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DEVELOPMENT OF SOFTWARE FOR EFFECTIVE ENTERPRICE PRODUCT POLICY CREATION

The problem of developing a software tool for an effective enterprise product policy creation is considered. Existing methods for an enterprise product policy creation require the execution of a large number of computational operations, and those operations can be processed faster and more accurate by using of personal computers. The object of this research is IT-enterprise which is developing web-applications for automatization of relationships between enterprises and clients. The main point of the work is developing of program tool that uses algorithmic model of information technology for enterprise product policy creation to increase enterprise profitability. During the work, the current state of the problem of enterprise product policy creation, as well as existing software tools that could be used to create the enterprise product policy, were considered. A review of existing software development methodologies was performed. The task about developing of algorithmic model, software tool architecture and program system for enterprise product policy creation was set. The software tool that is developed contains of several functional modules. There are listed algorithms that describe how those modules work. The algorithmic model uses hierarchy analysis method for creation of assortment of product policy and simplex method for solving task of linear programming for calculation of production volumes for chosen products. The functional and non-functional requirements were developed for program, the three-layer software architecture of the web-application was chosen, program code was written, and program system was tested. The graphical user interface was developed and described. The graphical user interface provides users with ability to enter information, which is required for enterprise product policy creation, and retrieve results which are set of products, that enterprise should produce, and volumes of production of those products. The conclusion about results of developing program system and the possibility to use the algorithmic model in future researches were made. The results of the work can be used for development of information technology of enterprise product policy creation.

Keywords: product policy, enterprise, information technology, algorithmic model, hierarchy, optimization, effectivity.

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РОЗРОБКА ПРОГРАМНОГО ЗАСОБУ ФОРМУВАННЯ ЕФЕКТИВНОЇ ТОВАРНОЇ ПОЛІТИКИ ПІДПРИЄМСТВА

Розглядається проблема розробки програмного засобу для формування ефективної товарної політики підприємства. Існуючі методи формування товарної політики вимагають виконання великої кількості обчислювальних операцій, а використання електронно обчислювальних машин може збільшити швидкість і точність виконання таких операцій. Об'єктом дослідження є IT-підприємство, що здійснює розробку веб-додатків для автоматизації взаємодії між підприємствами та клієнтами. Метою даної роботи є розробка програмного засобу, який використовує алгоритмічну модель інформаційної технології формування товарної політики підприємства, для підвищення прибутковості підприємства. Під час виконання роботи, було розглянуто сучасний стан проблеми формування товарної політики підприємства, а також існуючі програмні засоби, що можуть бути використані для формування товарної політики підприємства. Було виконано огляд існуючих методів розробки програмних засобів. Поставлена задача розробити алгоритмічну модель, архітектуру програмної системи і програмну систему для формування товарної політики підприємства. Розроблений програмний засіб містить декілька функціональних модулів, алгоритми функціонування кожного модулю описані в цій статті. Алгоритмічна модель використовує метод аналізу ієрархії для формування товарного асортименту та симплекс-метод вирішення задачі лінійного програмування – для визначення об'ємів виробництва товарів. Для програмної системи були розроблені функціональні та нефункціональні вимоги, було обрано тришарову архітектуру веб-застосунку, написано програмний код і виконано тестування програмної системи. Розроблено графічний інтерфейс користувача, який надає можливість вводити інформацію, необхідну для формування товарної політики, та отримувати результати – товари, які необхідно виробляти, і об'єми виробництва таких товарів. Зроблено висновки про результати розробки програмного засобу і можливість використання алгоритмічної моделі в майбутніх дослідженнях. Результати роботи можуть бути використані як теоретичні основи для розробки інформаційної технології формування товарної політики підприємства.

Ключові слова: товарна політика, підприємство, інформаційна технологія, алгоритмічна модель, ієрархія, оптимізація, ефективність.

