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INNOVATIVE INFORMATION TECHNOLOGIES IN THE MODERNIZATION OF BUSINESS INFORMATION SUPPORT

Expansion and improvement of the technology of electronic formation and transmission of accounting data requires a review of the key principles of information processing systems and accounting. Automation of the primary recording of accounting data using modern coding systems is of great importance in this regard. The purpose of the study is to determine the possibilities for the complex use of two-dimensional barcoding in the form of QR coding for business information provision, electronic data exchange, electronic documentation and document flow. The study uses historical and bibliographic methods, scientific abstraction, methods of comparative analysis, statistical and logical methods. As part of the study the genesis of the introduction and development of barcoding technology and its use for information exchange has been studied. The expediency of using the technology of two-dimensional barcoding in the form of QR coding has been substantiated. The advantages and ways of using QR codes for business information support have been highlighted. New ways of applying barcoding for accounting purposes have been presented, in particular, for registering the movement of inventory, payment for goods, works, services, personnel management, access to information data on a website or other information resource, registration of relationships between business entities and exchanging documents.

Keywords: barcode marking, barcode, one-dimensional barcoding, two-dimensional barcoding, QR code, accounting, electronic documentation, electronic documents circulation.

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ІННОВАЦІЙНІ ІНФОРМАЦІЙНІ ТЕХНОЛОГІЇ У МОДЕРНІЗАЦІЇ ІНФОРМАЦІЙНОГО ЗАБЕЗПЕЧЕННЯ БІЗНЕСУ

Розширення і вдосконалення технології електронного формування та передачі облікових даних вимагає перегляду ключових засад інформаційних систем обробки інформації та бухгалтерського обліку. Важливе значення у цьому відводиться автоматизації первинної фіксації облікових даних із застосуванням сучасних систем їх кодування. Метою дослідження є визначення можливостей комплексного використання двовимірного штрих-кодування у формі QR-кодування для інформаційного забезпечення бізнесу, електронного обміну даними, електронного документування і документообігу. Теоретичну й методичну основу дослідження склали загальнонаукові, спеціальні та емпіричні методи пізнання процесів та явищ. У статті використано історичний та бібліографічний методи, наукову абстракцію, методи порівняльного аналізу, статистичний та логічний. У рамках дослідження вивчено генезис запровадження і розвитку технології штрих-кодування та її використання для потреб обміну інформацією. Обґрунтовано доцільність використання технології двовимірного штрих-кодування у формі QR-кодування. Виділено переваги та способи використання QR-кодів для інформаційного забезпечення бізнесу. Виокремлено найбільш оптимальні шляхи застосування штрих-кодування для облікових потреб, зокрема: для реєстрації руху товарно-матеріальних цінностей; здійснення оплати у безготівковій та безконтактній формі та її врахування в обліку; управління персоналом з можливістю ідентифікації співробітників, обміну особистими та обліковими даними; доступу до інформаційних даних на веб-сайті чи іншому інформаційному ресурсі; оформлення взаємовідносин суб'єктами господарювання; електронного обміну документами.

Keywords (ключові слова): штрих-кодове маркування, штрих-код, одновимірне штрих-кодування, двовимірне штрих-кодування, QR-код, бухгалтерський облік, електронне документування, електронний документообіг.

Introduction. The modern economic environment is based on the use of the latest information systems and data collection and processing technologies. The success of a business largely depends on the level of mastery of these technologies, because information has now become a strategic product. Manufacturing or trading companies record, store, process and analyze significant amounts of data on the movement of inventory and other business processes on a daily basis, and carry out the exchange of such information. It is information systems and computer and communication technologies that allow to manage such processes effectively.

The most widespread in these conditions is the barcode labeling system. It is connected with the fact that first and foremost barcoding allows tracking the movement of inventory, in particular, identifying the movement of objects from production to warehouse, from warehouse to retail network, from sellers to buyers, etc. In addition, the involvement of advanced technological tools for barcoding, the updating of coding technology, in particular the adaptation of QR coding to work with large data sets, has made it possible to use these technologies for accounting and other needs, such as marketing operations or coordinating customer relationships.

