Using Business Intelligence techniques to increase the safety of citizens – The Tilburg case

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Abstract

The topic of applying Business Intelligence in a non-profit environment is quite unique and is still at an early stage. In this paper we report our experiences in applying Business Intelligence techniques to monitor safety indicators in the city of Tilburg, Netherlands. The work here reported was developed in the context of an Erasmus Intensive Programme (IP) project.

Key words: Business Intelligence, non-profit organization, KPI

1. Introduction

Local governments, non-profit organizations and organizations in the public sector strive more and more to a business-oriented management in order to increase the transparency and to guarantee a better quality of service. On top of that, globalization forces non-profit organizations to find standard ways of working in the different cultural contexts of the different European nations.

In order to achieve these aims, these organizations are still searching for the adequate ICT tools to measure the quality of service continuously. These tools can be found in a business environment.

Business Intelligence (BI) is by definition a multidisciplinary topic. In order to make more informed business decisions and gain competitive advantage, organizations are offered a broad category of applications and technologies for gathering, storing and analyzing the data [Turban and Sharda 2008; Turban, Sharda and Delen 2010]. For transforming the data into useful business information, knowledge of both business and ICT is needed.

We argue that Business Intelligence can provide much support for decision-making in non-profit organizations and to improve the quality of service. As the biggest growth in IT-expenditure will be in the public sector, and where the traditional curricula and work placement experiences of ICT students are mostly oriented to a commercial and technical environment, we also believe that future ICT professionals should be aware of these new opportunities in non-profit environments, with their specific needs and problems. To this end, we provide a practical case where these ideas were applied.

The work reported herein was developed in the context of an Erasmus Intensive Programme (IP) Project, the Miss Logo IP project [Miss Logo, 2008; 2009], where several European higher education partner institutions were involved. The long-run objective of the Miss Logo IP is to build an international BI curriculum in which the partners can subscribe. Each edition of the IP project is, therefore, a part of a long-term project to develop a European Curriculum for Business Intelligence studies.

The paper is structured as follows: Section 2 presents a description of the practical case in which the project was based and sets the objectives to fulfill during the project. Section 3 provides a description of the Key Performance Indicators (KPI's) that were considered and that drove the setup of the BI system. In Section 4 we present an outline of the way-of-working for developing the BI system for the case described and we present the major outcomes obtained with the project. Section 5 concludes with a summary of the project achievements and our directions for future work.

2. The case: Monitoring safety indicators in the city of Tilburg

One of the largest cities in the Netherlands wants to use the possibilities of Business Intelligence to strongly increase the safety of its citizens within a problem district. The main goal is to identify specific persons based on certain characteristics, who show criminal

behaviour within the district and to deny them access to the district for a certain (long) period based on their behaviour.

To accomplish this, the city wants to bring together a broad range of available electronic data about the district and its inhabitants and store these data in a secure environment, to analyze the data and make reports. This way, the individuals with criminal behavior can be identified. Also, tracing people who, at the moment, show no criminal behavior, but are likely adapt this behavior due to the influence of their direct environment (family, friends or neighbors), is one other goal.

It is essential to point out criminal networks by identifying patterns of illegal activities and relationships between persons within the district. Because of the privacy aspect and the political sensitivity of this project, the mayor, in collaboration with the minister, gave a one time permit under strict conditions and control procedures.

With this permit, the city wants to extract the following data from several sources. Data regarding:

- Social allowences (City)
- Income numbers (Tax administration)
- Reports of criminal activity (police department)
- Medical records (National Health Institute)
- Vehicle and motor ownership records (National road traffic institute)
- Historical criminal records (Justice department)
- Living area and family connections (City)
- Air and infrared photo's
- Building and house ownership (City)

After all these data are brought together, a strictly selected team of specialists will try to answer the following questions using Business Intelligence tools:

a. Who is a criminal?
b. What families are terrorising the streer or district?
c. Which criminal networks are present in the district?
d. Which criminal activities happen frequently in the district?

e. What criminal activities have notable connections?

f. What other unexpected but useful patterns can be found in this data?

g. Which criminal individuals in the district will be classified to temporarily leave the district, in order to improve the safety of the district?

h. Which individuals are qualified to receive special guidance to prevent them from growing towards criminal behavior?

i. In what way, based on the different analysis, can the social atmosphere between the inhabitants of the district be improved?

