associated with them. An example of its functionality is documented in Fig. 7.10.

The Service Management Module provides the following functions:

- service agreements - support for the creation of service agreements, the content and frequency of service operations, fixing of the price of service operations and their terms of payment;
- objects requiring service - registration of objects (e.g. production equipment) requiring service, solution of links to the service agreements, evidence of replaced parts of the object using the bills of material;
- service orders - manual or automated creation of service orders according to the service agreement, specification of the individual service cases in relation to a service agreement;
- management of repairs - records of reported problems for every service job, filing of complaints received, monitoring of the progress of repairs and finishing solutions, identification of defective products, analysis of trends in service for anticipation of customer needs;
- pre-paid service - billing and invoicing of prepaid service in relation to the service agreements, optimisation of service revenue and pricing according to the price indexes, etc.

11.1.2 Project Accounting

The Project Accounting module provides comprehensive support for project management, and is also integrated with Microsoft Office Project Server 2007. An example of its functionality is documented in Fig. 7.11.

The **Project Accounting Module provides the following functions:**

- specification of the projects - specification of the hierarchical structure of the project, specification of the teams and distribution of works, combination of various types of projects in a single hierarchical structure, including the determination of the price characteristics, time and material demandingness, etc.;
- project management - monitoring of actual project costs versus budget, accounting for travel expenses, evaluation of the planned and actual hours consumed, analysis of the budget and actual cash flow, billing analysis in comparison with the original offer;
- project-related billing - creation and editing of invoices according to the consumed hours, expenses and other items;
- revenues and work-in-progress - evidence of the revenues and pairing with the project costs, fixed price accounting and revenue deferrals according to the percentage of completion, evidence of work-in-progress as of the given date;
- project supply chain - tracking of manufacturing operations related to the project including the evidence of manufacturing costs, evidence of purchase orders and project requirements, creation of offers and sales orders related to the project.

11.2 e-business support

The objective of this chapter is to get acquainted with the information technologies that support the development of e-business and successful business in the digital environment. The modern Internet is conquering its position in the world of business. It is attractive to the users mainly for the reason that it provides them with a large volume of variegated services. The implementation of electronic tools in the business operations of the enterprise is becoming a very effective option not only for establishment of a position on the emerging electronic marketplace but also offers customers better quality satisfaction of their needs.

11.2.1 Types of e-business tools

e-business tools are usually classified into specific logical units, see Figure 20 e-business tools

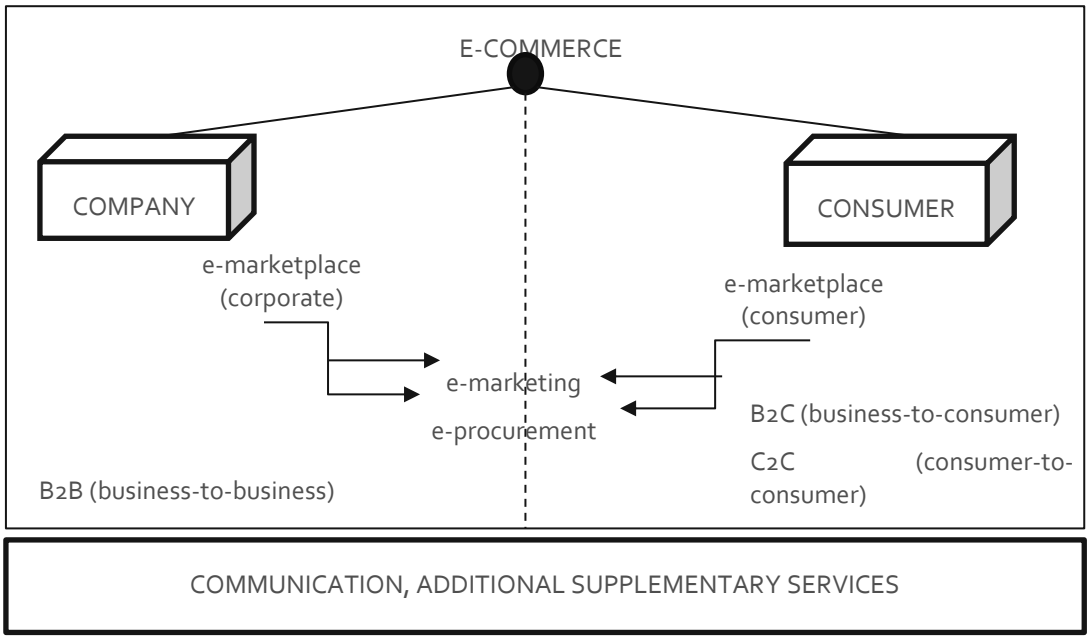


Figure 20 e-business tools (Tvrdíková, 2008)

The precise content of the terms e-business and e-commerce continues to be a subject of discussion. The Czech language uses equivalent terms that do not really fit, i.e. electronic shop or electronic commerce. (For this reason, the terms are given in the English language in the following text.) The degree of electronisation is gradually changing in the e-shop concept. At the beginning it included the existence of e-mail in the company, which was used for communication with the clients and sending of orders. Later, this idea expanded with the existence of the website, where the company presents its offer of products and services; in some cases, it is possible to see an order form that can be filled in and sent on the website. Today, e-commerce is comprehended more comprehensively:

E-business or business on-line is a way of communication and commerce that uses the Internet as the main tool. This term is often used as a synonym of e-commerce, but the concept of e-business is more general. The term e-business is understood more broadly than e-commerce, perhaps like a subset of business itself. Websites focused on e-business are usually very complex (search engines, catalogues, the option to place orders, payment system, additional services). E-business (electronic business) is a series of processes pursuing a specific objective, involving more than one entity and implemented by electronic means.

E-commerce refers to the use of modern information and communication technologies to improve the efficiency of relations between enterprises and between individual consumers. It includes not only error-free electronic transmission of information and documents, but also the actual conclusion of contracts and strategic business partnerships through the Internet. E-commerce is a series of processes associated with the course of business transactions undertaken by electronic means.

E-marketplace is a virtual, on-line marketplace where supply and demand meet on-line. Its main advantage over standard "brick & mortar" markets is the possibility to effectively and conveniently compare prices, delivery and payment terms, and especially the technical parameters of the individual products. We differentiate the consumer e-marketplace that works on the B2C (business to customer) principle and the corporate e-marketplace, where only the businesses trade with each in B2B (business to business) form.

E-procurement: For the present, the Czech language does not have a fitting equivalent. It can very loosely be translated as "acquisition", "procurement" of something through the Internet. It is practically the part of e-commerce, which is based on the requirements of the buyers. The enquirers specify their requirements and e-procurement to ensure their fulfilment. Its primary feature is the creation of value, hence cost savings for the buyer.

