Using RFID in supply chain and retail store unit

Použití RFID v dodavatelském řetězci a maloobchodní prodejní jednotce

M. Záboj

Mendel University of Agriculture and Forestry Brno, Czech Republic

Abstract: The paper deals with the very actual sphere of using new tool within the frame of entire supply chain from manufacturer towards consumer. The common idea is a management of the flow of goods by the method which should be enable more effective identification, control, tracking and many follow-ups processes in the distribution channel. Even in retail store, the final consumer could use this instrument for his/her increased satisfactory and comfort during his/her shopping. Presumption for realisation of this goal becomes the implementation of a new phenomenon RFID (radio frequency identification) into current operations performed throughout the all levels of value chain with using modern information technology.

Key words: radio frequency identification, goods, supply chain, costumer, distribution, point-of sale, future store

Abstrakt: Příspěvek se zaměřuje na velmi aktuální oblast využití nového nástroje v rámci celého dodavatelského řetězce od výrobce ke spotřebiteli. Společnou myšlenkou je řízení toku zboží metodou, která by měla umožnit efektivnější identifikaci, kontrolu, sledování a mnoho dalších distribučních procesů. I v maloobchodní prodejně by konečný spotřebitel mohl využít toto zařízení pro vyšší úroveň spokojenosti a pohodlí při svém nákupu. Předpokladem pro splnění tohoto cíle se stává zavádění nového fenoménu RFID (vysokofrekvenční identifikace) do stávajících činností prováděných ve všech etapách hodnotového řetězce s využitím moderních informačních technologií.

Klíčová slova: vysokofrekvenční identifikace, zboží, dodavatelský řetězec, zákazník, distribuce, místo prodeje, obchod budoucnosti

INTRODUCTION

As the number of devices attached to the Network has grown exponentially, the value of the Network and the benefits of being attached to it have increased dramatically as well. First, thousands of mainframes and mini computers shared business data. Then, millions of PCs connected to the Network did the same, followed by tens of millions of mobile phones and handhelds, which spawned more high-value networked services such as e-mail on any device, instant messaging, push-to-talk, file sharing, business-to-business commerce, and many more. Today, shared applications and services are the norm. But the revolution is just beginning. Soon, billions of devices will connect to the Network. Many will utilize a single powerful technology: Radio Frequency Identification (RFID).

Understanding the consumer mindset trough the Radio Frequency Identification can help companies gain insight into consumers' willingness to purchase products enabled with the RFID technology. The implications may have a profound impact on businesses as they develop their RFID strategy and approach.

The main object of the paper is to consider the development of new phenomenon in management of the flow of goods in supply chain and increase in the comfort for consumers in retail stores – RFID. The partial aims represent specifying of the stages of the RFID utilizing within the supply chain, recognising of the benefits from the using of the RFID, describing of substance how the RFID works and illustration of this tool in the real practice project, so called "Future store".

Supported by the Ministry of Education, Youth and Sports of the Czech Republic (Grant No. MSM 6215648904).

MATERIAL AND METHODS

To fulfill the described tasks, there are used the methods of analysis and synthesis of information obtained from either literature, interviews with the representatives of the relevant subjects or the EDI (electronic data interchange) shared by organisations participating in implementation of the RFID. It is neccessary to mention that no publication exists in the Czech books market regarding the in given theme due to the relatively new research problem and that is why it was very difficult to gather the neccessary data.

Radio Frequency Identification (RFID) technology has been hailed for its ability to enable the automatic identification and data capture of the tagged items without human intervention, and for its potential to revolutionise supply chains across many industries. While the tagging of individual products is still several years away, it represents the end state that many companies hope to achieve in order to gain the full benefits of the RFID. Realising this objective, however, is dependent to some degree on consumer acceptance of the technology. That acceptance is likely to depend on how well companies educate consumers about the reality of the RFID. Should the industry fail to educate consumers about the RFID, that role will default to consumer advocacy groups, which have already raised the issue of privacy as the key concern. It is important, therefore, that companies gain an understanding of the consumer mindset surrounding the RFID so they can set the stage in a positive way. With the current consumer-related debate around the RFID focused primarily on privacy concerns, it is difficult to assess what consumers think of the technology on a broader basis and how much they really understand about it (Bhuptani, Moradpour 2005).