Within the city, there is a need to replace the existing two year statistical rapport by a modern environment of flexible and dynamic analysis and reports with actual operational information, dashboards and statistical research results based on data mining. For this project, the city of Tilburg developed a vision, based on several policies, to strongly address this problem at its roots.

To best implement and monitor this vision, the city of Tilburg wants to achieve the following objectives, with the support of a BI system:

1. To have a dashboard to monitor the progress of the realization of this vision;
2. To have a real time (geographical) dashboard to monitor the current situation in the city;
3. To be able to perform (ad hoc) statistical analysis on all the available data.

The first objective, the progress dashboard, should be based on the 26 Key Performance Indicators (KPI's) determined by the local authorities of Tilburg. This dashboard should provide them with a quick overview on how far the city is with reaching these 26 goals. It should also strongly indicate a point of attention when one of the goals will not be reached in time. This dashboard will be used on a monthly or quarterly basis.

The second objective, the real-time dashboard, should be a dashboard with the geographical division of the city of Tilburg as a basis. Figure 1 shows an overview of the city structure where District 00 is the city center. This dashboard should feature a similar view of the city, but then with the possibility to show different overlays and different geographical divisions. The users

should be able to see a number of different types of information for each district, or change the geographical division from district to bigger or smaller subsets. Examples are a view of the number of reported incidents for each district and the number of reported cases of child abuse per district. Users would also be able to view the number of reported incidents not per district but per city part (Tilburg-North or Tilburg-East).

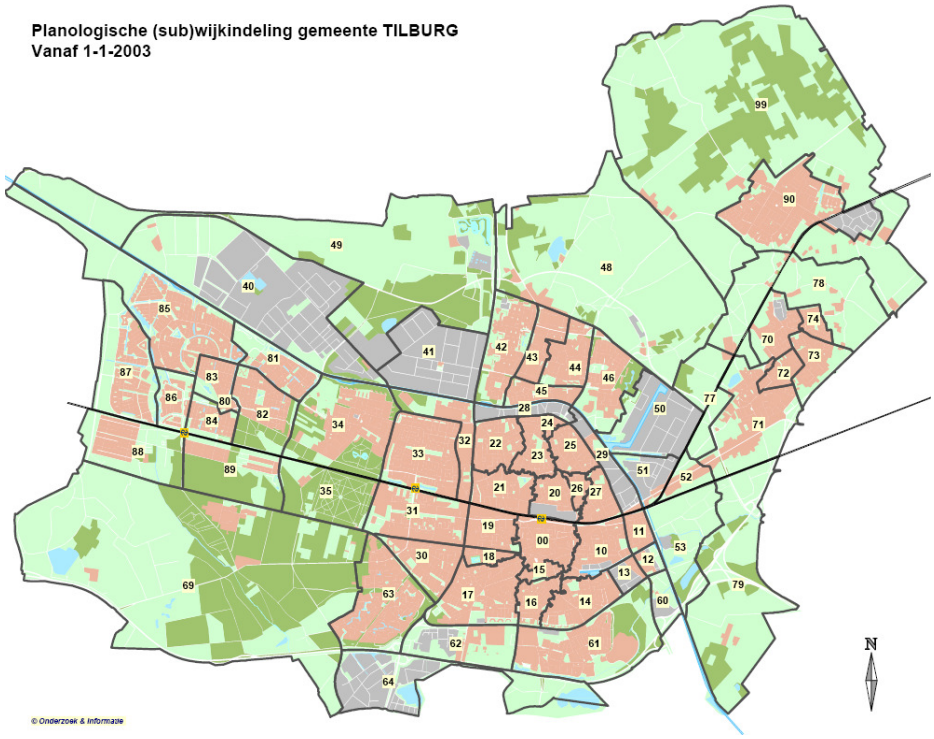


Figure 1 – Overview of the geographical division of the city of Tilburg by districts [Miss Logo 2009]

The third objective, the statistical analysis, requires a fully operational BI system. This system requires a large operational database (a data warehouse) to gather all the data as well as analytical tools to analyze the data.

