The Cognitive Model And Its Implementation Of The Enterprise Uzmobile

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Abstract: The use of IoT technologies in Uzbekistan is fraught with a number of features and limitations associated with the economic, technological, legislative, geographical and cultural characteristics of the country. Most of the existing methods for planning the activities of the enterprise cannot be applied to assess the current state, to formulate a set of recommendations for the development of the industry as a whole, and its individual companies. Some methods operate only with stable quantitative indicators, rely on established standards and require sufficient historical data. The Internet of things is one of the breakthrough technologies of the 21st century. The market for Internet of things devices is relatively young in our state's economy. Despite the growing growth rates of industry indicators, there is no clear understanding of its future development. This article is devoted to the application of the cognitive modeling method to assessing the current activities of the company, conducting scenario analysis and constructing a methodology for planning further development of the enterprise. The methodology used in the study is based on a review of secondary sources by the authors conducted earlier. As a result of the work, a list of influential concepts was formed, the relationships between them were determined, and the cognitive model of the company itself was built. As part of the experiments with the model, drivers and development barriers, strengths and weaknesses of the company were identified, various development scenarios were considered

Keywords: IoT, UZMOBILE, enterprise competitiveness

1. Introduction

The process of forming a methodology for planning the activities of an enterprise involves taking into account the influence of qualitative factors that are different in nature [4]. Therefore, the task is to formulate development scenarios for a poorly structured, poorly studied system, on the basis of which the company will be able to make decisions based on the chosen direction of development. Expert knowledge is required on the current state of the company and the industry as a whole, because the future values of key development indicators will depend on how priorities are formed and determined within the framework of the company's planning methodology [7]. Cognitive maps allow formalizing poorly structured scenarios for the development of the Internet of things company based on expert knowledge. A cognitive map is a graph, in the nodes of which there are factors that influence the development of the system or situation under consideration, and the interconnections of factors are reflected by arcs. Currently, cognitive modeling technologies are actively developed and applied in economics, psychology, biology, philology and other sciences [2,8].

The formation of the cognitive model of the studied subject area is the identification of future target and undesirable states of the control object and key indicators of the environmental impact that affect the transition of the object to these states, as well as the establishment of a qualitative level of causal relationships between them, taking into account the mutual influence of factors on friend.

Objective: to develop a cognitive model of a company manufacturing devices for a smart home, and assess its development trends based on scenario forecasting.

2. Literature Review

On the issues of modeling, design and development of systems and networks of the Internet of things, a relatively small number of works have been published due to the formation of this area of research.

Among the works of the authors, we note the works of Sharifi S. S., Esfidani M. R. [16]. Cruz and others that make up the theoretical basis for the design of the Internet of things, as well as the work of Tkachenko S., Berezovska L., Protas O., Parashchenko L. in the field of modeling the functioning processes of distributed systems and their elements, which include the Internet of things [17]. This new direction is in a state of constant development.

