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RESEARCH ARTICLE

Cloud-based Metabase GIS Data Analysis Platform Quality Management According to ISO 9126 Indicators

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Abstract: Platform metabase GIS data analysis based on the cloud that has been successfully developed is an alternative solution for spatial-text data analysis. The output of this cloud-based platform not only provides accurate textual information but also precise location representation of the objects. This research examines the quality of the developed platform based on ISO 9126, which consists of six main indicators: functionality, reliability, feasibility, efficiency, maintainability, and portability. Each indicator has different sub-indicators, totaling 22 sub-indicators. The quality assessment results indicate that the platform for metabase GIS data analysis based on the cloud exhibits excellent quality, with an average test result based on the ISO 9126 indicators reaching 93 %.

Keywords: data analysis, cloud computing, ISO 9126, Metabase, quality management

1 Introduction

Data analysis plays a crucial role in various fields, including business, science, and government. It involves examining and interpreting data to uncover patterns, trends, and insights that can inform decision-making and drive improvements [1]. Traditionally, data analysis has primarily focused on textual data, such as numerical values, text documents, or structured databases [2]. However, with the increasing availability of geospatial data, there is a growing need to incorporate spatial information into the analysis process.

Geospatial data refers to information that is tied to a specific location on the Earth's surface. It can include data about land use, population density, transportation networks, and many other spatial attributes. By integrating geospatial data into the analysis, researchers and analysts can gain a deeper understanding of the relationships between different variables and their spatial distribution.

Currently, a system has been developed called Metapolije. Metapolije is a platform metabase GIS data analysis based on the cloud addresses this need by providing a comprehensive solution for analyzing both textual and geospatial data. Platform metabase GIS data analysis based on the cloud has been successfully developed as one of the solutions to problems related to data analysis. The solution addresses the need for data analysis that not only presents textual analysis results but also incorporates non-textual data analysis [3]. This cloud-based platform combines textual and geospatial data analysis, commonly referred to as spatial-textual data analysis [4]. The output of this platform combines accurate textual analysis results with precise location visualization by utilizing the library provided by metabase, a popular library for data visualization and exploration, to generate accurate and insightful visualizations of the analyzed data [5]. The platform leverages the power of cloud computing to store and process large volumes of data, ensuring scalability and efficiency. Moreover, the platform's emphasis on precise location representation ensures that the visualizations accurately reflect the spatial distribution of the analyzed objects. As a result, the output of this cloud-based platform not only provides accurate textual analysis but also precise location representation of the objects [6].

In the general software development cycle, every software that is being developed needs to be tested [7]. Testing software quality is a crucial process in ensuring the reliability and functionality of software. Various techniques are employed to assess the quality of software, ensuring that it meets the required standards and specifications [8]. One commonly used technique is functional testing, which involves testing the software against predefined functional requirements to verify its accuracy and adherence to user expectations [9]. Another technique is performance testing, which evaluates the software's ability to perform under different workloads and stress conditions [10]. This type of testing helps identify any performance bottlenecks or issues that may arise during real-world usage. Security testing is also an essential technique used to assess the software's vulnerability to potential security threats [11]. By conducting various tests, such as penetration testing and vulnerability scanning, any weaknesses or vulnerabilities in the software can be identified and addressed promptly [12]. Usability testing is another technique that focuses on evaluating the software's user-friendliness and ease of use [13]. This type of testing involves observing users as they interact with the software, collecting feedback and identifying areas that may require improvement to enhance the overall user experience. Additionally, regression testing is performed to ensure that any changes or updates to the software do not negatively impact its existing functionality [14]. This technique involves retesting previously tested functionalities to ensure that they still perform as expected after modifications have been made. A combination of various testing techniques is used to assess the quality of software. By employing functional testing, performance testing, security testing, usability testing, and regression testing, software developers can ensure that their software meets the required standards and specifications, providing a reliable and efficient solution to end-users.

There are several reasons why it is essential to utilize standardized indicators to assess the quality of software [15]. Firstly, standardized indicators provide a common language and framework for evaluating software quality, allowing for consistent and objective comparisons across different software products. This ensures that the assessment process is fair and unbiased. Secondly, using standardized indicators helps to establish a baseline for measuring software quality. By employing recognized and widely accepted indicators, organizations can benchmark their software against industry standards and best practices. This enables them to identify areas of improvement and make informed decisions regarding software development and maintenance. Moreover, standardized indicators facilitate effective communication and collaboration among stakeholders [16]. When everyone involved in the software development process is familiar with the indicators being used, it becomes easier to discuss and address quality-related issues. This promotes transparency and ensures that all parties are on the same page when it comes to evaluating and improving software quality. Furthermore, standardized indicators contribute to the overall credibility and reliability of software assessments. When organizations adhere to established standards and use recognized indicators, the results of their evaluations carry more weight and are more likely to be trusted by clients, users, and other stakeholders. This enhances the reputation of the organization and instills confidence in the quality of their software products. The use of standardized indicators is crucial for testing the quality of software due to the benefits they offer. From providing a common language and framework to facilitating benchmarking and promoting effective communication, standardized indicators play a vital role in ensuring fair, objective, and credible software assessments.

