Visual systems for supporting decision-making in health institutions in R. of Macedonia

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Abstract: everyday, managers look for better ways to access data in order to discern changes more effectively. Dashboards today are the preferred tool for managers. They offer the managers to support critical decisions with information obtained from dashboards. With them managers can follow the plan and its execution.
The aim of this paper is to show which data managers want to see in dashboards. For instance the pilot visual system for supporting the decision making in health institutions, will be demonstrated. The benefits of visual systems for managers will be presented with specific dashboards – the data of which are shown, for which type of managers and for which part of the operations they can be used, will be explained.

Keywords: Dashboards, Health institutions, Decision making.

1 Introduction

Long time ago people where aware that “a picture is worth a thousand words”. For that reason, they have been making efforts to apply visualization wherever possible. Visualization is an area that has rapidly developed in recent decades. It is a method that enables the viewing data and with its help you can discover connections and dependencies between data, i.e. to “penetrate” into the data. Visualization can be applied to data from all areas, which once again confirms its great application. With its help we can say that the thinking of people has changed and visualization has become a preferred form of getting information [1].

The effects that managers are expecting are to decrease the visualization time spent on data analysis and delve into the data, leading to better decision making process and better decisions [9].

To have a good and efficient data visualization, data should we be very well prepared. That process includes the selection of the data that will be subject of visualization and their visualization, i.e. their representation [2].

Visualization can have different purposes depending on what needs to be visualized. The most important goal is to make the “invisible visible”, i.e. obtain new understandings, effective presentation of significant features, more research

and use of data and information. Usually these dashboards are part of business intelligence systems [9].

Today there are a number of techniques that you can use in the process of visualization. Selecting the most appropriate technique depends on the types of data that will be subject to the visualization. One of the most desirable displays which are especially favored for managers is called dashboard that has made a significant impact on the decision making of managers in different areas [5].

In the first part of this paper, is introduced the problem that we solved and the term visualization. In the second part, analysis of the data that is subject to visual analysis and problems that we have solved is made. In the third part, pilot visual system to support decision-making in health institution, is described.

2 Analysis of the data that is subject to visual analysis and problems that we have solved

Data for the problems that we solved was collected in a conducted survey [4]. The collected results are derived the following conclusions. In the health institution that is the subject of research, data for drug consumption by type and by volume is stored daily. These data are coded under sections, and it is known which and what drugs are consumes by each department daily. This is still a new part in the information system, so there is no available data from previous years in electronic format. For that, there was a problem with compliance codes for drugs in the health institution and the health insurance fund, but efforts were made to overcome it. We expect this part to work correctly in the future.

For accurate records of entry and exit of staff in health institution a card reader is set. All employees have a card and there need to be accurate data for input and output of all employees. According to these data, measures need to be taken for delays in payment and etc.

There is a request for statistical processing of purchased materials (spent) and monitor their prices on an annual basis (for example, prices of food, medical supplies, etc.), yet there is no data stored in the database which will allow to make a visual system that will help with the statistical processing. For this application, first we need to create a suitable base, to input data for purchased materials and even after you have collected data that can be developed by a visual system for this part of the operation.

For comparison, between plan and implementation of the budget items, especially in the material section as well as in the organizational structure, there are some data in the database. In the pilot visual system there are parts of the budget, but there is a problem with the fact that in the previous years' data was not stored in the same format, i.e. each year data was saved in different data formats for budget and are not suitable for simple loading of data in a single database and to compare the years. But for 2012 and 2013 data are entered into a database

information system manually, with entering data for the following years, thus temporarily this problem was overcome.

The data base consists of human resources and their structure but it is not quantified. The only quantifiable data is about the performance, salary and the institution includes human resources data. The medical examinations are written down according to the ministry of health criteria. The previously mentioned information is private by the state law therefore we were not able to access it to make visual systems about it.

A hospital and a pharmacy for instance do not have network connection yet, so the managers are not able to collaborate and share information about these visual systems. Since network connection is provided in the institution then the visual systems would be available and common storage would be created so as this data could be visualized.

The consumables are kept in the database in the institution. But it should be refilled with additional information about the consumption of the materials as well as being inserted into the base according to the days so we could generate visual displays about daily, monthly and annual material consumption.

Financial condition data, partly and overall, can be seen from the realization data according to the accounts of budget. Part of the data is still in the base but consequently it will be finished and we will acquire revised and advanced visual displays in this matter.

