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THE HEURISTIC EVALUATION OF VISUALIZATION IN SEARCHING ECONOMIC INFORMATION IN THE TOPIC MAP. THE PROPOSAL OF A RESEARCH METHOD

Introduction

Nowadays there is a need for solutions which allow obtaining information from different, scattered sources in order to integrate, analyze and present them in various layouts, as well as discover new knowledge. More and more attention is paid to the use of semantic technologies such as a topic map (TM) as a solution that can be used to search and acquire unique information (see e.g. [WuSm08]). Usually TM is a semantic graph which contains definitions of a set of topics and a set of associations between topics called ontology of a domain. Used visualization of the semantic network in TM can provide valuable assistance for the economic data analysis and decision making tasks.

Issues of searching information basing on semantic network technologies is a subject of many studies and concerns various fields (see inter alia [AAOL04]; [WuSm08]; [WIEN10]; [Yi08]). It is caused by the users' need to search information also on account of contextual connections. In this approach the special attention is paid on the role of the visualization of a semantic network which is not only a tool for presenting data, but also provides an interface allowing interactive visual searching information (see inter alia [GrSo10]; [WIEN10]). Interactive visualization of data supports innovative looking on information, allowing user to formulate new hypotheses and their validation. Graphical methods and techniques can increase effectiveness of used automated exploration data methods by using perception and user's general knowledge [KeSc05, p. 1767].

Visualization in TM allows navigation from a topic to a topic in a highly interactive manner: interesting nodes can be put in the foreground with zooms, translations and rotations. Fundamental factors for a good visualization of the application of TM are:
1) the overview of the structure for the global understanding of the structure and of the relationships within the hierarchy,
2) the ability to zoom and to select some nodes,
3) dynamic requests in order to filter data in real time.

One of the most pressing questions about visualization-based information retrieval systems is: "Can people use them?" (see [Kosh05, p. 824]). This question can also be raised for the semantic searching in TM for the analysis of economic indicators, where the visualization plays important role. Systems that enable information retrieval should be intuitive to use and easy to interpret by the users.

The aim of the present article is to present the proposal of the research method of the heuristic evaluation of visualization in searching economic information through a topic map. The article is structured as follows. The first section presents shortly the evaluation of the usability of IT system. In section 2, there is a brief description of the planning the research. In section 3, the proposal of a research method on the usability of the visualization of semantic network in searching economic information is discussed. Finally, in the last section there is a summary of the work.

1. The evaluation of usability of IT system

The standard ISO 9241-11 defines the usability of IT systems as the three components: effectiveness, efficiency and satisfaction. A well-designed user interface facilitates inter alia the performance of user's task (effectiveness) and provides the pleasure of its use (satisfaction). J. Nielsen defines the usability of an IT product by such component characteristics as: ease of learning, effectiveness in achieving task objectives, ease in remembering gained skills, tolerance for human errors, as well as creating user satisfaction, understood as subjectively perceived enjoyment from using the system [Niel93]. B. Shneiderman defined five measures essential in studying the system usability: system familiarity time, task performance speed, errors in task assignments, system feature retention, and subjective satisfaction [Shne98]. However, in the research on evaluation of visualization in searching economic information the following parameters are important: information retrieval speed, errors in interpretation of data (errors in task assignments), and subjective satisfaction.

One of the most important areas of IT system is the user-system interaction design, because [Siko12, p. 12]:

− usability requirements are usually not given in a quantitative manner (as measurable parameters), and the evaluation of their fulfillment is often subjective,
− the impact of psychological and social factors requires performing experiments, tests and studies involving users.

In literature many methods of the research and evaluation of the system usability and human-computer interaction are described (see inter alia [LaFH10]; [Siko12]; [Siko10]; [TuAl08]). The study of a prototype is conducted with the participation of experts (e.g. heuristic evaluation, inspections, reviews, checklists) and/or users (e.g. usability tests, eye tracking, evaluation by observation). There are many questionnaires of heuristic evaluation and checklists for evaluating user interface, available both in the literature (see e.g. [RaJo89]; [Siko10]) and on the Internet (see e.g. [Pier12]). We suggest two research methods on the usability of the visualization of semantic network in searching economic information. These are usability tests and heuristic evaluation.

2. The design of research

TM application may be a useful tool in the visual searching of information for decision-makers. However, firstly the method requires a study of the solution. Our study has been carried out in the two main phases and five stages (Figure 1).

Phase 1 is a conceptualization of the ontology of economic indicators and creating TM application. The goal of this study is to verify the concept of using TM standard for the model of knowledge about analysis of economic indicators. This phase consists of three stages.

