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COMPETITION ANALYSIS ON THE OPERATING SYSTEM MARKET USING PRINCIPAL COMPONENT ANALYSIS

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Abstract: *Operating system market has evolved greatly. The largest software producer in the world, Microsoft, dominates the operating systems segment. With three operating systems: Windows XP, Windows Vista and Windows 7 the company held a market share of 87.54% in January 2011. Over time, open source operating systems have begun to penetrate the market very strongly affecting other manufacturers. Companies such as Apple Inc. and Google Inc. penetrated the operating system market. This paper aims to compare the best-selling operating systems on the market in terms of defining characteristics. To this purpose the principal components analysis method was used.*

Key words: *software, operating system, correlation, component analysis.*

1. Introduction

In 2010, the software and IT market was around 700 million Euros and this year it could climb to around 780 million Euros, according to data presented by the research firm Pierre Audoin Consultants (PAC). Even if the demand for software products has declined, it is expected to register growth in the second half of 2011.

In terms of operating systems segment, the new challenge for the big producing companies are the organizations that offer their clients open source software such as operating systems: Linux, Solaris or Android.

Thus, the client has two options: to buy closed operating systems, such as those offered by Microsoft, or to use open source operating systems free of charge.

Big producers like Microsoft and Apple have begun to face more this increasingly competitiveness of the open source products.

Increasingly more, because free and easily accessible operating systems, web servers or database systems manangement, manufacturers are forced to offer their software for free, and this affects their financial results, but most powerful, non-recovery resources used for innovation and launch of new products.

2. History of software

During Alan was the one who first proposed a theory of software related to his work in 1935, Computable numbers with application to the Entscheidungsproblem.

The term software is used to describe a software application. Specialists in IT and software define the term as all the

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information processed by computer systems, programs and data. [1]

Software history dates back to 1946 with the appearance of the first software bug, software industry developing more and more because of its automatic networking hardware industry. A large number of applications and programs began to multiply while the computers were becoming smaller and smaller - the first computer was built in 1948 and weighed a ton. Software systems have become cheaper, more efficient, faster, and, due to the development of marketing strategies in this area, more accessible. [1]

Software industry, like other industries, such as cars or electronic, from the beginning was based on innovation, ideas put into practice in the garage "of some visionaries such as Steve Jobs and Bill Gates (co-founders of Microsoft Corporation) led to rapid development of computer and software industry.

3. The operating system market

While the hardware of any given computer system does the actual work, it is just so much useless junk without an operating system to coordinate it and run applications. The operating system must continue to evolve at frantic pace in order to service humanity's never-ending thirst for machines, gadgets and entertainment.

The most important part of a computer is its operating system. [8]

Today's the facto definition of an operating system generally includes everything that is available when a computer is turned on, including all applications such as word processors, games and web browsers. In fact, the operating system itself is only the part of the machine that manages system resources such as memory and disk drives. The applications that an operator uses are just that – applications. They are not part of the operating system proper. [8]

Commercial operating systems vendors such as Microsoft or Apple recognize that today's typical computer user neither needs to know about the kernel nor would they care if they did know. People don't run computers for the sake of running computers. They run it to do something and these something can only be done by applications that sit on top of the operating systems. [8]

By far, the most prevalent operating system is the product of Microsoft. The history of MS-DOS is the history of Microsoft. It first appeared on IBM's personal computer in the early 1980s. IBM"s decision to buy an operating system instead of write one was unprecedented. In fact, much of that first PC was made from purchased, commercial products, rather than designed in-house. [6]

Today, Microsoft and the Windows family of operating systems began to lose ground. Windows XP and Vista continued to fade in January 2011, with XP now well below 60 per cent share, while Windows 7 continues to grow share. Apple's OS 10.6 Snow Leopard at 16 months since its release in August, 2009, is by far the most prolific Mac OS version, with more than eight times OS 10.4 Tiger's receding user share (3.33 % per cent share).

iOS (iPod, iPad, and iPod versions collectively) continued its impressive market share ascendency, for a solid second place in the Apple OS spectrum for the second consecutive month.

However, the iOS's 2.06 percent global share is vastly exceeded in some countries, notably Singapore (9.98 percent), Australia (5.6 percent), the U.K. (5.1 percent), and the U.S. (3.4 percent). Linux remains stalled at less than one percent market penetration. [6]

4. Principal components analysis

Given the global market for operating systems, we extract the first seven operating systems on the market. Each operating system is characterized by means of seven variables: the average price of the operating system, the market share held by the operating systems, the functions embedded in the operating system, whether or not the operating systems are open source, the number of distribution channels in Romania for each operating system, existence on the market (number of months) of the operating system, number of editions for each operating system.

Thus, to achieve the principal components analysis, we compared the main operating systems on the market in terms of economic and technical factors.