There are procurements about the medical supplies but this data division should be expanded by the daily consumption and minus the daily consumption we get the wasted materials and the remaining ones. The requirement to align the budget with the actual needs of the institution, the information system which is in the initial stage of its operation is not in a state to offer sufficient information for this part. Therefore the data about the functioning of the institution for the previous year should be available. This data should be compared with the planned one and the differences will lead to making the budget plan for the following year.

To sum up, the information system is in its beginnings. For lots of years data is non-existent and that is the reason why we cannot do a better comparison of data. The exploring motif and the job done were from the existing data on the subject.

This thesis shows a visual system based on the available data, which is part of the basis and some of it was not available for us to use. We consider that in the future an improvement of the databases of the information system is needed in the health facilities as well as acquisition and input and store of data from the past years. This will help in gaining relevant information about the visual system which helps the managers to make decisions and it will increase their efficiency in data analysis, solving the upcoming problems which will follow with more effective decisions.

4 Pilot visual system to support decision-making in health institution

According to the managers' requirements, a visual control system which allows data view on the table Budget was made. Most of the managers have declared that the Budget is the most critical part of the operations of the institution [11]. Visualization has to help users to analyze all the data and come up with new hypotheses. In this part large data sets are analyzed, so the user first gets a full view of the data. In the view, the user identifies interesting patterns in data sets and focuses on one or more. To analyze the patterns, the user should list and start the process of exploring of the data. The visual view can be distorted in order to focus on interesting subsets of data. This may allow the allocation of a percentage of the display of the set of interest, while reducing the use of screen data that are not of interest. For the research on the set of interest, users needs drop-down capacity to observe details of the data. All these techniques are shown in the prepared visual system and can be seen in the images below. The visual system is developed by using the tool Dundas Dashboars. The completed dashboards can be used in almost all software tools like an object.

With prepared visual in place, managers will be able to choose for which account they want to open a dashboard and for which the costs are. Figure 1 shows part of the visual system that provides a view of budget expenses billed to the primary account 421 (utilities, electricity, water and utilities, trash and other utilities). In the figure, the billable expenses in denars are in the y axis, while the x axis shows the sub accounts for primary account 421. The graph shows data for all four quarters, with different types of graphs. Here are shown the data of expenses, and if we want to look for which under accounts costs are highest, we select Line area graph that is appropriate for this type of data. For all four quarters we chose different types of line graphs and charts of different colors, to faster and better see the differences. The dashboard has the filter that allows you to select and view data for a specific sub account where you can see the data for all four quarters.

If managers want to see the graphics from various quarters one to one, and they do not want them to be folded, they only need to click on the graphic of Figure 1 and a pop-up window will be opened where they can see the data for all four quarters separately (Figure 2). For all four graphics they can see such measures are set billable costs in denars, as long as the dimensions we have under account for the account 421. On this dashboard, managers can detect which quarter and which sub account costs are highest and make rapid comparisons of the amount of certain sub account in all four quarters. This dashboard can help managers in the decision making process for planning the budget for next year, and to see how big amounts billed and for which sub accounts.

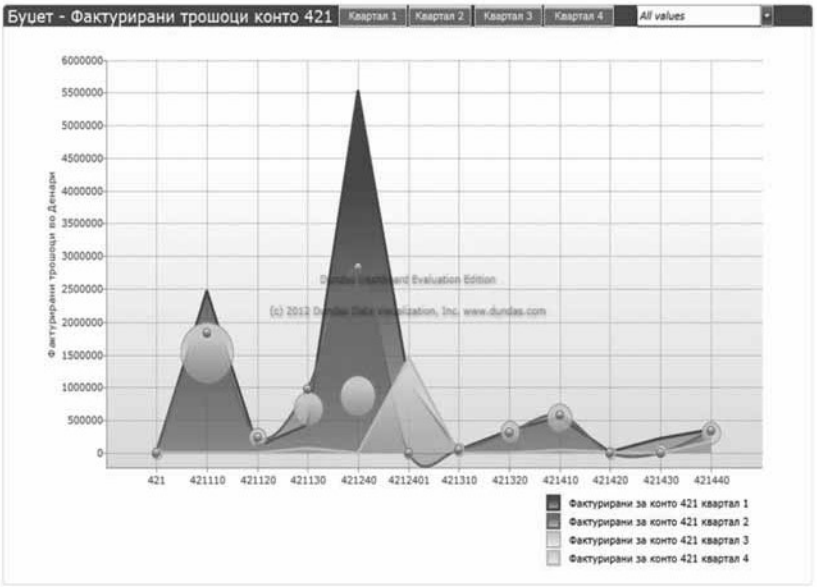

Figure 1: Line and point charts for billable expenses in denars (y axis) for the sub accounts for the account 421 (x axis) by quarters

