Business intelligence is not only for business purposes – business intelligence in e-matura

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ABSTRACT: The authors in this paper aim to demonstrate how Business Intelligence (BI) could improve the process of education and prevent certain problems from arising. Conducting school-leaving examinations using the Internet made it possible to collect data to create a platform to support statistical analyses and draw conclusions concerning the educational process. A system called *e-matura* was created that made use of Microsoft SQL Server 2008, to build analytical data cubes and a data warehouse. The development and application of such a platform is presented and discussed in this paper.

INTRODUCTION

How do particular aspects of a sale look to you? Which regions have the best sales? When is it worthwhile implementing a new product with the greatest chance of success? Managers look for answers to these, and similar, questions from Business Intelligence systems. However, data warehouses also can be used to improve the quality of education.

Why is business intelligence so popular? Because it is a data acquisition and analysis system that supports business decisions [1]. Conclusions are based on historical data and can, for example, determine the financial standing of a company, and enable projection ahead. At present, BI systems' origins date from the 1970s. Companies by then had started to aggregate transaction data, which could be used for business decision support by seeking trends and relationships [2] between the data.

BUSINESS BENEFITS FROM BUSINESS INTELLIGENCE SOLUTIONS

Managers often analyse business processes, such as sales, based on dimensions of time, region, branch or product. This type of analysis can be done using data cubes. Data processing, based on analytical cubes, enables answers to be derived for questions such as *How do sales look in a given region?* or *In which regions were the best sales made over the past quarter?*

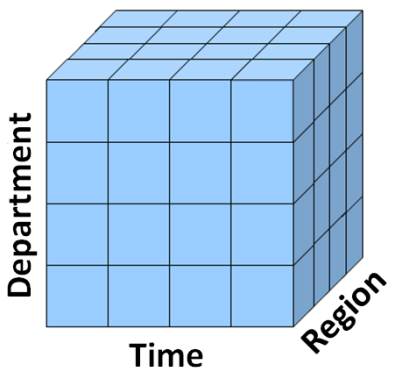


Figure 1: The analytical cube.

Why not, in education, search for answers to such questions as: *What types of school produced the best results? Which batches of teaching material gave the worst results?* or *How does the size of a town influence results?* It is possible to derive answers for these questions based on these analytical cubes.

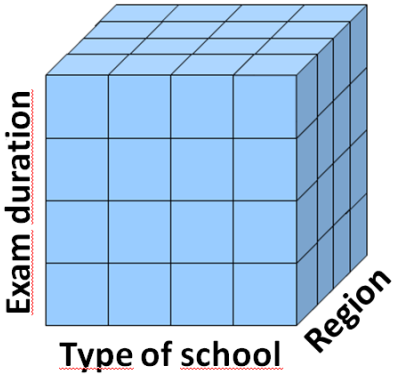
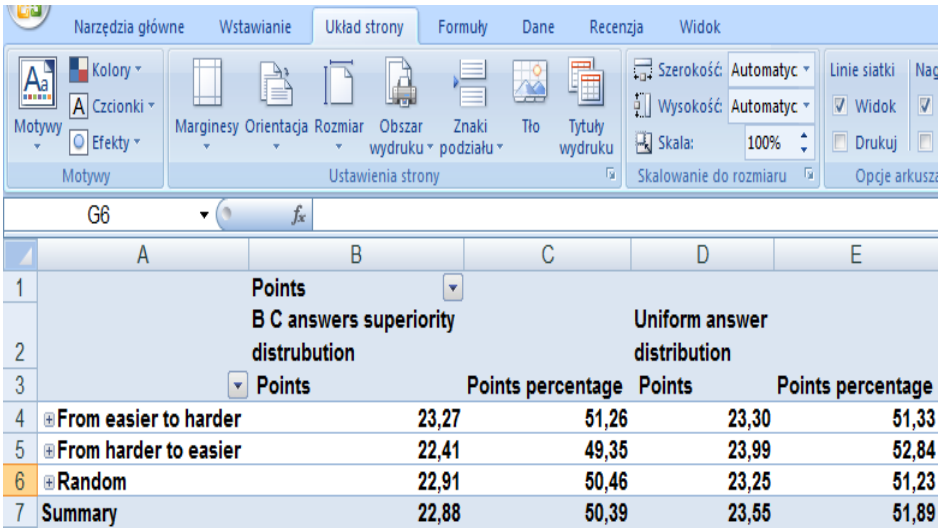


Figure 2: Example of an analytical cube in non-business usage.

NON-BUSINESS APPLICATIONS OF BUSINESS INTELLIGENCE

The e-matura examination platform was created under the direction of Professor Sławomir Wiak at the Technical University of Łódź, Łódź, Poland, and under the auspices of the Ministry of Education. The examination was held in October 2009. It was strongly publicised and admired by the Polish media. Several thousands of students from all over Poland took a matriculation examination in mathematics at the same time via the Internet. Information Technology corporations such as IBM and Microsoft actively committed themselves to the project, supporting the programming team with professional servers and the required software. The examination used both multiple choice and open questions tests. Students undertaking the examination valued the new technologies, animations in the questions, and the speed of achieving results. Teachers involved with the examination received the results of their students. The nature of the project enables statistical, comprehensive and precise analysis of the students' answers to be derived, hence improving the quality of education.