3. The Key Performance Indicators (KPI's)

The local authorities of the city of Tilburg identified a set of 26 KPI's to be used in the BI project. These KPI's should be turned into a dashboard, which should provide them with a quick overview on how far the city is with reaching these 26 goals.

Examples of these KPI's are:

- Possession of arms
- Violence and robberies
- Drug addicts
- Prostitution
- Radicalism
- "Helingaanpak", which is a sort of a black market
- Moroccans
- Antilleans
- Young Troublemakers
- Violent crimes, trouble makers
- People who has a lot of valuable assets, but don't have any income
- Bars and pubs, where criminals are gathering together
- Significance of care house services
- Smartshops
- Domestic violence
- House rob
- Bike theft

As an assignment for this project, each project team was given three KPI's to analyze and turn into a dashboard. Information about these KPI's should be collected and, therefore, each group interviewed local authorities of the Tilburg city so as to gather more information about the indicators.

The interviews aimed to get more accurate definitions of the indicators, help to find out the means to acquire information about the indicators from existing files, and envisage the best means to represent these indicators in a dashboard. Furthermore, the structure of each KPI should be checked in terms of its adequacy to be used on a dashboard. Figure 2 shows the result of the analysis that was performed for KPI "Young Troublemakers".

KPI – Young Troublemakers

KPI – Drop-out Rate (number of kids who dropped out of school)

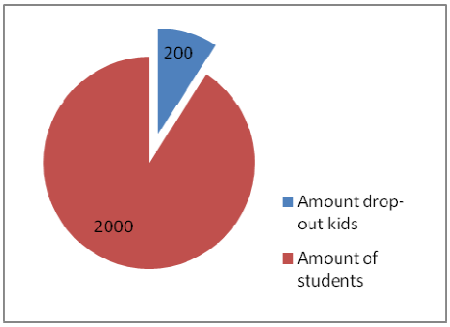
Definition: The Drop-out Rate measures the percentage of young kids who drop-out their studies.

Objectives: Reduce amount of drop-outs by 40% until 2011.

Unit scale: Tilburg Young Troublemakers

Frequency: Once a Year

Algorithm: Drop-out Rate = Number of Drop-outs/Total amount of Students



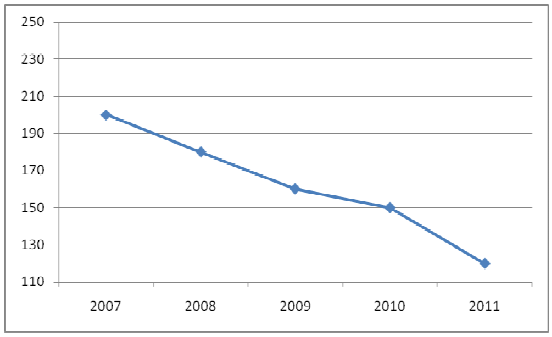


Figure 2 – Result of analysis of KPI "Young Troublemakers"

4. The BI system

In this section we show the several tasks and outcomes included in our project for creating a BI system to address the third objective. We followed the general steps for creating a BI system as suggested in Figure 3.