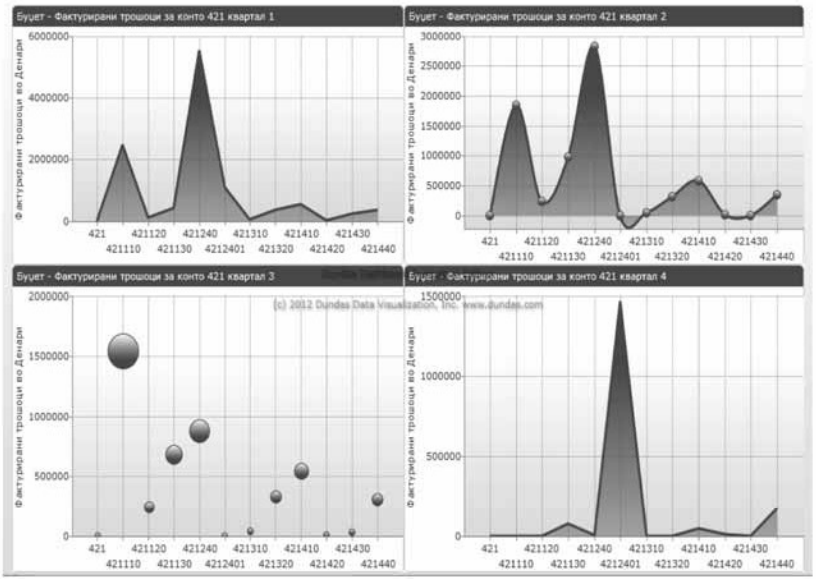

Figure 2: Line diagram and point of billed charges in denars (y axis) for the sub accounts for the account 421 (x axis) for all four quarters separately

Besides the quarters, the data can also be divided by dimension – from which

accounts come from (from which of the three accounts of the institution). According to the requirements of managers for the need of visual display of the invoiced cost of class 4, is made a visual display of synthetic account 421 for 1 account with its analytical accounts. In Figure 3, with bar diagram, the amount of billable costs for all analytical accounts for 421 synthetic account of account 1, is shown. This dashboard uses a visual bar diagram that is appropriate for displaying the data where we want to make a comparison of the amount of costs, i.e. where we compared the highest and the lowest costs [10].

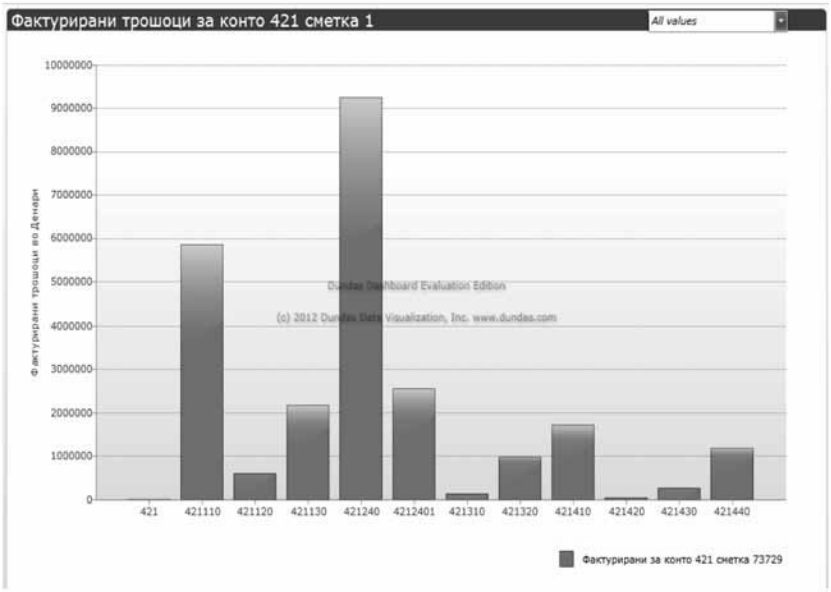

Figure 3: Bar diagram where the x axis is the sub ledger account 421, while in y axis is billable expenses in denars for account 1

Apart from the data on the budget, the options for displaying data in a visual system form i.e. in the visual system created for this purpose, we have data for revenues and expenditures. Part of the revenues data is presented in Figure 4. Here you can see the data for 2009, 2010 and 2011. Data are presented on line graphs. The blue line marks data for 2009, the green line marks revenues for 2010 and the turquoise line presents data for 2011 [12]. On the x axis we see the data for the type of revenue, while the y axis shows the values for that type of revenue.