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РАЗРАБОТКА ПРОГРАММНОГО СРЕДСТВА ФОРМИРОВАНИЯ ЭФФЕКТИВНОЙ ТОВАРНОЙ ПОЛИТИКИ ПРЕДПРИЯТИЯ

Рассматривается проблема разработки программного средства для формирования эффективной товарной политики предприятия. Существующие методы формирования товарной политики требуют выполнения большого количества вычислительных операций, а использование электронно-вычислительных машин может увеличить скорость и точность выполнения таких операций. Объектом исследования является IT-предприятие, которое занимается разработкой веб-приложений для автоматизации взаимодействия между предприятиями и клиентами. Целью данной работы является разработка программного средства, которое использует алгоритмическую модель информационной технологии формирования товарной политики предприятия, для повышения прибыльности предприятия. В ходе выполнения работы, были рассмотрены современное состояние проблемы формирования товарной политики предприятия, а также существующие программные средства, которые могут быть использованными для формирования товарной политики предприятия. Были рассмотрены существующие методы разработки программных средств. Поставлена задача разработать алгоритмическую модель, архитектуру программной системы и программную систему для формирования товарной политики предприятия. Разработанное программное средство содержит несколько функциональных модулей, алгоритмы функционирования каждого из модулей описаны в статье. Алгоритмическая модель использует метод анализа иерархий для формирования товарного ассортимента и симплекс-метод решения задачи линейного программирования – для определения объемов производства товаров. Для программной системы были разработаны функциональные и нефункциональные требования, была выбрана трехслойная архитектура веб-приложения, написан программный код и выполнено тестирование программной системы. Разработан графический интерфейс пользователя, который дает возможность вводить информацию, необходимую для формирования товарной политики, и получать результаты – товары, которые необходимо производить, и объемы производства таких товаров. Сделаны выводы о результатах разработки программного средства и возможность использования алгоритмической модели в будущих исследованиях. Результаты работы могут быть использованы как теоретический основы для разработки информационной технологии формирования товарной политики предприятия.

Ключевые слова: товарная политика, предприятие, информационная технология, алгоритмическая модель, иерархия, оптимизация, эффективность.

Introduction. Nowadays enterprise, that acts within the market economy, requires achievement and supporting high level of enterprise competitiveness and customers demand on made products or services. Modern market is dynamic, so that all changes should be analyzed by enterprise management as soon as possible to develop fast response in order to increase their profit. Current subject oriented technologies of enterprise product policy (PP) developing use methods with a lot of calculation operations to find optimal decision [1].

The usage of computer systems could process big information amounts in a few seconds and store data, that are required for further processing. Existing software tools (ST) made good toolkit for enterprise product assortment creation. They provide a person who creates PP with an ability to execute all required calculations to create effective enterprise product assortment by using experience and toolkit. Therefore, actual task is developing of ST that should provide ability (by using modern effective methods and models) to create in interactive mode optimal enterprise PP dependent on limitation, ensure maximum profit in planned time measures.

Formulation of the problem. The object of research is IT-enterprise which is developing web-applications (web-sites, forums, online-shops) for automatization processes of customer relationships. The enterprise has qualified experts, information resources, equipment and materials that provide ability to develop web-applications based on modern information technologies. The enterprise has limited resources.

The current situation within the market of intellectual product is characterized by favorable conditions. The mid-term effective PP can be created because of raised demand for web-applications. Therefore, the task about developing ST for effective enterprise PP creation is raised. For solving this task, it is necessary to do next steps:

1 To develop algorithmic model (AM) of information technology (IT) for creation enterprise product policy based on qualitative and quantitative methods;
2 To design architecture of program system (PS) that will implement the AM of IT;
3 To develop program tools and their interfaces that are parts of PS.