In addition, a reflection of the effectiveness of the enterprise is profit, which shows how much revenue from sales of products covers production, management and other costs that ensure the stable functioning of the business. The study of profit as a characteristic of the effective activity of the enterprise is an urgent task [5], allowing, in particular, to justify the pricing policy of a small enterprise. Aspects of profit growth are actively discussed by Uzbek and foreign researchers. The article by Chown, E. [1] substantiates the thesis that the main factors of profit growth are a decrease in the cost of production, an increase in the volume of production and sale of products, as well as an improvement in its quality. Durmanov, A., Bartosova, V., Drobyazko, S., Melnyk, O., & Fillipov, V. (2019) [3] consider the efficiency of cost accounting as a tool for regulating profits. They calculated an example and proposes to use a multi-channel cost-cutting mechanism based on the theory of management of organizational systems. Hilorme, T., et. al. (2019) believes that cost management is the most important direction in the formation of their optimal level to maximize profits on the basis of maneuvering fixed and variable costs [9]. Hu J., Ji N., Yu Q justifies the decrease in the profit of small firms with large rents levied on trading places in large shopping centers [10]. LaRose, R., & Eastin, M. S. (2004) developed a linear regression model for forecasting the value of shares, since the price of shares affects the profit of the enterprise [11]. The article by Lee, M. D., & Wagenmakers, E. J. discusses the factors of increasing profit at Australian biochemical enterprises, such as successful innovations, the identification of new distribution networks, cooperation of enterprises from different industrial clusters, etc. [12]. Li R. Y. M describes the results of studies conducted in fast-growing companies in Australia by constructing a model with six variables. It has been established that large profits and long-term growth depend on the reputation of the company [13]. Miyake, A. using an empirical approach, studied the performance of Irish enterprises and proved that innovation is the key to increasing the performance of the economic system [14]. Saadé, R., & Bahli, B. (2005) Foss conducted experiments that show that the profit of enterprises operating in conditions of uncertainty is affected by economic freedom and new combinations with resources [15]. Yi I. G., Jeong H. M., Choi W., Jang S., Lee H., Kim B. J. built a business model of start-up enterprises and statistically substantiated the dependence of enterprise efficiency on the scale of the economy and management costs. In their view, innovation is a key factor in operational success [19]. The aim of the study, Zheng X., Xu Y., is a modification of the Hotelling spatial model for predicting the profits of high-tech firms based on the incentive mechanism and sustainability using mathematical statistics [20]. Umarov, S. R., believe that one of the key factors in the growth of labor productivity in the semiconductor industry is to improve the overall efficiency of equipment, affecting, among other things, net profit, operating expenses, etc. [18]. It would seem that there are many models for business, but new subjective models contribute to the acquisition of elements of new knowledge. We suggest using cognitive modeling to study aspects of the problems associated with profit [21].

3. Methodology

The solution to the problem of developing models and algorithms of information interaction in the networks of the Internet of things formulated in the research is based on the methods of system analysis, probability theory, random processes and mathematical statistics, methods of numerical analysis, and cognitive modeling. The object of research is the company UZMOBILE - the developer and manufacturer of the "smart home" system, the pioneer of this direction in Uzbekistan. The company is one of the leaders among manufacturers of smart home devices and offers its products in Uzbekistan.

4. Findings And Discussions

As a result of the analysis, a problem field is formed in the form of a set of basic factors. To build a cognitive map of an enterprise, it is necessary to identify factors affecting key indicators of the company's effective activity. As such, “Profit from sales” and “Market share” were chosen - the central concepts that you need to focus on when determining the direction for further actions and constructing a methodology for planning the company’s activities.

Based on the analysis of national and foreign sources of literature, analysis of information portals and other sources of secondary data, SWOT and PEST analyzes, the following groups of control concepts were identified:

- Economic;
- competitive;
- Technological;
- promotional;

- Marketing;

- Information Security;

In addition to dividing factors into categories according to the principle above, they can be conditionally divided into external ones - those that the company cannot influence, they influence at the level of the entire industry, not one firm, and internal ones - positive and negative aspects of the company's activity, their advantages and disadvantages.

The composition of factors and certain relationships between them, formed as a result of preliminary analysis, were proposed for evaluation and editing by five experts using the Delphi method using the Google Forms questionnaire, a developed cognitive model and a matrix of communication between concepts. The questionnaire is conditionally divided into the following blocks (table).

After interviewing the experts, we received an updated array of factors and relationships between them (direction and significance) and an assessment of the current level of development of each of them. Expert data were aggregated. To form a single level based on the opinions of experts, the geometric mean calculated using the formula.

$$a_{ij}^{A} = \sqrt[n]{a_{ij}^{1} a_{ij}^{2} \dots a_{ij}^{n}}, \quad (1)$$

Where a_{ij}^{A} - aggregated assessment of an item belonging to;

п – number of experts.

Standard deviations from the mean for the values of each factor were also calculated using the following formula:

$$S = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2}, \quad (2)$$

Where S – standard deviation, xi – i-th sample element, n – sample size, x – arithmetic mean of the sample.

Checks of evaluations for consistency were conducted. For this, the coefficient of variation was calculated.

$$K_v = \frac{S}{M}, \quad (3)$$

Where K_v – coefficient of variation, S - standard deviation, M - mathematical expectation / arithmetic mean of the sample.

