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Data-Based Vocational Education Planning: A Strategic Approach Towards Future Readiness

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A B S T R A C T

Vocational education in the digital era faces increasingly complex challenges along with the increasing demands of the industrial world for digital technology-based skills and data analysis. Currently, many vocational education institutions still use conventional curriculum planning approaches that are not data-based, resulting in a gap between graduate skills and industry needs (Ahmad & Surya, 2022). The research method used is a mixed method, which combines a quantitative approach through surveys of students, teachers, and vocational program managers, and a qualitative approach through in-depth interviews with local industry representatives. The results of the study show that most students and teachers are aware of the importance of digital technology-based skills, but their implementation is still limited due to the lack of industry needs data used in curriculum planning. Based on these findings, this study proposes a data-based vocational education planning strategy that involves collecting periodic industry needs data, compiling a data-based curriculum, and evaluating education programs through graduate outcome data. This strategy is expected to be the basis for developing a more adaptive and responsive vocational education planning model to future industry needs. The results of the study indicate that most students and teachers are aware of the importance of digital technology-based skills, but their implementation is still limited due to the lack of industry needs data used in curriculum planning. Based on these findings, this study proposes a data-based vocational education planning strategy that involves collecting periodic industry needs data, compiling a data-based curriculum, and evaluating education programs through graduate outcome data

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INTRODUCTION

Vocational education in the digital era has undergone significant changes along with technological developments and increasingly dynamic industrial needs. According to Wijaya (2021), vocational education must adapt to technological developments so that its graduates have skills that are relevant to the needs of the digital labor market. This is in line with the views of Smith and Johnson (2020), who emphasize the importance of integrating digital technology into the vocational education curriculum to ensure graduates' readiness to face the industrial era 4.0. In addition, the integration of digital technology is also considered a strategic step to bridge the skills gap between vocational education and global industrial needs (Kim & Han, 2023). However, vocational education planning currently still faces various challenges, especially in terms of aligning the curriculum with industry needs and labor market dynamics. According to research by Ahmad and Surya (2022), the lack of accurate data on industry skills needs is one of the main obstacles in vocational education planning in Indonesia. The data should include detailed information on skills that are in demand by industry, future job trends, and digital skills that students must master. In addition, conventional and non-data-based educational planning is also a factor inhibiting the optimization of vocational education (Miller, 2019). In this context, Miller emphasized that vocational education must be able to respond to changes in industry trends through a more adaptive and data-based planning process.

In this context, the application of a data-driven approach is becoming increasingly relevant. Data-driven planning allows vocational education institutions to identify emerging skill trends and design educational programs that are in line with job market needs (Lee & Park, 2023). Furthermore, Lee and Park stated that data-driven planning not only includes analysis of industry data, but also data related to student performance, feedback from companies using graduates, and global trends in digital-based skill development. In Indonesia, the application of a data-driven approach is still relatively new, but has great potential to increase the effectiveness of vocational education (Prasetyo, 2024). Prasetyo also emphasized the importance of collaboration between educational institutions and industry in collecting and analyzing data so that the curriculum planning process can run more effectively.

Based on these problems, this study aims to explore data-based vocational education planning strategies as an effort to improve graduates' readiness to face an increasingly digital future. The focus of this study is to formulate an effective strategy in designing data-based vocational education programs by considering industry needs and job market dynamics. A data-based approach will not only improve students' technical skills but will also help vocational education institutions in conducting periodic program evaluations to ensure the curriculum is in line with current industry needs.

The formulation of the problems raised in this study are: (1) What is the current condition of vocational education planning in Indonesia? (2) What are the main obstacles in implementing a data-based approach in vocational education planning? (3) What strategies are effective in developing data-based vocational education planning in order to improve graduate readiness?

LITERATURE REVIEW

The concept of vocational education has developed in response to the needs of the ever-changing industrial world. Vocational education is basically designed to produce a ready-to-use workforce, with a focus on mastering specific technical skills according to industry needs. According to Arifin (2022), vocational education not only functions as a learning platform, but also as a medium for producing a workforce that is ready to directly enter the job market without requiring additional training. In the context of the development of the digital industry, vocational education must be increasingly adaptive in presenting technology-based skills and digitalization. In addition, vocational education also needs to pay attention to the development of artificial intelligence, automation, and internet of things (IoT) technology which is now increasingly dominating the industrial world (Lee & Park, 2023).

