Maturity Assessment in Public Institutions Using Management and Monitoring Network Free Software

Avaliação da Maturidade em Instituições Públicas Utilizando Software Gratuito de Gestão e Monitorização de Redes

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ABSTRACT
In this case study, the ABNT ISO/IEC 14598-6 tool was used to measure the quality of the ZABBIX software applied in the IT area, of a federal research and teaching institute, regarding the network asset management and monitoring system, based on free software. This system was adopted due to the great relevance of modern network monitoring. This ISO tool, based on the international software quality measurement standards, was applied to verify the user's perception of the ZABBIX system, obtaining as a result of the evaluation an approval in all software attributes evaluated. The implementation of the solution brought real gains in quality, management, security, performance and savings in institutional resources.

Keywords: ABNT, Zabbix, Software Quality, Monitoring Network.

RESUMO
Neste estudo de caso, a ferramenta ABNT ISO/IEC 14598-6 foi utilizada para medir a qualidade do software ZABBIX aplicado na área das TI, de um instituto federal de investigação e ensino, relativamente ao sistema de gestão e monitorização do património da rede, baseado em software livre. Este sistema foi adoptado devido à grande relevância do moderno sistema de monitorização de redes. Esta ferramenta ISO, baseada nas normas internacionais de medição da qualidade do software, foi aplicada para verificar a percepção do utilizador sobre o sistema ZABBIX, obtendo como resultado da avaliação uma aprovação em todos os atributos de software avaliados. A implementação da solução trouxe ganhos reais em qualidade, gestão, segurança, desempenho e poupanças em recursos institucionais.

Palavras-chave: ABNT, Zabbix, Qualidade de Software, Rede de Monitorização.

1 INTRODUCTION

With the emergence, computer networks have increased exponentially and with great prominence in various segments, becoming essential for communication and information sharing. However, even with their importance, networks are a great challenge in terms of their management (LEONHARDT, 2005; DIAS, 2002).

For Franciscatto, Cristo and Berlin (2014) computer networks can be defined as two or more computers, interconnected and with the objective of performing resource sharing and information exchange. It is essential to manage computer networks in order to function correctly and with a good level of performance for its users. However, for this to occur, it is necessary to use qualified labor and specific tools to perform these management.

Thus it is evident the great evolution in the area of Information Technology (IT), most companies have computerized their processes, whether large, medium or small, public or private, these companies have their own local computer network, at various levels of complexity. Institutions need more and more quality software to meet their management and operational needs. However, one of the

biggest problems in the software market is finding quality products that meet all the company's requirements (LUZ, 2016).

The evaluation of the quality of the software product is very important to measure the quality of the system. The user evaluator of the system provides answers, from the perceptions of the software product, according to the experience obtained from the use of the system. Each significant feature of the software should be defined and evaluated, making use of consolidated and widely accepted NBR ISO/IEC 9126 tools (ISO, 2003).

Thus, the importance of evaluating the satisfaction of end users in relation to the system is observed. In this context, this work sought to deepen the knowledge in Software Quality Evaluation, especially regarding the critical factors the satisfaction of the system's end users. Thus, the central question of this research, through which it was investigated: What is the level of satisfaction of the end users of the ZABBIX software product?