The average standard deviation is 0.08, the coefficient of variation of expert estimates is 13.8%. Given the rating scale from 0.1 to 0.9, we can conclude that the estimates obtained are consistent, there were no obvious outliers and polar estimates for any factor.

Table 1. Expert Survey Algorithm

Instructions, a brief description of the study, its purpose and key tasks	Determining the presence of influence and its degree of each factor on others within the framework of the developed cognitive map (from –1 to 1)	Quantitative assessment (in the form of fuzzy numbers) of the current level of development of concepts - from 0.1 to 0.9	Block of open information: indication of "unnecessary" factors, adding missing concepts (+ explanation of the reasons for the need to introduce this concept into the model and its level at the moment)

Experiments on the model were carried out using the programs MentalModeler and FCMapper. MentalModeler. The estimated model, taking into account the assessments of experts, was tested for stability. Different cognitive models with each new iteration can either adjust the values of indicators included in the concept model at the same level, or provide an alternation of low and high level values. A correct and close to the objective situation model must be stable. This is ensured by the equality of positive and negative relationships, as well as the presence of feedbacks, as a result of which, with each new iteration, a cycle of influences is produced by model factors. The developed model passed the stability test, which is shown in the line graph of the model values. After 5 iterations, the factors stabilized taking into account 3 digits after the decimal point, after ten - up to 5 decimal places, and after 15 iterations - taking into account 10 digits after the decimal point.

As a result, we get that experts' ideas about key success factors are underestimated. Taking into account the degree of development of other concepts according to expert estimates, indicators of development of the company's activity are of greater importance (Fig. 1). The change in the values of factors over time is given by the formula

$$x_i(t+1) = x_i(t) + \sum_{j \neq i} a_{ij} x_j(t) - x_j(t-1) + g_j(t)$$

,

i = 1… N, (4) Where $x_j(t)$ and $x_j(t-1)$ values of the i-th factor at a time t + 1 and t, respectively, $\Delta x_j(t) = x_j(t) - x_j(t-1)$ – increment (impulse) of the factor x_j, a_{ij} – weight of interference between factors xi и xj, Ii – indices of directly influencing factors on the factor xi, gj (t) - external influence (for example, control).

The final cognitive map is presented in Fig. 2. Red concepts - target indicators of the company's activity, pink - factors of negative impact on the company's activities, green - the strengths of the enterprise, yellow - concepts that cannot be influenced - environmental factors. Separately, competitors stand out.

To understand the strength of the influence of each factor on the criteria, separate experiments were conducted with each factor. These experiments can be carried out in two different ways. In the framework of the first, all factors are fixed at a certain level, while all targets are free and change during the iteration of modeling. This method does not show how the factor can generally affect the target indicators, because it does not take into account the influence through the connections of concepts to each other, since all other factors are fixed, and it is impossible to take into account such connections and changes. To find out how a certain factor affects target indicators, a comparison was made of situations where this factor is at the level of 0.1 with the situation when it is at the level of 0.9. This method allows you to evaluate the development of the company in the short term.

Another way is to consolidate only the studied concept in a specific experiment. These iterations will help you figure out how a factor can influence your long-term goals with direct and feedback. The studied factor is fixed in one case at the level of 0.1, in the other case - 0.9, and other factors are free and change during iterations. If we compare the amounts of changes in the target indicators for each factor obtained in two different ways, then in most cases the variability in the second case is greater, however, the impact of some concepts is offset by the influence of others (fixing them at a certain level other than 0), respectively, and the amount of changes below. The degree of influence of some negative factors is reduced due to the positive influence of other concepts.

Fig. 1. The level of development of key factors of the enterprise in the comparison of the scenarios "Self-development" and "Assessment of experts".