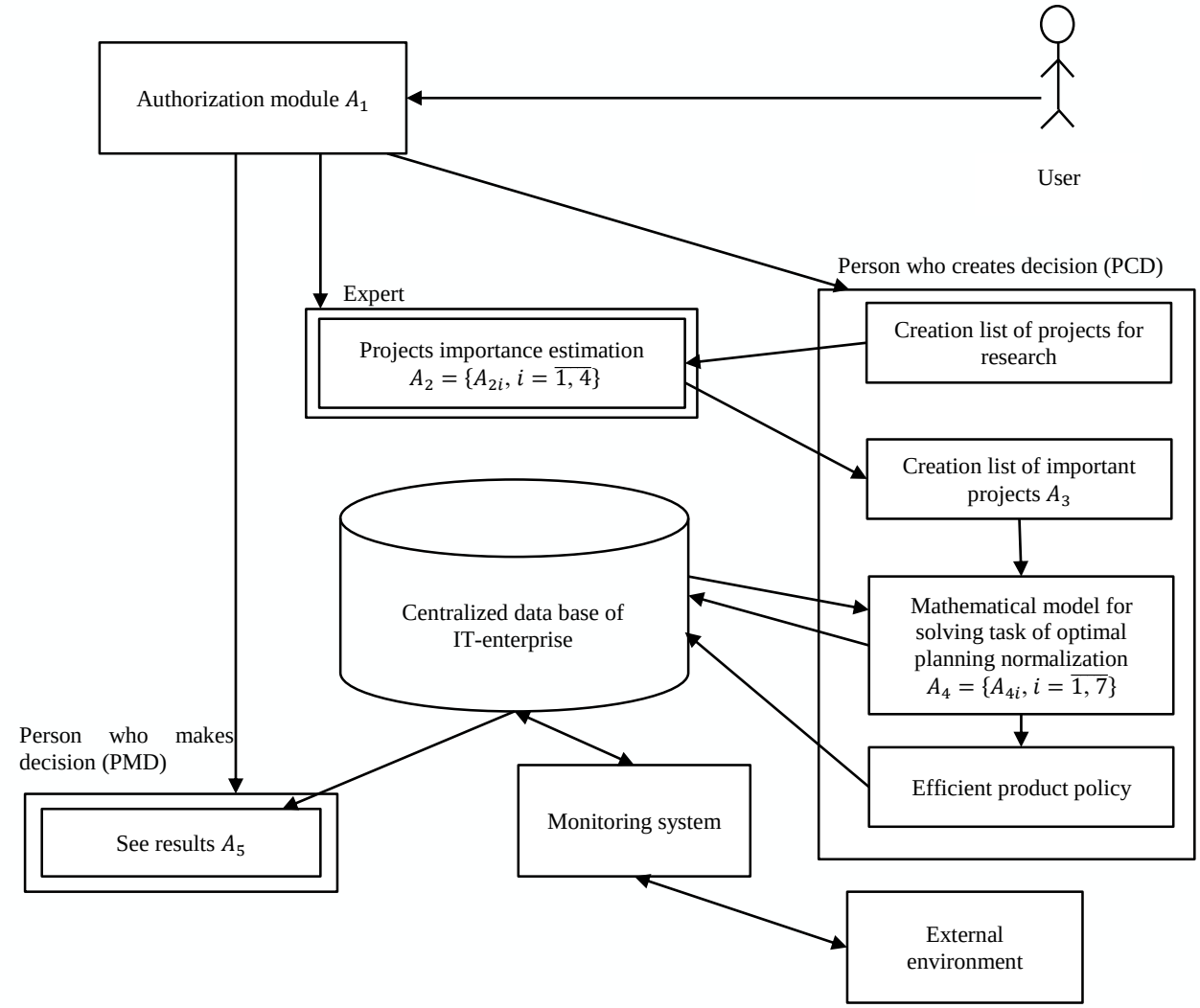

Fig. 1. Schema of interaction of parts of AM of IT for creation enterprise PP

Modules of program system. PS of IT for creation enterprise PP is a complex of interacting programmatical structural elements that build defined structure for active creation effective enterprise PP to support related technical tools. Architecture of PS is a basic organization describing its main structural elements their interrelationships and relationships with PS environment. The architecture developing process requires making several decisions about PS organization, selection ST that will be included to PS, their interfaces and behavior. The baseline of architecture development process is algorithmic model (AM) of IT for creation enterprise PP. Fig. 1 demonstrates structural features of algorithmic model $\mathrm{AM} = \{A; R \subset A \times A\}$, where $A = \{A_i\}$ – set of interacted algorithms A_i, $R \subset A \times A$ – connections between the algorithms.

The set of algorithms is listed below:

A_1 – user authorization algorithm;

A_2 – algorithm of hierarchy analysis method:

A_{21} – hierarchy creation algorithm;

A_{22} – defining of local priorities of hierarchy elements;

A_{23} – algorithm of creation of matrices for paired comparisons;

A_{24} – algorithm of products global priorities definition;

A_3 – algorithm of creation important projects list;

A_4 – algorithm of normalization of mathematical model for solving task of optimal planning:

A_{41} – data input (matrix of conditions $\boldsymbol{A}$, vector of limits $\boldsymbol{b}$, vector of coefficients of linear form $\boldsymbol{c}$);

A_{42} – validate input;

A_{43} – input data correction;

A_{44} – search of initial reference plan by the method of synthetic basis (II algorithm);

A_{45} – solving of linear programming (LP) task by the simplex method (II algorithm);

A_{46} – authenticate solution;

A_{47} – investigate area of stability of solution of LP task;

A_5 – algorithm of results presentation.

Connections between described algorithms are in Fig. 2.