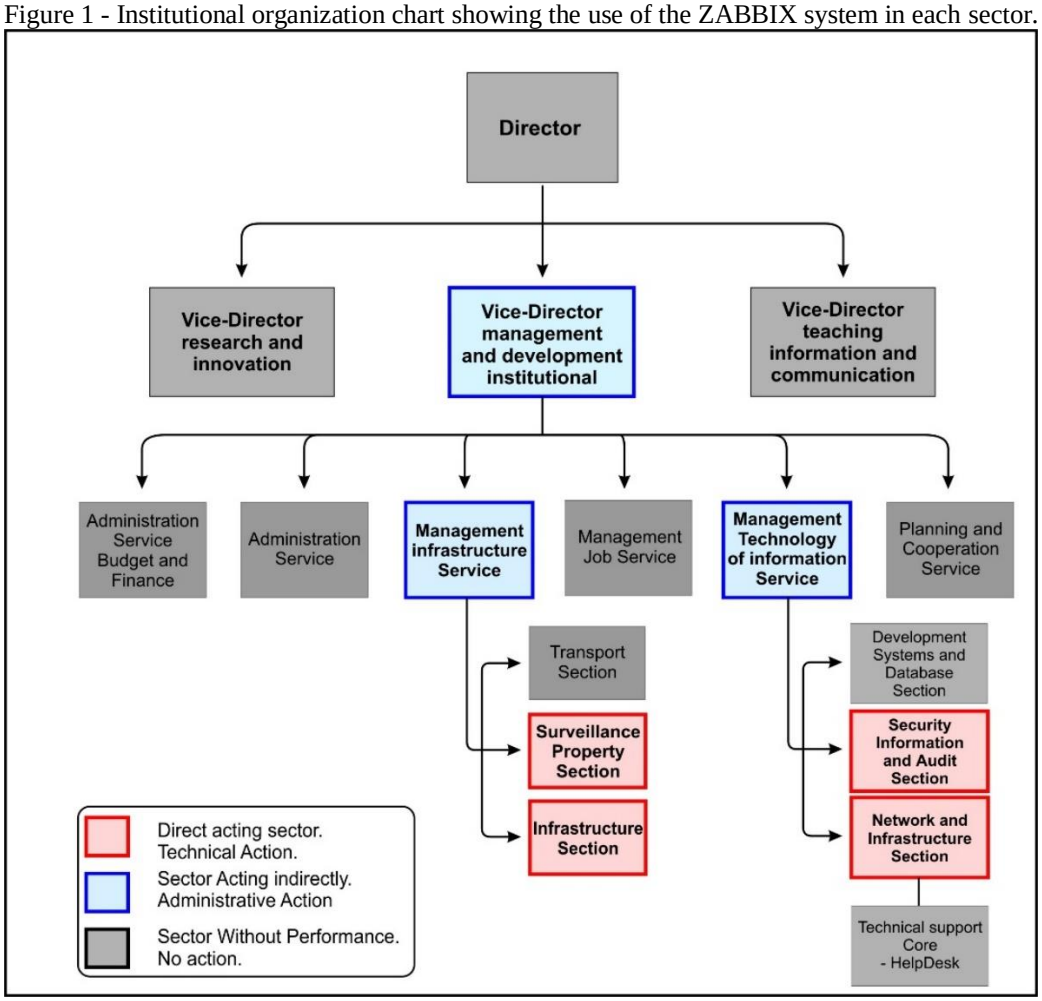
2 MATERIALS AND METHODS

2.1 STUDY AREA AND RESEARCH CHARACTERIZATION

The research was developed in order to evaluate the satisfaction of the end users of the software product ZABBIX, in relation to critical quality factors, at the Instituto Leônidas e Maria Deane (ILMD). The Institute is a technical-scientific unit of the Oswaldo Cruz Foundation in the Amazon, located in the city of Manaus. Its mission is to contribute to the improvement of the living conditions and health of the Amazonian populations and to the regional scientific and technological technical development of Brazil, integrating research, education and public health actions.

ILMD was chosen for the application of the study because it is a public organization, with approximately 250 collaborators, which presented the physical infrastructure and logic complex enough to justify the implementation of a network asset monitoring system.

Figure 1 - Institutional organization chart showing the use of the ZABBIX system in each sector.



2.2 CHOICE AND IMPLEMENTATION OF THE MONITORING SYSTEM

The ZABBIX system was the solution adopted at ILMD due to important features that differ from other network asset monitoring systems available in the market. This software can be installed in open source operating systems, it is a free system, has no use limitation and does not require acquisition of license to operate. This system was developed in PHP and C, and makes use of the MySQL database. It is also a distributed system (client - server), has extensive information and official manuals available for free on the Internet, and has several published books. Also, as it is an open source system at the business level, it is distributed under the GPLv2 license, being this system one of the most complete in resources available on the market (NELSON, 2015).

The infrastructure adopted for the ZABBIX solution was implemented in order to obtain maximum performance, the system used three independent servers. The first was a web server responsible for providing the entire interface (Frontend Server) for management, configuration and monitoring of the system. The second one is the Zabbix (Core Server) responsible for all data

processing in the system. The third server is the database server (Data Base Server), responsible for storing the data collected from the monitored environment (OLUPS, 2010).

Table 01: Comparison of Monitoring Tools.

Characteristics	ZABBIX	NAGIOS	CACTI	PRTG
Auto Discovery	yes	yes (plugin)	no	yes
SLA	yes	yes (plugin)	yes (plugin)	yes
SNMP	yes	yes (plugin)	yes	yes
Agent	yes	yes	no	yes
Scripts External	yes	yes	yes	no
Syslog	yes	yes (plugin)	no	yes
Plugins	yes	yes	yes	yes
Programming language	C and PHP	Perl	PHP	Visual Studio
Warning and triggers	yes	yes	yes	yes
Distributed Monitoring	yes	yes	yes	yes
Inventory	yes	yes (plugin)	yes (plugin)	yes
Database	Oracle, MySQL, PostgresSQL and SQLite	MySQL and MSSQL	RRDTool, MySQL and PostgreSQL	SQLite
Licensing	GLP	GLP	GLP	Commercial
Graphics / Maps	Yes/yes	yes / yes	yes / yes (plugins)	yes / yes

Source: Own Author.

2.3 CHARACTERIZATION OF THE EVALUATORS

The evaluation of the ZABBIX system encompassed two groups, the first comprising 10 infrastructure professionals, and the second comprising 15 IT professionals. A total of 25 professionals, over 18 years old, who had extensive experience with the ZABBIX system, were selected. All the evaluators met the following criteria: IT professionals: a) have at least the title of IT specialist; b) have at least one year experience in IT management, system support or developer; c) have knowledge of the infrastructure of servers and switches. Infrastructure Professionals: a) have at least one year experience with the ZABBIX system; b) have extensive experience of local electrical cabling, data and building hydraulic infrastructure; c) do the system utilization training and incident response procedures.

