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Improving The Quality Of Education In The 5.0 Era: Quality Control And Quality Improvement Approaches

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Abstract

Education in the 5.0 era faces major challenges in maintaining quality and relevance along with the development of smart technology and the need for 21st century skills. This article aims to analyze the role of Quality Control (QC) and Quality Improvement (QI) in improving the quality of education in the 5.0 era using the literature review method. Through the analysis of various current literature, it was found that QC and QI play an important role in ensuring education quality standards and encouraging continuous improvement. QC allows consistent quality monitoring, while QI allows continuous adaptation through technological innovations, such as data analytics and artificial intelligence. The results of the study indicate that the integration of technology in QC and QI provides various benefits, including real-time monitoring of student performance and personalization of learning that can improve educational outcomes. However, this implementation faces several challenges, such as limited infrastructure, lack of digital literacy among educators, and resistance to change. In addition, the synergy between technology and human skills is found to be a crucial aspect in creating an effective and meaningful education process. This article recommends the importance of investing in technological infrastructure and training for educators, as well as policies that support the implementation of QC and QI in various educational institutions. Further research is also needed to develop more adaptive QC and QI models to various educational contexts and to explore the impact of technology-based QC and QI on students' 21st century skills. These findings are expected to provide insights for the development of sustainable education quality improvement strategies in the 5.0 era.
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Keywords: quality of education, era 5.0, quality control, quality improvement, educational technology, digital literacy

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A. Introduction

In the era of globalization and rapid technological development, the world of education faces a major challenge to adapt to changes in society and the world of work. The Industrial Revolution 5.0, which is characterized by synergy between humans and intelligent technology, directs the education sector to improve the quality and relevance of learning so that graduates can have 21st-century skills such as digital literacy, critical thinking skills, and the ability to adapt to change (Schwab, 2017; Xu, David, & Kim, 2018). In this context, the implementation of quality control and quality improvement is very important to ensure that the education process is able to produce competent, innovative, and highly competitive human resources.

The Quality Control (QC) and Quality Improvement (QI) approaches have proven effective in improving the quality of education, especially in the era of education 5.0 which is characterized by the use of smart technology and the need for 21st century skills. In general, QC and QI in the context of education aim to ensure that the learning process meets certain standards, while striving for continuous improvement in every aspect.

Improving the quality of education must be done continuously through evaluation, developing learning strategies, and improving the professionalism of educators. According to Sukmadinata (2022), continuous evaluation is the key to ensuring that educational institutions remain relevant and adaptive to changing community needs.

This approach places schools as the main center in quality management. As expressed by Gunawan & Syahril (2023), the involvement of principals, teachers, and the community around the school in strategic decision-making has a positive impact on the quality of the education process.

A curriculum that is relevant to the needs of the workplace and character development is one of the pillars of educational quality. For example, Abdullah and Kurniawan (2020) showed that a competency-based curriculum can increase the relevance of education to the workplace and encourage student independence.

Technology is considered as one of the main levers in improving the quality of education, especially after the COVID-19 pandemic. According to Widodo and Anjani (2021), the use of educational technology such as online learning, artificial intelligence (AI), and educational analytics has the potential to accelerate the

improvement of the quality of the learning process. Teachers are the main actors in improving the quality of education. As stated by Rahman and Fitri (2023), continuous teacher training and development of pedagogical competence are the keys to success in improving the quality of learning outcomes.

Quality Control (QC) focuses on efforts to control quality standards through consistent monitoring and evaluation, so that educational institutions can ensure that learning outcomes are in accordance with established standards. According to Deming (1986), QC emphasizes the importance of conducting ongoing evaluations to maintain output quality, in this case competent graduates who are in accordance with industry needs. The application of QC in the educational environment includes the accreditation process, curriculum development, and student competency assessment (Juran, 1998).

For example, research by Tribus (1992) shows that the application of QC in education can help institutions to more quickly identify problems in the learning process and take corrective actions. Thus, QC serves as a mechanism to maintain quality standards and consistency through periodic inspections and necessary adjustments. "Quality control in education ensures that the learning outcomes meet the set standards through continuous monitoring and assessment processes" (Tribus, 1992).

Meanwhile, Quality Improvement (QI) focuses on efforts to continuously improve quality by seeking new ways to improve the effectiveness and efficiency of the educational process (Imai, 1986). The QI principle, also known as the Kaizen concept or continuous improvement, can be applied in education to create a learning environment that is more adaptive to student needs and technological developments (Schmoker, 2005).