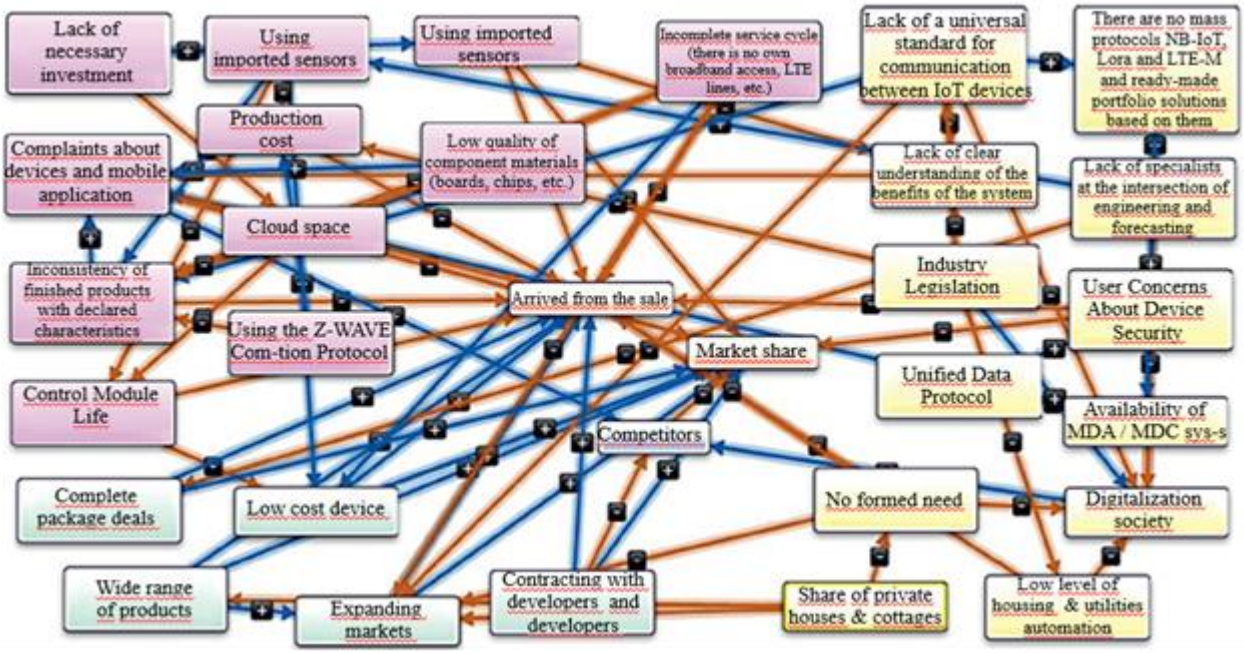

Fig. 2. Cognitive model of the enterprise UZMOBILE

If we consider the amount of change in key indicators at the minimum and maximum level of development of indicators of company and industry activity (Fig. 3) according to the table of the second method, we see that the most influential factors are “Expanding sales markets” (0.4), “Wide range of products ”(0.39),“ Low price of devices ”(0.36),“ Low level of marketing and advertising ”(–0.34), and“ User concern about device security ”(0.28) and“ Inconsistency of finished products ” declared requirements".

The analysis of the scenarios “Self-development” was carried out, when the values of the factors correspond to the current state of development [6], and “Maximum target indicators” are the ideal development option, when the target factors “Profit from sales” and “Market share” reach a maximum value of 1. This assessment method allows you to identify possible growth areas and market problems - something that you first need to work on (Fig. 4).

The figure shows that in order to achieve the desired level of development, it is necessary to work with a number of indicators. The company must take care of the configuration and quality of the services offered, with various packages of manufactured products. The Uzbek population has not formed a clear understanding of the benefits of systems and the formed needs, so they perceive such a product as entertainment, they do not see the real benefit and effect of use in it. Therefore, within the framework of this situation, consumers want to see a lower price, then they will be ready to try "new-fangled toys." Making partnerships with developers will increase the value of indicators of the company.

This comparison made it possible to identify the drivers of the external environment: the development of a unified regulatory legislation - there is no official document in Uzbekistan that enshrines the very concept of the Internet of Things, consolidates the base of legal secure protocols, increases the level of automation of housing and communal services and the private sector. As a result, the development of the external environment and the popularization of the Internet of things in general and smart homes in particular will lead to the growth of companies engaged in such activities. It is necessary to develop our own component materials and get rid of import dependence. Increasing the level of digitalization is a priority for the Decree of the President of the Republic of Uzbekistan “Digital Uzbekistan 2030” for the period until 2030. The industry is one of the priorities for the country in the near future. The development of the industry and the formation of consumer understanding of the benefits of smart home devices will create a conscious need, which will positively affect key indicators. Since demand creates supply, progress in the industry will undoubtedly affect both the number of companies providing Smart Home services and the price and cost of devices.