The importance of educating consumers about the RFID was apparent in the European research performed by the Capgemini organisation. Many consumers have not yet formed strong opinions about the RFID but are interested in learning more. However, some respondents expressed worries about privacy and the possibility that companies could track consumers via the RFID tags, making it clear that consumer education is needed sooner rather than later[1].

RESULTS AND DISCUSSION

Using the radio frequency technology, the radio frequency identification (RFID) enables non-contact identification, control and tracking for all goods and items throughout the entire value chain. The scope for optimising processes is immense and the savings potential is enormous. The RFID is not a pie in the sky – firm can use it today for manufacture, distribution and retail, across any company in the value chain (Taylor 2003).

For the first time, the RFID provides a complete control over the entire flow of goods. Equipped with a unique fingerprint, every single product can be recognised and traced at any time during its journey from manufacturer to consumer.

The RFID works automatically and does not require contact or line-of-sight for operation. Integrated with the data network, goods can be identified in real-time over any distance – across continents and even worldwide, if required. The RFID can be flexibly implemented. For example, firm can start with storage management and expand the system bit by bit to cover its entire internal materials management. The RFID can effortlessly grow to meet firm's demands. This fascinating technology is proven and tested. By applying the accepted standards, the RFID is compatible with any network. And the RFID is of most benefit when used across the board by every single partner along the value chain – from the manufacturer to the branch manager, working together hand-in-hand for fast, secure, freeflowing and cost-saving processes (Taylor 2003).

Production: Directly after manufacture, an item receives a so-called TAG containing a unique electronic code. Using this code, the item can be identified at every point in the supply chain.

Packaging: Items are packed individually or in batches and stacked onto pallets. The batches and pallets are each given an individual code TAG as well.

Outgoing goods: On leaving the factory floor, all TAGs are identified in a single registration process, which includes the batches and pallets as well as the individual items. Thanks to the RFID, there is no need for the line-of-sight or repacking.

Distribution centre for incoming goods: Fully automated, the RFID reader identifies items and batches delivered, and records quantities. A stockcheck against stored order and delivery data, confirmation of receipt to the manufacturer and the exact recording of incoming goods are also automatic.

High bay warehouses: When placing goods in storage, the shelf-mounted RFID readers register the receipt of the article and batch/pallet, and then balance the inventory with the data in the storage management system.

[1]Internet page of the Capgemini company.

Commissioning: Deliveries are put together according to branch orders. Pallets with the appropriate point of sale mix of goods also receive a transponder and are automatically registered together with their entire contents by the RFID reader when loaded for shipping.

Incoming goods at the branch: Incoming deliveries are recorded using the RFID and logged on the internal inventory control system. Following the fully automated inventory check, goods are moved into the interim storage or placed on the sales shelf as required.

Point of Sale: Shelf-mounted RFID readers automatically register every transaction without the need for the line-of-sight and regularly update the stock and location data in the inventory management system.

Customer information: If available, customers can view information on products, promotional campaigns and stock levels via a display. Thanks to the RFID, calling up this information is fully automated and occurs in real time.

Purchasing/payment: All the articles contained in a shopping basket are recorded using RFID at the cus-