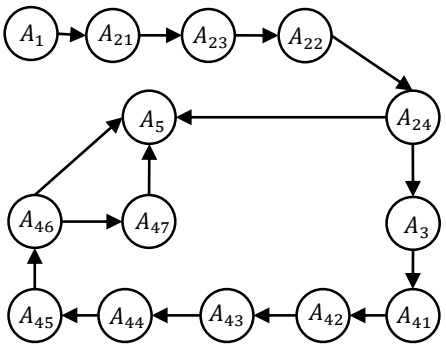

Fig. 2. Connections between algorithms $A_i \in A$

It is reasonable to develop PS as a web-oriented application, which implements the AM. That type of application allows usage of "thin" client architecture. The "thin" client architecture has three main modules: server of database, application server, client application. The database (DB), that support PS functionality, should be in DB server. The application server processes all information (hierarchy creation, mathematical calculations of project priorities, creation of list of the best projects, LP task solving, results presentation. Client performs only data input and calls available functions on the application server [2].

The JDBC (Java DataBase Connectivity) driver was used for configuration of connection between DB server and application server. It provides ability to configure and retrieve connection to database, build SQL-queries programmatically, manage transactions and configure handling of results of SQL-queries execution by using Java objects [3].

Presentation of user interface use HTML pages. Those pages are managed by application server and sent to client with response. The user interface includes such active elements like buttons and hyperlinks. HTML form generates and sends HTTP request to application server by clicking the active element. The application server processes each HTTP request and returns a response. This is how interaction between client and application server is implemented [4].

The PS is implemented based on popular MVC (Model-View-Controller) pattern. MVC pattern provides 3 parts of the PS:

1 Model – this PS component is intended to work with DB.
2 View component represents user's interface.
3 Controller.

The model component declares Java objects to represent all tables from DB. Also, in scope of the model component DB connection was configured and some classes were implemented. Those classes support creation and running custom SQL scripts and processing results of running SQL scripts [5].

View component is responsible for showing all program control elements to end-user. The main purpose of view component is data representing which are stored in application DB. One of advantages of MVC pattern is modular architecture, so that PS can support several view components simultaneously and each component can implement different method of representation of the same data. View component should build HTML pages to show them on the user's computer. JSP (Java Server Pages) technology was used to build HTML pages dynamically in runtime [6].

Controller component implements main business logic of data processing. Controller can process input data from user and stored data from DB. This component is responsible for handling input HTTP requests from user's computer (view component).

MVC is used to decouple data that are in DB from representation of data on user's computer. The main goal of taking this decision – flexible implementation of algorithmic model that can make it easier to do some changes in the future. Developed architecture is based on modular structure of PS [2].

Block of calculations. PP requires defining the assortment and volume of products to produce by IT enterprise. That's why PP includes qualitative and quantitative parts. The qualitative part of PP is an assortment of products to produce. This assortment contains a set of different products that enterprise can produce. The quantitative part describes production volume of each product from PP [1].

Considering such separation of PP, it's reasonable to use different methods for defining assortment of PP and for calculation production volume of chosen products.

Dependency of product policy assortment from the criterion declared by enterprise management can be presented by hierarchies. First or lower level of hierarchy contains different kinds of goods, that enterprise has been producing or wants to produce in the future. Last or top hierarchy level should describe the main goal of enterprise activity. There are should be several criteria for estimation of influence of some products to global goal achievement. Those criteria should be placed on intermediate hierarchy levels. Therefore, a hierarchy should contain at least three levels.

This hierarchy can be used in process of creation and managing of enterprise PP assortment. The example of possible hierarchy is in Fig. 3 [7].

Analytic hierarchy process (AHP) – is a mathematical tool of the system approach for hard decision-making tasks. This method describes sequence of algorithms which are used for calculation of priority of elements which are on the first level of the hierarchy (they are elements of IT-enterprise PP assortment) relatively to main goal from last level of the hierarchy. Fig. 2 presents the sequence of execution of algorithms $A_{2j}, j = \overline{1,4}$ to solve AHP task for IT-enterprise PP creation [8].

The process of defining a product range of future PP requires the creation of sorted set of products. That set should be ordered by global priority values decreasing. The first part of products, which have sum of global priorities equals to 0.8 will be included to compromise solution of multicriteria task. That measure value is configurable and can be changed depending on task [7].

The process of PP creation requires defining not only product assortment but production volumes of selected products to get maximum profit by sale that products [9].