Because the data we have received and the one we already had were not read, a very big difference in the values of revenue appeared, therefor it was necessary to apply a method for normalization of the data i.e. we applied data processing with normalization and used a logarithmic function over revenue to get more

adequate values for visualization i.e. values can be presented on a graph. An applied logarithmic function is used at transformation of the data (base 10 logarithms). And this visual dashboard allows filtering of data by a particular type of revenue.

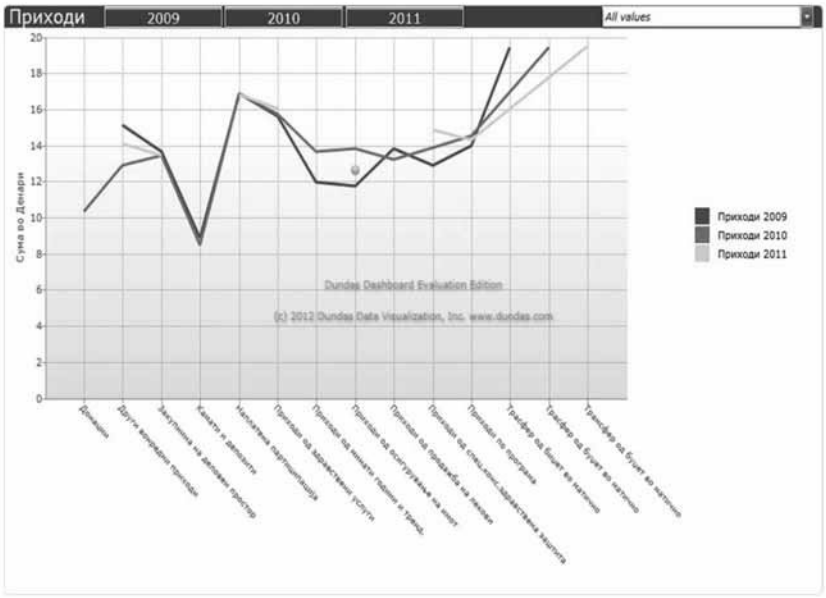

Figure 4: Line diagram of revenues for 2009, 2010 and 2011, where in the x axis we have shown income and in the y axis the amount in denars

The program for creating visual systems provides for a number of views that we can use. If on the visual dashboards we would like to display more data, line and column displays are most suitable. Fewer data will be displayed on the following visual dashboards but with slightly different visual displays that will refer to the costs in the budget.

In Figure 5 we can see the planned costs for a certain account. In the first part we showed the planned costs for the aggregated account 401-Basic salaries and personal tax for each quarter. Here managers can see the collective planned costs on account of all quarters, where we can notice that the charges of the second and third quarter overlap and they are same, and that the cost for the fourth quarter are the smallest. In the next sections present the planned costs of account 402-Contributions of pension fund and health care contribution, taxes for healthcare and employment also divided by quarters. Here the managers can see that the planned costs of account 402 for the second and third quarters are the same and they are the highest, while the costs for the fourth quarter are the lowest. In the

next part of the visual dashboard presents the planned costs of account 404-Compesations according to the four quarters. This shows that the most costs are planned for quarter 1 and the same costs have been planned for the second and fourth quarter. The last part of the visual dashboards present the planned costs of account 423-Materials, medications and other medical materials. This shows that most costs are planned for the fourth quarter, while the least for the third quarter. If with the cursor we go to a certain indicator of the planned costs the exact planned full amount will be displayed. This visual dashboard helps managers see witch accounts the most costs have been planned for and which quarter the most of the costs have been planned for. They can use this for planning costs for the next year and to have a look at the spending of resources.

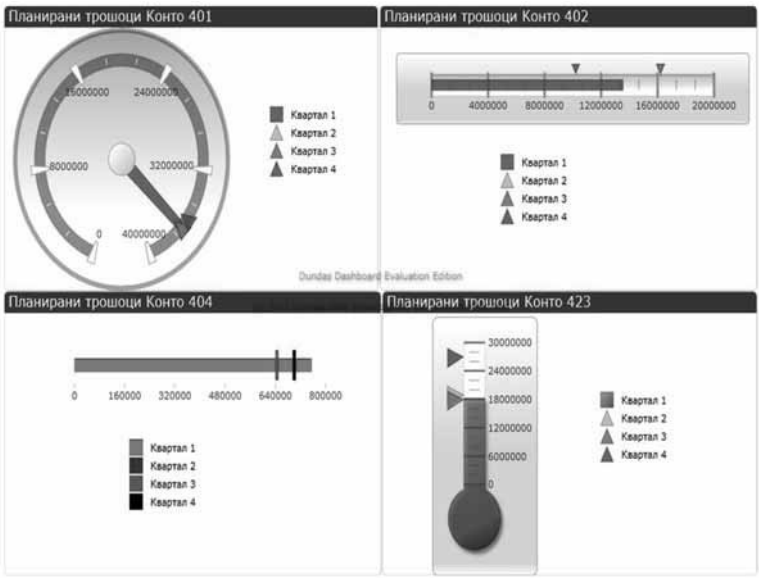

Figure 5: Planned costs for accounts 401, 402, 404 and 423 presented in 4 quarters