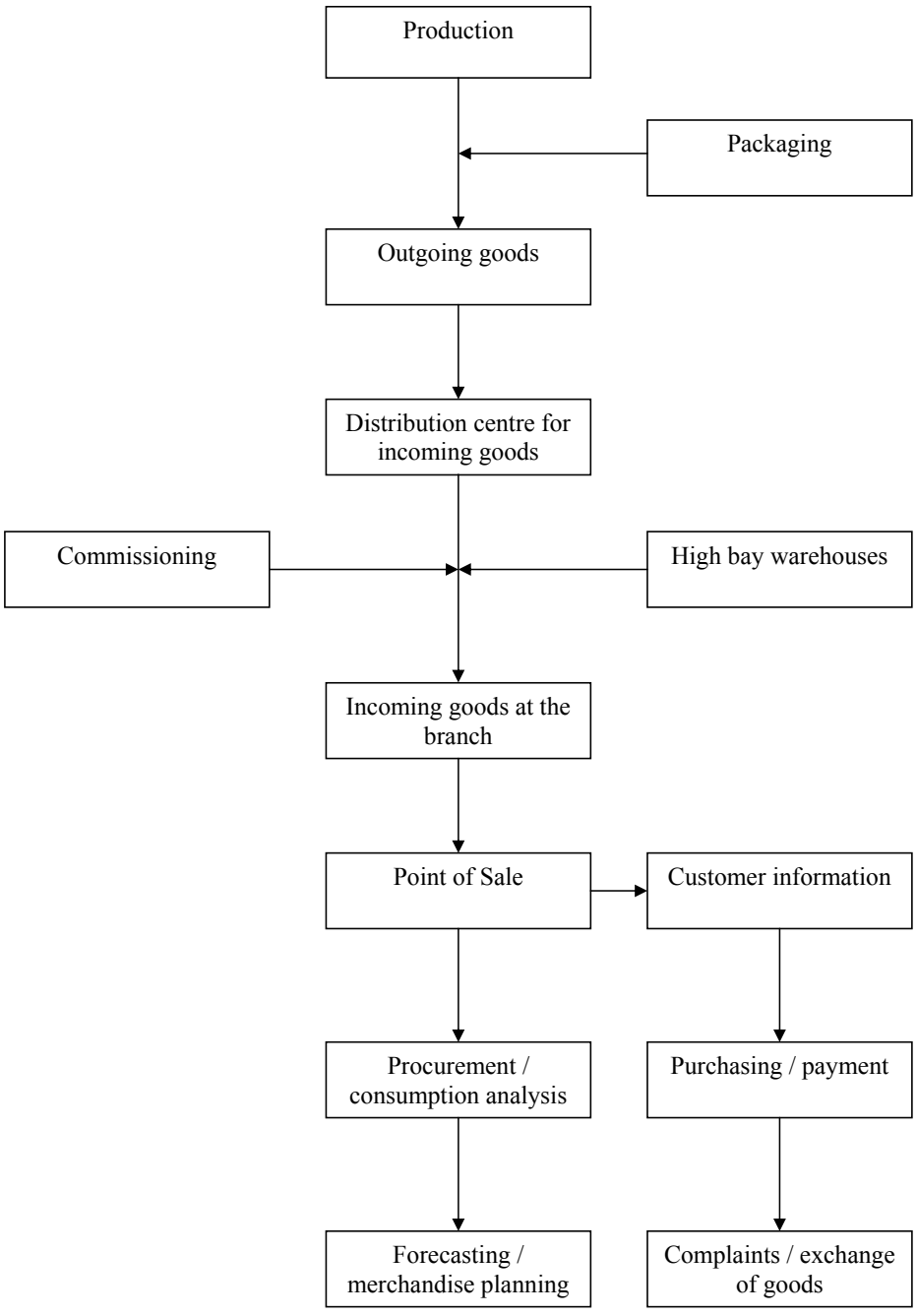

Figure 1. Processes utilizing of the RFID within the supply chain

tomer check-out in the store. Just one step is required to bill the goods using the electronic product code and authorisation from the customer's credit card.

Procurement/consumption analysis: The inventory management system logs sales and creates a systematised repeat order. In a further step, the RFID reader could, for example, generate an electronic shopping list for the end user.

Complaints/exchange of goods: Clear identification of goods using the RFID tags simplifies exchange or return of goods and complaints procedures – and you do not even need a receipt. The history of every item can be tracked exactly, so that claims submitted under the warranty can be quickly resolved – contributing added value to the customer.

Forecasting/merchandise planning: In connection with the automated data capture and processing systems, the RFID enables retail companies to constantly update their forecasts for goods requirements and place repeat orders with manufacturers at the optimum point in time.

Processes utilizing of the RFID within the supply chain are illustrated in Figure 1.

Benefits from the using of RFID

Manufacturers benefit from a marked increase in the efficiency of their materials management, and individual retailers can expect savings in storage costs and smaller losses resulting from theft or accounting errors. Over the last few years, the RFID has become firmly established in a wide range of manufacturing supply chains. There are two main targets in using of the RFID:

1. *Increased customer satisfaction***.** Gone are the days of empty shelves, because a popular product was stuck somewhere in the supply chain. As required, additional product information can be accessed and modern signpost systems aid orientation through an attractive consumer environment and improve shopping efficiency.
2. *More efficiency in the flow of goods.* Which products got stuck in the delivery chain and where? Which article is hanging around in which storage facility? The RFID provides answers at the click of a mouse and also ensures a fast and accurate inventory control of the incoming and outgoing goods.