E-procurement is therefore the electronic purchase of goods and services for which the main reason for implementation is reduction of transaction costs.

11.2.2 Basic classification of e-business

Business-to-Business (B2B)

The term B2B means business transactions undertaken by companies through public or private computer networks, primarily (not exclusively) through the Internet. The spectrum of these transactions mainly includes - Figure 21 Basic e-business relations :

- actual purchase and sale of goods or services;
- payments and other financial operations;
- financing of deliveries;
- logistics operations, delivery of goods to the point of delivery;
- return logistics (complaints, etc.);

Business-to-Consumer (B2C)

Business-to-consumer means the sale of goods to the final customer via the Internet and other information and communication technologies, without the customer's direct physical contact with the seller. The typical feature of B2C are one-off seller-buyer relationships without the necessity of long-term contractual underpinning. (For example, Amazon.com.)

The typical B2C models based on the classification by P. Timmers include:

- **Electronic Shop (e-shop)**

E-shops are one of the forms of direct sale. It can be likened to catalogue sales; the catalogue in this case has the form of a website and communication between the buyer and the seller takes place mostly in electronic format. A typical purchase is carried out in such a manner that the shopper browses through the catalogue and "places" the selected products into a virtual shopping cart. The e-shop must address the issue of payment and delivery of goods. In terms of transaction costs, it therefore seems to have the character of ideal goods of intangible nature (air-tickets, SW, tour orders). The transaction costs are often an obstacle to trade in goods whose unit price is very low.

- **Electronic Business Centre (e-mall)**

The Electronic Trade Centre is a set of electronic shops under one roof, or under the common umbrella of a single brand. It is basically the equivalent of gigantic shopping malls in which it is possible to "browse" through a large number of shops with various assortments. When you specialise in a specific market segment, such a commercial centre becomes the centre for the entire industry. (For instance, www.vltava2000.cz.)

Consumer-to-Consumer (C2C)

C2C is equivalent to a virtual stock exchange or auction in which final consumers mutually trade and where the Internet plays the role of mediator between the seller and the inquirer. The function of C2C (e-marketplace) is to centralise the individual offers, secure specific business transactions and act as auctioneer in the case of auctions. (For instance, www.aukce.cz.)

Consumer-to-business (C2B)

The C2B model consists in the fact that, for example, those interested in air-tickets shall make an offer of the price they are willing to pay, and the airline shall then consider whether they want to sell the air-tickets at the given price. (For instance, www.priceline.com.)

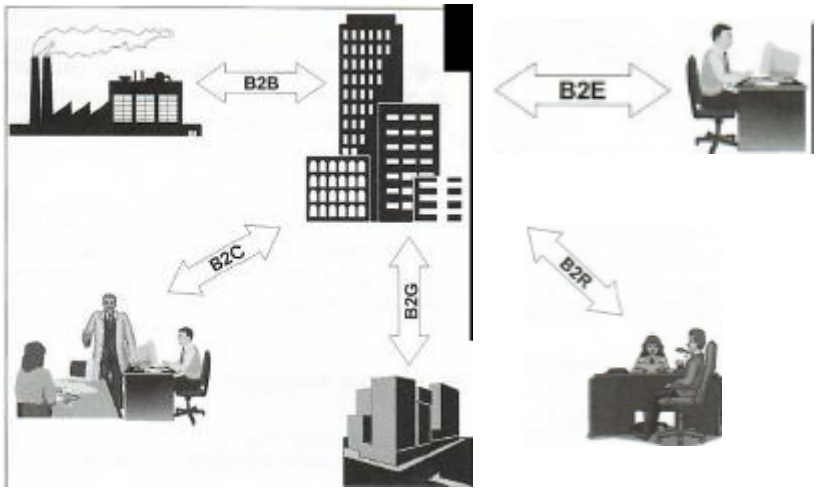


Figure 21 Basic e-business relations (Sodomka, P. , Klčová, H., 2010)

11.2.3 Current conditions of application of the e-business concept

Performance of the US economy in the 90s with a strong non-inflationary growth, high employment and productivity growth raised the question of whether something fundamental has changed. The economic downturn from 2001 prevails to date in spite of the survival considerations, but the issue of the "new economy" remains:

- e-business shall turn into simple business.
- While in the period of 1998-2000, it was primarily a B2C, in future we can expect that it will be a crucial segment of B2B e-business 828. While in 2000 the share of B2B transactions was 80% of total e-commerce, in 2004 it reached 88%.

The following have **provably changed**:

- **Marketplace** in consequence of globalisation.
- **Investment climate** thanks to the Internet "fever" and interest in investment in the early-stage development of the Internet.
- **Qualification requirements**. Currently, the qualifications required are most often either high or none, not medium.
- **Decentralisation** and interlinks - in consequence of the development of outsourcing, electronic communication with suppliers and creation of temporary teams is resulting in the reduction of the formation of large centralised enterprises.
- **Convergence** of disciplines.
- The **key factor is innovation**, not capital, labour costs and access to raw materials.
- **The role of the customer is changing**, the customer is more active and demands custom products and services.

Thanks to the information and communication technologies, the network character of the industry is increasing and the cost structure is also changing in (almost) all the sectors. It follows that the informatics sector is not a new economy but a fundamental change in all sectors.

12 SYSTEM INTEGRATION

12.1 Why it is necessary to integrate business applications

Enterprise Application Integration (**EAI**) is one of the key issues in the implementation of IT projects in the Czech companies. Many organisations, especially large branched organisational structures and detached workplaces have in

recent years accumulated a variety of information technology solutions. They often use many different hardware devices and a variety of mutually incompatible software applications.

Non-integrated architecture brings many duplicities and inconsistencies into the corporate data. For senior management decision-making, however, it is necessary to ensure the quick availability of information that creates an image of "one indisputable truth." But, how can it be obtained from inconsistent data scattered in various business applications? Many organisations choose easy, but inappropriate solutions by ordering the development of single-purpose interfaces between the business applications from which the critical data are requested. In the case of a large organisation, we can encounter dozens of such interfaces. Only their maintenance can burden the IT budget with costs amounting to hundreds of thousands of crowns per year.

In addition to the emergence of unnecessary costs, the fragmented infrastructure has an impact on the overall efficiency of information processing in the organisation. Extremely high demands are placed mainly on the flexible adaptation of business processes, and, of course, with the full support of the information system. While a small business may as required, for instance, change the production control method or directly change it under better conditions, a large corporation gets into trouble. It is "tied" to both the intercompany organisation and the far more developed relationships with the suppliers and customers.