Several previous software testing have used various testing techniques with non-standardized software quality testing basis. It is crucial to acknowledge the importance of implementing standardized testing methods in software development. By utilizing standardized testing techniques, we can ensure the reliability and effectiveness of the software being developed. Moreover, standardized testing allows for better collaboration among software developers and testers, as it provides a common language and framework for evaluating the quality of the software. This, in turn, leads to more efficient and effective software development processes. It is essential for software development teams to adopt standardized testing methods in order to improve the overall quality of the software being developed. By doing so, we can minimize errors and maximize the performance and usability of the software, ultimately resulting in a more satisfactory user experience.

This newly developed cloud-based metabase GIS data analysis platform will be tested based on the ISO 9126 indicators [17]. ISO 9126 is a software quality testing standard developed by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) [18]. ISO 9126 was chosen because it is an internationally recognized standard for software quality. ISO 9126 defines quality characteristics, product quality, models, and related metrics used to evaluate and establish the quality of a software product [19]. The ISO 9126 standard consists of six main indicators: functionality, reliability, feasibility, efficiency, maintainability, and portability, each with its own sub-indicators [20]. The results of this quality test will determine the quality of the developed cloud-based metabase GIS data analysis platform.

2 Research Method

The topic of this research is the indicators used in software testing, specifically referring to ISO 9126. ISO 9126 consists of six indicators that are widely used to evaluate quality of software. The indicators defined by ISO 9126 provide a comprehensive framework for evaluating software quality.

These indicators cover various aspects of software functionality, reliability, security, usability, efficiency, and portability. By assessing software against these indicators, organizations can ensure that their software meets the required standards and delivers a high-quality user experience. Understanding and implementing these indicators is crucial for software developers, testers, and organizations to deliver reliable, secure, and user-friendly the software products. In this research, we will discuss each of these indicators in detail and explore their significance in evaluating software quality.

The first indicator, functionality, refers to the software's ability to provide functions that meet the users' needs and specified requirements [21]. It encompasses several sub-indicators, including functional suitability, accuracy, interoperability, and functional security. Functional suitability measures how well the software meets the intended purpose and functional requirements. Accuracy refers to the software's ability to produce accurate and reliable results. Interoperability assesses the software's compatibility with other systems and its ability to exchange data and information seamlessly. Functional security focuses on ensuring that the software is protected against unauthorized access and maintains the confidentiality, integrity, availability, and accountability of data.

The second indicator, reliability, pertains to the software's ability to perform its functions consistently and without errors [22]. It includes sub-characteristics such as resilience, maturity, recoverability, and fault tolerance. Resilience refers to the software's ability to withstand failures and continue functioning properly. Maturity assesses the software's stability and reliability over time. Recoverability measures the software's ability to recover from failures and restore normal operations. Fault tolerance evaluates the software's ability to continue functioning despite errors or faults.

The third indicator, security, implies the protection of the system and data from unauthorized access, damage, or loss [23]. It encompasses sub-characteristics such as confidentiality, integrity, availability, and accountability. Confidentiality ensures that sensitive information is kept private and only accessible to authorized individuals. Integrity ensures that data remains accurate, complete, and unaltered. Availability measures the software's ability to be accessible and operational when needed. Accountability ensures that actions within the software can be traced back to the responsible individuals.

The fourth indicator, usability, describes how easily the software can be used by specific users to achieve their goals with effectiveness, efficiency, and adequate satisfaction [24]. It includes sub-characteristics such as understandability, learnability, operability, and user interface. Understandability assesses how easily users can comprehend the software's functions and features. Learnability measures the ease with which users can learn to operate the software. Operability evaluates the software's user-friendliness and ease of navigation. User interface focuses on the design and presentation of the software's graphical user interface to enhance user experience.

The fifth indicator, efficiency, refers to the optimal utilization of resources in running the software [25]. It involves sub-characteristics such as time usage, memory usage, and power usage. Time usage measures the software's responsiveness and speed in performing tasks. Memory usage evaluates the software's efficiency in managing and utilizing memory resources. Power usage assesses the software's energy consumption and efficiency.