Demand from the consumer industry and retailing is growing in parallel to rapid developments in technology. This is because the advantages of this future-oriented extension to traditional barcodes have gained attention across every sector:

1. *Less time spent on administration.* Complete goods registration and easy identification provides a continuous inventory. This reduces time and money spent on administration.
2. *Optimum protection against theft.* The RFID TAGs are already widely used as "honest gatekeepers" for the incoming and outgoing goods, transition zones and at the check-out. The multifunctional application of TAGs dispenses with additional costs for the manual goods protection.
3. *Easier way to pay.* The RFID transmitters make queuing at the check-out a thing of the past. Corresponding simpler ways of paying increase customer satisfaction and volumes of sales.
4. *Simplified warranty.* The RFID can replace the obligatory receipt for exchange of goods, complaints and claims under guarantee – together with all the administrative costs that go along with this. Product recall and tracking are also made considerably simpler.
5. *Better protection from pirating.* The RFID functions like an electronic fingerprint. Even production and procurement channels can be documented without trouble – this creates an extra protection against imitations and pirating.
6. *Tighter container management.* The RFID does not just track goods and products along the entire supply chain. It can also follow reusable transport containers in the supply chain and locate and identify them via radio.

The overall benefits from the using of the RFID for manufacturers, intermediaries and consumers are followed in Table 1.

The RFID optimises the essential core processes in the flow of goods for both the supply and demand sides. Since the mid 1990s, the RFID has been successfully used in a whole range of capital and consumer goods supply chains. The potential for the future is tremendous. From supplier management to production to warehousing, the technology simplifies the internal materials management: for incoming goods, warehouse management, stocktaking, commissioning as well as delivering finished products and purchasing raw and packing materials. Additionally, the RFID means you can track production right from the start through every stage of the value chain. Targeted control of the individual storage racks as you need it and correspondingly the accurate production alignment help to minimise uneconomical stockpiling and reduce costs (Kleist et al. 2004).

TAGs are not just used to individually code every single item and all kinds of consumables – they can be used to code all the packing and transport containers,

Table 1. Benefits from the using of the RFID

Manufacturers	Intermediaries	Consumers
Automatic identification of goods, data capture	Automatic identification of goods, data capture	Obtaining information on products, promotional campaigns and stock levels
Goods control and tracking	Goods control and tracking	Just one step to bill the goods
Flexible implementation	Flexible implementation	Simplifying the exchange or return of goods and complaints procedures
No need for line-of-sight or repacking	Automatic recording of incoming goods	Attractive consumer environment
Increasing in the efficiency of materials management	Generating an electronic shopping list	Increased customer satisfaction
More efficiency in the flow of goods	More efficiency in the flow of goods	"Personal shopping list"
Less time spent on administration	Less time spent on administration	Using of the existing cashless payment systems
Protection from pirating	Protection from pirating	Protection from pirating
	Updating of forecasts for goods requirements	
	Savings in storage costs	
	Smaller losses from theft or accounting errors	

such as pallets, crates, boxes, and packages as well. The RFID readers at the factory's exit gate can in one step read the information stored on all the tags – with no requirement to see or repack goods. Using the information read from the TAGs in combination with internal administration systems and the standard Internet applications, there are several processes which can be carried out automatically in just a few seconds: checks for product and volume against the relevant order, approval to ship, instant registration of outgoing goods on the production facility's inventory management system and the provision of electronic dispatch data at destination.

Whether in the distribution centre or the store: on receipt of goods, the RFID reader fast records all the TAG information in a delivery and identifies all articles one-to-one in a single step. There is no need to check the order by hand, because the information read is instantly checked against the distribution centre's inventory management system or the order and delivery dispatch data held at the store. Deviations from the order are immediately recognised during the automatic check routine. Electronic confirmation of goods received and the exact booking of every item are also automatic.

Using the radio frequency technology speeds up the entire process for the turnover of goods and increases data transparency at every logistic stage because all data and information is relayed. Reducing the need for work by hand considerably decreases the number of errors that occur in commissioning processes, for example. Deviations, losses and incorrect commissioning are recognised early on thanks to the RFID because all data is relayed consistently, and both transport units and individual products can be regularly checked one-to-one by reading their transponder information at the important stages in the supply chain.