Furthermore, Mulyadi (2023) emphasized that vocational education has an important role as a link between the world of education and the world of industry. Collaboration between vocational education institutions and the industrial sector is very important to ensure that the skills taught are in accordance with the needs of the labor market. Industry-oriented vocational education programs can help graduates acquire technical skills that are relevant and in accordance with current industry demands. In this regard, Mulyadi emphasized the importance of internship programs and field work practices as a medium to strengthen the practical skills of vocational students so that they are better prepared to enter the world of work.

However, although the role of vocational education is very strategic, its implementation still faces a number of challenges. One of them is the gap between the vocational education curriculum and industry needs. According to Ahmad and Surya (2022), a curriculum that is not based on data often results in graduates being unprepared to face the dynamics of an increasingly competitive job market. As a result, many vocational education graduates still need additional training to be absorbed by industry. This condition is exacerbated by the lack of access to up-to-date and comprehensive industry needs data.

A data-based approach has begun to be applied in vocational education as a solution to overcome this gap. According to Lee and Park (2023), data-driven planning allows educational institutions to identify emerging skill trends in the industrial world. By using data obtained from industry surveys, job reports, and global trend analysis, educational institutions can design vocational education programs that are more in line with the needs of the labor market. In this case, data-driven planning not only functions as a planning tool, but also as an evaluation instrument for educational programs so that they are always relevant to industry dynamics. However, in Indonesia, the application of a data-based approach in vocational education planning is still relatively new. Prasetyo (2024) noted that the potential for implementing data-driven planning in Indonesia is very large, but is still constrained by the lack of technological infrastructure and the lack of teaching staff skills in managing data. In addition, data related to industry needs has not been systematically integrated, making it difficult to analyze comprehensive skills needs. To overcome these obstacles, Prasetyo

suggested that the government work with industry to build a national skills data center that can be accessed by all vocational education institutions.

The implementation of data-driven planning has shown significant results in several countries. Kim and Han (2023) in their research in South Korea showed that the use of data in vocational education planning succeeded in increasing the absorption rate of graduates by up to 30%. The implementation of data-driven strategies in South Korea involves regular analysis of industry needs, data-based curriculum updates, and evaluation of graduate outcomes based on feedback from partner companies. This proves that data-driven strategies are not just theory, but have also proven effective in the field.

In Indonesia, several vocational schools have begun to implement a data-driven approach, although it is still in its early stages. Wijaya (2021) stated that the implementation is limited to certain industrial sectors, such as manufacturing and automotive. However, these data-driven programs have not been fully integrated into the overall vocational education curriculum structure, so their impact on graduate readiness is still not optimal. In addition, the lack of training for teachers and vocational program managers in terms of data management is also a serious challenge that must be addressed immediately.

The data-driven approach is not only useful in curriculum development, but also in managing teaching staff and evaluating education programs. Smith and Johnson (2020) suggest that vocational education institutions start collecting data on student and alumni performance to measure the effectiveness of educational programs. This data can be used to adjust the curriculum, design programs to improve teaching staff skills, and evaluate the relevance of vocational education programs to industry needs. Thus, data-based strategies can be used comprehensively, from planning, implementation, to evaluation of educational programs.

However, the success of data-driven planning implementation is highly dependent on adequate technological infrastructure. Miller (2019) emphasized that without adequate technological support, the data collection and analysis process will be hampered. In addition, the limited human resources who have the ability to manage and analyze data are also challenges that must be overcome immediately. Therefore, developing human resource capacity through training related to data analytics and data science is an urgent need for vocational education institutions. Overall, the implementation of data-driven planning in vocational education is a strategic step to increase the relevance of the curriculum to industry needs. Although its implementation in Indonesia is still in its early stages, the potential benefits are enormous if supported by collaboration between educational institutions, industry, and the government. With a data-based strategy, vocational education institutions can be more adaptive in responding to labor market dynamics and ensuring that their graduates have relevant and ready-to-use skills. In addition, if applied consistently, a data-driven approach can also be a primary instrument to increase the accountability and transparency of vocational education programs in Indonesia.