The QI approach emphasizes the participation of all stakeholders, including teachers, students, and school management, to collaborate in continuous improvement efforts (Sallis, 2002). A study by LeMahieu et al. (2017) showed that the QI approach encourages educational institutions to not only evaluate outcomes but also understand and improve the underlying processes. In the context of the 5.0 era, QI includes the use of technology and data analytics to monitor student progress and identify areas that need improvement.

"Quality improvement emphasizes ongoing improvements in educational processes by engaging all stakeholders and leveraging data analytics for continuous improvement" (LeMahieu et al., 2017).

In education 5.0 era, QC and QI not only

focus on results, but also on more dynamic and personalized learning processes and experiences. By utilizing data analytics and artificial intelligence, educational institutions can conduct QC more accurately and QI more adaptively (Zhu & He, 2020). Through technology, institutions can monitor student performance in real-time, identify barriers to learning, and offer specific solutions for each student.

For example, research conducted by Godino, Lasa, and Martinez (2020) shows that machine learning technology in QC can be used to predict student difficulties in a subject and provide timely interventions. On the other hand, QI through technology allows for the adjustment of curriculum and learning methods based on student needs data.

"In the era of Education 5.0, quality control and quality improvement approaches leverage advanced technologies such as data analytics and artificial intelligence to enhance the educational process in a personalized and efficient manner" (Zhu & He, 2020).

By implementing QC and QI in education, especially through the integration of technology in the 5.0 era, the quality of education can be significantly improved. QC ensures consistent quality standards, while QI enables continuous innovation and adaptation. This approach can help educational institutions produce graduates who not only have academic knowledge, but also critical skills that are relevant to the needs of the times.

Quality control and quality improvement are two main approaches that can be used to achieve these goals. Quality control in education involves the process of monitoring and evaluating established standards to ensure that educational outcomes are in line with expectations and needs of the times (Deming, 1986; Juran, 1998). Meanwhile, quality improvement focuses more on ongoing efforts to improve educational processes and outputs to be more effective and relevant to the challenges of the 5.0 era (Imai, 1986; Crosby, 1979).

The increasing complexity of education, especially with the need to integrate digital technologies, data analytics, and artificial intelligence, requires a fundamental shift in the approach to quality management. Research shows that traditional approaches to education are often inadequate to deal with the complexity and dynamics of the ever-evolving environment (Zhu & He, 2020; Alavi & Leidner, 2001). Therefore, the quality of education needs to be systematically improved through the

application of technology-based quality control and quality improvement methods that are adaptive to change.

However, the implementation of this approach faces a number of obstacles, including resistance to change, budget constraints, and limitations in the ability of educators to utilize technology effectively (Fullan, 2007; Hargreaves & Shirley, 2009). Therefore, an integrated effort is needed from various stakeholders to overcome these obstacles and ensure that quality control and quality improvement can truly be implemented effectively in education in the 5.0 era.

Research Gap

In the era of the Industrial Revolution 5.0, which is marked by collaboration between intelligent technology and human values, improving the quality of education is a complex challenge that requires an innovative approach. Although many studies have been conducted on the application of Quality Control (QC) and Quality Improvement (QI) in education, there are a number of research gaps that have not been answered comprehensively. The following are some of the main research gaps that have emerged in the related literature.

1. Limitations of Empirical Research on Technology Integration in Quality Control and Quality Improvement in the 5.0 Era

   Many previous studies have focused on the application of QC and QI in traditional educational contexts without significant involvement of digital technology (Deming, 1986; Juran, 1998). However, in the 5.0 era, the use of technologies such as artificial intelligence, machine learning, and data analytics offers new opportunities to conduct QC and QI more effectively (Zhu & He, 2020). Unfortunately, there is still little research exploring how these technologies can be integrated into QC and QI in educational institutions, especially in the local context of developing countries. "There remains a lack of empirical studies exploring the integration of advanced technology in quality control and improvement processes within educational settings" (Zhu & He, 2020).
2. Lack of Understanding of the Effectiveness of Quality Improvement Approaches in Diverse Educational Contexts

   QI approaches, which focus on continuous improvement, are often applied uniformly without considering the differences in cultural, social, and economic contexts of different educational institutions (Sallis, 2002).