2.4 DATA COLLECTION

In the data collection phase, ABNT NBR ISO/IEC 9126 (2003) and NBR ISO/IEC 14598-6 (2004) standards were used to prepare the questionnaire for this survey. The works of (OLIVEIRA, 2015; JUNIOR, 2016; DA SILVA, 2016), which dealt with methods and techniques for evaluating

software quality and used the Likert scale, also served as a basis for the preparation of this questionnaire.

In this questionnaire the Likert scale of 5 points or levels of response was adopted, this type of scale is widely used in academic work. From this scale collaborators select the degree of agreement in each statement in the questionnaire (JUNIOR, 2014).

The data were collected through this questionnaire, which has 54 structured questions that made it possible to achieve the proposed objectives. MARCONI and LAKATOS (2017, p. 94) conceptualize the questionnaire as a "data collection tool consisting of an ordered series of questions, which must be answered in writing and without the presence of the interviewer". The questions were included in the Google forms, and the link to the questionnaire was sent by e-mail to the professionals who submitted the survey.

2.5 DATA ANALYSIS

The answers to the questionnaires were analyzed in a descriptive manner in order to achieve the proposed objectives, establishing averages and frequency of occurrence, so as to characterize the profile of the system's professional evaluators and evaluate the satisfaction of the end users of the ZABBIX software product, in relation to critical quality factors. These data were compiled in a spreadsheet and organized into categories: gender, age group, education degree (undergraduate, specialization, master's or doctorate) and company in which the person works.

The objective is to determine the level of satisfaction of the software evaluator. The scoring scale based on NBR ISO/IEC 14598-1 (2001) was used. This standard presents a scale that can assume different levels of scores, such as: unacceptable any score below 70%, the minimum acceptable range goes from 79% to 70%, the target range 80% to 95% and what exceeds the requirements is above 95%. We adopted the value taken as the approval parameter above 70% positive responses (OLIVEIRA, 2018; PEREIRA, 2012; JENSEN, 2012). The calculation of the maximum scores of each measured attribute is made by using the sum of the points of each evaluator multiplied for the total of questions. Each attribute has a variable total of questions, so they have different maximum scores presented in Eq. (3.1).

After calculating the total of points, this information is used to obtain the percentage of approval of each attribute, by evaluation group: Percentage of Approval Infrastructure Eq. (3.2); Percentage of Approval Technology Eq. (3.3). Observe the assumed score in each answer (CT = 1; CP = 0.75; NCD = 0.5; DP = 0.25 and DT = 0).

$$PAI = \frac{100 * (CT * 1 + CP * 0.75 + NCO * 0.5 + DP * 0.25 + DT * 0)}{10} \quad (3.1)$$

Being:

PAI = Percentual de Aprovação de Infraestrura; (Percentage of Infrastructure Approval)

CT = Concorda Totalmente; (Fully Agree)

CP = Concorda Parcialmente; (Partially Agree)

NCO = Não Concorda nem Discorda; (Neither Agree nor Disagree)

DP = Discorda Parcialmente; (Partially Disagree)

DT = Discorda Totalmente. (Fully Disagree)

$$PAF = \frac{100 * (CT * 1 + CP * 0.75 + NCO * 0.5 + DP * 0.25 + DT * 0)}{15} \quad (3.2)$$

Being:

PAF = Percentual de Aprovação de Tecnologia de Informação (Percentage of Information Technology Approval);

CT = Concorda Totalmente; (Fully Agree)

CP = Concorda Parcialmente; (Partially Agree)

NCO = Não Concorda nem Discorda; (Neither Agree nor Disagree)

DP = Discorda Parcialmente; (Partially Disagree)

DT = Discorda Totalmente. (Fully Disagree)

The final percentage of approval Eq. (3.3) summing the two groups is obtained by using an average formula. That is, the two values are added together and divided by 2.

$$PFA = \frac{(PAI + PAT)}{2} \quad (3.3)$$

Being:

PFA = Percentual Final de Aprovação; (Final Approval Percentage)

PAI = Percentual de Aprovação de Infraestrutura; (Percentage of Infrastructure Approval)

PAT = Percentual de Aprovação de Tecnologia de Informação; (Percentage of Information Technology Approval)

