Information Visualization from the Public Utilities Databases of Local Municipality for Municipalities Managers

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Abstract. *In this paper, we present the advantages from the use of data visualization from information systems of communal arrangement department for the local self-management. This approach will provide help to the users to analyze and see information more quickly and more efficiently. These visual representations are expected to shorten required time for data analyses. In the paper, we present several visualizations of the integrated data for managers and analytical staff in the local municipality in a city in Republic of Macedonia where the one-stop-shop system is still not implemented.*

Keywords. Visualization, Local Municipality Information System, Data Warehouse

1. Introduction

Visualization is an area in the computer science that experiences a fast development. The growth has been rapidly increased especially with the computer technology development. The most important moment is the development of graphic workstations and the software that every kind of graphic presentation makes available. Visualization tools are used everyday in the business, law institutions, medicine, art, education, movies. A manager considered more useful having graphic presentation of the data and information from information systems. Using visual representations of data, the management team can make decisions on each level. "One picture is worth a thousand words" [3] some things that used to take hours to be analyzed now can be seen as a picture through a simple diagram and with the use of simple methods, users can get different views of the data diagram.

In this paper, we present the advantages of the use of data visualization from information systems in the Department of building documents issue for communal arrangement in the local self-management. This approach would make the process of data and information analysis quicker and efficient. It is expected that this approach will shorten the required time for analysis.

The Government Information Systems in the European countries are integrated, with integrated software solutions and databases. They provide answers on demand for all government analysts and citizens needs. The citizens may obtain the information through touch-screen monitors installed publicly. The government staff uses sophisticated applications for analysis, data-mining and visualization that help them to make decisions.

The example described in the paper is about the local municipality in the Republic of Macedonia, where the one-stop-shop system is still not implemented. We propose an approach how to add new functionality of the existing software. To obtain effective visual representation of the information the data from the local transactional information systems (TIS) have to be integrated. This will provide control functions and possibility to see what's happening with the building living and working space in the city and how to plan future city's infrastructure. Since the human eye has been frequently advocated as the ultimate data-mining tool data visualization is very important tool for government analysts, managers and decision-makers as decision support tool. In this case, they can see the information immediately and save time for analysis. They can see information that require hours to be analyzed in very short time, analyze data for urban zone and building working space and create plans for future detailed urban plan.

The paper is organized as follows. The next section describes current situation with building space in the city and compare it with situation in European countries. The third section describes our idea to visualize data warehouse from local municipalities' data. Then, we analyze the user tools for data access and the possibilities to drill-down and visualization. The following section describes the use and advantages of professional

visualization tools for visualization. The final section presents the summary of this paper.

2. Situation Analysis

The building process in the city is under the regulation of Local government and the actual law in the Republic of Macedonia. The amount of money that citizens pay for building the living and working objects is a considerable part of the city infrastructure and for these reasons, it often a subject of analysis. The issue procedure for building permission consists of many activities that require gathering all necessary documentation from an architectural plan to a building permission. After the documentation is completed, the administration office workers update the data in the local government database, and print all necessary documents from transactional databases for the citizens and the government archive.

According to the data, the office workers make a detailed calculation of space of every room in the building and determine the payment for communal and urban planning. The issued documents are a reflection of the transactional data in the databases. This means that they might be a subject for the management analysis of the Local municipality mayor and the other government staff. The visualizations are very effective in shortening the time to analyze some issues and make decisions. Visualization is a powerful tool that can help the community building politic in a city. This includes a recommendation for changing the city plan, with general purpose of minimizing the living spaces in the business zone and enlarging the urbanity zone in peaceful places. In the future, this information could be connected with GIS systems, where visual locations of the buildings can be provided too.

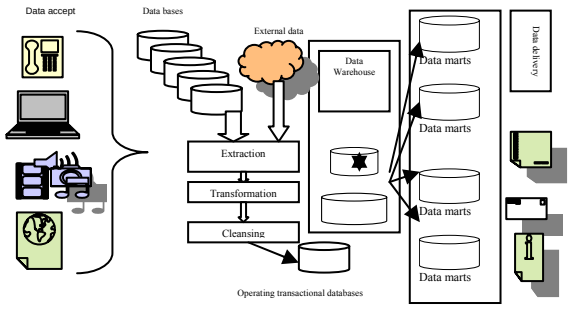
There are many examples of utilization of administration bases in the European countries and in the world. The most important thing is that all of them are put in the service of the citizens, who are able to analyze them and influence in the government's work and its transparency. They have a software solution with a great integration of all government information such as environment pollution, urban plans, legal acts, government services and information about the government work. All of them are inserted in the monitoring GIS software with touch-screen monitors. Government integrated information system in Germany is an example for such information system [12]. The manager's tools are software solutions with many possibilities that permit staff control and control of the amount of money paid for the building permissions. The directions for decreasing the gap between the administration procedures in our country and Europe union countries, lead us to requirement of data integration and introduction of the administrative data visualization for the managers and the public issue.

