

SELECTION OF THE MOST ACCEPTABLE TOOL FOR BUSINESS INTELLIGENCE FOR WORK IN PUBLIC ADMINISTRATION

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ABSTRACT

The development of business intelligence tools is gaining a new dimension every day, and this is an area of dynamic development. The importance of this paper is to select the tool that represents the best solution for the given needs in public administration. A multi-stage, broad-based survey with clear selection criteria leads to the choice of three tools. Criteria for tool evaluation were set, virtual machines were created, tests and analyzes were performed. The evaluations carried out give the choice of the most acceptable

business intelligence tool for use and interoperability in public administration.

Key words: Business Intelligence, Criteria, Public Administration, Interoperability, Virtual Machines.

INTRODUCTION

The field of research of this work, in a broader sense, is the improvement of information systems, which deals with monitoring (monitoring) implementation of projects in joint BiH institutions. More narrowly, the area narrows down to the selection of tools for business intelligence which will be implemented over databases.

A good information system enables all users to understand and learn things that could not be achieved in any other way (Radivojević, Tepšić, & Dumonjić, 2011). Quality information flow and good analytical tools give a completely different insight into the business potentials of the business system. It improves the strength of the human brain and reduces the need for physical work. In order for the management that manages public administration to succeed, it must: be competent; trained to make the right decisions; supervises subordinates; provides purpose, direction and motivation; must possess leadership skills; ensures the success of public administration; is of appropriate education; and relevant experience (Džino, Tepšić, Jovović, & Radivojević, 2019).

In the research itself, we were guided by the principle that all facts obtained are based on research and previously derived facts. In the work, we will manage the

following opinion: Regardless of the fact that scientific research is primarily individual and/or group, the scientific results that they come to their publication remain a public good, the property of humanity. The criteria are based on the needs of assessing the quality of project implementation at the level of BiH.

The term Business Intelligence (BI) defines the capacity of an organization, company or institution to collect, organize, analyze, maintain, distribute and present information using the capabilities of one of the various software tools. All of this for the purpose of distributing a given set of information to the management of an organization, company or institution simply and at a given time, in order to make timely and concrete decisions in business.

From the analytical database, the business system expects to provide quick answers to important questions. Different models and different architectures are needed to look at business problems or their solutions, which are similar to the natural structure of information used to manage with business system and to manage processes within this system. Many business systems have realized that decision support systems and better work of employees require a different data architecture designed and adapted for inquiries of people involved in the process of work and decision making.

Electronic public administration services are the future of the functioning of the public administration information system(s) and business intelligence gives an upgrade and a competitive advantage to the state administration. Many business systems have realized that decision support systems and better employee work require a different data architecture designed and tailored to the queries of those involved in the work and decision-making process (Džino, Latinović, & Avramović, 2020).

Superficial analysis could conclude that the business intelligence system is directly intended for the management cadre, however in today's modern way of doing

business, decisions should be made by everyone in their field, or at least propose them.

Business intelligence tools and their analysis

Business intelligence systems are present in practice today as a complement to certain systems such as databases or the like and some of the leading ones, ranked by value or ability, are according to Gartner presented in Figure 1 (Gartner, n.d). There are 495 types of processed software tools in 31 categories on this page. In the Business Intelligence Tools category, there are 17 types of software tools, and in the Business Intelligence Tool type there are 159 different software packages that can be ranked by: number of views, average rating, price, alphabet and number of recommendations. There is information for each individual package:

- about the price (given on request-not shown),
- a platform on which it can be installed:
 - a) Apple,
 - b) Windows or
 - c) Linux.
- where it can be installed:
 - a) on servers or
 - b) in the cloud.
- and what sizes of business can serve data software solutions:
 - a) small business (S-small),
 - b) midsize business (M-mid) and
 - c) Big Business (L-large).

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Figure 1. Overview of Business Intelligence Tool manufacturers

There is information for each individual package:

- about the price (given on request-not shown),
- a platform on which it can be installed:
 - d) Apple,
 - e) Windows or
 - f) Linux.
- where it can be installed:
 - c) on servers or
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Business intelligence softwares enables the collection and storage of intelligent data through their enrichment and increase. Business intelligence technologies provide historical, current and predictive views on business. Common functions of business intelligence

technologies include reporting, online analytical processing, data mining, process mining, business results management, benchmarking and analytics.