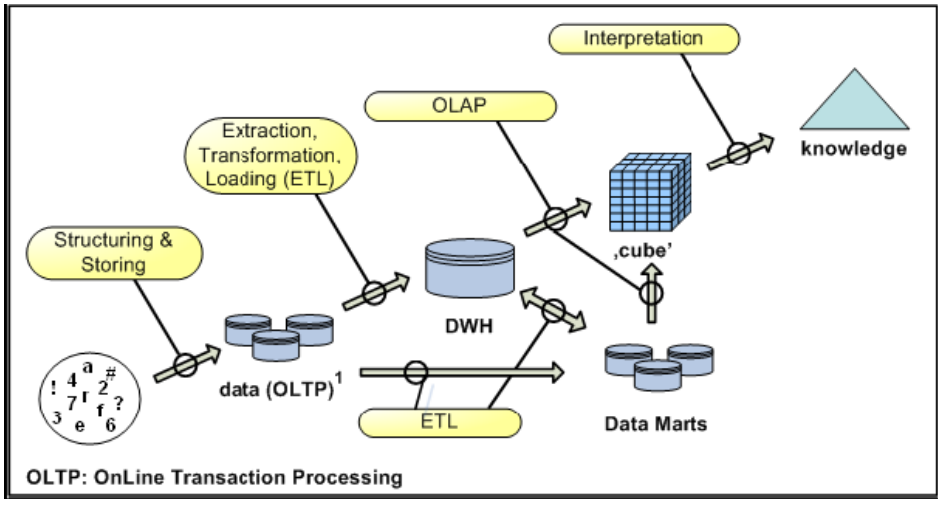


Figure 3 – General architecture of a BI system [Miss Logo 2009]

4.1 Creating a Star-Schema based Data Warehouse (DWH)

We used the DBDesigner v.4.0.5.6 software to create a star-schema for the data warehouse. At a first stage, we had to define the dimensions and hierarchies from the several Excel data sheets containing information about crime in the city of Tilburg.

We built the star-schema shown in Figure 4. It contains one fact table (Incidents_Table) and three dimension tables which represent the dimensions named “Time”, “Location” and “Age”. All the dimension tables are associated with the fact table; the fact table allows to measure the number of incidents in Tilburg and sort incidents by time, location, age or gender.

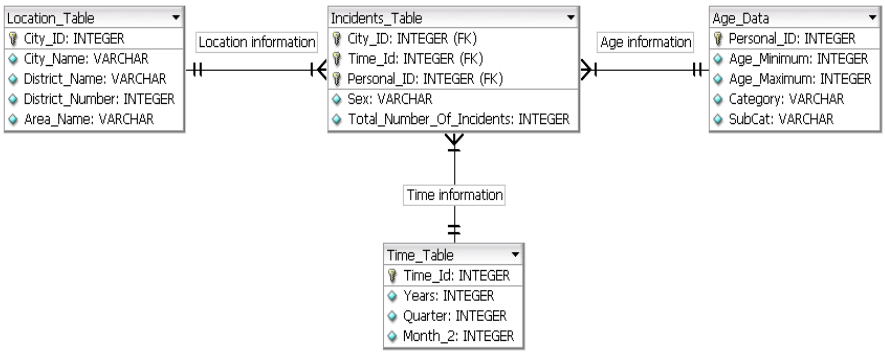


Figure 4 – The Star-Schema for the Data Warehouse

This star-schema was used in a later stage to create the data warehouse.

4.2 The Extract, Transform and Load (ETL) process from existing files to the DWH

ETL is a process in data warehousing that involves extracting data from external sources, transforming it to fit business needs and loading it to the end target, that is, the data warehouse. The source data can be in different formats and can contain errors. In order to import the data into a coherent database, data needs to be first extracted from the sources, then transformed into a format used in the database with all errors corrected, and finally loaded into the database.

The task performed at this point was to build a data mart based on the star-schema previously created and to import data from several Excel files into it.

Using Microsoft Visual Studio 2005, we created the tools to extract, transform and load the data from Tilburg Excel sheets into the data mart. The tools allowed the transformation of the data into a proper format and the correction of some errors found in the files.

After the ETL process was finished, we used Microsoft SQL Server 2005 to upload the database into a web server. Later, we used this server for further tasks. The ETL process is shown in Figure 5.