These are the main causes of the inflexibility of the large organisations, but in the end they must respond flexibly to the smaller businesses on the market in order to survive. In terms of securing the business processes with an information system, a long-term built and applied information strategy can help them in this. This strategy should also have clearly defined partial concepts that include the management of key enterprise processes (ERP), customer relationship management (CRM) and supply chain management (SCM).

The costs will rise in those organisations where it is necessary to work with a fragmented applications structure, where the business data are not processed in a targeted manner as well as where the system deficiencies are caused by inefficient management of the business processes.

The rise in the demand for integration platforms is thus no surprise. The main requirements of the corporate clients can be summarised under the following points:

- **High** reliability and performance - means zero downtime operation of the system and no restrictions during peaks.
- **Ease of operation and management system** - is primarily to minimise the cost of ownership.
- A high level of scalability and parametrisation - means no limitations on the further development of the system and its expansion.
- **Achievable return on investment (ROI)** - is based on the ability to quickly develop and integrate within the platform, and thus quickly implement t(Sodomka P. , 2010)

12.2 How enterprise applications are integrated

In principle, two integration methods exist. The first is called **point-to-point** - everybody with everybody. It consists in the creation of special-purpose interaction solutions that ensure synchronous communication between the applications. In practice, this highly ineffective approach is still widely used. It generates excessive development costs for each individual communication solution and assumes the considerable labour intensity of the various communication protocols or the source code of the non-standard applications. It also counts on the readiness of the applications for synchronous communication. However, the transaction cannot be executed when the application is not available.

The most common examples of point-to-point integration in corporate practice include the interlink of human resources and payroll management applications with the ERP systems.

The EAI platform allows interlinks on the **middleware principle**. It serves as a shared space to which data are sent from individual applications, transformed and submitted for processing in an understandable format. The EAI solution provides asynchronous data transmission. The data are in fact added to the middleware "queue". The relevant transactions can then be executed without the requirement for immediate connection of the source and target applications.

The integration through the EAI platform itself can then run at the level of:

- data
- user interface
- application interface

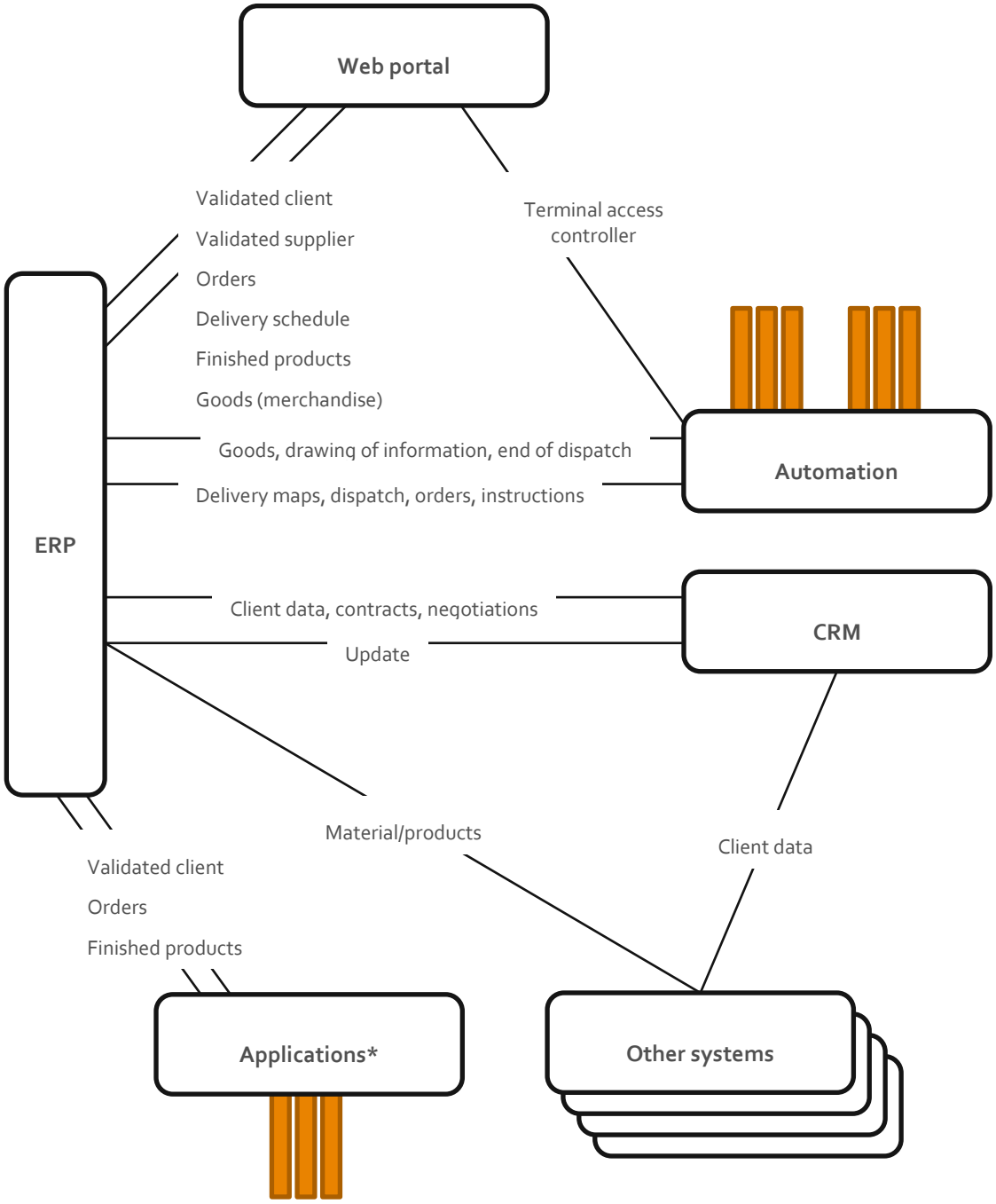
- business logic

The use of integration at a particular level should then be a reflection of the needs of the customer organisation and features of the integrated applications.

Integration of applications at the data level uses data storage and the possibility of their transfer. At the same time, it essentially ignores the existence of the applications as such. This approach need not be a bad thing because most of the applications work similarly - they store data in relational databases. Using ETL tools, the data from one database are then automatically scrubbed, transformed and stored in the desired structure in the database that serves as a data store of another application. It is quite a good and quick solution with clearly legible benefits consisting primarily in cost savings in comparison with other methods of integration. It is thus suitable for building the operational data stores (ODS). But it may encounter difficulties with maintenance of a large number of database tables. If we require the EAI to have high flexibility and ability to work in real time, then the integration at the data level is not a very fortunate solution.