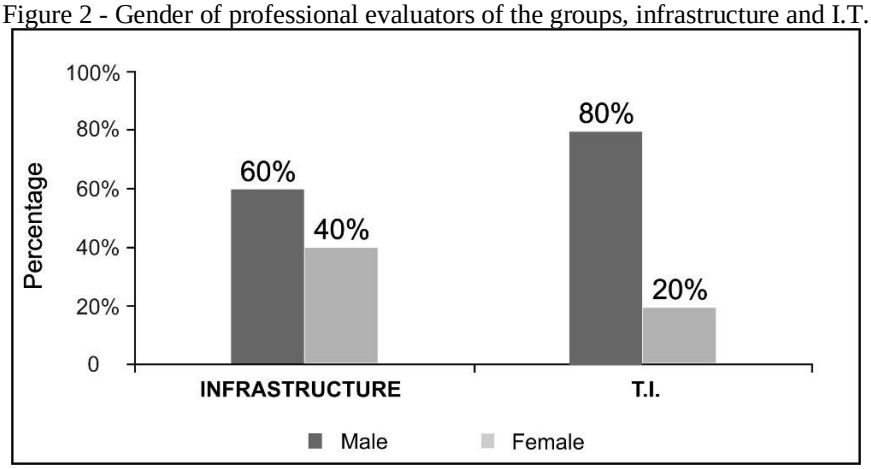
The procedure for calculating the final percentage for each of the 8 attributes follows the same procedure, paying attention to the total of questions that varies according to the atribute.

3 RESULTS AND DISCUSSION

3.1 PROFILE OF RESEARCH PROFESSIONALS

From the universe of professional evaluators of the Leônidas and Maria Deane Institute, which corresponds to two groups, infrastructure and I.T. Of the total professionals interviewed, 10 are evaluating professionals from the infrastructure group, 60% are male and 40% are female. For the evaluators of the I.T. group, which correspond to 15 evaluators, 80% of these are male and 20% are female (Figure 2).

Figure 2 - Gender of professional evaluators of the groups, infrastructure and I.T.



Among the professionals who evaluated the system, 31% are between 50 and 59 years old, highlighting that this age group was the one with the most participation. Other participants of the research are between 40 and 49 years old (29%), and 23% of these are in the 30 to 39 years old age group, other 15% of the evaluators are between 20 and 29 years old and only 2% of the evaluators 60 years old or more (Figure 3).

Figure 3 - Age range of professional evaluators of groups, infrastructure and I.T.

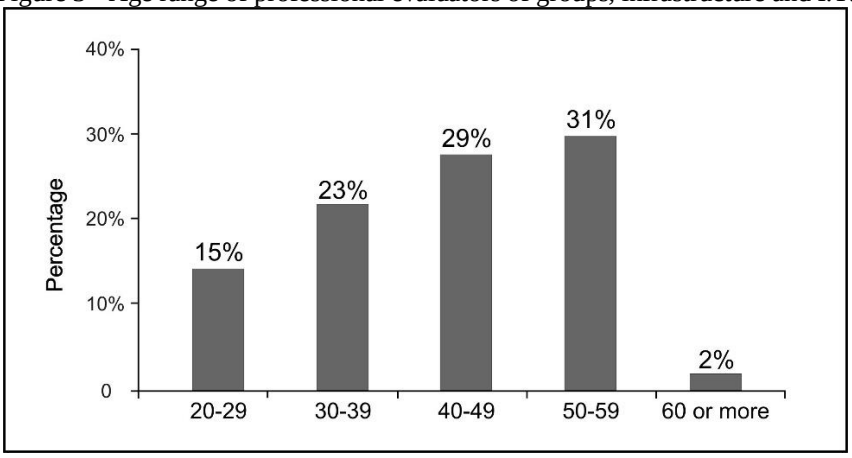
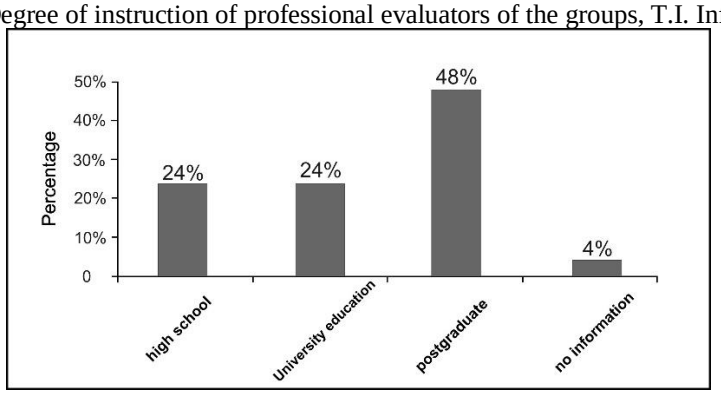


Figure 4 - Degree of instruction of professional evaluators of the groups, T.I. Infrastructure.