It should be mentioned that 600,000 answers were collected during the examination. If students answered a given question several times, changing their reply, then the system recorded all the steps. The time taken to produce each answer was also registered. What is more, by determining the correctness of answers to a given question by region, city, and type of school, it was possible to draw conclusions concerning the quality of the education process. Three sets of questions were implemented for the examination - from the simplest to the most difficult or from the most difficult to the simplest - to be accessed randomly. Further, it was also possible to analyse how the choice of initial question affected the examination. For the purpose of research, two versions of the answers were used: in the first the correct answer to 70% of the questions was by selecting B or C (however, 30% is A or B); in the second, this order is completely random.



	A	B	C	D	E
1		Points			
2		B C answers superiority distrubution		Uniform answer distribution	
3		Points	Points percentage	Points	Points percentage
4	From easier to harder	23,27	51,26	23,30	51,33
5	From harder to easier	22,41	49,35	23,99	52,84
6	Random	22,91	50,46	23,25	51,23
7	Summary	22,88	50,39	23,55	51,89

Figure 3: A report on how initial questions and the order of correct answers affected the exam results.

The data warehouse in Microsoft SQL Server Analysis enabled processing based on analytical cubes. In-depth analyses were carried out. It is possible to process aggregated data in the popular spreadsheet Microsoft Excel 2007 by using Microsoft SQL Server Analysis Services. Also, it is convenient for the user to apply familiar tools. When examining the

reports, it is possible to find information on the types of school and what part of the program caused problems and, additionally, how a specific region affected the results.

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Province	Avarage	Maximum	Minimum	Average standard deviation	Number of schools
⊞dolnośląskie	25,44	41	8	5,60	10
⊞kujawsko-pomorskie	21,60	42	7	6,62	16
⊟lubelskie	24,22	43	7	6,66	15
BIAŁA PODLASKA	22,00	30	15	5,75	1
BIŁGORAJ	20,00	25	12	6,27	1
JÓZEFÓW	30,00	38	26	3,65	1
KRASNYSTAW	19,00	29	14	6,78	1
LUBLIN	25,00	42	7	8,72	6
PUŁAWY	25,00	28	21	3,61	1
WISZNICE	16,00	37	9	10,08	1
ZAMOSC	32,00	43	16	10,93	2
ŻÓŁKIEWKA	29,00	34	26	4,16	1
⊞lubuskie	21,50	34	13	4,55	3
⊞łódzkie	26,94	45	6	5,82	43
⊞małopolskie	22,60	39	9	6,20	6
⊞mazowieckie	26,18	41	7	4,54	22
⊞opolskie	27,33	39	15	5,27	3
⊞podkarpackie	21,75	39	10	5,19	26
⊞podlaskie	23,00	43	9	4,45	6
⊞pomorskie	23,00	40	0	7,14	16
⊞śląskie	22,07	42	6	6,68	20
⊞świętokrzyskie	28,00	43	13	5,30	7
⊞warmińsko-mazurskie	22,20	36	13	5,43	5
⊞wielkopolskie	22,56	42	6	5,67	21
⊞zachodniopomorskie	23,33	40	14	5,75	4

Figure 4: A report on how region and city affected exam results.

By applying *Drill down* and *Drill up* functions, it is possible to go from the whole to the detail and vice versa. It is possible to conduct data analysis with the differing levels of accuracy.

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	A	B	C	D
1		Points		
2	Population	Average points	Standard deviation	Number of schools
3	⊞>500 000	19,71	6,23	56
4	⊞10 000 - 50 000	22,95	5,69	73
5	⊞100 000 - 500 000	23,88	6,72	32
6	⊞50 000 - 100 000	24,77	5,98	24
7	⊞<10 000	25,97	5,48	72
8	Total average	23,90	5,82	257

Figure 5: A report showing how the size of a city affected examination results.

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	A	B	C	D
1		Points		
2	Population	Average points	Standard deviation	Number of schools
3	⊟>500 000	19,71	6,23	56
4	GDAŃSK	17,00	7,50	5
5	GDYNIA	27,00	6,98	3
6	ŁÓDŹ	19,00	6,71	34
7	POZNAŃ	11,00	2,14	2
8	WARSZAWA	20,00	6,93	11
9	Wrocław	25,00	6,63	1
10	⊞10 000 - 50 000	22,95	5,69	73
11	⊞100 000 - 500 000	23,88	6,72	32
12	⊞50 000 - 100 000	24,77	5,98	24
13	⊞<10 000	25,97	5,48	72
14	Total average	23,90	5,82	257

Figure 6: A report showing the *Drill down* technique.

Based on the results, one can easily analyse how the size of a city influences the results. The researchers have not gathered enough data to draw strong conclusions, but the statistical selection of schools in the future can help to draw conclusions. Work continues on the development of a system able to provide aggregated data for each group of users, including:

- students - results by class, school, country, including an investigation onto which parts of the program greater emphasis should be placed;
- teachers - which parts of the program should be repeated with students, and how the results achieved by his/her students relate to the background of the school and country;
- authorities - which types of school recorded the weakest result, and how the results of the examination are affected by the size of city, region, etc.

CONCLUSIONS

Business Intelligence is a technology which can be used not only for business purposes. In using the e-matura platform, it is possible to analyse trends to improve education and diagnose problematic issues that require additional attention.

The use of BI can support the education process at every level. Students can check their level of knowledge; teachers can find out which areas to repeat; and authorities can examine how different factors affect students' knowledge in order to prevent recurring problems. Anyone can analyse results based on aggregated data analysis cubes in an easy-to-use spreadsheet.

REFERENCES

1. Gartner Research, *Business Intelligence Tools: Perspective* (2003).
2. Surma, J., *Business Intelligence Systemy Wspomagania Decyzji Biznesowych.* Warszawa: Wydawnictwo Naukowe PWN (2009) (in Polish).