Research by Fullan (2007) shows that the success of QI is highly dependent on the context and cultural support within the educational institution. However, there is still little research exploring how QI approaches should be adapted to various educational contexts, especially in an increasingly digitalized era. "While continuous improvement is universally advocated, the lack of context-sensitive approaches to QI in diverse educational settings is a significant research gap" (Fullan, 2007).

3. Lack of Studies on Collaboration between Humans and Technology in Quality Control in the Era of Education 5.0

   The Industry 5.0 era emphasizes the importance of synergy between humans and technology. However, most research on QC in education still focuses on manual and traditional approaches, without integrating technological components that actively collaborate with educators (Schwab, 2017). Further research is needed to explore how collaboration between humans (teachers, administrators) and technology (AI, data analytics) can improve the effectiveness of QC in educational institutions. "The potential synergy between human educators and intelligent technology in quality control processes remains largely unexplored in the current literature" (Schwab, 2017).

4. Lack of Research on the Impact of QC and QI on 21st Century Skills and Graduate Employability

   Research on QC and QI in education often focuses only on students' academic outcomes (e.g., test scores) and the management of the learning process (Tribus, 1992). However, in the 5.0 era, there is a growing need to produce graduates with 21st-century skills, such as critical thinking, creativity, and collaboration (Xu, David, & Kim, 2018). Unfortunately, there is still a lack of research exploring how QC and QI can be adapted to measure and improve these skills in the education curriculum. "There is a limited body of research examining the impact of quality control and improvement on 21st-century skills and employability of graduates" (Xu, David, & Kim, 2018).

5. Uncertainty about the Effectiveness of QC and QI Implementation in Different Educational Institutions

   Most research on QC and QI focuses

on higher education institutions or secondary schools, while applications at the primary or informal education levels are still underexplored (Alavi & Leidner, 2001; Schmoker, 2005). In addition, some educational institutions face constraints in terms of resources and infrastructure, which affect the effectiveness of QC and QI implementation. Further research is needed to understand how QC and QI approaches can be effectively implemented in different types of educational institutions. "There is limited evidence on the adaptability and effectiveness of quality control and improvement strategies across diverse educational institutions, especially those with limited resources" (Alavi & Leidner, 2001). To support the relevance and effectiveness of QC and QI in education 5.0, further research is needed to fill the above gaps. With more in-depth research on technology integration, contextualization of QI approaches, human-technology synergy in QC, and the impact of QC and QI on 21st-century skills, educational institutions can be better prepared to face the challenges of the 5.0 era.

B. Metode

This study uses a literature review method to explore and analyze various concepts, approaches, and empirical findings related to the application of Quality Control (QC) and Quality Improvement (QI) in improving the quality of education in the 5.0 era. A literature review is an effective method for collecting and synthesizing various relevant studies, especially in evolving topics such as education and technology. Through a literature review, the author can identify patterns, research gaps, and current trends that are relevant to improving the quality of education in the context of the Industrial Revolution 5.0 (Snyder, 2019). "Literature review as a research method is particularly valuable for identifying patterns, research gaps, and current trends in rapidly evolving fields like education and technology" (Snyder, 2019). This article collects data from various sources related to Quality Control and Quality Improvement in education, especially those focusing on the context of education in the 5.0 era.

C. Objective

This study aims to provide theoretical and practical contributions in order to improve the quality of education by using the Quality Control and Quality Improvement approaches in the 5.0 era. The specific objectives of this study are as follows:

1) Identifying Challenges to Education Quality in the 5.0 Era

   This study aims to identify the main challenges faced in maintaining and improving the quality of education in the 5.0 era, especially challenges related to technology integration, 21st century competency needs, and changes in student characteristics.

2) Analyzing the Implementation of Quality Control Approach in Education

   This study aims to examine how the Quality Control approach can be applied effectively in the world of education to maintain the quality of the learning process and educational outcomes.

3) Digging into Quality Improvement Strategies with Quality Improvement

   This study aims to explore strategies for improving the quality of education based on Quality Improvement, with a focus on learning innovation, teacher professional development, and curriculum updates that are relevant to the 5.0 era.

4) Developing a Synergy Model for Quality Control and Quality Improvement

   This study aims to design an integrative model or framework that combines the Quality Control and Quality Improvement approaches to improve the quality of education holistically and sustainably.