The sixth indicator, portability, indicates the ease with which the software can be moved or used in different environments [26]. It includes sub-characteristics such as adaptability, installability, and replaceability. Adaptability measures the software's ability to run on different hardware or software platforms. Installability evaluates the ease of installing the software on different systems. Replaceability assesses the ease of replacing the software with an alternative solution.

Measurement is conducted using a questionnaire form filled out by users of the cloud-based metabase GIS data analysis platform. The selected respondents used the reliance available sampling technique. This means that any suitable subject seen as a data source can be chosen as a respondent sample. A total of 20 users were requested to fill out the questionnaire. Each questionnaire question correlates with one ISO 9126 sub-indicator [27].

The questionnaire comprises the following list of questions:

1. List of questions related to the functionality indicator, for sub-indicators:
   (a) Suitability: According to you, is the cloud-based metabase GIS data analysis platform suitable for its intended purpose and functionality?
   (b) Accuracy: Do you think the location data displayed on the cloud-based metabase GIS data analysis platform is accurate and matches the original data?
   (c) Security: In your opinion, is the security of the cloud-based metabase GIS data analysis platform sufficient and reliable?
   (d) Interoperability: Can the cloud-based metabase GIS data analysis platform interact effectively with other applications, according to you?
   (e) Compliance: Do you believe that the cloud-based metabase GIS data analysis platform complies with the applicable regulations and standards of a general system?
2. List of questions related to the reliability indicator, for sub-indicators:
   (a) Maturity: When using the cloud-based metabase GIS data analysis platform and encountering data loading failures, does the system provide solutions to overcome them?
   (b) Fault tolerance: How would you rate the level of tolerance exhibited by the cloud-based metabase GIS data analysis platform when errors or omissions occur within the system?
   (c) Recoverability: What is the recovery process of the cloud-based metabase GIS data analysis platform when errors are encountered or identified?
3. List of questions related to the feasibility indicator, for sub-indicators:
   (a) Understandability: Is the cloud-based metabase GIS data analysis platform easy to understand, in your opinion?
   (b) Learnability: Do you find the features of the cloud-based metabase GIS data analysis platform easy to learn?
   (c) Operability: How user-friendly do you find the cloud-based metabase GIS data analysis platform to be?
   (d) Attractiveness: Do you consider the interface of the cloud-based metabase GIS data analysis platform to be visually appealing?
4. List of questions related to the efficiency indicator, for sub-indicators:
   (a) Time behavior: How would you rate the time required to switch between menus or features on the cloud-based metabase GIS data analysis platform?
   (b) Resource behavior: How do you perceive the utilization of system resources by the cloud-based metabase GIS data analysis platform?
5. List of questions related to the maintainability indicator, for sub-indicators:

(a) Analyzability: What is your opinion on the notice or pop-up messages displayed by the cloud-based metabase GIS data analysis platform when errors occur during its usage?
(b) Changeability: How capable do you think the cloud-based metabase GIS data analysis platform is in modifying its data and features?
(c) Stability: How effective do you find the cloud-based metabase GIS data analysis platform in minimizing unexpected effects resulting from modifications?
(d) Testability: What are your thoughts on the results of user testing conducted on the cloud-based metabase GIS data analysis platform after system updates?

6. List of questions related to the portability indicator, for sub-indicators:

(a) Adaptability: How well does the cloud-based metabase GIS data analysis platform perform when used on various devices?
(b) Installability: How easy do you find the installation process of the cloud-based metabase GIS data analysis platform?
(c) Coexistence: What is your experience when running the cloud-based metabase GIS data analysis platform simultaneously with other applications?
(d) Replaceability: How suitable do you think the cloud-based metabase GIS data analysis platform is as a replacement for similar applications or systems?

To ensure the quality of the platform, a comprehensive quality testing process is essential. This point aims to discuss the steps involved in conducting quality testing for the cloud-based metabase GIS data analysis platform, with a focus on the calculation stages involved in determining its quality.

The first step in the quality testing process is to establish the ideal value for each indicator and sub-indicator. In this study, a scale of 1 to 5 is used, with 5 being the ideal value indicating excellent quality. This step involves identifying key indicators and sub-indicators that are crucial for evaluating the platform's performance.

Once the ideal values for the indicators and sub-indicators are determined, the next step is to calculate the actual values obtained from the respondents. This involves collecting data from a sample of users who have experience using the platform. The respondents provide ratings or scores for each indicator and sub-indicator based on their experience and perception of the platform's performance.