While "data access" ignored the existing applications, the **interlink through the user interface** goes precisely in the opposite direction. It makes an effort to automate the user's work in such a manner that the system responses to a request are the result of the simulation of the user procedure. This is a method used mainly when it is necessary to integrate very old applications, which do not have a source code, and where it is not possible to use another integration process. But in other cases, this solution would be very inefficient. It is dependent on the immutability of the application that we can hardly count on in the case of more modern software.

The integration via the user interface can certainly also be associated with the modern trend of **deployment of portal technologies** - one of the key components of the EAI solutions. But the portal does not serve primarily for



* applications that register phone orders since individual orders generate several transactions to ERP and CRM must be answered immediately

Figure 22 Model of ensuring distribution in the manufacturing enterprise through EAI (Sodomka, P. , Klčová, H., 2010)

in order to secure data exchange between applications. Its mission is to unify the user interface and ensure intuitive access to applications without bothering the user with their monitoring as part of the business process - Figure 22 Model of ensuring distribution in the manufacturing enterprise through EAI.

During integration, it is possible to also use **Application Programming Interface** (**API**), which is provided by the producer of the specific application. It is possible to use API to access the data resources and the business logic of the individual applications. The interconnection via the API is used for complicated, non-standard applications. It is however completely dependent on the producer of the given API.

Business logic based integration is a method that impacts the structure of the existing enterprise applications. The objective of the interconnection at this level is to share the key procedures applied in the management of the entire organisation. Operations performed by various applications shall then be performed likewise. This procedure also simplifies the administration and update of individual components. On the other hand, it also carries many risks. It mainly creates a very close link between the applications and interdependence. In essence, it is too complicated, costly and labour-intensive for the developers or service support staff. Integration at the level of data, user and application interface have similar risks. It also assumes the sharing of the inherent characteristics of the individual applications.

12.3 Service oriented architecture and composite applications

The way out of too tight and complex integration is the **concept of service oriented architecture** (**SOA**). This architecture is focused on the recurrent and shared provision of services using such standards, which allow this collaboration. Service - an autonomous part of software - is used to fulfil precisely defined tasks and is available via the network. This may specifically concern, for instance, the input of invoices to the ERP system or acquisition of customer data from the CRM system.

In principle, SOA in itself contains the best practices from the areas of design, development, operation and integration of applications. Today, we would hardly seek an alternative to this standard. SOA as a complete concept together with the web services leads to the development of so-called composite applications, thus merging two earlier separate areas - **development and integration of applications**.

SOA introduces application topology in which the functional logic of the application is arranged in modules (services) with clear identity, purpose and interfaces accessible to software. The services behave like "black boxes". Their inner structure is independent of the type and nature of the environments which are used. In service oriented architecture, the data and functions are encapsulated in the modular components with documented interfaces. This method simplifies application design and provides the option of incremental development and future expansion. The integration of applications developed in SOA with various externally acquired applications can be significantly simpler than applies to the monolithic applications (GARTNER, INC., 2010).

Composite applications use the services (components) of other autonomous systems, which were interconnected via an integration platform. In simple words: the required functionality is packaged in the form of a web service and executed as required. If SOA is used in this process, then the newly developed components can be used repeatedly and their duplicity is minimal. This has the direct consequence of cost reduction and higher flexibility of the deployment of new services.

12.4 Middleware

First mention of the need to shield the application software from the basic operating system services in the form of suitable software was made in a NATO Report (Naur & Brian, 1969). These resources were designated as middleware.

Middleware is software that is located between the operating system and the applications that offers a versatile set of useful services to the applications (Bernstein, 1996). Services make up the operating system environment, enabling processes, programs and applications to interact in a distributed system via a network (Lheureux, 2008).

Resources can be divided according to the basic functionality and integration middleware and application integration means (Lheureux, 2008). Each of the resources in addition to the specific functionality also offers security, development and administration services.

12.4.1 Functionality of basic middleware

Basic middleware is a set of resources, which can be divided into the following categories:

- **Communication Middleware**, which enables mutual communication of software, regardless of whether it is an integral part of one or various applications;
- **Data Management Middleware**, which enables access of software to data stored in various data resources;
- **Platform Middleware**, which creates a suitable operating environment with a set of generally applicable services.

12.5 System Integration

System Integration is a phenomenon, which is clear in informatics since the beginning of the nineties. It is triggered by the high heterogeneity of products, applications and services, their providers as well as the related complexity of their interdependent and reconciliation.

System integration is a principle and approach to IS/ICT management where the key tasks are:

- specification of the overall IS/ICT concept, including its architecture,
- selection of resources, services and their providers (including internal) for fulfilment of the defined IS/ICT concept,
- integration of resources, services and providers into a functional unit.

Only to get the initial idea of the extent of this issue, let us mention that system integration differentiates vertical integration level from the integration concepts and vision of business development, and within the framework of this, its information system to integration of the individual technological components, which we discussed in the preceding text. The integration of individual IS/ICT components is solved at partial levels. This concerns **horizontal** integration. The issue of system integration according to the defined levels is documented in Figure 23 Level and scope of system integration.