3. Visualization of Local Municipalities' Data

Data and information of Macedonia municipalities are not stored in integrated information system. The databases are located in distributed computer systems. For this reason, the first step is to provide data integration of all required information. Therefore we create data warehouse where necessary data from transactional database systems was loaded. This procedure consisted of the following steps [1]:

a) Analysis of the environment.
b) Collecting data for visualization by interviewing the administration managers
c) Comparing the obtained results with TIS analysis
d) Developing algorithms for building the data warehouse
e) Developing cleansing algorithms and update procedures.
f) Selecting visualization tools.

This process is presented in the picture 1.



Picture 1 Creating Data Warehouse process

For the aim of visualization, we created the star join schema structure, fact table and dimensional tables with the building space data for the last four years. The fact table is composed from data of building living and working space like the code of urban zone, building type and amount of payments. Data stored in the fact table also include analytical data for construction dimensions, refused building space from the total

building space (to reduce the amount of payment) and all valid information for this number of building document (building client, address, urban plan data, cadastre data). The analytical data for each building document are located in the dimensional tables. The dimensional tables with analytical data for all city urban zones, the building type, analytical data for every building space, dependence of building rooms type, the coefficients for type of building room and flats are the part of star join schema.

The data which was used for visualization are attributes of database records like urban zone code, year and time scale, type of building space... Each record attribute is described by the scalar value. Some of the attributes represent measured values like a quantity of building space. The value range of these measured attributes is wide – for an example for area it ranges from zero to couple thousand of square-meters (m^2). The other attributes like urban zone code, type of building space can take only a few values.

4. Visualization Tools for Local government managers

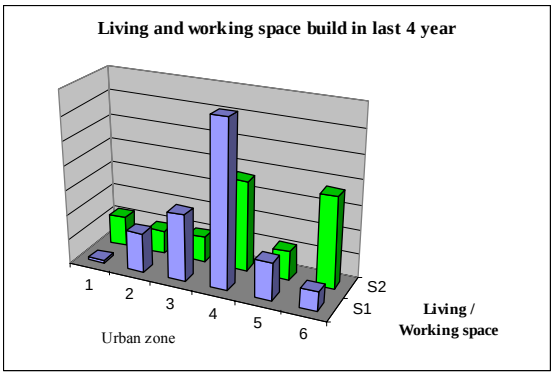
The utilization of data warehouse for data reporting and visualization is not easy task for users who do not have enough knowledge of data warehouse and specialized visualization software tools. For this reason, they need to use the user friendly tools which do not require long training [5].

Depending on the tools for visualization and parameter selection, the user can obtain periodic, quarterly, monthly, weakly analysis, and all may be associated with drill-down possibility when he wants to divide the analytical from syntactical data. To analyze data and their properties, the most effective way to visualize data and "see the invisible things in the data" must be selected. This will help him to take valid and quick information from the data, which can be applied in the process of decision making and project plan making. Many methods and techniques for data visualization are available for this kind of problems. The methods are included in the software solution and the users may use it easily. The users can analyze numerical data for the amount of the building space depending on the urban zone, the amount of living space and the amount of business space. Also, they may want to know which period the building process is the most intensive, how many permissions are issued in some period, the amount of revenue from this zone and many other things. If we have the correct information about the local area and the signs of the cadastre parceled place, we may connect with GIS government system and sign in the detail urban plan of the city. This is the way to make the visual presentation of the building demands and permissions for the citizens, the flow of this work in different periods. The users may see the percent and amount of revenue for all zones.

The most frequently used technique for data visualization and reporting for the managers are Excel Pivot tables and OLAP Analysis services [6]. The OLAP cubes are formed by the programmers. Managers use them with Excel pivot tables which update the data from databases at the client side and may change the form of the table in an easy way, similar to ordinary Excel table. At the end, they may visualize information in the desired way with Excel pivot tables and graph wizard. But, the problem is that the Excel has limited capabilities in visualization and sometimes the managers' visualization needs outrun the Excel visualization abilities.

