

Artur Kwasek  
Akademia Finansów i Biznesu Vistula – Warszawa  
Michał Marczak  
Politechnika Łódzka

## IT TOOLS USED IN THE MANAGEMENT OF NEW MODEL OF ECONOMY, THE KNOWLEDGE-BASED ECONOMY

### Summary

The modern IT tools significantly influence the changes in the management methods, and their use also influences the changes of organisation methods and business processes management. The scope, range, time, and functional character of business are changed. The Internet plays a special role in the change of the nature and scope of the operations of the business. Our article tries to identify IT tools such as Data Warehouse (DM) systems, Customer Relationship Management (CRM) systems, Electronic Data Interchange (EDI), and Enterprise Resources Planning (ERP), an integrated IT system for management support, and to indicate their influence on the change of the traditional production process management model.

**Key words:** data warehouse, customer relationship management, electronic data interchange, enterprise resources planning, management model.

**JEL codes:** O3, O31, O32, O33

### Introduction

The development of new IT technologies at the end of the 20<sup>th</sup> century enabled unparalleled ease of data processing and speed of data acquisition. This has resulted in changes in many areas of social and economic life. The most important among them are the globalisation processes and the creation of a new model of economy, the knowledge-based economy.

The appearance of the new model of the knowledge-based economy is mainly related to the use of new IT tools. Their use causes changes in the manner of manufacturing. These changes are deep and very rapid. Observation allows one to remark that modern businesses are dominated by new technologies, and the traditional model is enriched or significantly changed by these technologies. Completely new methods of operation are created, based on e-commerce and e-business models. New options for business process organisation appear. We encounter a transformation in the manner in which

manufacturing is conducted – in the broad meaning of the word – caused by modern IT technologies. The dynamics of their development is frequently ahead of the changes in mentality, legal solutions, etc.

The ability to gather, process, exchange, and use information (which with an increasing frequency is in the multimedia form) is a cornerstone of the modern model of economy.

## Data Warehouse

Management is the process of informed decision making. Correct decisions are crucial for the efficient management of a company. However, in order to make the least risky decision multiple facts have to be analysed, concerning trends, customers, competition, forecasts, etc. This information is usually based on data from the past. There are usually many sources based on which the information is created.

A Data Warehouse collects operational data from various functional areas of a company such as the marketing department, the accounting department, the sales department, the Human Resources as well as external data such as customers, competing companies, business partners, etc. These data should be collected in a manner that enables their rapid recovery.

So far, data have been collected in operational databases. Such systems considerably assist processes of management, since they are able to perform large number of operations at the same time. However, they are intended for assisting only the management processes in a given organisation.

However, the storage of data itself, although necessary during daily work, is not a value in itself. One of the factors, which enable a significant competitive edge, is the obtaining of information by connecting internal and external data, and then using this information for decision-making, at both tactical and strategic levels.

A Data Warehouse is an IT solution, which is oriented towards the improvement of decision-making processes, in order to effectively react to the changes in an organisation and in its market environment. They are an unquestionable standard in the area of computer aided decision-making. There are no ready solutions (products) of that type – every enterprise has to create such a system on its own, adapting it to its individual needs.

Typical areas of use of Data Warehouses and the tasks, which result from them, are presented in the table below.

**Table 1. Areas of use of Data Warehouses**

Manufacturing and logistics	Optimisation of manufacturing processes, quality management, Just-in-Time planning.
Sales and marketing	Market analysis, customer relationship management, sales results planning and analysis, market segment and new market identification, customer profitability, marketing campaign efficiency and promotion analysis, product analysis.
Finances	Market and investment profitability analysis, effectiveness analysis, cost management, budget planning.
Human resource management	Working time planning and optimisation, wages planning and optimisation, employee turnover analysis.
Supply chain management	Distribution efficiency and optimisation, demand planning, warehouse stock inspection.