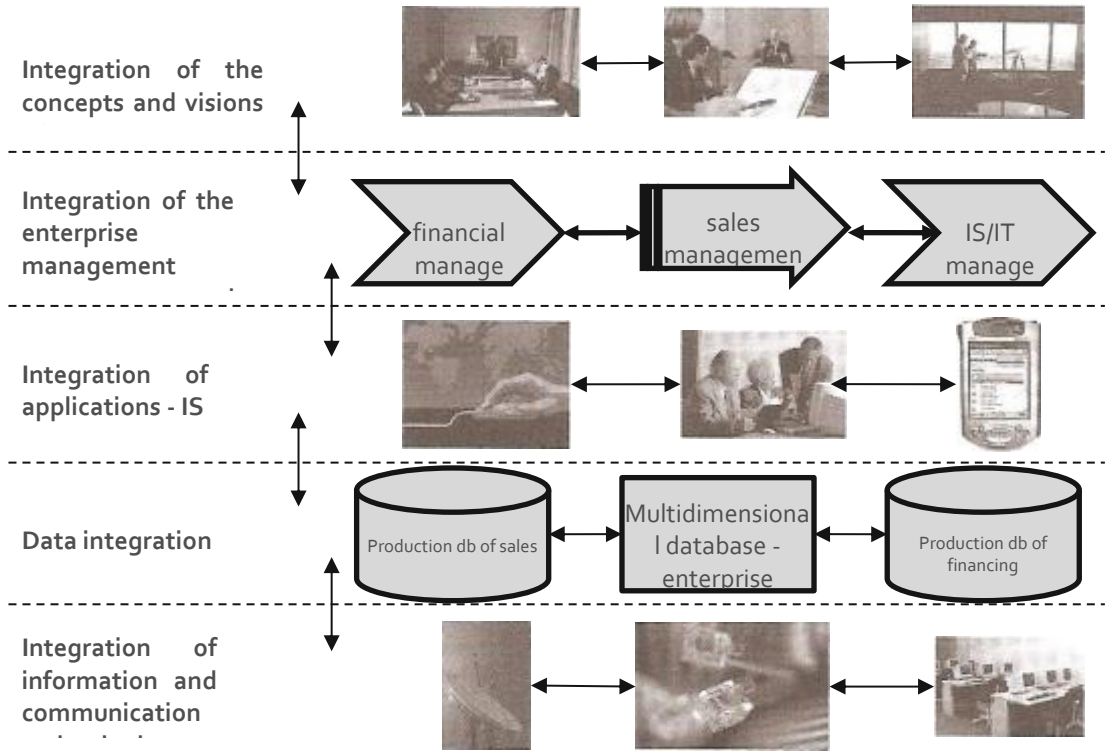


Figure 23 Level and scope of system integration (Gála, Pour, & Šedivá, 2009)

In the current situation, the key problem is not only the development of software components, but mainly making a choice from them with adequate consideration of the needs of the specific information system and integrating them into a functional unit. For this reason, system integration has become one of the core terms of modern informatics. System integration is thus a common principle for management of information systems.

If a smaller organisation with a uniform information system based on relatively small software and technical resources is concerned, then the application of the principles of system integration is practically necessary. In terms of their implementation, there are two basic approaches to the solution:

- system integration is provided by a specialised company (software, consulting) - **external system integrator** (then it is related to outsourcing);
- integration is implemented internally, i.e. it is provided by a specialised company department, a dedicated team of specialists or only the informatics management.

The deployment of an **external system integrator** has the following **effects**:

- system integration as a method for management of IS/ICT requires specialists who may not be available to the customer;
- it transfers the responsibility for functionality of the entire system to the specialised provider;
- an external system integrator usually has long-term and professionally defined relations with subcontractors;
- the specialised company (system integrator) has a better opportunity to invest in the qualifications of people, testing, learning, or in the development of new products;
- the knowledge of state-of-the-art IS/ICT management and development methodologies and tools.

In this context, it is clear that we can comprehend system integration not only as a basic principle of informatics management (see above), but also as a specific service provided by the provider to the customer, which has clearly defined content and a price.

In connection with the integration aspects of enterprise informatics, we can formulate the following conclusions:

- A specific selected integration solution depends on the character of the integrated applications and is a combination of style, level, architecture and orientation of the integration.
- The integration solutions are implemented through middleware resources.
- The principles applied in integration solutions are used both in internal and external integration.
- SOA is a specific approach to the building of applications, which uses the principles of web services and as a part of enterprise architecture:
    - it makes it possible to respond resiliently to the needs of the organisation;
    - it reduces development costs because it enables the use of ready-made application packages;
    - it reduces operating and maintenance costs;
    - it minimises the costs related to the integration of applications, as it uses standards;
    - it also enables small organisations to engage in electronic data exchange.
- System integration is one of the principles and approaches to enterprise informatics management.

13 SECURITY IN INFORMATION SYSTEMS

The purpose of the chapter is to create an overview of the provision of IS/ICT security, definition of potential risks, respectively, threats, and definition of the fundamental characteristics of selected countermeasures that could be applied in response to the threats.

IS/ICT security is an IS/ICT property whose level is impacted by all the aspects, which are related to the definition, achievement and maintenance of a suitable level of security requirements (confidentiality, integrity, availability, individual responsibility, authenticity and reliability) that respect the culture and sector in which the IS/ICT is operated.

13.1 Solution of IS/ICT security

13.1.1 Basic terminology

In connection with the solution of security, we encounter many terms. Figure 24 shows the basic relations between the terms that are used in the solution of security.

Assets are individual IS/ICT elements and resources. An asset is anything of value to the individual or organisation, whose value can be reduced by the action of a certain threat (see below). The basic characteristic of an asset is its **value**. It is based on the objective expression of the generally perceived price or on the subjective evaluation of importance (criticality) of the asset, or on a combination of both approaches. The value of the asset is relative depending on the angle of view during its evaluation. When evaluating an asset, we consider many aspects, for instance, purchase or development costs, importance of the asset for the operation of the entire IS/ICT, the cost of the processed information, the cost of bridging damage to the asset and naturally also further aspects, which may be specific case-to-case - Figure 24 Basic security terms and their mutual relations .

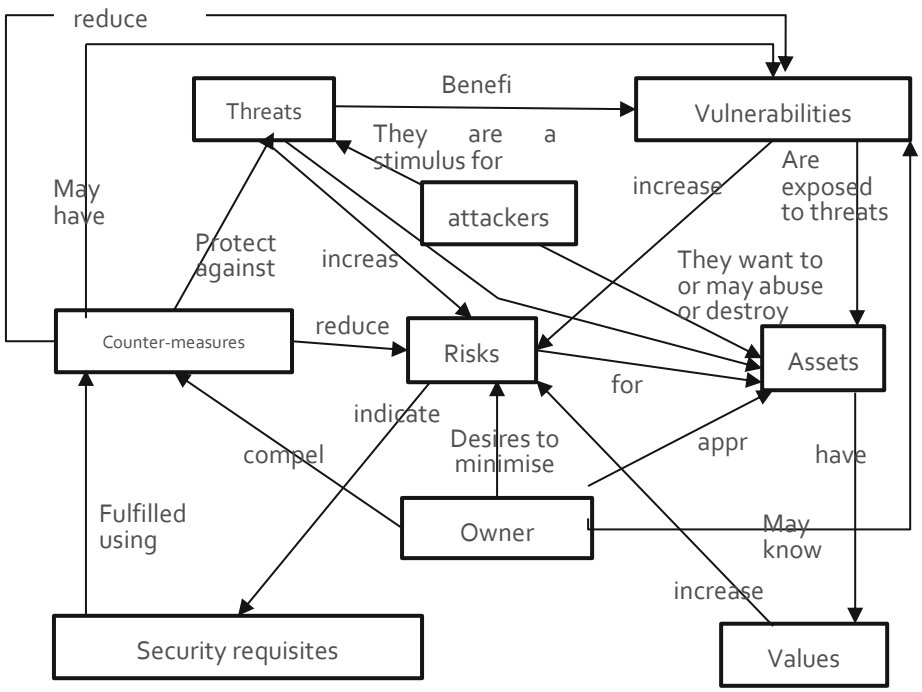


Figure 24 Basic security terms and their mutual relations (Hanáček & Staudek, 2000)