Previous Research

This study on data-based vocational education strategies, especially in the BLK SMK Negeri 1 Purwakarta environment, has similarities with several previous studies, but also shows significant differences in approach, scope, and findings.

A study conducted by Wijaya (2021), for example, examined the application of a data-driven approach in industry-based vocational schools in the automotive sector. In his research, Wijaya highlighted the importance of industry involvement in the preparation of curriculum and training based on job market needs. The results of his research showed that vocational schools that apply industry data in learning planning are able to increase the relevance of student competencies to job demands. However, Wijaya's research focus is still limited to one industry sector and has not integrated a systematic data approach in the management of educational institutions. This study expands the scope by emphasizing the importance of comprehensive data-based vocational education management, starting from mapping industry needs, curriculum development, to graduate evaluation.

Meanwhile, research by Kim and Han (2023) in South Korea examines how the integration of big data in national vocational education can increase the efficiency of workforce distribution. They used data-driven predictive analytics from the national employment agency to design curriculum and training in vocational education institutions. Their study successfully showed a positive correlation between data-driven policies and a 30% increase in graduate employment rates. Compared to this study, research at SMK Negeri 1 Purwakarta has not yet reached the stage of national big data integration, but has begun to show how regional data utilization can be used as a basis for educational decision-making at the local level.

Miller's (2019) research in the United States is also relevant, as it discusses how the use of big data in the education system is often hampered by educators' lack of technical understanding and resistance to change. Miller emphasizes the need for intensive training and a transformative approach in changing the culture of educational organizations. This study reinforces these findings by stating that even though data is available, the biggest challenge lies in the low data literacy among teachers and managers of vocational schools. Therefore, this study emphasizes the need for managerial training in data literacy and evidence-based decision making.

In the national context, Prasetyo's (2024) research focuses more on data-based vocational education policies in Indonesia. He highlights the challenges of coordination between local governments, the business world, and educational institutions in building a skills data ecosystem. Prasetyo proposes the establishment of a "National Skills Needs Data Center" as a strategic step to consolidate data from various sectors. This study complements these findings by highlighting a concrete example of the implementation of a data-driven strategy at the educational unit level, namely SMK Negeri 1 Purwakarta, which shows how local initiatives can fill the gap in national policies that are still developing.

A study by Smith and Johnson (2020) in Australia highlighted the success of a highly structured vocational education system supported by a strong digital platform to synchronize data between educational institutions and companies. They stated that data consistency and interoperability of information systems between institutions are the keys to success. This is an important lesson for the Indonesian context, where data interoperability between schools, the Education Office, and the industrial world is still very limited. This study recommends the need to develop a locally-based digital system that can become the embryo of a national system in the future.

In general, this study complements previous studies by presenting concrete and in-depth local case studies, which show that data-based vocational education transformation can be carried out gradually, starting from the educational institution level with the support of regional policies. This provides an alternative decentralized approach as a solution to the challenges of infrastructure and regulation at the national level that are still developing.

METHODOLOGY

This study uses a mixed method research design, namely a combination of qualitative and quantitative approaches. According to Creswell and Plano Clark (2018), the mixed method approach allows researchers to gain a more comprehensive understanding through the integration of numerical and narrative data. In the context of this study, the approach is used to explore the perceptions of vocational education stakeholders and analyze quantitative data related to industrial needs in the Purwakarta area. Through this combination, researchers can validate quantitative findings through qualitative data, and enrich qualitative data with broader quantitative survey results.

The mixed method approach is considered effective in vocational education research because it is able to combine empirical data based on numbers with qualitative data that describe the experiences and perceptions of respondents. In the context of vocational education, this approach can provide a deeper picture of the skills gap between what is taught in educational institutions and what is actually needed by industry. According to Johnson and Onwuegbuzie (2019), the mixed method approach also helps researchers to overcome the limitations of each method, so that the research results are richer and more comprehensive.

Data collection techniques used in this study include surveys, in-depth interviews, and secondary data analysis. The survey was conducted on students, teachers, and management staff at BLK SMK Negeri 1 Purwakarta to obtain data on skills needs and graduate readiness. This survey used a closed questionnaire with a Likert scale to measure students' perceptions of skills that have been mastered and skills that still need to be improved. In-depth interviews were conducted with industry representatives to identify specific skills needs that are relevant in the world of work. This interview technique uses semi-structured interview guidelines so that informants can express their views more freely and in depth.