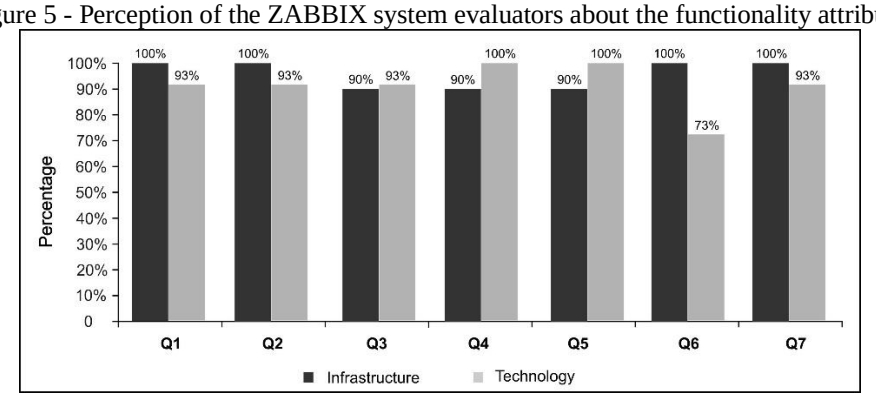
Of the total of interviewed professionals, 48% of the evaluators have some course in graduate level, and another 24% have higher education and /or complete high school, respectively, while another 4% have not inform the degree of schooling (Figure 4).

3.2 ZABBIX SYSTEM EVALUATION PROCESS

3.2.1 Functionality Attributes

Although the system was approved, these values were different, and for the Infrastructure group the highest values were 100% and the lowest 90% (items 3.4 and 5, Figure 5). For T.I. evaluators . two questions were evaluated with 100%, item 4 and 5 and 93% (1,2,3 and 7) and item 6 with 73% as the lowest indication value.

Figure 5 - Perception of the ZABBIX system evaluators about the functionality attribute.

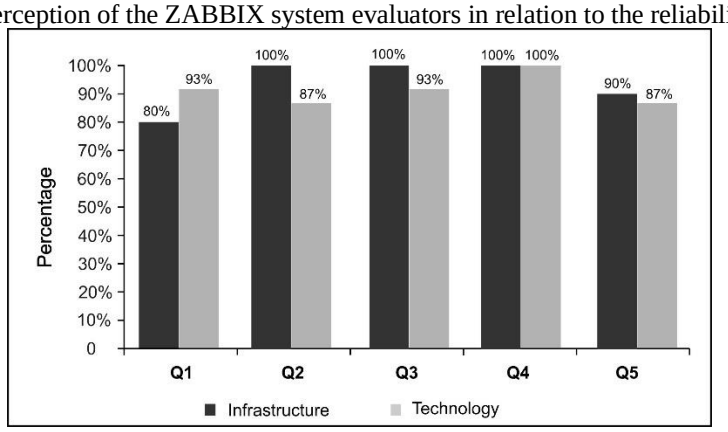


Q1 = ZABBIX serves the network infrastructure monitoring function; Q2 = ZABBIX has all the necessary functionalities for network monitoring; Q3 = ZABBIX functionalities are adequate and precise in its execution; Q4 = ZABBIX is accurate in the notifications sent; Q5 = ZABBIX has efficient triggers (trigger and sensors); Q6 = ZABBIX is accurate in the results obtained in monitoring; Q7 = ZABBIX makes monitoring work easier or faster.

3.2.2 Reliability attributes

For the reliability attribute, the approval values were different, for the Infrastructure group the maximum were 100%, the minimum values were 80% (Figure 6). For the I.T. evaluators one question was evaluated with 100% (item 4), two questions assumed values of 93% (1 and 3) and items 2 and 5 indicated value of 87%.

Figure 6 - Perception of the ZABBIX system evaluators in relation to the reliability attribute.

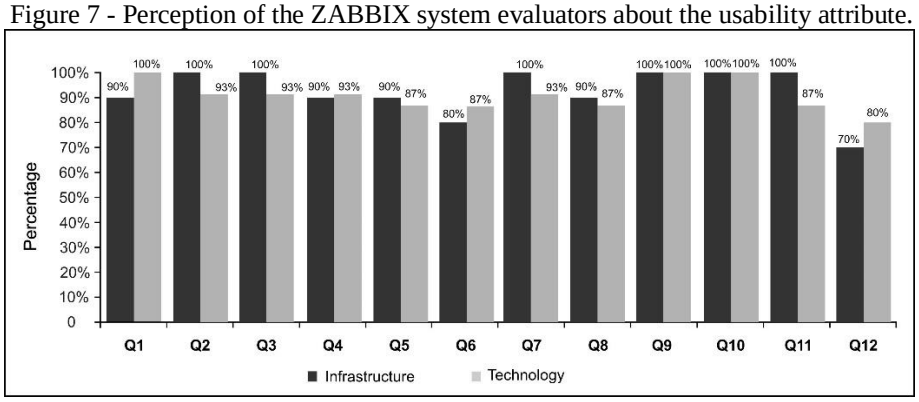


Q1 = ZABBIX does not fail frequently; Q2 = ZABBIX continues to work normally after failures have occurred; Q3 = ZABBIX is able to recover data affected by failures; Q4 = ZABBIX is not often slow or underperforming; Q5 = ZABBIX is accessible for using when needed.