In order to calculate production volumes of selected products the task of linear programming was set. This task provides the opportunity to specify global target of optimization and limits for existed resources. One of existed method for solving that type of task is simplex method that provides sequence of solutions and search for optimal solution [10].

Fig. 2 shows sequence of executing algorithms A_{4j}, $j = \overline{1,7}$ for solving task (1) for planning production volumes for the products.

$$L = (\boldsymbol{c}, \boldsymbol{x}) \to \max, \quad \boldsymbol{Ax} = \boldsymbol{b}, \boldsymbol{x} \geq \boldsymbol{0}, \tag{1}$$

where $\boldsymbol{x} = (x_1, \dots, x_i, \dots, x_n)^{\mathrm{T}}$ – is a vector of production volumes of i-th product from PP assortment;

$\boldsymbol{b} = (b_1, \dots, b_m)^{\mathrm{T}}$ – is a vector of limits, that are related to production technology, delivery, and sale of products;

$\boldsymbol{A} = (\boldsymbol{a_1}, \dots, \boldsymbol{a_n})$ – is a matrix $m \times n$ $(n \geq m)$ of condition of production technology;

$\boldsymbol{a_1} = \left(a_{1j}, a_{2j}, \dots, a_{mj}\right)^{\mathrm{T}}$ – is a vector of condition of production technology;

$\boldsymbol{c} = (c_1, \dots, c_i, \dots, c_n)$ – is a vector of prices, that are used while selling one item of i-th product.

User interface. National bank of standardized science-technical definitions defines "user interface" (UI) as a complex of hardware and software to support interaction between end-user and computer [11].

Graphical UI was developed for ST for creation of IT-enterprise PP. That decision is based on high popularity of that user interface type. Also, graphical UI is easy to learn from end-user point of view.

Interface for ST was implemented based on HTML-pages which show main elements to control program like menu, buttons, hyperlinks, and data retrieved from the server. Also, HTML-pages provide ability to configure graphical style of user interface [12].

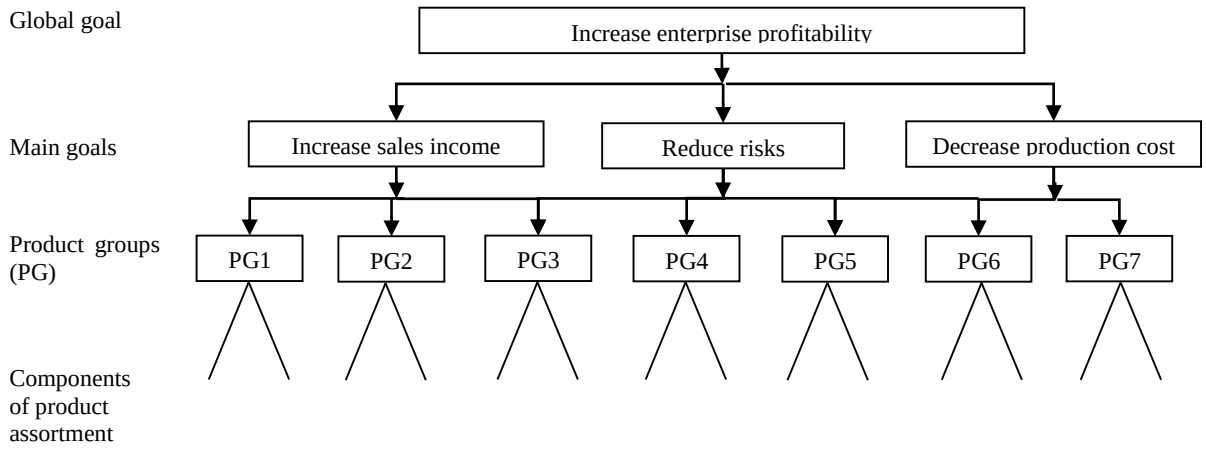

Fig. 3. Hierarchy model of impact of products to enterprise profitability

Each authorized user has rights to perform certain operations within developed ST. PS defines 3 user roles: “PMD” – a person who makes a decision, “PCD” – a person who creates a decision, “Expert” – a person who participates in process of pair comparisons. All user’s eligible actions depend on his role and they are shown in ST main menu (Fig. 4).