After obtaining the actual values, the third step is to calculate the percentage. This calculation is performed by dividing the actual value by the ideal value and multiplying it by 100. The resulting percentage indicates the platform's performance relative to the ideal value. A higher percentage suggests a better performance, while a lower percentage indicates room for improvement.

Finally, based on the calculated percentages, the quality of the platform is categorized into different criteria or categories. These categories are defined using predetermined intervals that reflect the overall quality of the platform. In this case, the intervals specified by [28] are used. The categories range as follows :

- 1% - 20% = Very poor
- 21% - 40% = Poor
- 41% - 60% = Fair
- 61% - 80% = Good
- 81% - 100% = Excellent

3 Result

In this study analyzed the responses of 20 individuals who completed a questionnaire using the Likert scale to assess the quality indicators of the platform [29]. The Likert scale used in this study consists of five response options, ranging from "1 = Very Poor" to "5 = Excellent." These options are intended to capture the respondents' perception of the quality platform being evaluated. The scale allows for a nuanced assessment, enabling participants to express their opinions within a predefined range. Table 1 presents the aggregated results of the respondents' input for the functionality and reliability indicators. Table 2 shows the respondents' input for the feasibility and efficiency indicator. Table 3 provides the respondent's input for the maintainability and portability indicator.

Table 1: Results of the respondents' input for the functionality and reliability indicators

Responden	Functionality					Reliability		
	X1	X2	X3	X4	X5	X6	X7	X8
1	5	5	4	5	4	5	5	5
2	5	5	5	5	5	5	5	5
3	5	5	5	5	5	5	5	5
4	5	5	5	5	5	5	5	5
5	5	5	5	5	5	5	5	5
6	4	4	4	4	4	4	4	4
7	5	5	5	4	5	5	5	4
8	5	4	5	4	5	4	5	4
9	5	4	5	4	5	4	5	4
10	4	3	4	3	4	5	4	5
11	5	5	5	5	5	5	5	5
12	5	5	5	5	5	5	5	5
13	5	5	5	5	5	5	5	5
14	5	4	5	4	5	5	5	5
15	5	5	5	5	5	5	5	5
16	5	5	5	5	4	5	4	5
17	4	1	2	4	3	5	2	5
18	5	4	5	5	5	5	4	5
19	4	5	3	4	4	5	5	4
20	5	5	5	4	5	4	5	5

Note: X1, X2, X3, X4, X5, X6, X7, and X8 refer to suitability, accuracy, security, interoperability, compliance, maturity, fault tolerance, and recoverability, respectively.

4 Discussion

In this particular case, the data obtained from the input values of the respondents is being categorized based on the number of input values for each scale group of the indicator questions. This approach allows for a more structured and systematic analysis of the data, making it easier to draw meaningful insights and conclusions.

Table 2: The respondents' input for the feasibility and efficiency indicator

Responden	Feasibility				Efficiency	
	Y1	Y2	Y3	Y4	Y5	Y6
1	4	4	5	5	5	5
2	5	5	5	5	5	5
3	5	5	5	5	5	5
4	5	5	4	5	5	5
5	5	5	5	5	5	5
6	4	4	4	4	4	4
7	5	4	5	5	5	5
8	5	4	5	4	5	4
9	5	4	5	4	5	4
10	5	5	5	3	3	3
11	4	5	4	5	5	5
12	5	5	5	5	5	5
13	5	5	5	5	4	4
14	5	5	5	5	5	5
15	5	5	5	5	5	5
16	5	5	5	5	5	5
17	3	2	5	3	1	4
18	5	5	5	5	4	5
19	5	5	5	5	5	5
20	5	5	5	5	5	5

Note: Y1, Y2, Y3, Y4, Y5, and Y6 refer to understandbility, learnability, operability, attractiveness, time behavior, and resource behavior, respectively.

By grouping the data according to the scale groups, we can gain a better understanding of the distribution of responses across different levels of the indicators. This information can be valuable in identifying any patterns or trends that may exist within the data.

The process of grouping the data based on the number of input values for each scale group involves several steps. Firstly, the input values for each respondent are recorded and categorized according to the predefined scale groups. These scale groups can be determined based on the specific requirements and objectives of the research or survey. For instance, if the scale ranges from 1 to 5, the data can be grouped into categories such as 1-2, 3-4, and 5.

Once the data is categorized into scale groups, the next step is to calculate the frequency or count of responses within each group. This can be done by tallying the number of responses falling within each scale group. The frequency count provides valuable information about the distribution of responses across different levels of the indicators. Table 4 to Table 9 show the group results obtained.