Beside the data for the budget, in the database we have the data for medicine consumption. On Figure 6 you can see the consumption of medicines by departments. There are more data to be seen for medicines on the visual dashboards that are important to know, so more data are presented in the data grid (table). On this visual table we have three filters and we can do data filtering by department, by group and by the name of the medicine.

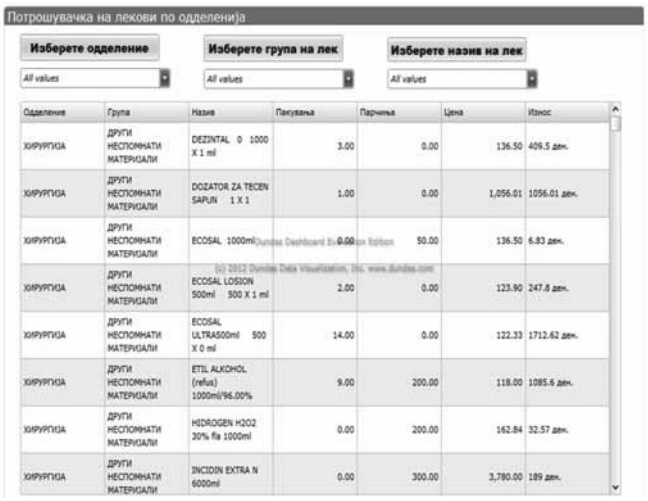

Figure 6: Consumption of drugs by departments

The possibilities for getting reports by using the visual dashboards and their combinations are endless, limited only by the imagination of users and their requirements [6]. Many different combinations are possible depending on the needs of the target manager. Here you have to work with a good strategy for deciding on the base of the real needs of the applicants' services – to effected the outcomes and to receive automated visual dashboards. It is a task on which the managers of health institutions and IT personnel need to work together, to make a system which will help managers in their decision making.

5 Conclusion

Based on the research made, we came to the conclusion that managers have constant need of obtaining quick and reliable reports, from where they can easily and visually see the changes and improve their decision making. The reports that they now receive are not sufficient for a timely registration of the changes and hence for improving the process of decision making.

The future of improving the process of decision making lies exactly in the use of these visual systems. They will improve the work of health institutions where they will improve the services and increase the profit of the health institution. If they respond on time and quickly to all changes, the health institutions will be able to save resources and with that they will get the opportunity for progress [8].

The implementation of visual systems in all of the public health institutions in Macedonia will take time and expertise from employees in the IT sector. First

they need to create dashboards that will be useful to managers and will be created for each part of the operation of the institution. Health institutions have a lot of data for all parts of the operations and for that the creation of this system will be a very hard process. But, when once it is created, it can be used in all public health institutions. The long term benefits that a visual system will bring are much larger than the time and costs for creating the system.

When the visual system is created and implemented, it is necessary to train managers for its use [3]. If managers previously understood the need and usefulness of the system, they will be motivated enough to use the system. The system is very simple for usage. Managers just need to choose which dashboards with witch data they want to see and the system will visually show them. With this the changes in the work of health institutions will be detected on time and appropriate measures will be taken in time.

In the future, we think that the concept should expand to all public health institutions in Macedonia where managers can get the data that they want to see on those dashboards. They should be applied to that part of the operations for which there is a necessity for that kind of a visual system. Once the data is collected and processed, it is necessary to expand the database so that it includes all of the data requested by the managers. But, even when we have all the data, we must create algorithms to prepare the data to be used for visualization. That means we need to create a new database that will communicate with the databases from the hospital and will take the data from there, and it build views that provide data needed for visualization. This way of connection with the databases of the actual system is not possible, but is essential for creating the visual system. It would be an excellent topic for future surveys. The next step is creating a visual system that will satisfy the needs of all managers in the health institution by the example proposed in this paper. For that visual system every manager will have password protected access and access to the visual dashboards that are of his interest. The visual system should be implemented in all public health institutions in Macedonia. At the end managers need to be trained for using the visual system, and understand the opportunities that it offers and how they can use those opportunities to improve the work of the health institution.

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