3.2.3 Usability Attributes

In Figure 7, the following values were obtained for the Infrastructure group the values were 100% for items 2, 3, 7,9,10 and 11 and in item 12 obtained approval limit of 70%. For the evaluators of the I.T. it was observed with point of maximum 100%, and point of minimum 80%.

Figure 7 - Perception of the ZABBIX system evaluators about the usability attribute.

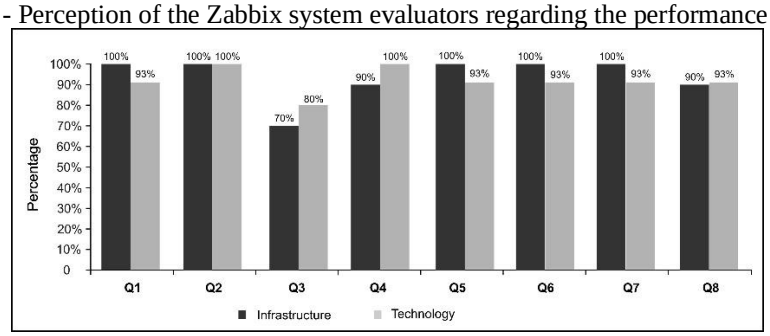


Q1 = ZABBIX is user friendly, it is intuitive; Q2 = ZABBIX has help module; Q3 = ZABBIX meets users' needs; Q4 = ZABBIX is suitable to meet network monitoring needs; Q5 = ZABBIX available functions are easy to perform; Q6 = ZABBIX system is easy to learn; Q7 = ZABBIX is easy for the system user to enter data; Q8 = ZABBIX is easy to work with, handle, operate and control; Q9 = ZABBIX has attributes that facilitate network monitoring; Q10 = ZABBIX has attributes that facilitate system notifications; Q11 = ZABBIX interface is nice and well organized; Q12 = ZABBIX interface facilitates system use.

3.2.4 Performance Attributes

Regarding the percentage of approval for the performance attribute, the values obtained for the Infrastructure group are the maximum values of 100% and 70% for item 3 (Figure 8). For the evaluators of the I.T. two questions were evaluated with 100% (item 2 and 4), five questions assumed values of 93% (1, 5, 6, 7 and 8) and item 3 indicated the value of 80%.

Figure 8 - Perception of the Zabbix system evaluators regarding the performance attribute.

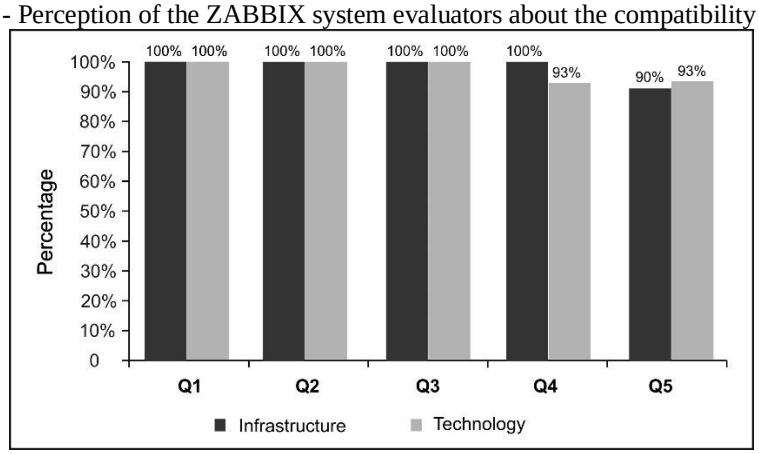


Q1 = ZABBIX is efficient in what it proposes; Q2 = The resources used by the ZABBIX system are appropriate; Q3 = ZABBIX is slow or crashed; Q4 = The response time to ZABBIX system commands is acceptable; Q5 = ZABBIX database has good performance; Q6 = ZABBIX database has good storage capacity; Q7 = ZABBIX has good navigation; Q8 = ZABBIX has a multi-user environment.

3.2.5 Compatibility Attributes

The compatibility attribute, obtained as maximum score of 100% and minimum score 90% (item 5). For I.T. evaluators. three questions were evaluated with 100%, item 1, 2 and 3 and 93% (in items 4 and 5) (Figure 9).

Figure 9 - Perception of the ZABBIX system evaluators about the compatibility attribute.