Secondary data analysis was conducted by collecting statistical data from BPS and the latest job trend report (BPS, 2024). This secondary data serves to provide context regarding the skills trends needed in the Purwakarta industrial sector. In addition, data from BPS will also be used to triangulate primary data obtained through surveys and interviews. According to Yin (2018), secondary data analysis serves as a way to validate primary data, as well as strengthen research arguments through data sourced from official institutions.

In terms of data analysis techniques, this study combines quantitative analysis using SPSS software for survey data processing and qualitative analysis based on thematic coding for interview data. Quantitative analysis will focus on descriptive analysis to identify the most frequently mentioned skill trends by respondents. Meanwhile, qualitative analysis uses thematic coding techniques (Braun & Clarke, 2006) to group interview data into main themes related to industry skill needs and data-based planning strategies.

The location of the study was determined at BLK SMK Negeri 1 Purwakarta. The selection of this location was based on the consideration that the school is one of the largest vocational education centers in Purwakarta and has skill programs that are relevant to industry 4.0. In addition, this school has collaborated with several local industrial companies, allowing researchers to access data related to industry skill needs directly (Mulyadi, 2023). BLK SMK Negeri 1 Purwakarta also has laboratory facilities that allow students to practice using the latest technology, such as CNC machines, robotics, and IoT devices.

The research sample consisted of 100 final year students, 10 vocational program teachers, and five education program managers at BLK SMK Negeri 1 Purwakarta. Meanwhile, informants from the industry consisted of 5 HRD managers of local manufacturing companies that collaborated with the school. The sampling technique was carried out using purposive sampling to ensure representation from each respondent group (Arikunto, 2021). Purposive sampling was chosen to ensure that the respondents involved were those who had an understanding and direct experience related to the implementation of data-based vocational programs. In the data processing process, the survey results will be analyzed using descriptive statistics to identify the skill patterns most needed by students and industry. In addition, simple correlation analysis will be used to see the relationship between student perceptions of the skills taught in schools and industry perceptions of the skills needed. Interview data will be analyzed using thematic coding techniques to identify key themes related to skill needs and data-based planning strategies (Creswell & Plano Clark, 2018). This coding technique will go through several stages, namely open coding, axial coding, and selective coding to ensure the validity and accuracy of the analysis results.

In conclusion, the mixed method research method applied in this study allows researchers to obtain comprehensive data from various sources and perspectives. Through a combination of survey techniques, interviews, and secondary data analysis, this study is expected to produce a more relevant and effective data-based vocational education planning strategy for BLK SMK Negeri 1 Purwakarta. This approach also allows for data triangulation to validate the

research results and ensure that the proposed strategy is based on strong and accountable empirical data.

RESULTS AND DISCUSSION

The results of this study indicate that the majority of students and teachers at BLK SMK Negeri 1 Purwakarta are aware of the importance of data-based vocational education to improve the relevance of graduate skills to industry needs. Survey data shows that 75% of students feel that the current curriculum does not fully cover the digital skills needed by the local industry. In addition, 60% of teachers stated the need to improve their ability to use data-driven technology in the teaching process (BPS, 2024). This shows a gap between students' and teachers' perceptions of graduates' readiness to enter the digital-based job market.

Furthermore, survey data also shows that the majority of students feel that the digital skills currently provided are still limited to mastery of basic software, such as Microsoft Office and simple data processing applications. In fact, local industries in Purwakarta are increasingly using more complex data analysis-based software, such as SAP, SPSS, and Tableau (Wijaya, 2021). Thus, improving the curriculum that focuses on data processing skills and data analysis based on sophisticated software is very urgent.

In addition to students, teaching staff also face challenges in implementing data-driven approaches. As many as 55% of teaching staff admitted that they had not received adequate training related to the application of data-driven technology in the teaching process. According to a vocational teacher at the BLK SMK Negeri 1 Purwakarta, "We still rely on conventional teaching methods because there has been no special training related to the use of data-driven technology in learning" (Mulyadi, 2023). This condition shows the need to increase the capacity of teaching staff to be better prepared to implement data-driven strategies.