Using the RFID in-store enables consistent optimisation of many process involved in shelf management. From now on, you can avoid out-of-stock situations because information about stock levels and reordering behaviour is constantly updated. Above-average turnover or differences in stock levels are recognised quickly, and restocking orders are sent. You can easily and accurately check the data on expiry and the best-before dates. The RFID readers and displays mean prices are simpler to update and more customer-friendly. In future, multimedia applications will make it possible to inform customers in a targeted and more personalized way about products and promotional campaigns. At the same time, this automatically creates reliable data for future marketing activities.

Every article in the shopping trolley or basket is automatically registered in one single process (batch reading). Thanks to a unique customer card also equipped with a RFID chip and non-contact recognition, customer service and the ease of payment improve even more. Alternatives include the use of the existing cashless payment systems (credit cards, debit cards, etc.). Using the RFID does not require any new check-out systems. Existing check-outs can

be equipped with an RFID reader and upgraded using the appropriate software.

Using the RFID, stocktaking (in the warehouse and at the POS) can be fully automated. This can be done at any time and any place at the push of a button. You can determine the location and volumes of stock and exactly identify every single product as required. This makes it easy to find goods stored in the wrong place. Special handheld readers mean you can make specific inputs and checks.

The RFID applications are finding greater use in product protection at check-outs. Here, the RFID TAGs can be easily combined with electronic security systems (Electronic Article Surveillance or EAS), as long as the current EAS technology is based on radio frequency technology. Handling costs for theft prevention and activating and deactivating security systems are eliminated. This means retail can make considerable cost savings. At the same time, the RFID offers greater security against theft and more customer-friendly checks at the check-out (Bhuptani, Moradpour 2005).

How RFID works

The radio frequency technology enables electronic contact-free identification, control and tracking of one or a whole range of items in the value chain – and it can span every company in the chain. The special features offered by this futurefacing technology means the RFID offers a whole range of advantages compared to existing barcode technology. Similar to barcode technology, the RFID also reads data carriers – but rather than using optical wavelengths (such as infrared), the RFID uses radio frequencies. The difference is that dark and light fields are not read with a sensor. Instead, alternating electromagnetic fields are used to carry data. The RFID does not just mean non-contact identification of the objects you want registered (individual items or transport batches), it can do this independent of the position and place these objects are kept. No line-of-sight is required between the reader and the information carrier (TAG). Through batch reading, a multitude of objects can be read in one process without the need for repacking.

In inductive systems, a wafer-thin wire, the antenna, is wound around the memory chip. The antenna is used to send the information stored on the chip as well as to receive signal pulses from the RFID reader. The unit comprising chip and antenna is referred to as a TAG or transponder.

A microscopically small data carrier can store a whole range of information (e.g. manufacturer, product version, serial number, expiry date, etc.). Depending on the kind of application and the chip, storage units can be repeatedly rewritten (Kleist et al. 2004).

The power required to send and read the stored information is taken from the reader, which transmits electromagnetic waves. These are intercepted by the TAG and converted into energy in the chip using a mini-transformer. Alternatively, there are also TAGs that have an active power supply provided by minute batteries, to increase the transmission range.

The RFID reader communicates with the TAG with no contact or line-of-sight requirement. Installed at every point in the value chain, these interfaces independently process the data read and communicate with external data processing applications (such as inventory management systems, storage management, etc.).

Future store: using the RFID

The METRO Group calls it the "Future Store", and that is the name of the game. Outside, the Extra Future Store in Rheinberg, near Duisburg (Germany), looks just like any other supermarket. But the customer is transported into the future the minute he or she steps through the door. The shopping trolley is equipped with a minicomputer complete with touch screen that guides the customer through the store as a kind of "personal shopping consultant". The computer scans articles chosen and, as required, provides the customer with various additional information[2].

Whatever happens, information is top of the bill in the METRO supermarket of the future. Electronic price tags on the shelves inform customers about special offers, as do electronic advertising displays and special terminals where customers can access specific further information. And incidentally, the little electronic pilot on the shopping trolley is not just a "personal shopping list" based on what the customer bought last week. Via radio, it can speed up the check-out process while the customer walks through the aisles.

When the customer gets to the check-out there are three ways to pay: "Traditionally", i.e., check-out staff scans the goods before the customer pays. Or, using the personal shopper, instead of loading the groceries onto the conveyor belt, the customer can send the list of goods from the minicomputer to the check-out and then pay. And then there is the self-service payment

[2]Internet page of the Metro Group.

desk: Customers can scan goods themselves and then pay at a machine (Metro Group 2005).