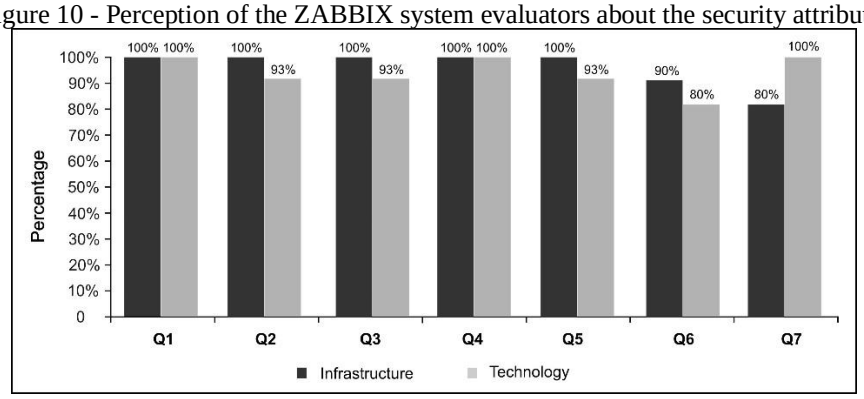


Q1 = ZABBIX can exchange data with other systems or software; Q2 = The information exchange between ZABBIX and the TELEGRAM app is satisfactory; Q3 = ZABBIX can exchange data with embedded systems, or closed systems (printers, temperature sensors, nobreak, etc); Q4 = ZABBIX allows adding modules or plug-ins, created or modified by third parties, opensource or closed code; Q5 = ZABBIX allows interaction of all internal modules

3.2.6 Security Attributes

For the security attribute, it was observed that for the Infrastructure group the values were 100% and a minimum value of 80% for item 7. For the I.T. evaluators three questions were evaluated with 100% (items 1, 4 and 7) and item 6 indicated a value of 80% (Figure 10).

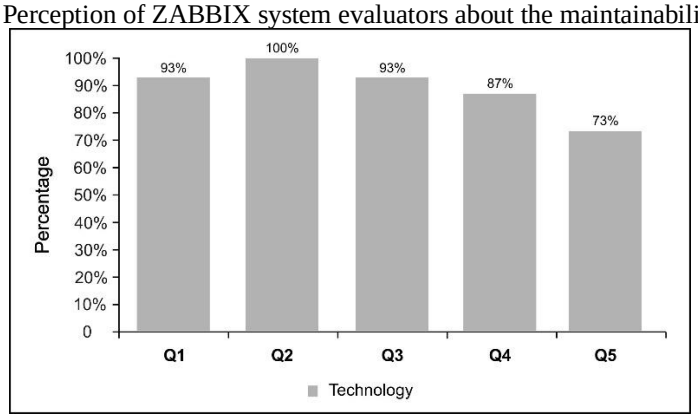
Figure 10 - Perception of the ZABBIX system evaluators about the security attribute.



Q1 = ZABBIX has HTTPS secure internet connection function; Q2 = ZABBIX has access level control functionality; Q3 = ZABBIX has strong password protected access control, which guarantees non-repudiation; Q4 = ZABBIX prevents access by unauthorized people; Q5 = ZABBIX provides information and reports whenever required, and without failures; Q6 = ZABBIX has a backup function; Q7 = ZABBIX has auditing with access data (who, when and what was done).

3.2.7 Maintenance Attributes

Figure 11 - Perception of ZABBIX system evaluators about the maintainability attribute.



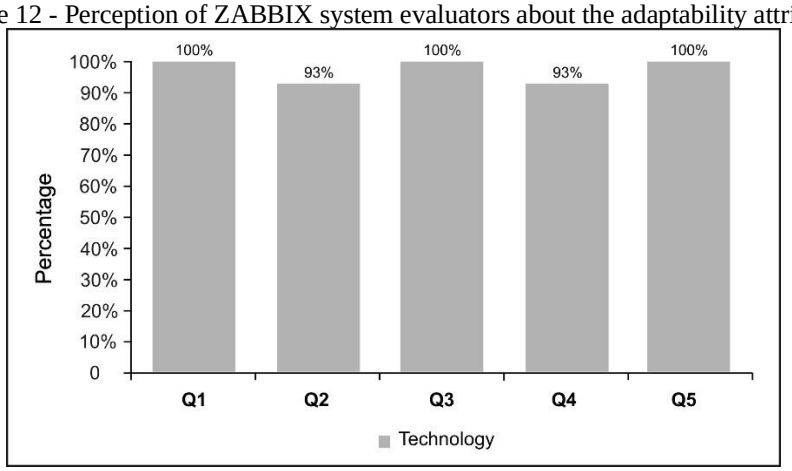
Q1 = ZABBIX presents update and new versions; Q2 = System update/migration is facilitated in ZABBIX; Q3 = ZABBIX presents plugins with new functionality and features; Q4 = It is possible to test when any any changes are made; Q5 = The addition or removal of a module or plugin interferes with the performance of other ZABBIX modules.

The maintenance attribute was applied exclusively to the Information Technology group, due to the strictly technical nature of the issues. Although there was system approval, these values were different, and the value of 100% was obtained for item 2, and with indications of 93% (items 1 and 3), item 4 assumed value of 87% and item 5 obtained limit approval of 73%.

3.2.8 Adaptability Attributes

The adaptability attribute has been applied to the IT group only, due to the strictly technical nature of the issues. The system was approved and the value of 100% was obtained for items 1, 3 and 4 and with 93% indications (items 2 and 4, Figure 12).