A further characteristic of the asset is the so-called **vulnerability** . This expresses the sensitivity of the asset to the action of the threat. It is necessary to count on the fact that each asset has a **vulnerability**, or has a weak spot that may be used to cause damage or loss in this or some other asset. The vulnerability is actually one of the IS/ICT properties. Such a vulnerability may be:

- **physical**, where the IS/ICT element is physically located in an environment in which it can easily be damaged, destroyed or lost;
- **natural**, where the IS/ICT element has no capability to cope with some objective factors such as flood, fire, lightning, etc.;
- **technological** where the IS/ICT element does not allow securing, for instance, the required smooth permanent operation, due to its design characteristics;
- **physical**, where the IS/ICT element works along such physical principles, which allow their abuse. An example may be the electromagnetic radiation of some components, such as monitors, communication network cables, etc.;
- **human**, where the IS/ICT element is endangered by the action of people, their mistakes and ignorance.

The vulnerability level of the asset is evaluated according to its sensitivity, i.e. susceptibility of the asset (to damage), and criticality, i.e. importance of the asset for IS/ICT.

The vulnerability is a **threat** to the system, which we characterise as an opportunity to use the vulnerability of the asset to attack it. We designate the attack as a **security incident**, which is an event that results in breach of the defined rules and procedures during operation of the IS/ICT, including the attempts at such breach. At the same time, a security incident is also any event that results in a threat to the configured security features.

The threats and vulnerabilities are used by the attackers for their attack. An attacker may be a person within the organisation or a person outside the organisation. The attack may have a clear purpose or may be an unintentional attack. In the case of persons who make intentional attacks, several terms are used for their actions, particularly:

- hacker - considers the attack as a challenge and a resource to get prestige;
- spy - makes attacks in order to get information, which is used for various political purposes;

- terrorist - makes attacks in order to cause apprehension and fear;
- criminal -) attacks the systems for own financial profit;
- vandal -) attacks the systems with objective to destroy or damage them;
- cracker, usually a programmer - makes an effort to penetrate into the systems of other owners for the purpose of theft; he typically focuses on the theft of intellectual property, i.e. those parts of the systems which are protected by copyright;
- phracker - his objective it to get free access to telephone services;
- phreaker - his objective is to get telecommunication information, which allows him to get access to other computers.

13.1.2 Access to the IS/ICT security solutions

When solving IS/ICT security, we rely on the de jure standards (for instance, ISO 27000 standards) and de facto standards (for instance, ITIL - Information Technology Infrastructure Library). These formulate the IS/ICT security solution process and the content of the individual solution activities.

What level of ensuring security requirements should be applied to the specific IS/ICT, is defined by the so-called **security policy**.

The security policy is a set of principles and rules that the organisation uses to protect its assets. The security policy is continuously updated in accordance with changes in the environment and may include:

- the policy of permissible use of assets,
- specification of the educational process of their employees in the field of asset protection,
- clarification of the mode of implementation and enforcement of security measures,
- a procedure for evaluation of the effectiveness of a policy leading to the implementation of its change.

According to the required security level, it is possible to define four basic general types of security policy:

- **promiscuous** a security policy that does not restrict anybody in its rules and allows operators to do everything, including what they should not do;
- **liberal** - its rules allow the implementation of everything, excluding the exceptions that are explicitly stated;
- **cautious** - its rules forbid everything except what is explicitly stated;
- **paranoid** - forbids doing anything that is potentially dangerous, and therefore also anything that need not be explicitly prohibited.

13.2 Threats

If we talk about threats, then they can be classified into the following groups:

- **natural and physical**, for instance, natural disasters and accidents, for example, electric power failures, fires, floods, etc.;
- **technical** - data carrier and computer failures, network disorders:
- **technological** - disorders caused by software - viruses, Trojans, etc.;
- **human**, i.e. **unintentional**, resulting from ignorance, mistakes or negligence, and **intentional**, which are divided into attacking the system from outside (WIPO, terrorists, espionage, etc.) and internally (malicious, unacknowledged employees, guests and visitors of the organisation, etc.).

The vast majority of the threats (more than 50% of all) belong to the category of unintentional threats. The basic threats to the above-stated assets include unauthorised, accidental or intentional:

- **disclosure** of secret information - a secure system cannot permit access to anyone (individual, software, device) without their authorisation;
- **adaptation** - a secure system must ensure that there is no breach of data integrity in an unauthorised, accidental or intentional way:

- **destruction** - a secure system must not allow unauthorised destruction of the information system and its resources;
- **obstruction** of authorised user access to the information system - a secure system must not allow obstruction of the access of authorised users to the information system and its resources.

13.3 Counter-measures

In this section, we discuss the countermeasures to attacks. It is important to realise that a universal countermeasure that would comprehensively protect the system does not exist and that a specific solution is always focused on minimisation of a specific risk. Choosing the countermeasures, including their proper deployment, is the task of risk analysis.

It is generally possible to classify countermeasures from many viewpoints and we shall only focus on two of them, i.e. the aspect of the relationship of the countermeasures to the potential progress of the incident and the aspect of the form (character) of the countermeasures. According to the relationship of the countermeasures to the progress of a security incident, the countermeasures can be divided into:

- **preventive** - designed to minimise the causes of already possible occurrence of a security incident;
- **dynamic** (proactive) - the purpose is to minimise the possible impact of a current ongoing security incident, including the early detection of such an incident;
- **reactive** - the purpose is to minimise the potential impacts of a previous security incident.

According to the form of countermeasure, they can be broken down as follows:

- **administrative** - the purpose is to define the administrative and organisational arrangements leading to minimisation of the occurrence of and progress of the security incidents, including their impacts;
- **physical** - the purpose is to physically secure the assets so as to minimise the occurrence and progress of security incidents, including their impacts;
- **technological** - the purpose is to technologically (by hardware and software) secure the assets so as to minimise the conditions for occurrence and progress of security incidents, including their impacts.

Table 4 Examples of countermeasures illustrates examples of counter-measures. In the next section, we will discuss some countermeasures in greater detail.