The first stage consists of the creation of the ontology for the selected analysis of economic indicators. This stage can be realized either by a team consisting only of economic experts or by a team in which they participate. Additionally this ontology should be reviewed by other economic experts. Experts in economic indicators should be involved in the process of creating ontology in order to use an appropriate vocabulary and consider semantic connections that can be tacit knowledge (see inter alia [SaST07]). However, if the ontology is built by the team consisting only of economic experts it should be reviewed by the experts of the ontology design. Created ontology is independent of any IT solution.
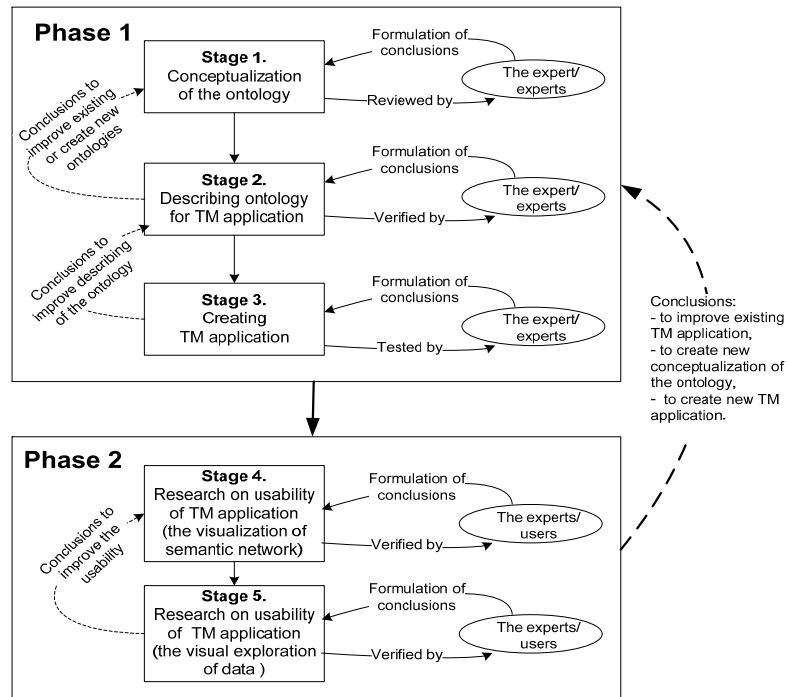
Fig. 1. Scheme of the design of the research on the visual exploration of information using the semantic searching based on the applications of TM

Source: [Dudy12, p. 132].

In the second stage the ontology is described in the topic map standard. This stage is realized by people knowing TM standard. Furthermore this description of the ontology is verified by economic experts. Created ontology is described in the topic map standard, and therefore dependent on a specific IT solution. In case of building ontology in order to create TM application, stages I and II can be merged, that is at once describing created ontology in TM standard. If the ontology for the selected analysis economic indicators already exists for other IT systems, stage I can be omitted, that is we can begin from describing the existing ontology in the topic map standard.

In the third stage a topic map application is built, which is then tested by the experts. Results of this work are inter alia the following: the creation of TM application for a specific field of analysis of economic indicators, the creation of the procedure of building TM applications for the ontology of the analysis of economic indicators (based on the analysis of existing methods and methodologies), and the verification of the visualization semantic network in TM for searching and acquiring unique information on economic indicators.

Phase 2 is a study on the usability of the visualization in economic information retrieval in TM application. The goal of this study is to verify the usability of applying the visualization of semantic network in TM in searching and acquiring unique information in the analysis of economic indicators. This phase consists of two stages (numbers 4 and 5).

The fourth stage is the heuristic evaluation of the visualization in searching economic information in a topic map. The research is carried out with the participation of experts and potential users.

In the fifth stage the visual exploration of data from all relevant subsystems existing in an enterprise is verified by decision-makers using TM as a model of economic knowledge representation. Results of this stage are inter alia the following: the evaluation of the usability of visualizing a semantic network based on TM, the solution of the problem of large number of topics in using TM as a tool enabling a visual exploration of a huge, complex and multidimensional data set.

Research in the phase 2 is carried out on the basis of the model proposed by E. Brangier (the usage – adaptation – re-engineering cycle), "(…) which highlights how human adaptations (of the users) are a source of innovation to design new uses" [EASB09]. These studies enable to identify users' needs precisely and may contribute to the development of innovations (see [Dudy12, p. 134]).