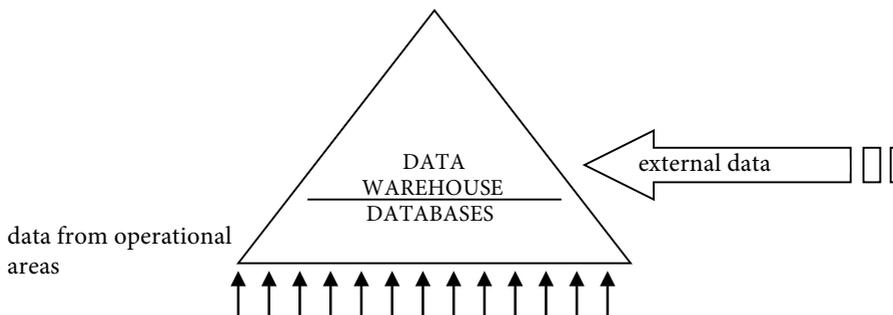
Source: own work.

The following factors have an influence on the implementation of a Data Warehouse: amount of data processed in the company,

- dispersion of IT systems,
- lack of cross-sectional information about the company,
- the ability to be used in all significant sectors of the economy.

From the technical point of view a data warehouse is a database, since it stores data, but it differs from a traditional database in its function, in the quantity and the quality of stored data. It is an IT system, which should be designed in order to provide rapid access to the required data, which will enable decisions that are better justified strategically.

**Chart 1. Diagram of data used for decision making.**



Source: own work.

The table below presents the main advantages and features which distinguish data warehouses from a normal database.

**Table 2. Advantages of Data Warehouses**

Subject-oriented	The data it contains concern specific subjects of analyses, and are grouped according to the selected categories, e.g. suppliers, customers, products.
Unchangeable	The entered data provide a picture of the company at a given moment, and thus should not be changed later on.
Integrity	Data analysis is possible when the data are first normalised and standardised, which enable the comparison of the studied phenomena, e.g. converting to the chosen unit.
Time stamped	Data gathered in the data warehouse are time stamped, and although they may be updated, all the changes will be remembered. This enables an analysis of the trends happening over a period of time, and the ability to collect data over very long periods of time.

Source: like in Table 1.

In order to provide its benefits the data warehouse should be properly designed. Such a data warehouse is a valuable source of analyses for all the operations of the company. The basic benefits from the use of a data warehouse in a company are presented in the table below.

**Table 3. Benefits from the use of Data Warehouses.**

<b>Benefit</b>	<b>Example</b>
Creation and presentation of cross-sectional analyses	In the form of reports, with interactive data exploration options.
Detection of sudden changes	The ability to track current changes (in real time), with no waiting for a defined period required.
Tracking most important elements	E.g. customer turnover, employee turnover, level of satisfaction, products and services ordered most frequently by the selected customers, etc.
Data consolidation and linking	The ability to present in a report data which could not be aggregated together earlier.
Inspection	The ability to verify the effects of decisions that were made.
Simulations	Forecasting functions (simulations based on the past data)

Source: like in Table 1.

The Data Warehouse is an important tool, which enables complex collection and processing of all the data, which could influence the process of decision-making. It should be easy to use, enabling the searching, analysing, presenting, and verifying information when working in an on-line mode.

## Customer Relationship Management – CRM

CRM is a system that enables the creation of a customer profile or, in other words, the management of relationships with customers. It means a business strategy which is based on selecting and managing contacts with the company's customers in order to optimise long-term profits. This requires the introduction of a customer-oriented management philosophy and culture, in order to ensure effective marketing, sales and servicing processes. CRM applications should enable an effective management of potential customer relationships, thus leading to this approach being “imperative” over the company's business strategy.

In the 1980s and in the beginning of the 1990s, the dominating trend was restructuring. Most frequently, this entailed reducing costs (which usually reduced the quality of customer service), increasing work effectiveness, improving internal processes and introducing stringent standards of quality. These processes were complemented by the implementation of IT systems for finance and accounting, production and logistics.

When these goals have been achieved, it frequently is turned out that the competition is also prepared for the new challenges of the market. Companies have started to seek other ways to gain advantage over their competitors. The company's customers have found themselves in the spotlight again, as the companies have tried to learn what are their needs, habits, requirements, and what is their level of satisfaction for the products and services they are offered.