To reduce the complexity of comparing these competing operating systems, we used principal components analysis in order to find two main components (factors) independent, to synthesize the bulk of the total information being expressed by the seven variables in correlation ratios. For the 7 operating systems considered, the data are as follows:

Operating systems features Table 1

Operating system	Average price ($)	Market share	Features	Open source	Distribution channels	Months on the market	Versions
Windows XP	591.99	41.70%	63	NO	6	114	8
Windows Vista	554.34	15.43%	42	NO	6	51	6
Windows 7	650.19	25.42%	62	NO	6	24	6
MAC OS	499.00	8.97%	54	NO	5	305	7
Linux	0	1.64%	62	YES	3	209	13
Solaris	0	0.35%	49	YES	2	242	17
Android	0	0.57%	51	YES	2	28	7

5. The results

Based on the above data, through the SPSS program were obtained the following results (see Table 2). The next table indicates the levels of correlation between variables taken into account, a strong correlation between average price and market share, between average price and distribution channels. An average correlation between functionality and market share, between the time on the market and the number of versions of each operating system. There is also strong but opposite correlations between: the average price and type of sources, the number of channels of distribution and the type of source. Also inverse correlations exists between the average price of the operating systems and the number of versions of the operating systems, the number of versions of the operating systems and the number of Channels of distribution. The main diagonal is the correlation coefficient of a variable with itself. The set of results in Table 3 shows the eigenvalues of each component and the variations explained by using the Varimax method.

Denomination of the table Table 2

	Average _price	Market share	Features	Open source	Distribution channels	Versions	Months on the_market
Average price	1,000	,811	,150	-,989	,977	-,705	-,263
Market share	,811	1,000	,452	-,759	,817	-,477	-,356
Features	,150	,452	1,000	-,084	,183	,001	,053
Open source	-,989	-,759	-,084	1,000	-,966	,707	,171
Distribution channels	,977	,817	,183	-,966	1,000	-,675	-,268
Versions	-,705	-,477	,001	,707	-,675	1,000	,568
Months on the market	-,263	-,356	,053	,171	-,268	,568	1,000

Total Variance Explained Table 3

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4,377	62,528	62,528	4,377	62,528	62,528	4,322	61,736	61,736
2	1,234	17,625	80,153	1,234	17,625	80,153	1,289	18,417	80,153
3	,931	13,302	93,455						
4	,353	5,048	98,503						
5	,082	1,175	99,678						
6	,023	,322	100,000						
7	0,000	0,000	100,000						

Extraction Method: Principal Component Analysis.

The table shows the eigenvalues of each component, the contribution of each factor and the contribution of the first two factors to the explanation of the total variance. In the table of the explained variance there are two components eigenvalues greater than one, which will lead to consideration of these two components.

The first part will explain about 62.528% of the total variation of the indicators, and the second component explains another 17.625%, leading to a cumulative variance explained, at a rate of approximately 80.153%. Of course, the next two components are explaining in proportions of 1.175% and 13.302%% the total variation of the indicators. All four components will lead to a total explanation of the total variance of the indicators in the rate of 99.678%. We can thus see that in the case of the seven competing operating systems on the market, the first two factors express the 80.153% of the total variance. It follows that the first two factors can be used to synthetic represent the characteristics of the operating systems taken in to account. Next we analyze the situation of total variance of indicators explained by they first two components in a ratio of 80.153%.

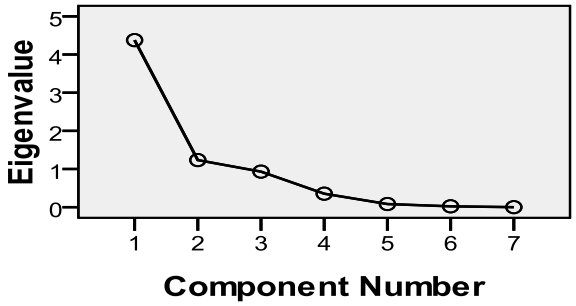

Fig. 1. *Screen Plot*

The first chart of the eigenvalues highlights the first eigenvalue as the largest one (4.377) and the second with a value over 1 (1.234), causing retention of the first two components.

The determination of components is based on the variables most correlated with them. (see Table 4).

Thus, the first component brings together the effects of characteristics like: average price (0.973), number of main channels of distribution (0.966) and marke share (0.867). The first component could be defined as "*Accessibility of the operating systems*."

The second component includes characteristics like: the number of features included in the operating system (0.412) and the time of existence of the operating system on the market (0.587). The second component can be defined as "*Technical performance of the operating systems*."

Component Matrix[a] Table 1

Component	
1	2
,973	,042
,867	,291
,228	,792
-,948	-,029
,966	,072
-,787	,412
-,420	,587

Extraction Method: Principal Component Analysis.
a. 2 components extracted.

These two components, which combine the features of the seven operating systems analyzed, describe, in a simplified manner, the differences between the systems.

Through these components we can determinate which systems best meet user preferences and which systems show the best results regarding not only the technical characteristics but also the economic ones.

