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AUTOMATED SYSTEM FOR ANALYZING AND RESEARCHING THE EFFECTIVENESS OF BUSINESS OPERATIONS

Мороз Б. І., Сироткіна О. І., Марочко А. М. Автоматизована система аналізу і досліджень ефективності торгової організації. Представлений комплексний алгоритм створення автоматизованої системи збору, складування, аналізу і досліджень торгової організації з синхронізацією і виводом в програму, встановлену на ПК або смартфон.
Ключові слова: Аналітична система, ефективність торгової організації, алгоритм аналізу і досліджень, моделювання і прогнозування результатів.

Мороз Б. И., Сироткина Е. И., Марочко А. Н. Автоматизированная система анализа и исследований эффективности торговой организации. Представлен комплексный алгоритм создания автоматизированной системы по сбору, хранению, анализу и исследований торговой организации с синхронизацией и выводом в приложение, установленным на ПК или смартфон.
Ключевые слова: Аналитическая система, эффективность торговой организации, алгоритм анализа и исследований, моделирование и прогнозирование результатов.

B. Moroz, O. Syrotkina, A. Marochko. Automated system for analyzing and researching the effectiveness of business operations. This paper presents a comprehensive algorithm for creating an automated system to collect, store, analyze and research data from a business. Its main features include synchronization with, and output to, an application installed on a PC or smartphone.
Keywords: Analytical system, effectiveness of business operations, algorithm analysis and research, modeling and forecasting results.

Introduction and formulation of the problem. The primary goal of any business is to make a profit. Baseline data in the analysis of the store's efficiency are data about sales: their volume, dynamics, and range. By analyzing these data, you can solve the following problems:

1. Identify which groups of products generate the biggest profit in the store, and which ones the smallest;
2. Obtain information on the effectiveness of marketing and management decisions;
3. Compare the efficiency of personnel on different shifts or in different stores;
4. Identify the effectiveness of seasonal sales.

Having collected the necessary data, placing them into the database, and structuring them we can define the weak and strong sides of the enterprise. Based on this, we can recommend improvements to the business in an easy-to-understand format, for example, visual indicators in the form of graphs or tables.

Aim of the article. We would like to offer a comprehensive algorithm for creating an automated system to collect, store, process and display the information about the workings of a business. This would allow us to show where efficiencies can be had, thus further increasing sales for that enterprise. We also describe the concept of collecting, storing, structuring, analyzing and displaying this information.

Analysis of previous experience in the development of similar systems. At the present time, there are a vast number of scientific developments regarding this topic:

- SPSS Statistics [1] is a computer program capable of processing statistical data and is one of the market leaders in the field of commercial statistical products intended for applied research in social sciences;
- Deductor [2] is a platform for creating complete analytical solutions. The platform employs advanced methods for extracting, rendering and analyzing data;
- Amazon GO [3] is similar to a brick-and-mortar shop, but without cash desks and queues. It is built in such a way that each customer authenticates himself at the entrance with a special application by simply lifting his smartphone to the turnstile. When taking goods from the shelf, he puts them in a basket and the purchases are debited from his bank account.

However, despite the abundance of scientific research (including any programs already implemented), one main issue still remains: the creation of a single, automated system to perform special functions to collect and analyze information. Further research and study is thus required in this area.

Disadvantages of the automated system:

1. A high level of dependency on various sorts of devices to collect information;
2. The need to put forward certain requirements for a business to provide software and technical support;
3. The need for a certain amount of time to adapt to the system, gain experience, and self-training;
4. The chance that the system could be unprofitable and costly for very small business.

Advantages of the automated system:

1. Unity of the system;
2. The opportunity to receive data in real time, for example, on a smartphone;
3. Self-training of the system and forecasting marketing factors, thus reducing the number of staff;
4. Future performance can be expected to accelerate, thereby increasing the efficiency of the enterprises.

Main part

To create an automated analysis and research system it is necessary to implement the following algorithm:

1. Collection of information;
2. Processing the information by way of recording and structuring it into the database;
3. Analysis of information;
4. Conclusions.

The sources of information collection within the shop are:

1. Turnstiles or doors that are able to track the flow of customers;
2. A cash system that provides all the information about the product and its pricing;
3. Cameras and other sensors.