This process has converged with a few important facts. The reduction of costs has resulted in the lowering of customer service quality. Consumers have started to require better quality of servicing and more rapid access to information. Many companies have then changed their strategy: instead of focusing on fighting for the market share, they have concentrated on retaining their customers. Some companies are deliberately servicing small, but carefully selected groups of customers.

Carlson Marketing Group defines CRM as “a business strategy, which actively builds preference and favour for the organisation among its employees, agents and customers, resulting in better relations and better results of activities” (Newell 2002). It seems that this definition explains the essence of the CRM. At its core is recognising and then providing the customers with the value they expect. Individual customers can have different ideas on what constitutes value, though. In the real world of business, every company must offer a product or service which will fulfil the customer's requirements – nowadays highly subjective and personalised – to the best possible degree.

Robert Shaw assumes that “CRM is an interactive process for achieving the optimum balance between the organisation's investments and the satisfaction of its customers, in order to maximise the profits” (Węcel 2001).

According to this author, CRM covers, among other, the following things:

- measurement of marketing, sales and services costs (input data) and various customers' profits;
- collection and continuous updating of knowledge about the customers' needs, their motivation and behaviour;
- use of customer knowledge to continuously improve the results of the organisation, in a learning process based on successes and failures;
- integration of activities of the marketing, sales and services department in order to achieve common goals;
- implementation of appropriate systems which support the collection and sharing of customer knowledge and measure CRM effectiveness (Węcel 2001).

As for Regis McKenna, he explains, referring to marketing, that "Marketing is the creation and maintenance of a customer relationship. It means the inclusion of customers in the processes of design, development, manufacture, and sale" (Majewski).

And Steve Morrell and Laurent Philonenko, in their book, *20:20 CRM* state that the name CRM is self-explanatory (Zachara 2001).

**Table 4. Explanation of the term CRM**

<b>C</b> – Customer	Means that customers are placed first, requiring the fulfilment of their needs, while at the same time ensuring an acceptable level of costs.
<b>R</b> – Relationship	Means the creation of relationships with customers, by knowing their expectations and individual preferences. Modern technology enables studying, and then building long-term relationships with loyal customers, and thus increases their value to the company.
<b>M</b> – Management	Means managing the company in order to bring profits. Loyalty of customers also means profit. The effectiveness of the CRM strategy should be confirmed by specific results.

Source: like in Table 1.

The knowledge of customers provides mainly:

- an advantage over the competition,
- a reduction of costs,
- an increase of profits.

It should be emphasised that the real value for the company does not stem from a single transaction, but from the entirety of customer interactions, starting from the first contact, through marketing actions and ending with purchases of various products. The customer who is happy with the service he or she has received will more willingly choose other products of the company later on. Thus it should be assumed that customer knowledge is essential for the business success of the company.

CRM supports comprehensive understanding of customers, especially in the determination of the ability of the company to:

- specify the customer groups it wants to acquire and maintain,
- determine the key customers and product and services groups which are attractive to them,
- acquire and maintain customers through high quality of services and customer care,
- increase the degree of satisfaction and strengthen customer loyalty.

The CRM class systems contain most of the modules presented in the table below.

**Table 5. CRM system modules.**

Sale	Contact management and customer accounts management.
Sale management	Analyses and forecasts of the sale cycle, monitoring of customer status and potential sale, management of calendar and database of a single customer or an entire group.
Correspondence	Mailing, e-mail, fax.
Marketing	Management of products, prices, marketing campaign, effectiveness analysis.
Servicing of potential sale declarations	Acceptance and distribution of information on customers who are interested in the company's offer.
Telemarketing	Creation of phone lists in accordance with target group definitions, automatic dialling, and collection of orders.
Servicing and after-sale support	Assigning, tracking and reporting tasks, problem management, order control, warranty.
Information	Comprehensive and easy to use reporting function.
ERP system integration	Accounting, production, distribution.
Data synchronisation	Between portable devices and the central database.
E-commerce	Electronic commerce.
Call centre	Phone call centre for customer communications.