The issue of using barcoding for the needs of information exchange between business entities is considered in the works of scientists from many countries, such as M. Benko, Heider A. M. Wahsheh and Flaminia L. Luccio, Z.-M. Zadorozhnyi, V. Muravskiy, N. Pochynok, A. Hrytshyn, I. Bashir, K. Naik, C. Madhavaiah, G. Kiryakova, N. Angelova, L. Yordanova. Most of the above-mentioned scholars have studied the barcoding system from the standpoint of technological capabilities and secure data exchange. However, few associate the use of the barcoding system for recording the movement of inventory items, other accounting needs, electronic documentation and electronic documents circulation, which provides in general significant advantages in accounting at an enterprise.

The purpose of the article lies in studying the possibilities for the complex use of two-dimensional barcoding in the form of QR-coding for business information provision, electronic data exchange, electronic documentation and electronic document flow.

Results. The study of the use of barcoding technology for the exchange of economic information must first begin with the history of its emergence and technological capabilities.

Barcoding technology was invented by Norman Joseph Woodland and Bernard Silver in 1948 (patented in the United States in 1952) to automate stock management and customer payments [1]. However, due to the technological limitations at that time, the use of barcodes seemed impractical. The practical application of barcoding was proposed by David Collins (USA) in the 1960s, when he developed the KarTrak system for the automatic identification of railcars and other rolling stock, which involved encoding information by placing colored stripes in various combinations on railcars that were read by a track scanner [2].

Later, in 1973, based on the above developments, the universal one-dimensional product coding system using the Universal Product Code (UPC) for industry and trade was introduced in the United States. Taking into account the positive practice of barcoding in the United States, in 1977, a similar system was introduced in Western Europe under the name European Article Number (EAN) for identification of consumer goods. Subsequently, on the basis of UPC and EAN, the GS1 standardization organization developed an international product number intended for use in computer systems, namely the Global Trade Item Number (GTIN).

In 1994, another innovation in barcoding was introduced, in particular by the Japanese company Denso-Wave, which developed two-dimensional barcodes for inventory tracking, which were approved by ISO in 2000 [3]. And in 2018, the GS1 URI Web standard structure was ratified, which allowed adding Uniform Resource Identifiers (URIs) to products in the form of a web page-like address as a QR code [4].

As for the barcoding technology itself, it is based on the use of the method of optical reading of information and is based on the binary number system. Information about the available type of value is recorded as a sequence of zeros and ones [5]. A modern barcode consists of successively placed narrow or wide stripes, light or dark geometric objects applied to different media. Dark squares and wide stripes mean 1, and narrow or light ones mean 0.

There are two main standards for barcoding - linear (one-dimensional or 1D) and two-dimensional (2D) barcode symbolism (Figure 1).

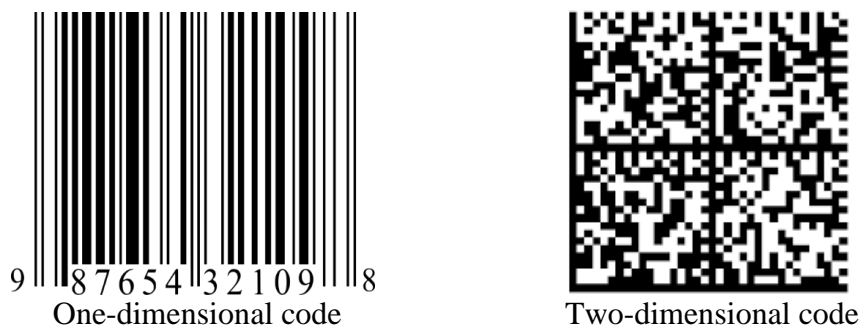


Fig. 1. *Samples of one-dimensional and two-dimensional barcoding of products and goods*
Source: own elaboration.

The initial ones were linear (one-dimensional) codes, which have long been used in the business practice of tracking the movement of inventory items. These are bar codes that are read in one direction (horizontally). Two-dimensional codes are built like a matrix barcode, which uses a black-and-white pattern to encode symbolic data and is distributed in a plane using a specific geometry [6]. The best examples of such codes are QR codes. The two-dimensional codes designed to encode a large amount of information (up to several pages of text) and are read by a special scanner. Encoding of such codes is conducted in two dimensions (horizontal and vertical).

The barcode method of identification when moving products from production to warehouse, from warehouse to retail network and further when transferring them to customers allows you to record each operation in a documentless mode. With the help of special scanners, this information is read at the places of business operations and transmitted to the company's accounting department for generalization and further processing via computer and communication tools.

In manufacturing industries, various types of materials, assemblies, parts, components, and finished products are subject to coding and labeling for the purpose of automated record-keeping at their storage locations, transfer to production workshops, to the finished goods warehouse, and when they latter are shipped to customers.