In the process of studying the developed model, positive and negative scenarios were also formed and compared (Fig. 5). For the positive scenario, a scenario was adopted in which all factors except the target ones that have a positive impact on the targets had a value of 0.9, which had a negative impact - a value of 0.1. The levels of target values were calculated for the scenario “Self-development” in the previous iteration, which is a neutral scenario.

The resulting fuzzy values were converted to numerical values by carrying out the defuzzification stage using the center of gravity method for single-point sets:

$$y = \frac{\sum_{i=1}^{n} A_i C_i}{\sum_{i=1}^{n} A_i}, \quad (5)$$

where Ci - clear values of conclusions (real numbers),

Ai - degrees of truth for the premises or conditions of each of the rules.

The final values of the four scenarios considered are as follows (Fig. 6).

In fig. Figure 6 shows that in the positive scenario, the targets are much higher than in the neutral scenario ("Self-development" scenario), and in the negative scenario, lower. This indicates the proper functioning of the model as a whole, and also shows that in order to achieve high performance on key performance indicators, it is necessary to competently build the company's work, focus on strengths, minimizing the negative impact of the external environment and constantly working on improving the company's development strategy.

Fig. 3. Factors of maximum impact on company performance indicators

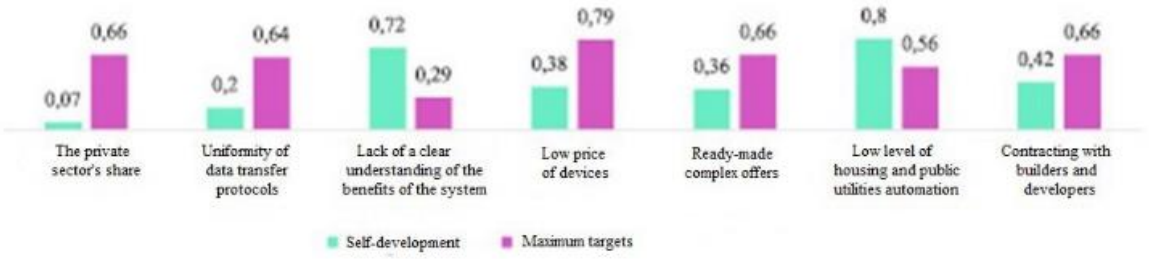

Fig. 4. Comparison of the scenarios "Self-development" and "Maximum targets"

Fig. 5. Target values under various market development scenarios: Self-development / Expert evaluation / Negative / Positive

Fig. 6. Defazzification of target values under various market development scenarios

In addition, an analysis was made of the influence of environmental factors on target indicators using negative (all positive environmental factors were 0.1, negative equaled 0.9), positive (vice versa) and neutral scenarios. It was found that the environmental indicators that are more affecting the key indicators are "The share of the private sector (individual construction)", "Uniformity of data transfer protocols", "Lack of a clear understanding of the benefits of the system". These factors are logical, a conservative view of smart home devices does not allow the industry and company to develop fully, it is necessary to change the minds of consumers, to show the benefits of introducing IoT technologies. Residents of the private sector benefit greatly, the area of premises are larger - budget savings are felt due to the rational consumption of energy, water, etc. The formation of common standards will allow to unify the entire process of creating and implementing smart home devices, increase the level of trust in the company and in the security of smart home systems.

5. Conclusion

The formed cognitive map of the IoT-technology market enterprise based on the method of expert assessments and its subsequent analysis revealed the key factors of the company's development, weaknesses to which attention should be paid. Possible scenarios of the company's development are considered, using which you can improve the quality of decisions made by the top management of the company while developing its development strategy. Also, this card can be used in scenario analysis by industry experts. To improve the accuracy of forecasts obtained using this map, it is further planned to add new factors and use more detailed linguistic scales.

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