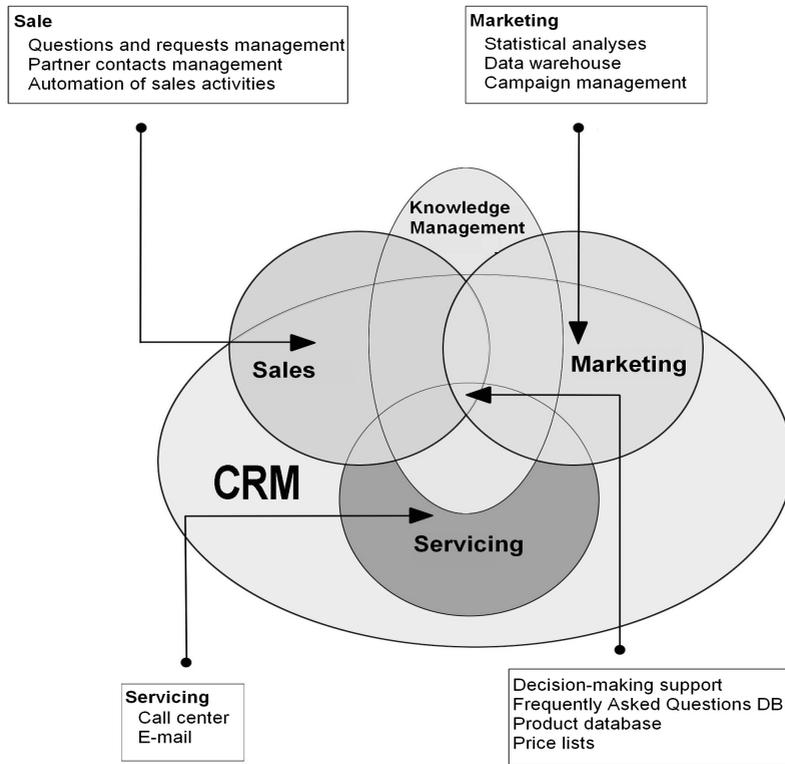
Source: like in Table 1.

The above-mentioned CRM modules can be presented as a group of four units related with the operation of any business-oriented company, that is:

- marketing,
- sales,
- servicing,
- knowledge management.

These are presented in Figure 2.

**Figure 2. CRM organisation units**



Source: created on the basis of: Mazur, Jaworska, Mazur (2001).

From the analysis performed so far it can be seen that CRM can be understood as:

1. The organisation of actions realised by appropriate positions and organisational units of the enterprise using technological measures that is hardware and software.
2. The creation of marketing strategies based on the study of customer satisfaction, trust and brand loyalty.

The table below shows the main elements of the definition of CRM, which are present most frequently.

To sum up the issue of CRM systems, it is worth emphasising that the Internet has played a significant role in their development, not only as an additional channel of product distribution, but mainly as a source of data.

Today, one of the most rapidly developing segments of the IT market is the software for the support of sales, customer service, marketing, and servicing.

Thus, the requirement was created to enable the classification of frequently non-measurable information, which is created during cooperation with the company's customers and business partners.

**Table 6. Ranking of the main elements of the CRM definition**

Ordered by the frequency of use	Definition	Implications
	Customer needs	Identifying and meeting the needs of customers is the main goal of relationship management. Despite its high weight, the tracking of customer needs is frequently not used as a parameterisation tool.
	Partnership	Partner relationships with suppliers and recipients, in both wholesale and retail markets.
	Increase of the profits	The goal is maximisation of value for customers, and thus increasing profitability. The increase of the group of permanent customers leads to an increase of profits.
	Loyalty	The main task of customer relationship management is retaining customer loyalty understood as the inclination to make purchases in the same company.
	Value	Managing the value of the customer and organisation and increasing it as a part of the relationship.
	Satisfaction	Concentration on satisfaction has received relatively low weight, although it is the most popular measuring method.

Source: own work.

Identification of customers, increasing their loyalty and improvement of the quality of services is nowadays the foundation of business activity. Companies have to become Real Time Companies – to react immediately to the changing requirements of their customers, and manage these requirements effectively. The customers have received the ability to directly participate in the creation of new products, which gives them the understanding that the products are custom-tailored for their needs. The companies able to most rapidly and efficiently find out the needs of their customers and transform them into products sold with profit will achieve market successes. In order to fulfil the needs of the market and of the potential customers it is necessary to possess appropriate data and to be able to convert them into information, and then to analyse them creatively. Modern IT systems enable the gathering, selection and analysis of data. Of course, the issues of gathering of appropriate data, their creative analysis, and the ability to use its results depend only on the management of the company.