In wholesale trade, such automated accounting systems are based on the use of the UCC/EAN-128 barcode and electronic data exchange. They combine the following into a single network: a server for summarizing accounting information, scanners for identifying goods, barcode-labeled storage shelves for storing goods, transporters equipped with reading scanners, and printers for printing barcode labels [7].

In retail trade, barcoding and electronic data transmission are combined into a single integrated automated system for accounting and controlling the movement of goods. Such a system includes a server for generalizing accounting information, recorders of payment transactions, weighing and cash devices, printers for printing and scanners for recognizing barcodes.

The barcoding system, as a means of automated recording of material values, effectively replaces the previous procedure for documenting and primary accounting, is closely connected with accounting, and allows you to automatically generate accounting records for the receipt, movement, sale of goods and material values in electronic format. Further automated processing of these data allows you to generate output information and prepare internal and external reports.

However, the use of standard (one-dimensional) barcodes for organizing the primary accounting of the movement of material values has certain disadvantages. The most significant disadvantage of barcoding is that it is applied by printing on goods or packages. Poor quality of

code application, its damage during transportation and storage does not allow to read the codes using a special scanner. There are also cases of non-compliance with scaling when coding is done, low contrast of the applied codes. As a result, the scanner does not perceive the marks. Then the goods need to be relabeled. This process is too time-consuming and costly, which leads to conflicts between the supplier and the seller. Therefore, the specific terms of barcode labeling are often specified in the product supply agreement.

In general, standard (one-dimensional) barcode labeling has many other technical inconveniences, including the limitation of the amount of encoded information data. Therefore, it is being replaced by a more technically complex and information-rich system of two-dimensional barcoding (in particular, in the form of QR codes). This system is more resistant to damage and can also contain large amounts of data. In addition to constant indicators, it allows you to include variable information, such as origin, date and consignment, content, ingredients, etc.

These QR codes properties have a certain impact on the structure of technological solutions for encoding information. In particular, a study of the market of information support of commodity products showed that the QR code is the most popular among respondents-manufacturers (suppliers) (Fig. 2).

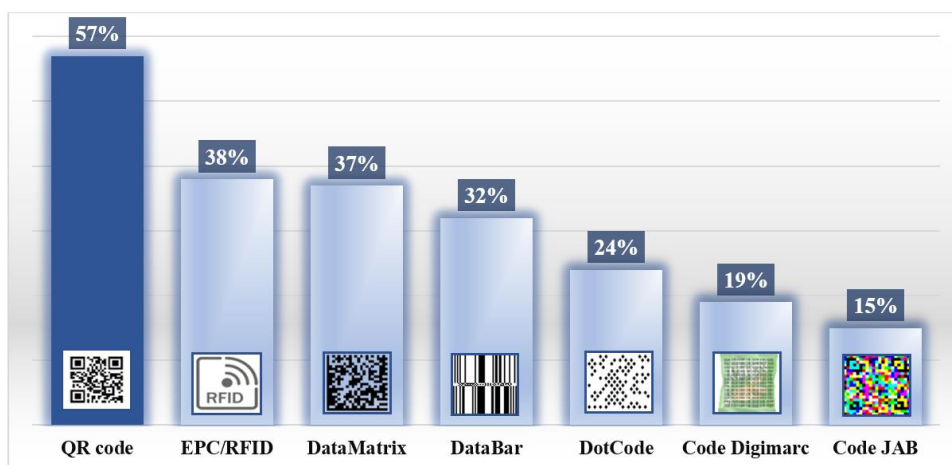


Fig. 2. Assessment of manufacturers' interest in the latest information coding technologies
Source: own elaboration on the basis [8].

Such popularity of QR coding among manufacturers is connected with its advantages over other systems. In particular, the code can be engraved/printed on small products and read by mobile operating systems such as Google Android or Apple iOS. No less important, in our opinion, is that the QR code can contain volumetric variable data, it can be used, apart from documentless registration of the movement of inventory items, and in the process of documenting relationships with counterparties: when placing orders and documents for the release of inventory items, making payments and other data exchange by means of technical means using paperless virtual technologies.

This method of information exchange is becoming increasingly popular among buyers (customers) in developed economies. This is confirmed by statistics from international research institutions. For example, according to the GlobalWebIndex research platform, from 2015 to 2019, the volume of QR code scanning by information users increased significantly: in Europe - by 99 per cent, North America – by 86 per cent, Latin America – by 58 per cent, slightly increased in the Middle East and Africa by 19 per cent, and remained at the same level in the Asia-Pacific region (this is due to the fact that this technology was already widespread in these countries) [9].