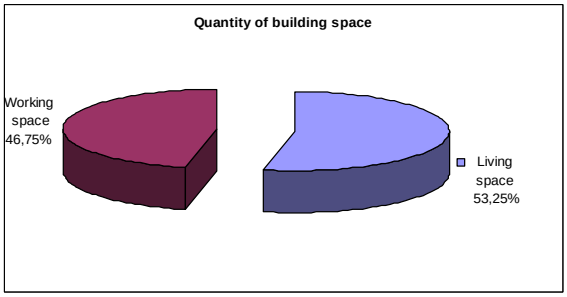
When we interviewed municipality department managers and staff and analyzed the information requirements of the potential users, we defined the following requirements for data reports which were the subject of visualization:

- The number of demands for building permissions and amount of square-meters which are allowed to build on
- The amount of revenue from the citizens' payment for the municipality and urban taxis for building regulation depending on urban area and time dimensions
- The analysis of the annual, quarter or monthly amount of revenue
- The part of building urban space that includes living space permissions and those which are planned for business offices or trade off shops
- The quantity of living and business space depending on urban zones and amount of revenue depending on the urban zone with possibilities for drill-down



Picture 2 Living and working space build in last 4 year

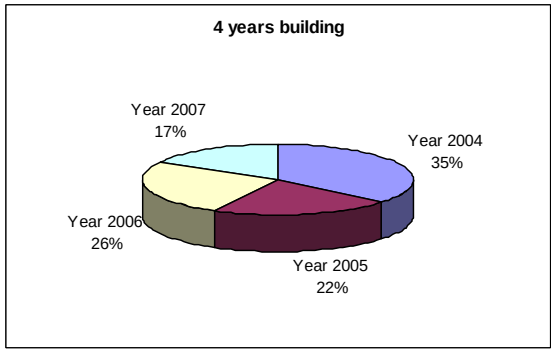
This section describes some of the reports that we did for managers during the analysis. The picture 2 presents Local Government data for last four years. It is obvious that the zones 1 and 6 have the lowest built space and the zone 4 has highest. The fourth zone is most interesting zone for space building and the city is expanded in this area. The first and sixth zones have much more working buildings than living space because the central zone is very interesting for business and sixth zone is probably industrial zone out of city border. This visual presentation is still satisfied. But, as the number of parameters growth, the managers needs for better visualization tolls, growth too.



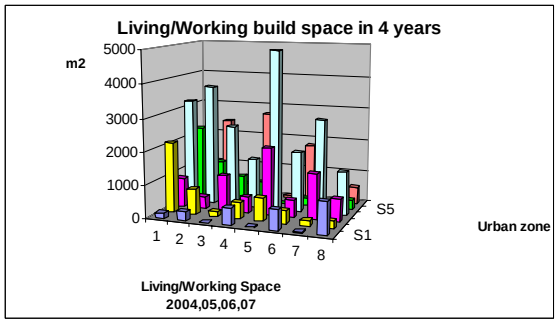
Picture 3a Quantity of build space in last 4 year

The building living space takes 53,25% of total amount of building space in the city in last four years and the working building space takes 46,75% (Picture 3a). The pie diagram gives us a clear presentation of shared quantity of building living and working space. For this reasons this type of presentation is very suitable to achieve clarity and visibility at first sight.

When we analyze the building space for the last four years, we can see that the year 2004 shows 35% of total building in last four years in the city (see picture 3b), 22% in 2005, 26% in 2006 and the lowest percent shows 2007, 17%. The pie diagram is more convenient for this kind of information because give us clear representation of share parts of dimensions. But, in this case there are two pies – other disadvantages for this visualisation tool. It will be appropriate to have just one pie for presenting two data dimensions - for example amount of building living and working place depending of urban zone or building living and working space divided in years.



Picture 3b Quantity of build space in last 4 year



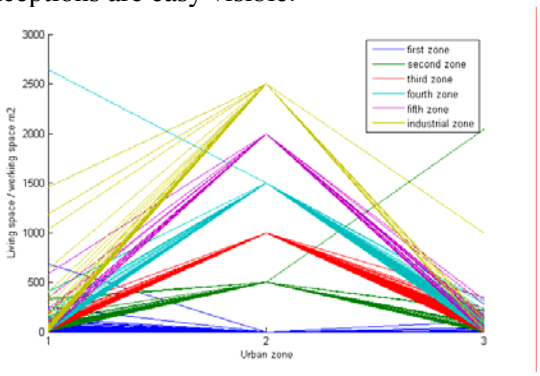
Picture 4 Living/Working build space (4 year)

3D graphics enable to see much more information in the graphs. The 3D bar chart is one of the most appropriate chart diagrams for this kind of data. This format is desirable for managers because it enables to see all required information for the selected dimension and also create automatic rescaling of axes. From the picture 4, we can see that the citizens build much more working space in 2007 in the first zone. The conclusion is that we have satisfactory visualization of data because there is a possibility to see the information from the different angles and dimension and different measure scales. Although we can see this graph from different angles, the managers can obtain zoom of this graph and see clear picture of separated zones. This will be very attractive and appropriate decision tool. In this case, they can not see clearly what is happening with the building living and working space in the third, forth and

sixth zone. For this reasons, we have to find more effective way to find out the facts from picture.