## Electronic Data Interchange – EDI

EDI is an acronym for Electronic Data Interchange or Electronic Document Interchange. This solution eliminates paper documents, increasing the effectiveness of all activities related to the operation of the business. It is a simple

method of realisation of commercial transactions while bypassing the creation, copying and sending of paper documentation. This enables instant transfer of information contained in typical commercial documents, thus creating a direct interface between the IT systems of cooperating companies. Heretofore, IT systems were related to specific business functions such as finance, accounting, logistics, and marketing. EDI creates a document interchange system integrated with business applications.

EDI is the cornerstone of the electronic market – the technology which forms the basis of such strategies as Continuous Replenishment in the retail sector, Just-in-Time in the manufacturing sector, transport tracking in distribution and electronic payments in all market environments. First solutions of this type were costly and technically complicated. Currently, the users of EDI have the Internet platform at their disposal, which is a more effective and profitable option. All businesses, regardless of their size, have turned towards network services (Dziuba, Durkiewicz 2000).

EDI is a technology that saves time and money naturally. The need for human processing of information is minimised, since the processes of data translation, conversion and transport are performed automatically by IT systems. Exchange of documents is incomparably faster than with the use of traditional technologies. Electronic Data Interchange eliminates the necessity to copy the data from one paper document to another, or to manually enter data in a business application.

This causes the improvement of accuracy due to the following interrelations:

- electronic data are usually entered in a database where they have been already verified,
- electronic documents are usually sent without errors,
- multiple persons may work on the same document at the same time.

Initially, EDI systems were used by companies which could afford the creation of data channels between themselves. Due to the Internet, this solution became the basic and even required methods of conducting business in many companies. Both corporations, as well as small and medium enterprises have noticed that EDI enables them meeting the requirements of a rapidly changing market. Electronic Data Interchange interweaves manufacturers, distributors, logistic companies, customers, and other business partners. The benefits stemming from the use of EDI are presented in the table below.

To sum up, it seems obvious that an Internet platform is a perfect solution for the companies who want to reduce the costs of implementing an EDI system. The Internet versions of EDI technologies are being developed based on the existing infrastructure and on the growing number of its users. They are intended for other customers than large international corporations. For individual customers and for small and medium enterprises the Internet is a compromise between relatively low implementation costs and the universality

of access. It also facilitates partial integration with the internal IT system. The Internet should be perceived as a superstructure platform over the classical dedicated EDI system. The universality of its use by small and medium enterprises enables easy, secure and rapid transmission of documents.

**Table 7. Benefits from the use of Electronic Data Interchange**

Area	Benefits
Logistics	Swifter exchange of documents within the deadlines, lower probability of error.
Recipients	Electronic data interchange has a global scope. For smaller subcontractors this is a chance for joining the global market.
Business procedures	Improvements in the control of costs and in-work efficiency, increasing the level of customer care. This results in lowering the warehouse stock and reducing administration costs.
Document processing accuracy	In particular: <ul style="list-style-type: none"> <li>– convenient exchange of documents regardless of the working hours,</li> <li>– reduction of document mailing costs,</li> <li>– increase of the customer care level,</li> <li>– more rapid replenishment and better control of warehouse stock,</li> <li>– reduction of minimum warehouse stock levels,</li> <li>– advanced notification of shortages and limitations,</li> <li>– reliable forecasting of supplier and customer requirements,</li> <li>– rapid, accurate and automatic confirmation of documents,</li> <li>– improvement of financial availability of capital,</li> <li>– improvement of productivity of commercial dependencies.</li> </ul>

Source: own work.

## Integrated IT system for planning support

Efficient management of even a small company requires taking into account multiple figures and facts. Analysing them is a difficult and time consuming process which, however, cannot be omitted, since it would mean that decisions are being made without taking appropriate issues into consideration. This would also practically prevent the reaction to changes in demand and to new trends, thus in turn causing shortages of products or overproduction. IT systems, which gather information from various departments, are helpful in planning, enabling managers to make immediate decisions concerning the quantity and the profile of production, the orders for materials, and the requirements of potential customers.