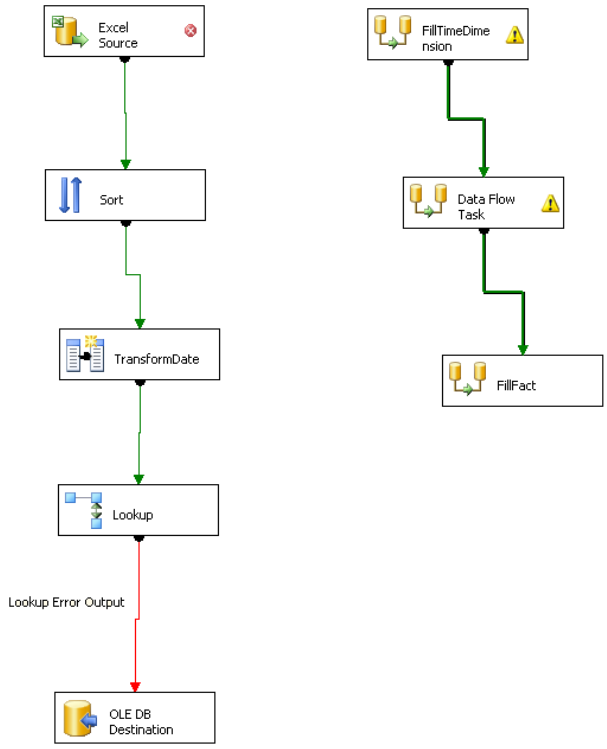


Figure 5 – The ETL process

4.3 Analyzing the DWH: building a Data Cube

To analyze the data warehouse, the BI Online Analytics Processing (OLAP) technique was used, which allows to support decision making at a later stage in the process. OLAP helps in a dynamic search and in real time storage at the data warehouse/data mart. It allows the creation of multidimensional hierarchical structures that are called *cubes*. One of the best features of this technique is the easiness to browse through the information in the cube.

In a cube, data are analyzed in a multidimensional perspective (for example, for Tilburg Incidents data: Time, Location, Age) through analysis dimensions. Each dimension may have

an hierarchy, which is a path of aggregation within a dimension (for example, for the Location dimension: Area, City, District). The measures are the values or indicators used to analyze data (like quantity, value and other measurable quantities).

The cube is, therefore, a graphical presentation of the data within a database. Dimension tables from the defined star-schema make up the dimensions of the cube. The data within the cube can be viewed from many different perspectives, using different measures and parameters to isolate the needed information from the vast amount of data. Figure 6 shows the cube that was built for analyzing the data warehouse.

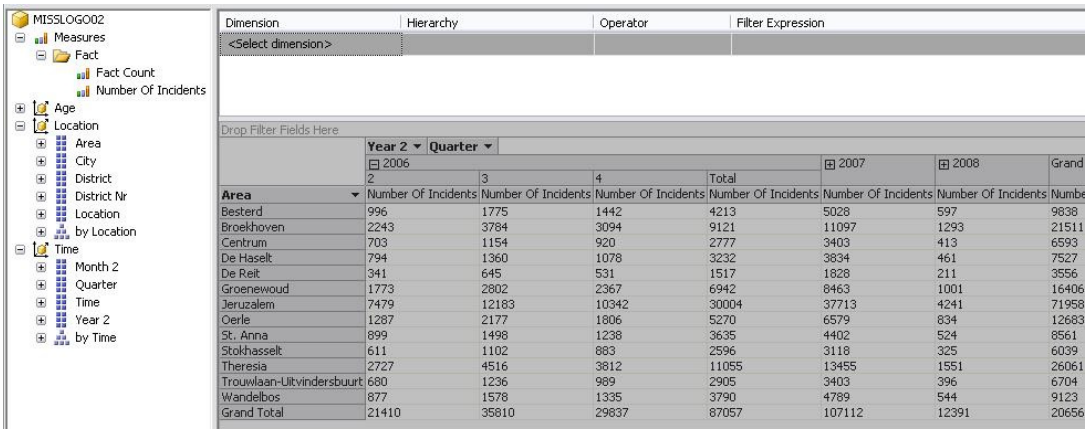


Figure 6 – Building the cube for analyzing the data warehouse

4.4 Data Mining

Data Mining is the process of analyzing large amounts of data with the purpose of discovering significant new relationships, patterns and trends via pattern recognition as well as statistical and mathematical models. These rules and patterns can be used to make short term predictions. Data mining may be used in BI to find useful information in the existing data warehouse that was missed during the initial process of extracting information.