Between phases of proposed research method there is a feedback, i.e. conclusions from the second phase influence both the improvement of the created a topic map application and procedure of creating the ontology and TM for the analysis of economic indicators.

The characteristic feature of proposed approach is the process' interactivity at the level of both phases and stages. This procedure assumes cooperation of creators of the ontology and a topic map application with economic and financial experts and potential users.

3. The proposal of a research method

The topic map can be one of various tools for the information visualization, which – as a visual interactive interface – allows decision-makers to search information. However, it requires carrying out a research on the usability of visualization in searching information. Before starting the research on the system utility we have created an ontology for economic indicators and built TM.

In the heuristic evaluation of visualization in searching economic information in a topic map the applied method is a combination of two methods of evaluating interface enabling human-computer interaction that is heuristic evaluation and usability tests. In literature there are described many procedures

using these methods. Basing on the research procedure proposed by M. Sikorski (see e.g. [Siko12]; [SiGa10]), research with the use of these two methods is realized according to the following plan:

1. Creating test task for the usability testing and questionnaire of heuristic evaluation of TM application for ontology economic indicators.
2. Study with participation of users and experts:
   2.1. Selection of research participants.
   2.2. Introduction to the study (short training: 20-30 minutes).
   2.3. Performing usability tests.
   2.4. Heuristic evaluation of usability of using the visualization of semantic network in searching information.
3. Data analysis on account of the following criterions:
   − correctness of performing tasks,
   − evaluation of easiness of finding information,
   − evaluation of interface usability,
   − identification of potential difficulties connected with used human-computer interaction.
4. Discussion of results and conclusions.

Presented procedure contains both tasks to be performed by research participants and heuristic evaluation of visual searching information.

In the first stage of this procedure questionnaires are prepared. They consist of three parts. The first part contains tasks to be performed by a user, which consist in searching needed information basing on visualization of semantic network. Research participant writes answers (that is found information). Orders are placed from potentially easiest to hardest to accomplish. In this part of the questionnaire heuristic evaluation is also used. For every task there is a table in which, after performing the task, a research participant assesses the difficulty in finding information. In the questionnaire five-grade scale was used: *very easily (quickly)*, *easily (quickly)*, *average, hard (long)*, *very hard (long)*.

The second part of the questionnaire contains some criterions of an interface evaluation. The evaluation of visualization in searching economic information can be conducted in terms of the following four criterions:

1. How would you rate the system in terms of visual clarity?
2. How would you rate the system in terms of its functionality (in the context of searching information)?
3. How would you rate the system in terms of flexibility of its structure and the presentation of information?
4. How would you rate the way of searching information which is based on the visualization of semantic network?

Each of listed criterions is assessed by a user according to five-grade scale, i.e.: *highly satisfactory*, *satisfactory*, *average*, *unsatisfactory*, *and very unsatisfactory*.

The third part of the questionnaire concerns identification and evaluation of potential difficulties in using the system. It is very important part of the research. In case of evaluation of the visualization in searching economic information these difficulties can be as follows:

1. Understanding how to navigate the *OntoGraf*.
2. Understanding how to perform tasks.
3. Understanding the relation between the information on the screen and the performed operation.
4. Finding necessary information.
5. The difficulty in reading the information on the screen.
6. Too many colors on the screen.
7. The necessity to memorize too much information during the execution of the task.
8. Understanding names of relations between topics.

Participants of the research choose one of the following answers: *no problem*, *a small problem*, *an important problem*.

The preparation of questionnaires is followed by the process of carrying out the research. The important issue is the selection of research participants, because they cannot be random people. They need to fulfil a double role. The first one is to be a typical user, performing specific tasks in a topic map application for ontology indicators (research using the usability testing technique). The second role is to be an expert evaluating the usability of the applied interface (research using the heuristic evaluation of a user's interface). The selection of the research participants allowed obtaining a group of people, who had various experience and knowledge concerning economy and analysis of economic indicators as well as systems and information technology, e.g.: with only computer education, computer science and econometrics education, economic education, non-computer education. None of them searched information basing on the visualization of ontology before or was familiar with the topic map program.

Before performing usability tests by a user there is an introduction, in which it is shown how to open the application with an ontology and what is the idea of semantic search and the topic map standard. The introduction should not be longer than 30 minutes.

After executing usability tests, the same people perform the heuristic evaluation of the visualization in searching economic information in a topic map.

Obtaining data from the research is followed by its analysis according to different criterions (i.e. according to presented four basic ones listed in presented procedure of research).