As a result of evolution of support systems, the planning systems have adopted the following names: MRP/MRP/II/ERP.

**MRP** – Material Requirements Planning is the standard which was created in the 1970s by the American Production and Inventory Control Society. Its goal

was to support the logistics areas of the enterprise in precise determination of the amount and time of delivery of materials, and to correlate them with the changing demand for the manufactured products, while taking into account multiple business partners.

**MRP II** – Material Resource Planning is the standard which was published and defined at the end of the 1980s. It is still used in most of the integrated planning support solutions.

The MRP standard that had been used before was improved by the addition of new elements related to the sale management process and of modules for the support of decision-making process at strategic levels of management. MRPII is a complex manufacturing process planning system which facilitates the management of the company and covers such areas of the enterprise as production planning, new enterprise related logistics requirements planning, and production capacities planning.

The comparison of the tasks set before the MRP and MRP II systems is shown in the table below.

**Table 8. Tasks of the MRP and MRP II systems**

	MRP	MRP II
<b>Support areas</b>	control of individual production stages, determination of the time and specification of deliveries – lowering of delivery costs, reduction of stock – increasing financial capital availability and capital rotation, assessment of production costs, the use of existing infrastructure, reaction to changes in the business environment.	planning of sales and production, management of demand, specification of the ready production, planning of the material requirements and material purchases, accounting of orders and transactions, planning of production capacity and working positions, planning of distribution, integration of financial modules, measurement of results, analyses and simulations.

Source: own work.

In the 1990s, many methods, complementary to and derivative of the – MRP II standard were created. The most popular include:

- **CPM** – Critical Path Method,
- **JIT** – Just-in-Time delivery systems,
- **OPT** – Optimised Production Timetable – also called the bottleneck theory,
- **DRP** – Distribution Resource Planning,
- **TQM** – Total Quality Management,
- Workflow.

These methods are still used in ERP systems.

**ERP** – Enterprise Resource Planning is an integrated management system. This system includes all the manufacturing and distribution systems, integrates various functional areas of business operation, improves the information flow, and enables immediate reaction to the changes in demand. For systems that are working on-line in the real time mode, the information is constantly updated and available at the moment the decision is made. The characteristic feature of the ERP system is the inbuilt optimisation mechanism for the decision making and planning process and the option of integrated delivery chain electronic connections built in the system.

The mechanisms, which enable the simulation of various versions and analysis of the results of decisions, which were made, are also used in these systems. This enables accurate planning, testing and comparing of consequences of actions which are undertaken as a part of the implemented BPR process (Business Process Reengineering).

The integrated ERP class system covers the areas presented in the table below.

**Table 9. Areas of use of the ERP class systems**

Area	Description of use
Manufacturing management	Purchasing raw materials and production materials, supporting warehouse logistics, assessing manufacturing costs, establishing manufacturing draft budgets, managing changes in the enterprise (e.g. the introduction of new, innovative solutions), forecasting of production capacity, controlling production processes, etc.
Finance management	Keeping accounting records, creating financial reports for respective recipient groups, preparing financial analysis and indicator analysis reports, controlling the flow of accounting documents.
Customer contacts management	Keeping the customer database and records, servicing, implementing and processing orders, Electronic Data Interchange.
Supply chain integration	Area which establishes future directions of development of ERP system, with the consequence of planning systems reaching outside of the enterprise.

Source: own work.

The creation of a new **ERP II** standard is also worth mentioning here. It is a development based on the earlier ERP-class systems standard. The basic factor that has transformed ERP into ERP II is the Internet. This platform has enabled the addition of functions which allow easy and secure exchange of data between business partners or even between participants in virtual exchange markets to an integrated planning system. This has enabled another, higher level of e-commerce development. The functionality of ERP II includes the trade of goods and services and electronic document interchange between the buyers, the sellers and other entities present in the market. During its evolution ERP has taken over the functionality of electronic information exchange within the supply chain of business

partners – providing the raw materials, creating the product and distributing the product. ERP II takes over and complements the traditional functions of earlier systems such as production planning, management of company finances and logistics, product stock and raw materials stock, which were integrated into the electronic exchange of offers, orders, invoices, and transactions. Management of the supply chain may form an integral part of the new standard. This new system functionality enables the preparation of an electronic transaction document which may be confirmed with the use of an electronic signature.