5) Evaluating the Impact of Using Technology in Supporting the Quality of Education

   This research also aims to evaluate how technologies, such as artificial intelligence (AI), Internet of Things (IoT), and data-driven learning, can be integrated to support quality control mechanisms and improve the quality of education.

6) Providing Policy Recommendations to Stakeholders

   This study aims to provide applicable recommendations to education stakeholders (government, educational institutions, teachers, and the community) in designing policies and practices to improve the quality of education that is relevant to the needs of the 5.0 era.

D. Benefit

This research will contribute to the development of literature in the field of educational quality management, especially by integrating the concepts of Quality Control (QC) and Quality Improvement (QI) into the education system in the 5.0 era. The expected theoretical benefits include:

1) Increasing insight and conceptual

framework regarding the implementation of quality control and continuous quality improvement in the education system.

2) Developing theories about how human-centered technology (typical of the 5.0 era) can play a role in supporting improvements in the quality of education.
3) Providing a theoretical basis for further research related to improving the quality of education based on local technology and culture.

E. Results and Discussion

Results

This chapter presents the results of a literature review on the application of Quality Control (QC) and Quality Improvement (QI) in improving the quality of education in the 5.0 era. The analysis was conducted by reviewing the main themes found in the literature, as well as identifying gaps that still need to be explored further. The discussion includes the benefits, challenges, and opportunities of implementing QC and QI in the context of increasingly digitalized education.

1. The Role of Quality Control in Education Era 5.0

   The results of the literature review show that QC plays an important role in ensuring consistent educational quality standards amidst technological developments. QC in education aims to monitor and evaluate standards of learning processes and outcomes to ensure that the expected quality can be achieved (Deming, 1986; Juran, 1998). In the 5.0 era, QC is increasingly developing with the presence of data analytics technology and artificial intelligence (AI), which allows educational institutions to track and measure student and teacher performance in real-time (Zhu & He, 2020). According to research by Zhu & He (2020), data analytics technology helps educational institutions monitor student achievement, detect difficulties faced by students in real time, and take quick corrective actions. The use of this data analytics increases the accuracy and efficiency of the QC process compared to traditional manual methods.

   "With advanced data analytics, educational institutions can conduct quality control processes in real-time, allowing for timely interventions and more accurate performance tracking" (Zhu & He, 2020). However, the main challenge in implementing technology-based QC is the infrastructure and expertise needed to utilize the technology. In some developing countries, budget constraints and lack of access to modern technology tools

limit schools' ability to adopt data-based QC (Alavi & Leidner, 2001).

2. Quality Improvement as a Continuous Improvement Strategy

   Quality Improvement (QI) in education in the 5.0 era aims to continuously improve the education process by paying attention to feedback, technological innovation, and dynamic student needs. QI principles, such as Kaizen or continuous improvement, prioritize the participation of all stakeholders in efforts to continuously improve quality (Imai, 1986). The literature shows that QI in the 5.0 era can be maximized through the use of digital technology, such as learning management systems (LMS) applications that allow schools to personalize learning according to student needs (Godino, Lasa, & Martinez, 2020). In addition, technology allows schools to implement data-based feedback that can improve the learning process. "Continuous quality improvement in education is enhanced by technology, which allows for personalized learning experiences and data-driven feedback systems" (Godino, Lasa, & Martinez, 2020).

   The challenge faced in implementing QI is resistance to change, especially from teachers who are uncomfortable with technology or constant change. A study by Fullan (2007) highlighted the importance of changing organizational culture for QI to be successfully implemented. In the context of education 5.0, this change includes increasing digital literacy for teachers and students.

3. Synergy between Technology and Human Skills in QC and QI

   In the 5.0 era, QC and QI are not only about controlling and improving quality through digital systems, but also about the synergy between technology and humans. Human skills, such as creativity, empathy, and critical thinking skills, remain very important, especially in educational processes that require adaptation and understanding of context. Schwab's study (2017) emphasizes the importance of combining smart technology with human values to create more meaningful education.

   According to research, technology can help in aspects of measurement and monitoring, but final decisions often still require human judgment, especially regarding students' social-emotional skills and character

development (Xu, David, & Kim, 2018). In the context of QC and QI, technologies such as AI and data analytics can provide supporting data, but educational decisions still require contextual understanding and human judgment. "While technology aids in data-driven quality control, human insight remains essential for interpreting data in a meaningful educational context" (Xu, David, & Kim, 2018).