The implementation algorithm proposed in this study is shown in Fig. 1

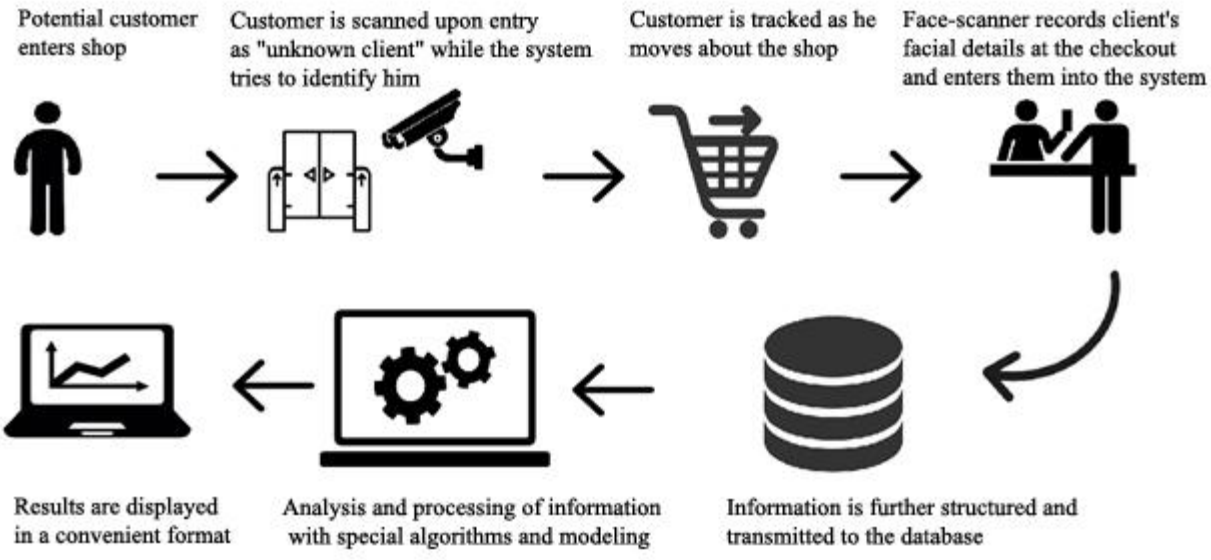

Fig. 1. Schematic of the system complex algorithm for collecting and analyzing business effectiveness

Consider all the stages of our algorithm. In order to assess how well the system works, it is necessary to know how many customers entered, how long they stayed, a heat map which records their movements, the time they spent considering whether or not to purchase a certain product and, finally, whether the customer actually purchased the product. The need for tracking technology is necessary throughout the enterprise. To begin with, we need to determine why the customer visited the shop. We can achieve this with the help of special doors, in which there are sensors to distinguish the output and input. In addition, we can provide cameras capable of instructing automated doors to reroute traffic in the event a door fails. Similarly, the technology can also redirect the number of customers to another door in the event of a heavy volume [4]. If this is not enough, it is possible to set sensors 40-50 cm above the floor to monitor the number of legs passing by [5].

An example of a door with sensors determining to monitor how many people enter a shop is shown in Fig. 2

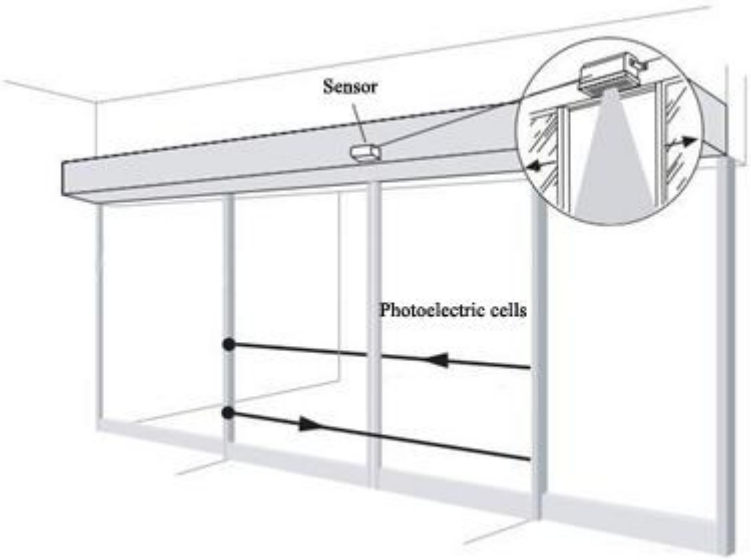

Fig. 2. Doors with sensors

There are special cameras to watch customers' movements throughout the shop. These cameras form a heat map in two-dimensional space, that is, on the floor. We can also obtain a heat map of the customer in three-dimensional space to determine the most popular sections, shelves, etc. That is, the customer's focus on a particular product. It is also possible to put sensors either near the goods or locate cameras near the floor, focusing perpendicularly on a rack, shelf, row, etc.

An example of a heat map of the customer's movements in the store is shown in Fig. 3.