It should be pointed out that the selection of a software solution to be used for business intelligence was considered from two aspects:

- commercial and
- strategic.

In a given work, access to tool selection and used criteria are exclusively in the function of choosing the appropriate tool without the intention of minimizing the value of all tools in any way. Each of the software tools has its own good characteristics. Essentially, the criteria are conflicting and the final decision represents a compromise between the above criteria. Selection within this approach represents a solution that does not exist better in the given circumstances.

The basic approach in working when choosing tools is to use free open source tools for business intelligence, to specify, some tools have their free versions as well

as commercial—here the subject of consideration will be free versions.

Since the budgets of institutions are difficult to adapt and unoriented to development, thus rarely funds for improving the business can be found. It should be pointed out that the branch that offers the improvement of services and for this solution is the IT industry branch that of course have their own price, which are quite expensive, and are mostly based on annual licenses for commercial solutions. From the above stated it follows that the research is based on free solutions and available to all, which are based on "open source", in other words work with business intelligence tools licensed with open source. The reason for this approach as we have stated is primarily in the budgetary means that are assigned for such purposes and their limited and narrow approach.

In our circumstances the reason is limited resources, but if we look at the environments that have funds, they are oriented towards open-code solutions for reasons of great savings. This statement is from a general view of the use of open code software. So we can say no matter how much we want it or not, we go in, and we press with limited funds in this way, and we follow trends that are current. Of course, there are opposing opinions that we respect and the additional argument for this approach is the development of our own personnel.

The work itself has several stages, the beginning as can be seen from the above text starts from general concepts of business intelligence, as we gave the basic direction to work and these are free open source solutions, we can say that this is the second stage of work.

The third phase is defining open code software solutions. After comprehensive analyses and in accordance with the criteria which are set, about 30 tools belonging to this category were found here.

In the fourth phase, for easier work with them, we divide them and as follows below.

During the research, it was concluded that open source business intelligence

software solutions can be divided by two approaches. So we can make a basic division into:

- Open source business intelligence software solutions according to rights and
- Open source business intelligence software solutions according to where they may be located.

In line with the approach that Solver open source business intelligence solutions can be divided according to proprietary rights we have:

- Free proprietary business intelligence tools,
- Free open source business intelligence tools.

The software listed under point a) are with limited additions and functionality of software that is commercial, in accordance with the scientific and research approach in this work, this category will not be subject to further consideration. According to where they may be located:

- Cloud Business Intelligence Tools in Cloud,
- Free non-cloud business intelligence tools.

The business intelligence tools in Cloud for free use have functionalities that are limited and commercialized, in line with the scientific-research approach in this paper, this category will not be subject to further consideration.

Each state, in order to protect its data, keeps it on its own resources that, point a) free cloud intelligence tools, we cannot speak because we would come into conflict with the Personal Data Protection Act, so they will not be subject to further consideration. This is about clarifications on the tools that are in the cloud and their inapplicability in this case it is necessary to point out that they could be used, but it would require hosting in this case in BiH. Since these tools have hosting somewhere unknown to us, and this is not the case that they are in BiH, they will not be considered.

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Phase five: analysis of software solutions for open-source business intelligence.

To summarize, the following category still remains: Free business intelligence tools with open code.

The analysis of the entirety reflects the criteria of future development and adaptation, so we are not only looking for a solution to a given time, but a solution that will in future bring a series of advantages. The criteria of choosing a software solution for business intelligence are based on the above mentioned and according to the quality assessment of project implementation at the BiH level, and they are as follows:

- the software solution for business intelligence to be used should be entirely independent,
- web-based,
- to have the current version in a year,
- to support the integration of data from SQL and
- a general impression of researcher.

Fifteen business solutions for open-code business intelligence were analyzed according to available data from webpages, 12 were excluded according to the specified criteria.

Phase six: software solutions for free open-source business intelligence tools.

The research found a smaller group of free open-plan business intelligence tools, including (without any particular guidance criteria): *Pentaho Community Edition*, *Report Server Community Editions* and *Jasper Reports Business Intelligence*.

COMPARATIVE ANALYSIS

Criteria for analyzing a group of selected tools

In accordance with the as follows, comparative analysis of the following open-source software solutions will be performed:

- *Pentaho Community Edition*

(Hitachiviantara, 2018),

- *JasperReports Business Intelligence* (Jasper Soft, 2018),
- *Report Server Community Edition* (Report Server, 2018).