4. Gaps in QC and QI Research and Implementation Across Different Types of Institutions

   The literature also shows that the implementation of QC and QI in various educational institutions still faces significant differences. Most research and implementation of QC and QI focuses on higher education, while implementation at the primary and secondary education levels is still minimal (Alavi & Leidner, 2001; Sallis, 2002). In some primary and secondary schools, especially in remote areas or in developing countries, the main challenge is access to technological infrastructure that supports QC and QI. Research shows that the success of QC and QI is highly dependent on resource support and technological readiness, which are often lacking in institutions with limited budget and access to technology (Sallis, 2002). Therefore, there is an urgent need to explore QC and QI models that are more flexible and can be adapted to local conditions. "Educational institutions with limited resources require adaptable quality control and improvement models that align with their specific contexts and constraints" (Sallis, 2002).

Discussion

From the results of the literature review above, it can be concluded that the implementation of QC and QI in the era of education 5.0 offers many opportunities to improve the quality of education through the use of technology. Data-based and analytical QC allows for more timely and accurate monitoring and evaluation processes, while technology-based QI can personalize learning and improve students' learning experiences. However, major challenges such as resistance to change, infrastructure limitations, and gaps in implementation at various levels of education require further attention.

One implication of these findings is the need for policy support that encourages the adoption of technology in QC and QI processes across educational institutions, especially in areas with minimal access to technology. In addition, increasing digital literacy for teachers and other education

personnel is essential so that they can utilize technology more effectively in QC and QI processes.

In the future, further research is needed to explore flexible and adaptive QC and QI approaches for educational institutions with limited resources. In addition, studies on the collaboration between humans and technology in QC and QI can provide new insights on how the educational process can be carried out effectively in the era of 5.0 which is technology-based but still maintains human values..

F. Conclusion

This study aims to analyze the implementation of Quality Control (QC) and Quality Improvement (QI) in an effort to improve the quality of education in the 5.0 era through the literature review method. By reviewing various current literature, it was found that the QC and QI approaches play an important role in ensuring educational quality standards that are in accordance with the needs of the times, especially in an era marked by the development of intelligent technology and collaboration between humans and machines.

1. Implementation of Quality Control and Quality Improvement in the Era of Education 5.0

   In the 5.0 era, the implementation of QC and QI has undergone significant development through the integration of technologies such as data analytics, artificial intelligence, and learning management systems (LMS). This technology enables the QC and QI processes to run more effectively and efficiently, both in monitoring student performance in real-time and in providing personalized feedback according to student needs. QC helps educational institutions to monitor quality standards consistently, while QI enables continuous improvement that focuses on adaptation and innovation.
2. Benefits and Challenges of Technology Implementation in QC and QI

   Integration of technology in QC and QI offers significant benefits in improving the quality of learning, enabling personalization of education, and supporting data-driven decision-making. However, the main challenges identified are limited infrastructure and resources, especially in developing countries and remote areas. In addition, resistance to change from educators and lack of digital literacy are also obstacles in implementing technology-based QC and QI.
3. The Role of Synergy between

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Technology and Human Skills

Although technology provides many conveniences in the implementation of QC and QI, the role of human skills remains important, especially in managing and interpreting the data obtained. The synergy between humans and technology is key to producing an educational process that is not only efficient, but also meaningful and in accordance with human values. Educators are expected to not only master technology, but also maintain a focus on developing student character, which is one of the important aspects in education in the 5.0 era.

4. Implications and Recommendations for Future Research and Practice

From the results of this literature review, it is recommended that educational institutions increase investment in technology infrastructure and digital literacy training for educators to support effective implementation of QC and QI. In addition, policies are needed that support the integration of technology in education, especially in educational institutions with limited resources.

Further research is needed to explore more flexible and adaptive QC and QI models, which can be applied to various types of educational institutions with various conditions and limitations. In addition, empirical studies exploring the impact of technology-based QC and QI on 21st century skills and graduate employability will be an important contribution to the development of education in the 5.0 era.

Overall, the QC and QI approaches in the context of education 5.0 show great potential in improving the quality of education that is relevant to future needs. With proper implementation, QC and QI can help educational institutions produce graduates who are not only knowledgeable, but also have the skills and character needed in a complex digital society. However, to achieve the full potential of this approach, it requires infrastructure support, digital literacy training, and policies that support technology-based education transformation in the 5.0 era.

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