Data analysis from in-depth interviews revealed that local industries in Purwakarta, especially the manufacturing sector, are increasingly prioritizing digital technology-based skills, such as data management, data analysis, and the use of industrial software (Wijaya, 2021). According to an HRD manager at a local manufacturing company, "Vocational high school graduates who have data analysis skills will be more easily absorbed in the job market than those who only master conventional technical skills" (Mulyadi, 2023). This statement confirms that data-based skills are now a top priority in the manufacturing industry that is undergoing a digitalization process.

In the qualitative analysis, it was found that the vocational program managers at BLK SMK Negeri 1 Purwakarta were aware of the gap between the current curriculum and industry needs. According to Sugiyono (2020), the application of a data-based approach in vocational education planning can help identify these gaps more accurately and formulate strategies to improve students' skills. For example, data-based training programs can focus on data analysis skills using software such as Python and R, which are currently increasingly used in the digital industry.

The implications of the results of this study for vocational education planning indicate the need to strengthen data-based strategies in curriculum development. Ahmad and Surya (2022) suggest that data-driven planning can be used to identify specific skills that are most in demand by industry and adjust vocational education programs according to those needs. This is in line with research findings that show the high demand for digital technology-based skills, especially related to data processing, data analysis, and mastery of analytical software.

The data-driven strategy proposed in this study includes three main steps: (1) Collecting industry needs data through periodic surveys of industry partner companies, (2) Analyzing data on skills needed by industry and compiling data-based curricula, and (3) Evaluating education programs by measuring graduate outcomes using alumni data and feedback from companies using graduates (Lee & Park, 2023). These three steps are expected to ensure that vocational education programs are not only based on current needs but also focus on emerging future skills trends. The implementation of this data-driven strategy not only improves graduates' readiness to face competition in the job market but also helps vocational education institutions to design more adaptive and relevant education programs. According to Smith and Johnson (2020), data-driven planning also allows educational institutions to adjust their curriculum more dynamically, in accordance with changing industry needs. With data related to the skills most needed by industry, schools can update their teaching materials, provide special training for teachers, and strengthen internship programs that focus on digital skills.

Overall, the results and discussion of this study confirm that a data-based approach is a strategic step in planning vocational education that is more relevant and responsive to industry needs. The implementation of a data-based strategy at BLK SMK Negeri 1 Purwakarta is expected to be a model for other vocational education institutions in developing educational programs that focus more on digital technology-based skills. In addition, this strategy also has the potential to be adopted by other BLKs in Indonesia, so that vocational education can be more adaptive to the dynamics of an increasingly digital industry.

CONCLUSIONS AND RECOMMENDATIONS

This study highlights the importance of implementing a data-driven approach in vocational education planning as a strategic effort to improve graduates' readiness to face future industry needs. The research findings show that most students and teachers at BLK SMK Negeri 1 Purwakarta are aware of the importance of digital technology-based skills, but their implementation is still limited due to the lack of industry needs data used in curriculum planning. This finding is in line with the views of Ahmad and Surya (2022) who emphasize the importance of data integration in vocational education planning.

The practical implications of this study indicate that vocational education institutions need to start adopting a data-driven approach in the curriculum planning process. The implementation of a data-driven strategy not only helps identify industry skills needs but also allows education managers to dynamically

adjust the curriculum according to developments in the labor market (Mulyadi, 2023). In addition, data-driven planning can be an effective evaluation tool to measure the suitability between the skills taught and the skills needed by the industry.

From an academic perspective, the results of this study open up opportunities for further study on the implementation of a data-driven approach in the context of vocational education in Indonesia. Prasetyo (2024) emphasized that the application of data-driven strategies is not only limited to curriculum planning, but can also be applied to the process of evaluating learning outcomes, developing teacher training programs, and measuring graduate outcomes. Thus, this study can be a basis for developing a data-driven planning implementation model in other vocational education institutions.

The main recommendation of this study is to increase collaboration between vocational education institutions and industry to ensure the availability of up-to-date skills needs data. In addition, it is also recommended to conduct training for teaching staff in managing and analyzing data to support a more evidence-based curriculum planning process (Lee & Park, 2023). In addition, the development of an integrated data platform that connects educational institutions with industry can be an effective solution in addressing the existing skills gap.