Analysis of open code software solutions will be conducted by comparative or comparative method. A comparative method is such a method that by comparing (analysis) multiple individual elements we reach the safest element. Since method for comparison can only use comparable elements, the comparison will be conducted on open code software solutions synchronously, that is, for each software solution, one virtual machine with the necessary software will be created. In accordance with consideration, if needed, a virtual machine and a tested solution will be launched. Testing on three computers was also considered here, but it would require three hardware configurations of the same characteristics, so this testing approach will not be applied here. Essentially a comparative method will be carried out with the same elements (tools) but not at the same time.

The comparison will be made on the basis of important elements:

- Performance,
- Functionality,
- Ease of use,
- Training materials, trainings and tutorials,
- Security,
- Community,
- General tool impression.

For these elements assessment can be made, and it can be qualitative or quantitative. By examining the above elements, we determine that each of the seven elements is qualitative. Each element is reviewed based on practice, importance, comparison and opinion by researchers. Ranking of elements are presented in Table 1.

Table 1. Description of each element by ranking.

Num.	Name of element	Element description	Rang
1.	Functionality	What functionality does the software have and in what relationship are relevant for further subject analysis?	1
2.	Performance	It refers to the speed of generating reports, to be available to a large number of users at a certain time, to scale well loads. Software performance and functionality during reporting. Here we monitor how the software behaves at drill down and drill up functionality.	2
3.	Security	Software and data security and limiting data availability to users with varying levels of access within the software.	3
4.	Ease of use	It tries to choose software that has an interface that is easily understood, manageable, and easy to use. How they are users who are not IT educated users and who do other kinds of jobs so that the IT is not in their focus but software that can make their job easier, accelerate, and simplify their business, are.	4
5.	Training materials, trainings and tutorials	Availability of educating materials, tutorials and training, their accessibility and currentity.	5
6.	General tool impression	A general impression of the tool.	6
7.	Community	Community development and its software-related strength, its commitment to helping each other solve problems.	7

In order to test criteria of performance, ease of use, functionality and security, and to rate certain criteria, Linux and a business intelligence tool that is connected to a database located on a separate server will be accessed on the virtual disk. The stress test will be conducted so that from the computer on which the virtual machine is located, which in this case plays the role of the client, is tested. The reason for this is a simulation of the actual condition. In this case, the virtual machine is used for the operation of the platform and the allocated resources that we have previously defined in the work. From the side of client and side of sending of requests requested resources are used, this does not burden the virtual machine's resources and client requirements, but we give it the ability to work fully and use available resources to execute requests. Reports created for testing purposes are used. To simulate multiple clients, multiple sessions are run, creating more clients who send their requests. How quickly reports are carried out and how it

gives the impression of the criterium of performances and the general impression of the work of the tools and the work of its functionality. For further research purposes, comparisons will be made of the elements - each with each. So that the intensity of importance can be assigned, according to Saaty's scale (Saaty, 2008).

Free BPMSG - *Business Performance Management Singapore* multi-criterion analysis (AHP - Analytical Hierarchy Process) software was used to analyze the criteria and we ranked them.

From the analysis, we clearly see that the order of the criteria and in order of functionality is 29% -those criteria is important from the aspect with which all possibilities the tool has. Following is performance criterion 28.8 %, security 14.2%, ease of use with 8.7%, educating materials, training and tutorials 7.4%, General Impression 6.7% and Community with 5.2%.