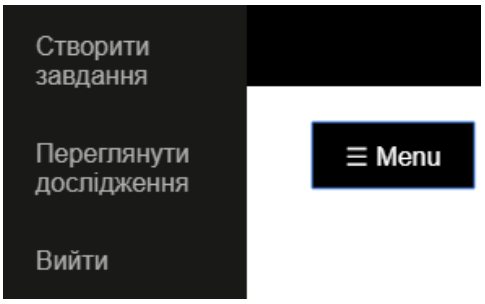

Fig. 4. Menu for user with role “PMD”

The Process of organization of data input is an important part of developing graphical UI. HTML language declares many standard input elements (i.e. text field, text area, numeric field, date field, dropdown list). These elements were used for implementation of graphical UI for ST for creation of IT-enterprise PP. Fig. 5 shows sample of form for task (1) normalization. Sample of form for hierarchy creation is in Fig. 6 [12].

Another important part of graphical UI developing is organization of results presentation. It requires thinking on available types of presenting information to user. There are several types of data presentation: presentation on window form, saving results to some file, report generation. Developed ST presents information on window forms [12].

Previously listed elements of graphical UI describe main control elements, methods of data input and presenting results.

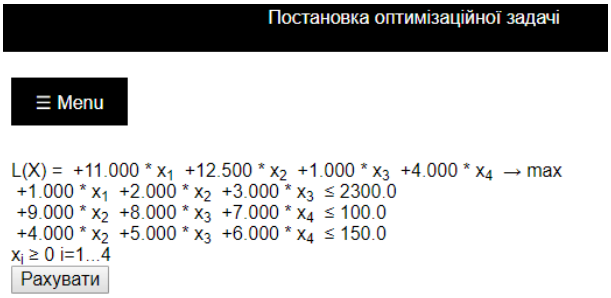

Fig. 5. The form for LP task normalization

Conclusions. As the result of scientific research, the following results were obtained:

1 The algorithmic model of information technology for enterprise PP creation was developed;
2 The architecture of program system that implements algorithmic model of information technology for enterprise PP creation was developed;
3 Software tools were developed to use in process of creation enterprise PP.

These results can be considered as theoretical basis for developing science-based information technology for enterprise product policy creation.

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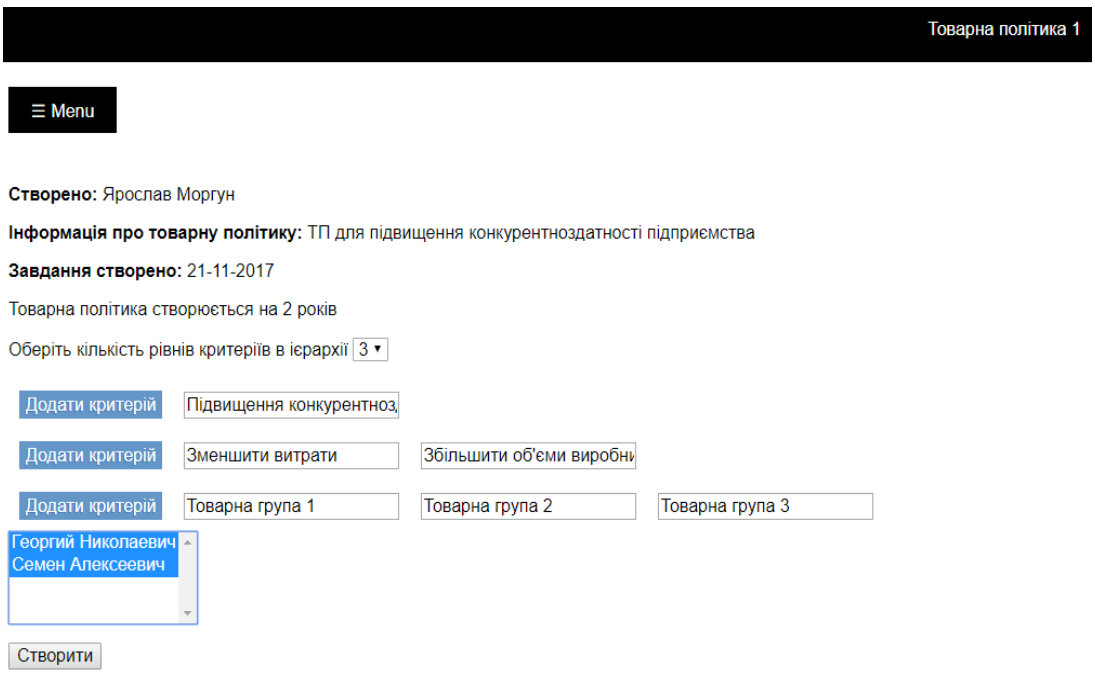

Fig. 6. The form for creation of hierarchy for PP research

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