In the scope of this project, data mining was performed using the KNIME 2.0 open source software and covered some attempts to define rules on the data and check related occurrences.

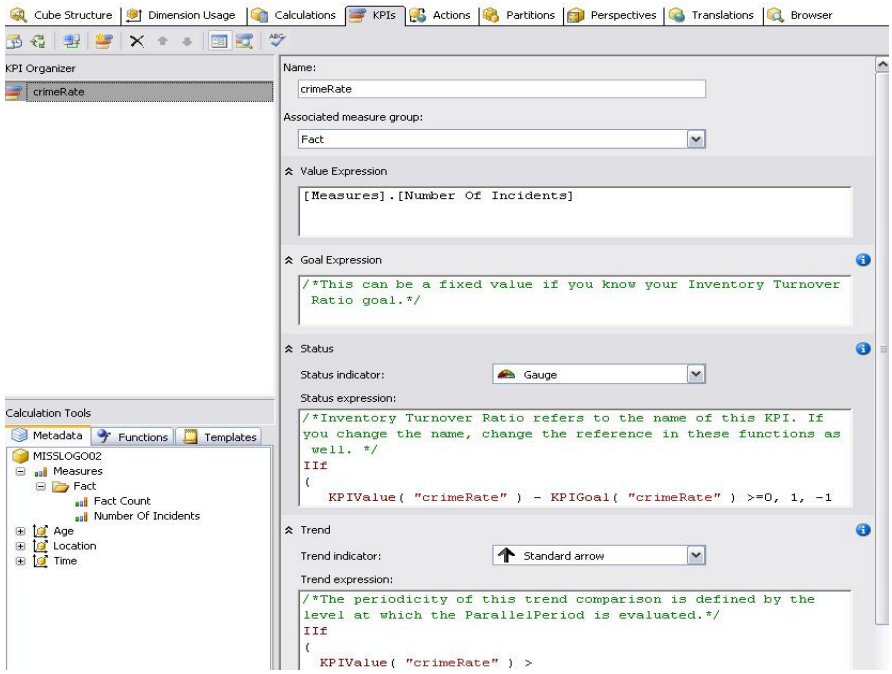
4.5 Presenting information to stakeholders: The Dashboard

Due to the vast amount of data that managers must operate with these days, it becomes more and more difficult to comprehend them all and to draw actual conclusions. A *management cockpit* or a *dashboard* aims to change that by presenting the many different types of data in a simple and easy-to-understand graphical way using icons and graphs like "traffic lights", "speedometers", etc.

A management cockpit allows to compile, filter and provide critical information for management to run the business. With a management cockpit, KPI's are better presented and analyzed than by just creating a simple report. This improves the overall productivity, efficiency and transparency of management, creating a whole view of the company which allows to detect potential problems and opportunities at an early stage more easily. A management cockpit allows its users to better absorb the information and ensures that company's goals are met in a timely fashion. The scope of a management cockpit can be extremely variable, ranging from a relatively small single screen one to entire rooms filled with banks of monitor screens displaying many different details of data, usually sorted by a specific theme.

The task at this final stage was to create a relatively simple dashboard in Microsoft Visual Studio 2005 using the data warehouse containing information about incidents in the city of Tilburg.

Figure 7 shows the design phase of our cockpit. From this phase, we would go on and create the "speedometers" and "traffic lights" for the cockpit. With the support of these graphical representations, it is easier for users to view and monitor the data within the database. If the user was limited to this design view only, it would be much harder to assimilate the data. Regrettably, we lacked the time to create such tools from this view.