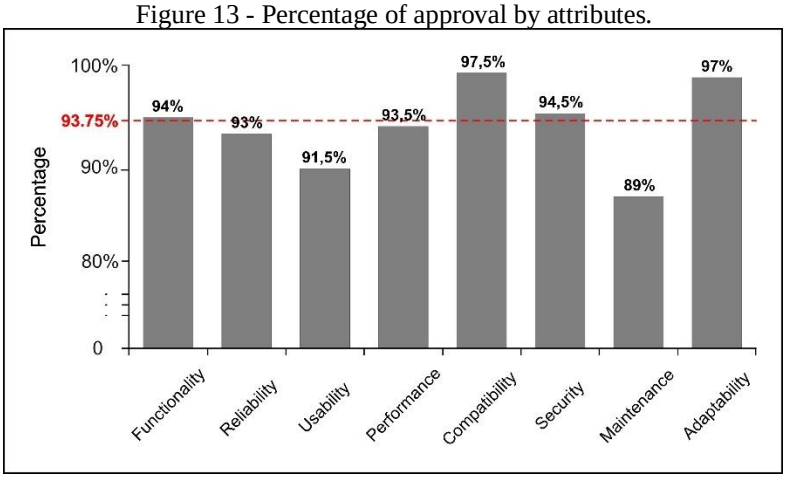
Figure 12 - Perception of ZABBIX system evaluators about the adaptability attribute.



Q1 = ZABBIX can be installed on the main operating systems on the market; Q2 = ZABBIX can be integrated on the main web servers; Q3 = ZABBIX can use the main databases on the market; Q4 = ZABBIX offers several ways to send a notification; Q5 ZABBIX offers several ways to configure a device.

3.2.9 ABNT ISO/IEC 14598 Assessment Summation

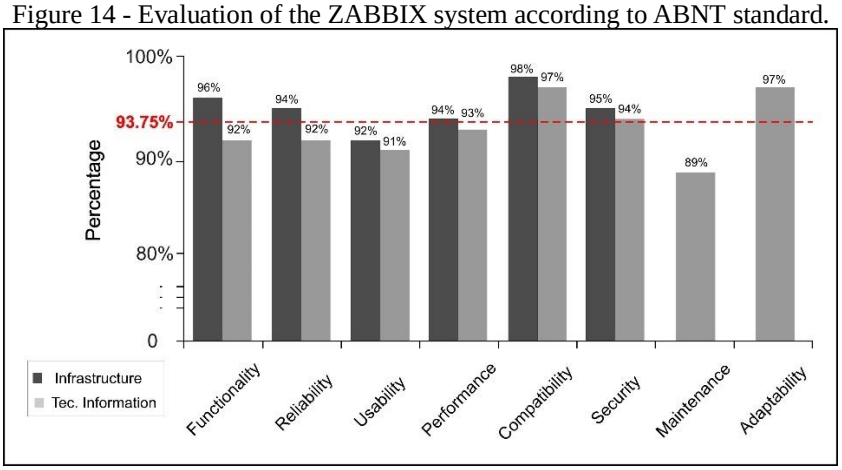
Figure 13 - Percentage of approval by attributes.



Regarding the percentage of approval by attributes in this survey, it can be verified that the maintainability attribute obtained the lowest percentage of approval (89%), while the compatibility attribute obtained the highest percentage of approval (97.5%), according to Figure 13. The average of approval obtained of the percentage of approval from all attributes was 93.75%, therefore the measured percentage was above the goal of 90% of approval, and obtained as the lowest measured value 89% of approval, well above the minimum defined by the norm of 70% and in accordance with the results of Oliveira (2018) and Pereira (2012).

Figure 14 presents the result, segregated between the two groups of system users. The infrastructure user group did not evaluate the maintainability and adaptability attributes, both are exclusive for evaluation of Information Technology teams. The IT user group presented results slightly below the infrastructure user, however the scores of both groups exceeded the minimum acceptable limit which is 70%.

Figure 14 - Evaluation of the ZABBIX system according to ABNT standard.



4 CONCLUSIONS

Nowadays, the use of virtualization systems and services, cloud computing, services on the most diverse platforms and systems integrated with mobile devices is a reality. In this context, it is necessary to manage and monitor the most diverse systems, in addition to the care of system administrators to keep several services working at full capacity, minimizing unavailability and allowing access to all who need and hold the necessary authorizations at the time you need.

Measuring the quality of monitoring systems is important to improve and optimize software on the market. International standards of quality measurement of software systems, ensures greater reliability in evaluations performed. The evaluation of the ZABBIX system was carried out with the application of the questionnaire based on ABNT ISO/IEC 14598-6, the research instrument of this work.

The ABNT NBR ISO/IEC 14598-6 evaluation takes into consideration the compatibility, maintainability, security, performance, usability, reliability and functionality attributes of ZABBIX. The minimum result to be successful according to the ABNT method is 70% approval the final result of the ZABBIX system received grades above the minimum value in all questions, therefore following ABNT the ZABBIX is approved. The final results can be seen in figure 13 and 14.

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