The analysis of responses in the questionnaire is to help verifying the correctness of the realization of tasks by research participants. This research can also tell how easy and clear is searching information with the use of the visualization of the semantic network, for a user who is not familiar with the topic map application.

The important part of the research is data obtained from the third part of the questionnaire (i.e. the identification and evaluation of potential difficulties of using the system). Its analysis allows both improving the interface and better preparing training for potential users of the topic map application.

The research following the presented research method was carried out twice: firstly for the ontology for return on investment (ROI) indicator, then for the ontology for early warning system. The conclusions from the verification of the first application were used in the creation of the application for an early warning system, whereas the conclusions from the heuristic evaluation of the second? application allowed us to better prepare a user-based study with the use of the application for the early warning system.

4. Discussion, implication, and conclusion

There is still problem of defining good solution that will allow representing economic knowledge in information systems. There are three reasons of that. Firstly, there is not still good representation of economic knowledge in information system. This is because economic phenomena usually have weakly structuralized form, and characterized with changeability. Secondly, knowledge on this subject is usually expert knowledge (so called hidden). Thirdly, there is lack of tools that would be appropriate to illustrate ontology covering economic reality, and at the same time would be effective and friendly solutions for users, and especially for decision makers.

Listed reasons caused developing the conception of using TM: as a model of economic knowledge, which put emphasis on data semantics and ease of finding desired information, as the useful visualization in searching and acquiring unique information, as a visual interactive interface, which allows decision-makers to search information. The present concept constitutes the new, original research subject. In the literature there is no the holistic approach to the research problem concerning the application of the topic maps to represent economic

knowledge in the information system. In the present article the emphasis was put on presenting the concept of the original method including the interdisciplinary way for conducting research related to the use of the topic maps to representation of economic knowledge in the information system. The essential element of this article is the description of the research method of the heuristic evaluation of the visualization in searching economic information. Presented procedure was verified twice by carrying out the research on applications built for the ontologies for ROI indicator and early warning system. This research is the first formal user evaluation of an application for the ontology for the selected analysis economic indicators.

The essential element of this study, unprecedented in the field of works related to usage of topic map, is research on evaluation of usability of topic map application. This issue is especially important in case of developing information systems for decision makers. In the literature there is lack of complex presentation of problems related to research on using topic map standard to represent economic knowledge in information system and evaluation of its usability in interactive and visual searching needed information.

The methods and the results presented in this article can be useful tips and recommendations of the usage of TM as a model of economic knowledge for other researchers, systems designers and managers.

The research, based on the presented methods, will be conducted in two ways: testing created topic maps applications for selected areas of the economic analysis and studying the usability of visualizing semantic network to search information. The presented methods in this article will be used during the InKoM project, which is conducted by a consortium led by the University of Economics in Wroclaw, and the other principal member is the company UNIT4 TETA BI Center. The work is supported by the National Research and Development Centre within the Innotech program (track In-Tech), grant agreement no. 153437.

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HEURYSTYCZNA OCENA WIZUALIZACJI W WYSZUKIWANIU INFORMACJI EKONOMICZNEJ W MAPIE POJĘĆ. PROPOZYCJA METODY PROWADZENIA BADAŃ

Streszczenie

Obecnie istnieje potrzeba rozwiązań, które pozwolą na uzyskanie informacji z różnych rozproszonych źródeł w celu pozyskania nowej wiedzy. Coraz więcej uwagi poświęca się wykorzystaniu technologii semantycznych, w tym bazujących na standardzie mapy pojęć, który może stanowić strukturę do zapisania opracowanej ontologii dla określonego obszaru wiedzy. Wizualizacja sieci semantycznej w mapie pojęć umożliwia interaktywną nawigację umożliwiającą zarówno przeglądanie struktury, jak i analizę szczegółów w celu filtrowania danych w czasie rzeczywistym. Tworzone systemy z mapą pojęć mogą potencjalnie stanowić użyteczne rozwiązanie wspomagające kadrę kierowniczą w pozyskiwaniu potrzebnych i unikatowych informacji ekonomicznych. Wymaga to jednak przeprowadzenia badań. Weryfikacja zastosowania standardu mapy pojęć zarówno jako struktury reprezentacji wiedzy, jak i wizualnego interfejsu jest realizowana według metody badawczej, która składa się z dwóch faz. Celem niniejszego artykułu jest omówienie zaproponowanej procedury badawczej i koncentracja na fazie drugiej, której celem jest weryfikacja zastosowania wizualizacji sieci semantycznej w mapie pojęć jako wizualnego interfejsu w pozyskiwaniu informacji.