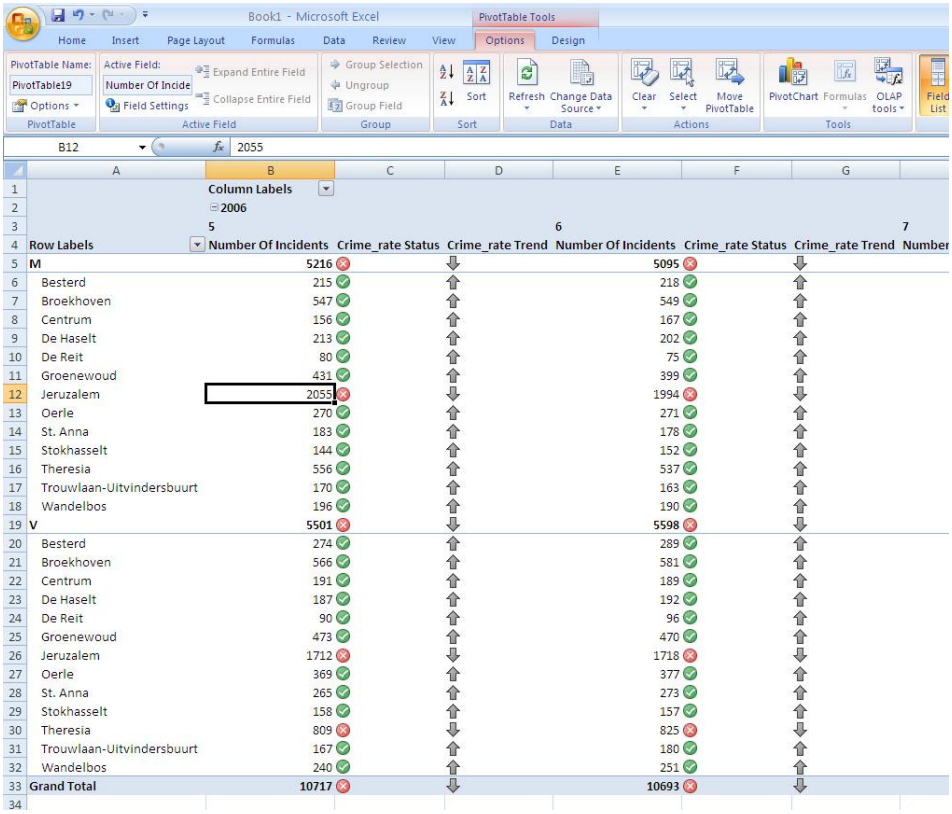


Figure 7 – Designing the Dashboard

5. Conclusion and Further Work

Overall we felt that we succeeded in our effort of setting up a BI system to be used in a real non-profit environment. We also believe that we provided a valuable contribution to a knowledge platform on BI for further discussion and sharing with other institutions and non-profit organizations. This opinion was corroborated by the organizing institution and project partners, the other project teams and by stakeholders - the local authorities of Tilburg - who were invited to participate in the project final session in order to evaluate the project outcomes.

In spite of this, due to time constraints – the project covered 10 working-days - , we didn't manage to fulfill the objective of providing a real time (geographical) dashboard to monitor the current situation in the city, nor to explore the data mining possibilities to a full extent, which would be valuable directions for further work to consider.

6. References

Miss Logo, 2008, *Miss Logo: Management Information Systems Supporting Local Government*, project documentation, http://www.misslogo2008, 2008.

Miss Logo, 2009, *Miss Logo: Management Information Systems Supporting Local Government*, project documentation, http://www.misslogo2009, 2009.

Turban, E. Sharda, R., *Business Intelligence – A Managerial Approach*, Prentice Hall, 2008.

Turban, E. Sharda, R., Delen, D., *Decision Support and Business Intelligence Systems*, Prentice Hall, 2010.