Table 4 Examples of countermeasures (Gála, Pour, & Šedivá, 2009)

Classification aspect		Example of a counter-measure
Preventive	Administrative	• User education and training • Definition of the data archiving policy
	Physical	• Computers, mainly servers, are kept in locked rooms • The security staff control the access of unauthorised persons
	Technological	• Confidential data is encrypted • Access passwords are changed at regular intervals
Dynamic	Administrative	• Guidelines exist for user behaviour during registration of incidents
	Physical	• The tracking systems automatically monitor the respective rooms. • The Generator or UPS (Uninterruptible Power Supply) will ensure the power supply
	Technological	• An attempt to get unauthorised access will result in automatic blocking of the account • The tracking systems automatically monitor the work of the system and immediately notify the administrator of any deviations • The system automatically shuts down its endangered parts

Follow-up	Administrative	• Defined mechanisms for return of the system to normal exist
	Physical	• A substitute technical component of the system that was destroyed after the attack exists (e.g. substitute keyboard, substitute power supply, etc.)
	Technological	• Data and software backups exist, including configurations

13.3.1 Authentication and authorisation of users, software and systems

In case of mutual communication between two or more parties, it is necessary to identify the parties in some way - to clarify who is communicating with whom. For example, two computers in the network should be clearly certified in the given network - otherwise collisions will inevitably occur. Similarly, a user identifies himself to the system using his user name - the user name is his identifier. Identification therefore means proof of identity.

During communication, we are rarely satisfied with mere identification - the system or communicating counter-party usually wants to verify that it is truly communicating with the entity that it desires to communicate with. It is necessary to verify that the counter-party is what it claims to be. We designate the process in which we implement these activities as **authentication**.

Authentication means a technique used to verify the proclaimed identity of any subject with the target to convince the counter-party of own identity and ensure protection against its falsification (*impersonation*, also termed *masquerade*). We differentiate:

- the authentication of an entity, where we verify that the entity (person or computer system) is really what it claims to be;
- authentication of a message, i.e. a mechanism, which is used to verify that a given subject (party) is the originator (source) of the message, which was created at some (mostly precisely unspecified) moment in the past (see above).

Authentication can be done using various mechanisms, which are based on the following:

- knowledge of secret information - password, PIN, cryptographic key, i.e. proof of knowledge - "I know something";
- ownership with a unique character - for instance, magnetic and chip cards, digital certificate, for instance, web server, i.e. proof of ownership - "I have something";
- biometric authentication - makes sense only for human users (handwritten signature, voice, fingerprints, scanning of the retina, etc.), i.e. proof of characteristics - "I am something".

14 MANAGEMENT OF ENTERPRISE INFORMATICS PROCESSES, IS STANDARDS

The issues of the management of operations and development of enterprise informatics hit a broad spectrum of company employees. From the viewpoint of the users, it may seem at first glance that it is a matter for the information managers and other staff of the informatics departments. But many reasons exist why not only the informatics experts, but also the users, particularly those holding managerial positions should have a general overview of the management of informatics:

- The management of informatics forms a substantial component of all-company management, and from the all-company viewpoint, it is necessary to respect its possibilities and demands.
- The informatics services are not only purely supportive issues for the basic functions of the business, but significantly impact the structure and quality of the goods and services offered to the customers and are,

moreover, also becoming specific trade commodities (for instance, design services, software, which rank among the most demanding industrial products, etc.).

- The increasingly higher accessibility to informatics resources (hardware, software, databases) for an already unlimited circle of users means that these resources also bring higher demands for their management and administration, which is manifest, for instance, in the security regulations, rules for specification of new requirements for informatics, assessment of the costs and effects of informatics, etc. This can be implemented only with the involvement of the corporate managers and all other users.

Informatics Management means all processes and activities related to the determination of the basic concept, strategy of informatics, planning of the individual development tasks, provision of information services to the users, and securing the essential financial, human, technical and other resources.

Every information system and its technology must develop to match the actual requirements of the users and the development of software and hardware resources on the ICT market. **The development of informatics** is based on **projects**, which may be related to the development of new applications, installation of new technologies, for instance, new computer networks, or their various combinations. The solution of these projects usually comprises a substantial number of partial tasks and activities based on all sorts of methodologies, methods, tools, and programming resources, as we have already seen in the preceding chapters. At this point, we must particularly emphasise that the solution of such a project without the direct involvement of the users is practically impossible or is very risky from the viewpoint of its further use. The effective **co-operation of analysts with the users** is an essential prerequisite of a quality solution, and especially the fact that the result will match the needs of the businesses and their employees and bring the expected effects.

Operation of enterprise informatics is directly linked to its usage. Every user thus utilises and also runs his own applications, creates or updates the databases allocated to him, provides information services to other users, external customers, or uses them for his own management, business and other activities. On the other hand, the operation of business informatics must be ensured continuously by many specialists and the whole **complex of activities** that we list only shows its shortest form:

- securing operations, **administration** of the entire computer **network**, monitoring of traffic, solution of failures, defects, network configuration, configuration of the access rights of users and informatics staff;
- **control and installation** of hardware and software within the framework of the computer network;
- supervision of the operation of applications, application software, execution, monitoring their load, solution of errors;
- securing operations, **administration of databases**, monitoring of traffic, traffic analysis protocol, so-called log files, monitoring the utilisation of disk capacity, ensuring the backup and archiving of databases;
- securing so-called, ongoing user consulting services (**help desk**), evidence and solution of the fundamental problems of users and evaluation of user requirements and their eventual routing to other specialists.

14.1 Enterprise informatics operation and development options

14.1.1 Outsourcing and offshoring

The essence of outsourcing in informatics is the provision of selected activities and services by external suppliers. The reasons for this solution can be competitive, professional, financial or organisational. The following are differentiated according to the subject of outsourcing:

- **informatics development outsourcing** - implementation of the individual types of application software and technologies, or the development of specialised applications directly tailored to the needs of the enterprise;
- **outsourcing of the operation** of computer technology - operation of individual applications or the entire system using the supplier's or customer's hardware and software where the supplier takes care of the maintenance and upgrading of the "loaned" technology.

In current practice, the outsourcing of IS/ICT development is dominant, but the outsourcing of operations is progressively gaining more followers. The customer's focus on outsourcing can bring him the following effects:

- the possibility to focus on their core business and continuously improve its quality;
- in the case of a high-quality supplier, there is an opportunity to access high-tech applications and technologies;
- faster application of hi-tech technologies;
- higher flexibility of informatics development with respect to the user requirements - the supplier usually has more facilities than the customer's own informatics resources;
- product and service distribution costs and the associated release of human resources and capital resources for other purposes, other investment programs;
- reduction of the costs of informatics since the supplier (outsourcer) usually shares resources among a larger number of customers;
- solution of a problem in which the customer does not have the necessary staff and technical resources for the development and operation of computer technology.