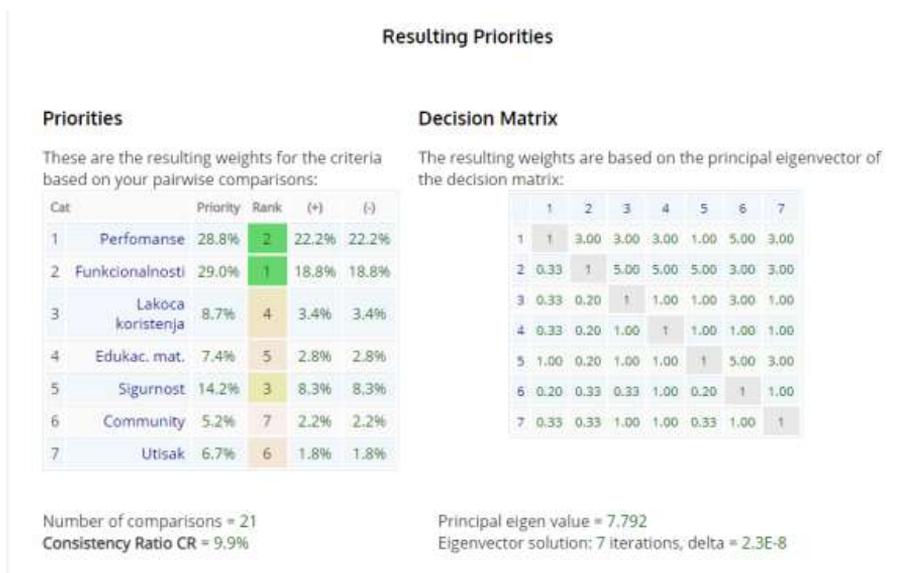


Figure 2. Overview after comparing criteria and decision matrix

Workstation Description

The following personal computer of following characteristics is used for testing: Intel (R) Core (TM) i3-2120 CPU @ 3.30 GHz, with RAM of 8.00 GB and 64-bit operating system. The operating system is Windows 7 Enterprise, Service Pack 1. Because of the same approach to analysis, tools will be installed on *Oracle VirtualBox* (Oracle, 2018). A separate disk is created for each virtual machine.

Reasons for using virtual box, virtual machine, VHD

In this research, the reasons for testing on a virtuoso machine are as follows:

- The ability to scale the given limitations of physical hardware,
- The independence of the virtual machine from the computer on which it is located,
- Possibility of testing and making different changes for the purpose of checking the value and manner of system behavior. If the results are acceptable, the changes can be accepted otherwise they can be discarded,

- Mobility, refers to the ability to copy and transfer VHD to another computer and use it,
- The possibility of cloning refers to a installed system that does not have to be reinstalled each time but can simply be cloned.

Most important virtual machine settings

Hard disc 20 GB, type VHD (*Virtual Hard Disk*), which has its own space on a fixed-sized physical hard drive. This type of hard drive is selected because the virtual machine already has space reserved on the physical hard drive, and all processes on it run faster the compared to the types of hard drives that are dynamically assored (Dynamically allocated). This may be a technical requirement that must be calculated because virtual machines must be located on the C disk, so it must be careful that there is enough space on the C disk and that it will not compromise your computer's operation and cause a crash. The virtual machine was adbroumed with a Ram 3.6 GB. Every virtual machine is installed: 64 bite *Linux Ubuntu Server* and *Java*.

In addition to common software on each virtual machine, a business intelligence software tool is installed.

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Results analyses

In Figure 3 presented what it looks like when all VMs are installed:

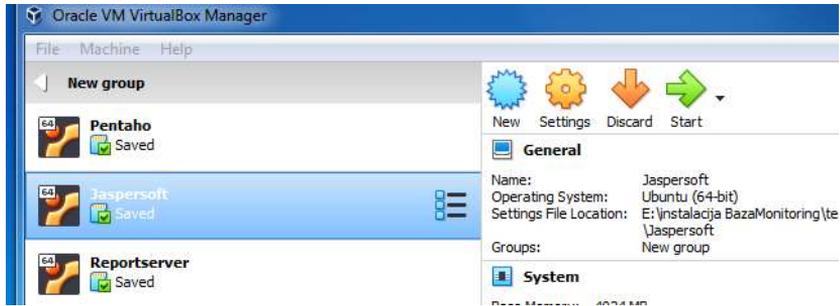


Figure 3. The look of a virtual box with created virtual machines

During work, we can track what happens, how everything is executed, at what speed, whether there are errors, etc. In

case there's any mistakes here we are looking for what happened. The Figure 4 below shows the code line.