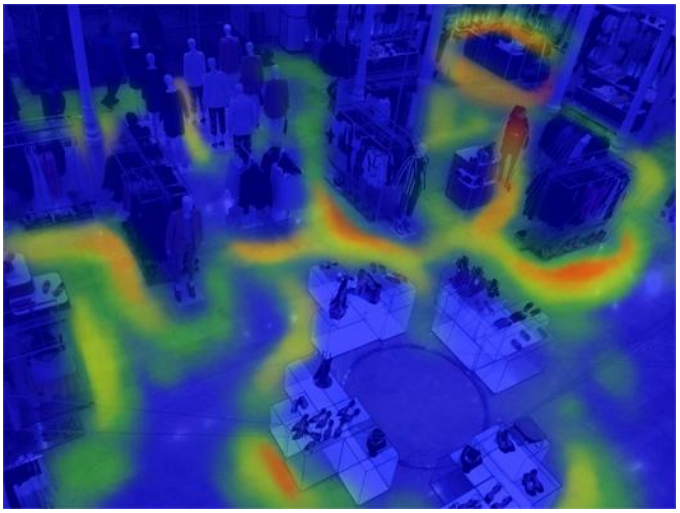

Fig. 3. An example of a heat map of the customers' movements

Similarly, we need to divide the "unknown" customers who entered and left without making a purchase and "identify" whom the system was able to recognize. Each customer entering the store is initially identified as "unknown" or "indefinite," but, nevertheless, is assigned a temporary identifier. The cameras provide identification and transfer their "guesses" to the system for processing [6].

If the customer wants to purchase the goods, he goes to the checkout where his face is clearly seen by the camera, which captures an image and very likely writes it to the database (if he is a new client) or compares it with this database and thus "recognizes" him. This is in contrast to a customer who comes in, spends some time in the store, maybe even handles the goods, but does not go to the checkout with them. This means he does not make a purchase and the system records him in the stream of the same customers. Based on this information we can find the most important indicator, which is the conversion rate.

An example of the camera installation providing further identification of the customer at the checkout is shown in Fig. 4. and Fig. 5

Fig. 4. Location of the camera near the checkout area

Fig. 5. Scanning and face recognition of a customer

The information collected should be stored, processed further and analyzed using OLAP technology. To store other data, we use relational MySQL or MongoDB databases. In the case of MongoDB, the data structure is based on documents. The data of most web applications are simple to display, so they are stored as an associated array [7]. The relational database is presented in the form of a more rigorous structure and imposes a number of restrictions. The main programming language will be JavaScript. React.js will be used for the client program and Node.js as the server platform. In this case, MongoDB will simplify the process of data exchange between the database and the server.

There are a vast number of indicators to establish the efficiency and effectiveness of a business. However, we are going to consider six fundamental indicators from which others are formed [8]:

1. Conversion is the ratio of customers who made a purchase to the total number of customers who entered the shop.
   Conversion can be increased and decreased and made many times cheaper or more expensive during sales, promotions, seasonal discounts, as part of research, in the case of new goods and collections to be imported, and even at how well sales associates perform [9];

2. A receipt (average receipt) is an indicator that characterizes the average sale, and then outgrows in the dynamics of the average receipt;
3. Deriving sales from a square meter or a square is an indicator that determines the revenue per square meter, although it is rather controversial and often unreliable due to many factors that are difficult to forecast. However, it is important for planning purposes to use this limited retail space as efficiently as possible.
4. Volume of revenue (sales) can be measured not only in monetary units, but also in physical units (pieces, liters, meters, etc.);
5. Product returns are mainly analyzed in parallel with the reasons for these returns, but the ultimate responsibility for this can lie in the quality of goods, in mismanagement and incompetent sales personnel. It is enough for the system to determine what was returned, when it was returned and in what quantities;
6. Salary capacity is the ratio of wages to the cost of the products produced.

Having analyzed the acquired data, the system can reveal a trend, seasonality, and offers. It can help to choose the best model to accurately determine a sales estimate. Also, based on the old data the system has already learned, it can acquire the ability to make data adjustments without requiring particularly complicated skills from the operator.

The system will model the best product decisions, price list, seasonality, number of personnel, and the required retail floor space. It would perform based on the calculations of the data and preferences defined by the operator. It is also based on comparisons with other methods and data using past experience. Ultimately, all these data will be presented in a convenient format in the form of charts, tables, and cross-diagrams [10]. It will also be possible to synchronize certain sensors and data at each of the stages with subsequent output to the application installed on a PC or smartphone.

Conclusions and prospects for further development. We presented a new system for collecting and analyzing information to assess business efficiency. We proposed a whole cycle of analysis: data preparation, selection of information types, systematization, modeling, forecasting, post-processing and concluding with an interpretation of the results. All of this is presented in a format convenient to the end user.

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