## Summary

To summarise, it should be noted that the use of IT technology tools in the production process is strategically important for every company. The construction of such tools should be highly prioritised. Companies will invest in solutions, which are adapted to their specific requirements, because the use of commercial off-the-shelf products, offered to all the entities in the market, does not provide a real competitive advantage. They may provide measurable economic benefits, but only until such solutions are implemented by competing companies. A source of competitive advantage may be obtained by acting innovatively and by searching for new solutions. The use of new IT tools and systems, and the work on their integration with the company will be a weapon in competing with others in the new model of the economy. The concept of internal integration of enterprise systems and then integration with IT systems of business partners – a part of creation of an integrated chain of added value – will be the key factor of the development of business models in the manufacturing process.

## Bibliography

- Dziuba D.T., Durkiewicz P. (2000), *Standaryzacja EDI w sferze ubezpieczeń i reasekuracji*, Electronic Data Interchange, Electronic Commerce, Łódź.
- Majewski P. (2001), *Istota i główne cele CRM*, [http://www.ekademia.pl/a/istota\\_crm](http://www.ekademia.pl/a/istota_crm), [access: 21.12.2015].
- Mazur A., Jaworska K., Mazur D. (2001), *CRM Zarządzanie Kontaktami z Klientami*, MADAR, Zabrze.
- Newell F. (2002), *Lojalność.com – Zarządzanie Relacjami z Klientami w nowej erze marketingu internetowego*, <http://archiwum.nf.pl/1004969-crm-to-nie-tylko-technologie/> [access: 21.12.2015].
- Węcel K. (2001), *Istota, cele i główne elementy CRM*, <http://www.czasnaebiznes.pl/teksty/istota-crm.html> [access: 21.12.2015].
- Zachara M. (2001), *Strategia CRM - pomysł na biznes czy system informatyczny*, <http://crm.pl/pokaz.php?kategoria=5&id=107&strona=3> [access: 21.12.2015].

## Narzędzia IT stosowane w zarządzaniu nowym modelem gospodarki opartej na wiedzy

### Streszczenie

Nowoczesne narzędzia IT w znacznym stopniu wpływają na zmiany w metodach zarządzania, zaś ich zastosowanie również wpływa na zmiany metod organizacji i zarządzania procesami biznesowymi. Zmieniły się skala, zakres, czas i funkcjonalny charakter biznesu. Internet odgrywa szczególną rolę w zmianie charakteru i zakresu działania biznesu. Nasz artykuł próbuje zidentyfikować narzędzia IT, takie jak systemy hurtowni danych (ang. DW), systemy zarządzania relacjami z klientami (CRM), elektroniczna wymiana danych (EDI) i planowanie zasobów przedsiębiorstwa (ERP), zintegrowany system IT dla wspierania zarządzania oraz wskazać ich wpływ na zmianę modelu zarządzania procesem tradycyjnej produkcji.

**Słowa kluczowe:** hurtownia danych, zarządzanie relacjami z klientami, elektroniczna wymiana danych, planowanie zasobów przedsiębiorstwa, model zarządzania.

**Kody JEL:** O3, O31, O32, O33

Artykuł nadesłany do redakcji w lipcu 2015 roku.

© All rights reserved

Afiliacja:

dr Artur Kwasek  
Akademia Finansów i Biznesu Vistula  
Wydział Biznesu i Stosunków Międzynarodowych  
ul. Stokłosa 3  
02-787 Warszawa  
tel.: 22 457 23 00  
e-mail: a.kwasek@vistula.edu.pl

dr hab. Michał Marczak, prof. PŁ  
Politechnika Łódzka  
Wydział Organizacji i Zarządzania  
ul. Piotrowska 266  
90-361 Łódź  
tel.: 42 631 37 60  
e-mail: michal.j.marczak@gmail.com