At the same time, in 2019, the number of regular users of QR codes was 15 per cent in Asia-Pacific, 13 per cent in Latin America, 10 per cent in Europe and the Middle East and Africa, and only 8 per cent in North America [10]. This trend has undergone significant changes with the increase in the share of contactless commerce associated with the spread of the Covid-19 epidemic. In particular, according to the Statista analytical platform, the use of smartphones for scanning QR codes in the United States in 2020 increased by 13.1 million (from 52.6 million to 65.7 million), and by 2025 it should almost double to 99.5 million. [11].

Such popularity of QR coding technology for providing information data is mainly connected with the fact that it has significant advantages [12]:

1. *Storage of large amounts of data.* QR codes can contain a significant amount of data or links to resources containing such data.

2. *Storage of different types of data.* With the help of QR codes, it is possible to encode four types of data: numeric, alphanumeric, binary, and kanji. As for the information content, such a code can encrypt URL addresses of websites, emails, other links, numbers, texts and files.

3. *Small size.* QR codes take up little space and can be read from both paper (material) and electronic media.

4. *Fast scanning.* QR codes can be scanned and read from any angle. In addition, to read such a code, you do not need any special hardware and complex expensive software products, just a smartphone (tablet) and a standard barcode reader.

5. *Error correction.* Depending on the selected error correction level, the QR code can be decoded even if part of it is dirty or damaged.

The research on the application of QR codes for business information provision and accounting needs has shown that currently, the most optimal approach is to utilize this method of information exchange in the following formats:

➤ identification of goods (with information about sellers, manufacturers, origin of goods, consignments, promotions, instructions for use, etc.), which is important for analytical accounting of the movement of goods;

➤ ordering goods, works, services (viewing prices, menus, placing an order, making a reservation);

➤ invoicing in electronic form (by scanning the QR code of the order (from the client's gadget)) [13];

➤ conducting self-service in stores (customers register using special applications with personal electronic profiles linked to their smartphones; upon entering the store, the customer's QR code is scanned; all goods purchased by the customer are automatically added to the virtual basket; upon completion of purchases (leaving the store), funds are automatically charged from the customer's account (e-wallet). At the same time, this information is transferred to the accounting department for inclusion in sales volumes. One of the most famous such stores is Amazon Go [14];

➤ stock management (control over the quantity and their needs in retail outlets and warehouses) [15];

➤ use of electronic tickets for travel (by scanning barcodes reproduced on paper or directly from the screen of electronic gadgets) and accounting for the calculation of transportation services;

➤ payment for goods, works, services and its inclusion in sales volumes (a fast payment method that allows for cashless and contactless transactions by directly going to the payment website via a QR code);

➤ personnel management (it allows quick identification of employees, exchange of exchange of personal and account data, uninterrupted recording of time worked and tasks performed);

➤ access to information data on a website or other information resource (it allows using an encrypted link to enter an online store, an information website, a cloud environment and access information data, online and offline documents, etc.)

This indicates about the active use of QR coding for information support of management and marketing needs of companies. As you can see, most of these needs are directly related to accounting information support and can greatly facilitate the process of documenting and accounting at an enterprise.

Conclusions. From the moment of the emergence of barcoding (mid-twentieth century) and up to the present day, there have been significant changes in the sphere of use of this technology from being used only for control of stocks to being used for customer identification, carrying out contactless sales, and also as a means of electronic documentation and electronic exchange of accounting documents. All this

happened thanks to the expansion of barcoding capabilities with the introduction of two-dimensional barcoding technology (QR coding in particular), which allows working with large amounts of data.

Popularity of QR coding technology for providing information data is mainly due to the fact that it has significant advantages over other systems of encryption and information transmission, namely: the ability to store large volumes and different types of data, small size, fast reproduction, the ability to correct errors or decode, automatic entry of the conducted transactions into the accounting system.

In its turn, the study of the possibilities of using QR codes for business information support has shown that at present, the most optimal is the use of this method of information exchange for the identification of inventory items placing orders and invoicing; accounting for the movement of goods in self-service retail outlets; using electronic tickets for travel; making payments for goods, works, services; personnel management; access to information data on a website or other information resource. This indicates that the great opportunities for using QR coding for information support of accounting, management and marketing needs of companies.

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