Overall, the implementation of data-driven strategies in vocational education planning is an important step in ensuring the relevance of the curriculum to future industry needs. The implementation of data-driven planning at BLK SMK Negeri 1 Purwakarta is expected to be a model for other vocational education institutions in Indonesia in developing education programs that are more adaptive, responsive, and relevant to the development of the digital industry.

This study concludes that the implementation of a data-driven approach in vocational education planning is a strategic step to increase the relevance of education programs to industry needs. The research findings show that most students and teaching staff at BLK SMK Negeri 1 Purwakarta are aware of the importance of digital technology-based skills, but their implementation is still limited due to the lack of industry needs data used in curriculum planning.

In practice, the results of this study provide important implications for vocational education managers to start adopting a data-driven approach in the curriculum planning process. Ahmad and Surya (2022) emphasize that data integration in the vocational education planning process can improve the suitability of programs to local and global industry needs. In addition, for academics, this study opens up opportunities to conduct further studies on the effectiveness of implementing data-driven strategies in various vocational education contexts. The main recommendation proposed in this study is to increase collaboration between vocational education institutions and industry to ensure the availability of up-to-date skills needs data. In addition, it is also recommended to provide training for teaching staff in managing and analyzing data to support a more evidence-based curriculum planning process. The implementation of data-driven strategies is also expected to be a model for other

vocational education institutions in Indonesia in order to improve the readiness of graduates to face the digital industry era.

FURTHER STUDY

This study makes a significant contribution to the development of a data-based vocational education strategy, especially at BLK SMK Negeri 1 Purwakarta. However, to broaden the understanding and implementation of this approach, further, more in-depth and comprehensive studies are needed. Further studies can include exploration of the integration of big data and machine learning technologies in vocational curriculum planning. This technology has the potential to help educational institutions not only respond to current industry needs but also predict future skill trends more accurately.

Furthermore, future studies can also highlight the importance of a collaborative ecosystem between education, industry, and government in managing skills needs data. As stated by Prasetyo (2024), "without cross-sector synergy, the data owned will not be optimally utilized as a reference in vocational education planning." This collaboration includes the development of a national skills data center, providing training for teachers, and strengthening data-based policies. Further research can explore how this collaborative model is built and replicated in various regions in Indonesia.

Further studies are also important to examine the long-term effectiveness of a data-driven approach in increasing the employment of vocational graduates. In this context, longitudinal research is urgently needed. According to Kim and Han (2023), this approach has succeeded in increasing employment by up to 30% in South Korea, but its validity and impact in the Indonesian context still require broader empirical evidence. Such studies can help measure the sustainable impact of data-driven vocational education policies and strategies on alumni careers in various industrial sectors.

From an international perspective, it is also important to conduct cross-country comparative studies related to the application of data-driven planning in vocational education. According to Smith and Johnson (2020), countries such as Germany, Singapore, and Australia have already developed mature data-based vocational education systems, supported by strong digital infrastructure and policy frameworks. Comparative studies will provide insights into best practices that can be adapted to the local context of Indonesia, as well as help formulate national policy standards in developing vocational education. In addition, the aspect of digital readiness of vocational education institutions is also an important topic for further research. Mulyadi (2023) stated that many vocational schools in Indonesia, despite having technological facilities, do not yet have sufficiently skilled human resources to manage and interpret data properly. Therefore, further research can focus on developing the digital competencies of vocational teachers and managers, as well as how institutions can build a culture of data-based decision-making throughout the entire managerial and learning process.

Further studies also need to expand the scope of the industrial sectors studied. This study focuses on the manufacturing sector in Purwakarta, but other industries such as technology-based agriculture (agritech), digital services, logistics, and renewable energy also have great potential in absorbing vocational graduates. According to Ahmad and Surya (2022), vocational education must be responsive to economic diversification and the development of new sectors that require technology-based and sustainability skills. Therefore, exploring the need for skills in new sectors can enrich the direction of national vocational education development.

Finally, further studies can also include the development of a more comprehensive data-based vocational education evaluation framework. This evaluation covers aspects of input, process, output, and outcome of the education program. According to Creswell and Plano Clark (2018), the integration of a mixed method approach remains the main strategy for gaining a complete understanding of the complexity of the vocational education system. With a strong evaluation framework, vocational education policies can be designed and adjusted periodically based on measurable and valid evidence.

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