New concepts and trend-setting technology that is not just tested in the lab but in a real supermarket with real customers under normal everyday conditions – that is the aim of METRO Group's Future Store Initiative. And it was not just about putting the technology to the test, but seeing how customers would respond. Up to 40 well-known IT service providers and consumer goods manufacturers have taken part in this initiative: Whether it is the founding partners Intel and SAP, or IBM, Cisco, Wincor Nixdorf or Procter & Gamble, Kraft Foods, Nestlé, Gillette, Henkel and Coca-Cola – all of these companies have been involved in turning these visions into reality right from the start.

CONCLUSION

Goods recognition using the RFID is about to make its breakthrough worldwide. If entrepreneur does not want to miss his connection to the future, he will need to join the intelligent recognition system fast. The advantages are obvious and more and more companies across ever more sectors are enjoying the benefits. In the face of increasingly complex goods flows and the continual internationalisation of manufacturing and retailing, the future belongs to electronic goods recognition using the RFID.

This new technology has an enormous potential. To capitalise on the potential requires a clear long-term corporate strategy:

- Checking the applications and potentials that the RFID technologies offer businesses.
- Taking part in pilot projects including a whole range of companies to collect valuable experience.
- Using internationally agreed standards for the consumer goods industry, beginning with their gradual introduction.

Depending on the type of company, there are all kinds of ways of getting started. It soon makes sense for manufacturer and retailer alike to use the RFID for transport and delivery units containing several individual products as well as for pallets and boxed packaging.

The RFID tags will be found embedded in everything from cereal boxes to prescription medicines to parts of an aircraft to a variety of other machinery. These tags, when in proximity of the right type of sensors, will broadcast information about the objects they are embedded in – dimensions, whereabouts, identification numbers, history of temperatures they were exposed to, and many other static and dynamic characteristics. Many sensors located in hospitals, manufacturing plants, stores, or automobiles will collect this data, aggregate it, and route it to various humans and decision support systems.

The benefits derived from offering services based on such information will be tremendous. Businesses will run more efficiently and consumers will experience better and more innovative services. For example, instead of a grocery store losing sales because of consumers not finding meat in stock, the RFID tags in the meat packages being bought will tell the store's in-house sensors that the shelves are more than half empty, triggering a reorder to the supplier. The supplier, armed with the latest information about the location of his meat shipments (thanks to the RFID-based pallets used in trucks connected to the central facility via a Global Positioning System), will direct the nearest available shipment to the store. As the truck carrying the goods is being unloaded at the loading dock, the RFID tags in those boxes will alert the store's inventory system, which in turn will alert the stocking clerk to get ready to stock the shelves. The time saved due to automatic detection of low stock levels and corresponding delivery means that the grocery store would not run out of meat, increasing profits.

In addition, the tags will have data about the temperatures the boxes were exposed to in transit. If the refrigeration system in the truck malfunctioned, exposing some of the packages to higher than recommended temperatures, the tags will help the store clerk identify and separate out packages containing spoilt goods. Detection of possibly spoilt goods means that the customers would not have to suffer the consequences, averting a potential health disaster and liability for the store.

REFERENCES

Bhuptani M., Moradpour S. (2005): RFID Field Guide: Deploying Radio Frequency Identifications Systems. Prentice Hall PTR, Dallas, 288 p.; ISBN 0-13-185355-4.

Kleist R.A., Chapman T.A., Sakai D.A., Jarvis B.S. (2004): RFID Labeling. Printronix, Irvine, 211 p.; ISBN 0-97-600860-2.

Taylor D.A. (2003): Supply chains: A manager's Guide. Addison-Wesley, Boston, 358 p.; ISBN 0-201-84463-X.

Záboj M. (2004): Analysis of using the Category Management in distribution process. Agricultural Economics – Czech, *50* (9): 417–422.

Internet pages of the company Capgemini: http://www.capgemini.com/news (2005-04-26).

Internet pages of the Metro Group: http://www.future-store.org (2005-04-14).

Arrived on 29th April 2005

Contact address:

Ing. Marek Záboj, Ph.D., Mendelova zemědělská a lesnická univerzita v Brně, Zemědělská 1, 613 00 Brno, Česká republika

tel.: +420545132324, fax: +420545132329, e-mail: marek@mendelu.cz