Outsourcing also carries some **risks**:

- long-term dependence on one supplier because change of supplier is a relatively complicated issue in the informatics;
- security risks mainly in the plant area;
- inadequate knowledge of the supplier in the concerned customer's area;
- poorly contrived contractual relationship;
- underestimation of procedural and organisational cooperation rules.

Based on the established concept of informatics, the rules for **selection of the outsourced activities**, the areas suitable for outsourcing and focus on the prospective suppliers of outsourced services are determined. For solution of outsourcing, the following must exist in addition to the outsourcing agreement:

- management processes must also be clearly defined, particularly at the interfaces between the customer and the outsourcing provider (management of user requirements, award and coordination of projects, ...),
- system of indicators for measurement and evaluation of the quantity and quality of the outsourced services as a basis for determination of the prices.

A specific variant of outsourcing is so-called **offshoring**, which means moving service activities abroad either from the company's headquarters to its foreign branch or foreign external providers.

14.1.2 Hosting

The scope and forms of outsourcing thus significantly also modify the management, development and operation of the information systems. In the area of outsourcing we can also include a variety of specific services offered by current suppliers on the ICT market. They are designated by the common term "hosting", i.e. provision of resources or space on the supplier's media. Several forms of hosting exist, especially webhosting or serverhosting. With the intensive development of all sorts of web presentations and applications, **webhosting** is an attractive form of their operation, particularly for smaller customers, and includes:

- provision of disk space on the servers for operation and development of the web applications,
- their connection to the network and ensuring continuous operations,
- e-mail services and support of various development environments and databases necessary for development and operation of the web applications,
- technical support for operation of web applications.

14.1.3 Application Service Provider (ASP)

The **ASP** (**Application Service Provider**) service is based on the separation of the ownership of a given application from its use. The ASP, unlike in the case of outsourcing, separates both the operation and ownership of the given solution from the use of the system. The ASP thus takes care of the operation of the application, performs all activities related to the initial acquisition and continuous ownership of the system and also bears all the related costs. The ASP thus offers

an option to the customers to use the application solution that it owns and operates.

14.1.4 Software-as-a-Service (SaaS)

Software-as-a-Service is a service, respectively, an application provision model, where their functionality is ensured by the provider of the service to a large number of users through the Internet. The specialised provider thus maintains and operates both the application itself and the IT infrastructure necessary to operate it as well as other auxiliary services. The technology of these applications is built on web services and the SOA - Service Oriented Architecture model (see chapter 12.3), which enables parallel access to the application for hundreds to thousands of users. On the user side, mostly only the Internet browser should be available.

14.1.5 Information strategy in the process managed organisation

COBIT (Control Objectives for Information and Related Technology) is a complex process that formalises IS/ICT management and assessment. It is the product of the ISACF (Information Systems Audit and Control Foundation), an organisation whose members are significant consulting firms such as Gartner, Deloitte, etc.

COBIT defines IT management as a correlation link between a set of requirements (criteria), the IT resources and the IT processes. The structure of the IT processes forms a cycle that contains the basic elements of the IS/ICT life-cycle (Učeň, 2001). It is similar to W. E. Deming's Shewhart Cycle. The principle of the PDCA (Plan-Do-Check-Act) cycle or the feedback structure of all control processes in the organisation, has been known since the beginning of the 1950s and was defined by **William Edwards Deming** (Walton, 1986).

The use of COBIT can be recommended for several reasons. Its basic process structure is simple and comprehensible not only to the IT managers, but also other executive staff in the organisation. According to ownership, COBIT defines the processes of power, responsibility and content of IT processes, including the link to the corporate targets. It thus significantly helps reduce duplicity of power and responsibilities or in the detection of their deficiencies.

COBIT also includes the comprehensive design of the performance and profit metrics. Last but not least, it supports process-based IS/ICT management, which provides a powerful tool to the management of the organisation.

The internationally acclaimed COBIT methodology in its fourth version significantly expands its scope. It emphasises the link between the business requirements, creation of values, corporate architecture, definition of processes and process flows. COBIT also has greater respect for the links between the all-enterprise and information strategy.

A further method may be used for IS/ICT operative management - **ITIL** (Information Technology Infrastructure Library). ITIL is the global standard in the area of ICT service provision. But it is not a standardised management system, which can be implemented in the company and eventually certified. ITIL is a compendium of the best practices and recommendations that can be used to specify concrete requirements for the organisation.

ITIL is rather intended for the IT managers because it has a greater focus on the management of ICT services and infrastructure. ITIL is compatible with COBIT and also some other standards, particularly in the area of quality management. It supports the documentation of information systems according to the **SOX** (Sarbanes-Oxley Act), which may be beneficial to companies that have branches in the USA or are branches of a parent company with headquarters in the USA or must comply with the SOX for some reason (for instance, European audit companies working with American clients).

It is necessary to warn that many other approaches exist, which are incompatible with the standard methodologies, for instance, **Configuration Management**. The risk from their implementation or combination with ITIL consists in incompatibility with the environment (for instance, during tenders) and confusion in the terminology, which is already relatively complicated and difficult to comprehend for many managers.

As we have already mentioned, ITIL in itself cannot be deployed as a standardised management system. However, it is a major input to such a system as the international standard **ISO 20000**. The standard is the first global standard, which is focused on the management of ICT services, improvement of quality, increase of the efficiency and reduction of the costs of IT processes. The standard itself comprises two parts - normative (ISO 20000-1 Specifications) and recommendations (ISO 20000-2 Procedural Guidance). The first part is intended for certification purposes while the second part clarifies some important normative areas and adds recommendations for management of ICT services using ITIL.

The essence of the ICT management according to the ISO 20000 Standard is the IT service to which the service level agreement attaches (**SLA - Service Level Agreement**). This agreement or also the annex to the agreement contains the description of all service provision parameters that include, for instance, the operating hours, load limit, details of the communication, reporting and of course the service price. (Čálek, 2010)define the level of the given service to allow for (Bon, Nugteren, & Polter, 2006)

The ISO 20000 standard is usually used by companies:

- that use ICT services from external suppliers, respectively, are considering the safeguard of a consistent approach from all their suppliers;
- that provide ICT services to ensure the most efficient procedures, or to prove the high quality of services provided to their clients;
- dealing with other certification bodies;
- that require an improvement in the quality of ICT services, increase in productivity and reduction of IS/ICT costs (Bon, Nugteren, & Polter, 2006). CITATION Bon06 \l 1029

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