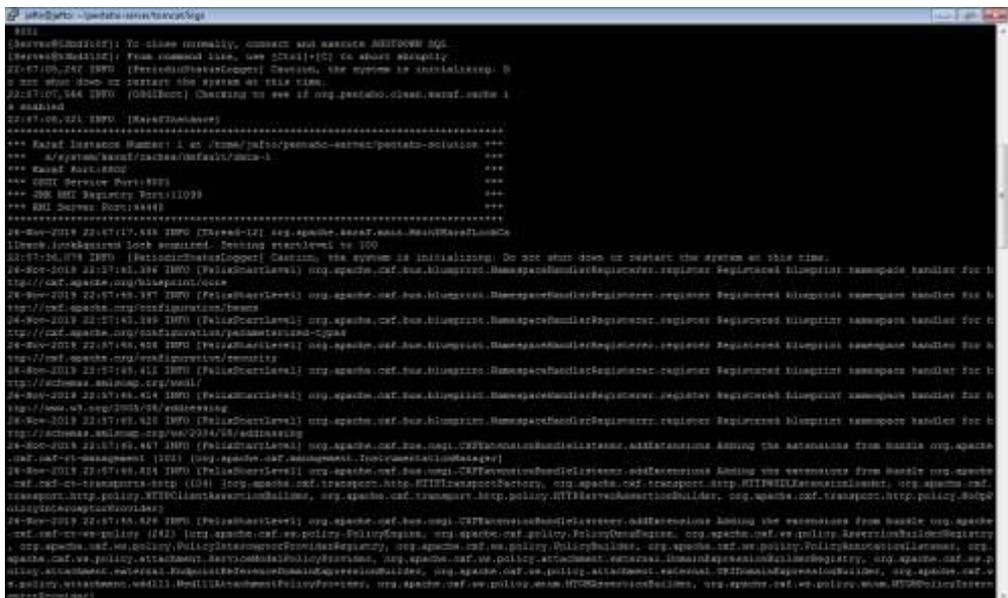


Figure 4. Appearance of code line

Yes, we can say that the picture is nothing special, but to make it easier to work and navigation where the text is framed by the star, the program begins, and if you have an error or problem, look where

the code line is interrupted. After analyses and consultations which are conducted, values are included in the tool and the obtained results are presented in Figure 5 and Figure 6.

A - wrt Odabir alata - or B?		Equal	How much more?							
1	<input checked="" type="radio"/> Pentaho <input type="radio"/> Jasper Reports	<input type="radio"/> 1	<input type="radio"/> 2	<input checked="" type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7	<input type="radio"/> 8	<input type="radio"/> 9
2	<input checked="" type="radio"/> Pentaho <input type="radio"/> Report Server	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input checked="" type="radio"/> 6	<input type="radio"/> 7	<input type="radio"/> 8	<input type="radio"/> 9
3	<input checked="" type="radio"/> Jasper Reports <input type="radio"/> Report Server	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input checked="" type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7	<input type="radio"/> 8	<input type="radio"/> 9

CR = 9.8% OK

Resulting Priorities

Cat	Priority	Rank
1 Pentaho	63.5%	1
2 Jasper Reports	28.7%	2
3 Report Server	7.8%	3

Figure 5. Value entry and result

Project Structure

Hierarchy with Alternatives						
No	Node	Criterion	Glb Prio.	Compare	Alt-1	Alt-2
1.	Odabir alata	Pentaho	63.5%	AHP	0.500	0.500
2.		Jasper Reports	28.7%	AHP	0.500	0.500
3.		Report Server	7.8%	AHP	0.500	0.500
Total weight of alternatives:					0.5	0.5

Figure 6. Results Analysis

The analysis was conducted through the Multicriteria Analysis (AHP-Analytical Hierarchy Process). The analysis is conducted based on knowledge, experience and research objectivity. The tools are compared to each one. The analyses come from research, creation and installation of

virtual machines, analyzing available documentation in the form of videos or tutorials of each tool, and conducted consultations. Separately, each criterion was considered and reviewed separately for each of the tools, and a comparison was

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conducted with each of the tools. The results are presented here.

CONCLUSION

The development of tools for business intelligence gets its new dimension every day and this is an area that has dynamic development. The development of hardware and software was not uniform - the development of hardware progressed by geometric progression (according to Moore's law), and software hardly by arithmetic (Vujović, Džino, & Radivojević, 2019). Those who are well acquainted with the situation in public administration can notice that even now large funds are spent on hardware, which is often not used even close to its capabilities. We sincerely hope that open-source tools will introduce advances towards the possibilities of commercial tools, especially towards data research, visualization and interactive control plates. Each product has its own qualities, and when we look at individually certain aspects of each tool can be challenging, leaving room for improvement. In essence, any advantage or weakness of the tools poses a challenge to their development for both those who support the development of tools and for competition. The significance of this work is choosing a tool that is the best solution for a given need. The selection of Pentaho Community Edition presents a challenge that will show all its quality in the coming works. Pentaho Community Edition has been selected as a solution that fully matches the superior requirements. For interoperability purposes, these results can be used in public administration in BiH, which increases the importance of the research.

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