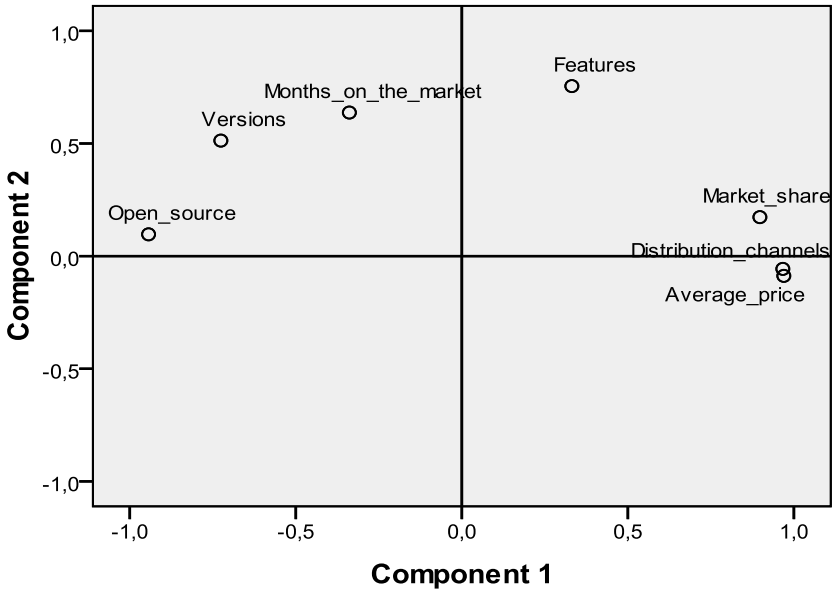

Fig. 2. *Component plot of factors 1 and 2*

It can be seen that the first factor is very close to the average price, the number of distribution channels and the market share. In contrast, factor 2 is very close to the number of features, the existing time of the operating systems on the market and the number of versions of the operating systems. The chart above also shows that at the formation of the axis the next variables: the average price, the number of distribution channels and the number of features have the largest contribution.

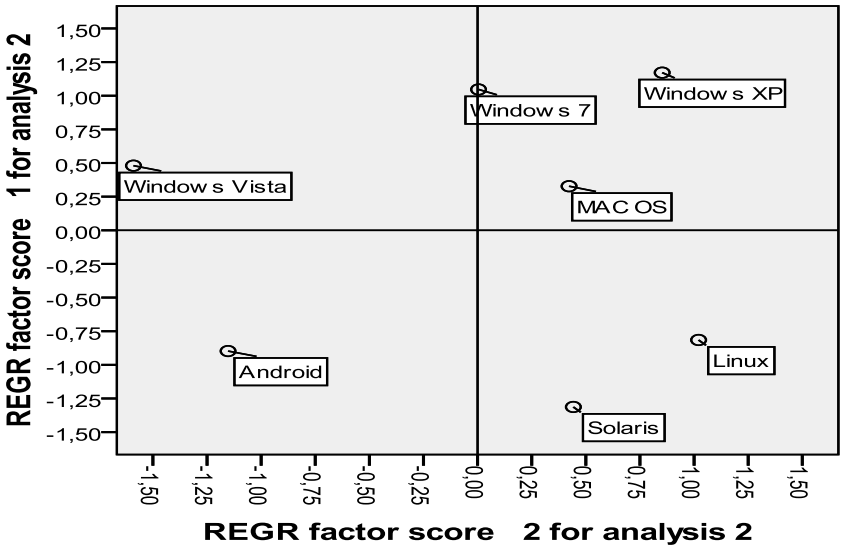

Fig. 3. *Representation of the variabiles in the plan of the two factors*

The interpretation of the above chart rises to an image of the position of the operation systems according to the two components identified by the analyzed variables .

According to the position of the operating systems , stands a group of two operating systems, as shown on the chart. If the chart of individuals would overlap with the circle correlation chart, you get a graphical biplot, which shows the position of operating systems from the components characterized by the variables plotted.

A potential buyer of an operating system will be able to choose one of seven operating systems based on its preference for what defines a combination of factor 1 and factor 2. If the buyer wants an operating system with the best performance in terms of average price, number of main channels of distribution and market share, he can opt for Windows Vista operating system.

But if he wants an operating system with the best performance in terms of existence on the market and the number of editions, he can opt for the Solaris operating system.

In contrast, if the client wants an operating system that simultaneously satisfies the requirements for market share, number of distribution channels, the average price, time existence on the market and the number of editions, will have the option of Windows XP or Linux.

After analyzing the main components we can consolidate in a large proportion the seven economic and technical factors in two main components which represent the performance of the operating systems and the market position.

This analysis helps to delimit competing systems, helps to achieve a classification and measurement of economic and technical characteristics of the main operating systems on the market. In the tests made, it is showed that the operating system which best meets the functions regarding the performance and market positions is the operating system Windows XP, followed by the MAC OS, Windows 7 and Linux.

Worst operating system when it comes to performance and market positioning is the operating system Android.

Regarding the intermediate places, return to operating systems that do not meet concomitant the characteristics regarding accessibility and technical performance, Windows Vista (which in turn meets the accessibility characteristics very well) and Solaris operating system (which meets only the technical performance characteristics).

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