Ideal values for each indicator i, which consists of several sub-indicators, are calculated in (1).

$$f(i_{\text{ideal}}) = IV(i) \times N_r \times N_s - I \quad (1)$$

where $IV(i)$ refers to ideal value of i. N_r refers to the number of respondents. N_s refers to the number of sub. Meanwhile, I refers to indicators. Actual values for each indicator are

Table 3: The respondent's input for the maintainability and portability indicator

Responden	Maintainability				Portability			
	Z1	**Z2**	**Z3**	**Z4**	**Z5**	**Z6**	**Z7**	**Z8**
1	5	5	5	5	4	5	4	5
2	5	5	5	5	5	5	5	4
3	5	5	5	4	5	5	5	5
4	5	5	5	5	4	5	5	5
5	5	5	5	5	4	5	5	5
6	4	4	4	4	4	4	4	4
7	5	5	5	5	5	4	5	5
8	5	4	5	4	5	4	5	4
9	5	4	5	4	5	4	5	4
10	4	3	3	3	4	5	4	4
11	5	5	5	5	5	5	5	5
12	5	5	5	5	5	5	5	5
13	5	5	5	5	5	5	5	5
14	5	5	5	4	5	5	5	5
15	4	5	5	5	5	5	5	5
16	5	5	5	5	5	5	5	4
17	2	5	3	5	5	3	4	2
18	5	5	5	5	5	4	5	5
19	5	5	5	5	4	5	4	4
20	5	5	4	5	5	5	5	5

Note: Z1, Z2, Z3, Z4, Z5, Z6, Z7 and Z8 refer to analizybility, changeability, stability, testability, adaptability, instalability, coexistence, replaceability, respectively.

Table 4: Group results value for functionality indicator

Value	Functionality				
	X1	**X2**	**X3**	**X4**	**X5**
1	0	1	0	0	0
2	0	0	1	0	0
3	0	1	1	1	1
4	4	5	3	8	5
5	16	13	15	11	14

Table 5: Group results value for reliability indicator

Value	Realibility		
	X6	**X7**	**X8**
1	0	0	0
2	0	1	0
3	0	0	0
4	4	4	5
5	16	15	15

calculated using (2).

$$f(i_{\text{actual}}) = \sum_{i=1}^{5} \sum_{j=1}^{n} (x_i y_i) \tag{2}$$

$x_i | x_i, 1 \leq x_i \leq 5$ and x represents the value range for each indicator $y_j \in \{1, 2, 3, 4, 5\}$ and y represents the number of sub-indicators for each indicator.

Based on the input data from respondents, the quality test results for each ISO 9126 indicator yield the results shown in Table 10.

Based on the input data from the respondents, the quality test results for the platform metabase GIS data analysis, which is based on cloud technology, have been evaluated using

Table 6: Group results value for feasibility indicator

Value	Feasibility			
	Y1	Y2	Y3	Y4
1	0	0	0	0
2	0	1	0	0
3	1	0	0	2
4	3	5	3	3
5	16	14	17	15

Table 7: Group results value for efficiency indicator

Value	Efficiency	
	Y5	Y6
1	1	0
2	0	0
3	1	1
4	3	5
5	15	14

Table 8: Group results value for maintainability indicator

Value	Maintainability			
	Z1	Z2	Z3	Z4
1	0	0	0	0
2	1	0	0	0
3	0	1	2	1
4	3	3	2	5
5	16	16	16	14

Table 9: Group results value for portability indicator

Value	Portability			
	Z5	Z6	Z7	Z8
1	0	0	0	0
2	0	0	0	1
3	0	1	0	0
4	6	5	5	7
5	14	14	15	12

the ISO 9126 indicators. The results indicate that the platform has performed exceptionally well, with an average test result of 93 %. This high score suggests that the platform excels in terms of functionality, reliability, usability, efficiency, maintainability, and portability.

5 Conclusion

This study examines the quality of a cloud-based metabase GIS data analysis platform based on the ISO 9126 indicators. The ISO 9126 indicators consist of six categories: functionality, reliability, feasibility, efficiency, maintainability, and portability. Each category contains a different set of sub-indicators, totaling 22 sub-indicators in total. The quality assessment of the platform was found to be excellent, with an average score of 93 % based on the ISO 9126 indicators. These results suggest that the platform is a reliable and efficient tool for spasial-text data analysis in a cloud-based environment

Table 10: Quality test results for each ISO 9126 indicator

Indicator	Actual value	Ideal value	Percentage	Result
Functionality	460	500	92 %	Excellent
Realiability	284	300	95 %	Excellent
Feasibility	377	400	94 %	Excellent
Efficiency	184	200	92 %	Excellent
Maintainability	376	400	94 %	Excellent
Portability	372	400	93 %	Excellent

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