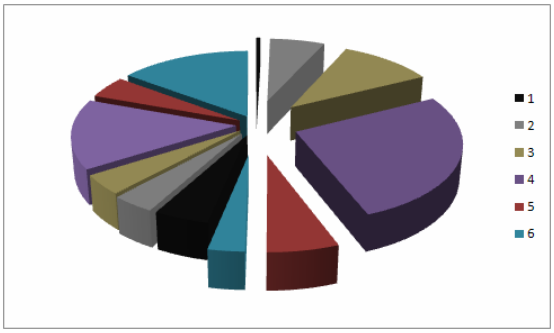
5. Creating visual representation of information with MATLAB as a Visualization Tool

Using more sophisticated visualization tools (Matlab) [9] we can provide much better visualization. In that context, we generated the parallel coordinate visualization graph [2] for the previously shown problem. This tool allows us to present the quantity of building living and working space, and also the stacking of building space – analytical view (picture 5). The managers can see analytical data stacking for living and working building space in the city in last 4 years. The urban zone is presented in the second parallel axis. The first and third axes represent analytical measure data for living and working building space. In this case, it is obvious that the managers can see exactly what is happen with the building space in all urban zones. The exceptions are easy visible.



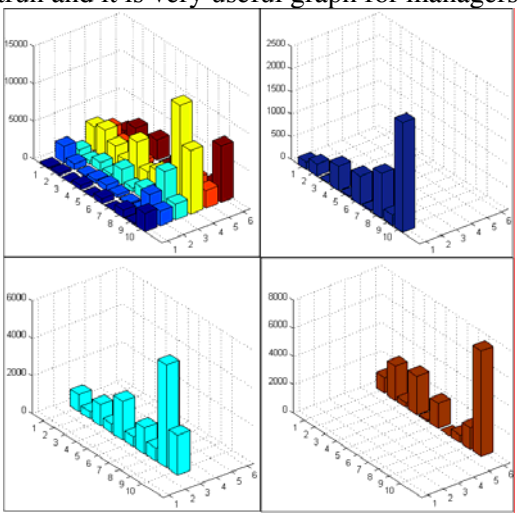
Picture 5 – Parallel coordinate visualization

The Matlab, provides us also with possibility to create more powerful pie presentation. In this case we have just one picture for separated building and working space in four years for each zone code (Picture 6). In the previous method, two pies were created for the same aim. The living and working space was shown in first pie, and the total building space separated in year in the second. It is more appropriate for saving managers time too.



Picture 6 Quantity of building space in 4 years

3D bar chart created in Matlab is very attractive because it enables to zoom separate parts of information. It shows full amount of data and enables zooming in the selected dimensions. Also, plot browser allows to make some graph modification for better data view. In this case, the disadvantages shown on the picture 4 are outrun and it is very useful graph for managers.



Picture 7 Quantity of building space in 4 years and 6 zones with focus

This visualization tool gives a possibility for data interaction because of some rescaling capabilities for axis values. Although there is many way to visualize this data types, the main disadvantages of this data visualization tool is his relative complexity and long training period. This mine that this data visualisation must be made by IT staff and the managers can them take already made.

6. Conclusion

The process of data visualization described in this paper is the example of application of data visualization for local government managers and analysts. The effective data visualization for managers in the local municipality in a city in Republic of Macedonia is connected with creating of central data repository – data warehouse. Creating the data warehouse from the local municipality was necessary because of the decreasing gap between the European Administration Information systems and Information systems in our country [12]. The another reason for the necessary involvement of data warehouse in the local government municipality information system is the requirement for analysis, which the analytic staff must make from the TIS, which are not transparent for all and are not accessible at any time. When the data warehouse is implemented, the most important issue is the managers and analytical staff training for proper use of the tools for reporting and data visualization from data warehouse. This is a good way to create and analyze all necessary data reports and useful data visualizations. Usually they create visual representation with Excel pivot tables, but in some cases they need more professional tool for data visualization because of disadvantages of Excel graph wizard. In this case, IT staff has to create more professional graphs necessary for decision making and clear representation of data in the repository.

6. References

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