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Evaluation of institutional models at the ministry of transportation's railway vocational school in the industrial revolution 4.0 ERA

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Abstract: PPI Madiun needs to evaluate and optimize its organizational structure to be more adaptive to technological changes and industrial needs in the Industrial Revolution 4.0 era. formulation of the problem in the study. How is the current institutional evaluation of PPI Madiun, what are the obstacles in organizing the PPI Madiun institution? how does the PPI Madiun institutional model adapt to the Industrial Revolution 4.0 theory in research United Nations Development Programme [1] in Sulaiman [2] Qualitative case study research method at PPI Madiun explores institutional adaptation to the Industrial Revolution 4.0 through in-depth analysis. Institutional evaluation at the Indonesian Railway Polytechnic (PPI) Madiun highlights the need for attention to the external context, organizational capacity, stakeholder involvement, learning and adaptation, and institutional transformation to remain relevant in the Industrial Revolution 4.0 era. With the active involvement of stakeholders and the application of continuous learning methods, PPI Madiun can meet the needs of the dynamic railway industry. Various constraints, such as external context and organizational capacity, require a comprehensive strategy, including increased coordination with the government and collaboration with industry. Digital-based transformation and innovative organizational culture will strengthen PPI Madiun as a superior vocational education institution. PPI Madiun's institutional model that is adaptive to the Industrial Revolution 4.0 focuses on external context, organizational capacity, stakeholder involvement, learning, and institutional transformation to produce a professional workforce.

Keywords: *Industrial revolution 4.0. Institutional development, Railway, Vocational school.*

1. Introduction

The Industrial Revolution 4.0 has transformed the global landscape through the integration of digital, physical, and biological technologies, including the development of *artificial intelligence*, biotechnology, and the internet. While increasing efficiency and connectivity, this revolution is also widening the digital and competency gap, especially for social science graduates. In the employment sector, automation and robotization have the potential to replace human roles, causing mass layoffs. Badan Pusat Statistik (BPS) [3] shows a decrease in unemployment from 9.77 million (2020) to 8.75 million (2021), but the main challenge remains in preparing superior and adaptive human resources.

The transportation sector, as the backbone of the economy, faces pressure to adapt to technological change. Demand for transportation services is increasing rapidly, but the imbalance in the availability of human resources has the potential to hamper development. Industry 4.0 demands a transformation of technology-based production models, which risks reducing conventional jobs. Therefore, competent human resources are needed through relevant vocational education and training, especially in the railway sector which is increasingly vital in urban mobility and national logistics.

Vocational colleges, such as the Indonesian Railway Polytechnic (PPI) Madiun, play a key role in preparing human resources who are ready to compete in the digital era. However, challenges such as a

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curriculum that is not fully in line with industry needs, an organizational structure that is less flexible, and competition with other colleges are obstacles. PPI Madiun, which offers study programs in railway technology and management, needs to strengthen collaboration with industry to ensure that its graduates have the skills needed by the job market.

PPI Madiun faces several internal and external challenges in the face of the Industrial Revolution 4.0. The traditional curriculum is less able to answer the demands of cutting-edge digital and technical skills. The rigid organizational structure also hinders innovation and rapid adaptation to technological changes. In addition, the demands of society for graduates who are not only technically competent but also have strong character add to the complexity of the challenges that must be faced.

Evaluation of the PPI Madiun institutional model is important to ensure the readiness of the institution in producing human resources that are relevant to the needs of Industry 4.0. Without updating the curriculum and organizational structure, the risk of graduate competency mismatch with the job market will be even higher. Integration of technology such as *e-learning* and *virtual reality*, as well as close collaboration with industry, are strategic steps that need to be taken. In addition, policy support and funding from the government are also needed to accelerate this transformation.

The Industrial Revolution 4.0 demands a fundamental transformation in the institutional model of railway vocational schools. PPI Madiun needs to revise the curriculum, strengthen industry collaboration, and adopt modern educational technology. With these steps, PPI Madiun can become an adaptive vocational institution, producing globally competitive graduates and supporting sustainable transportation development in Indonesia. Synergy between government, industry, and academics will be the key to success in facing the challenges of this digital era. This study examines the institutional structure of the Indonesian Railway Polytechnic (PPI) Madiun through three main questions. First, how is the evaluation of the current institutional conditions related to the organizational structure and its suitability to the needs of human resource development? Second, what are the operational obstacles faced in implementing railway vocational education?

Third, what is the ideal institutional model to adapt to the demands of the Industrial Revolution 4.0? The focus of the research is to find solutions to increase the relevance of vocational education to the needs of modern industry through curriculum adjustments, strengthening collaboration, and integrating digital technology.

2. Literature Review

This study fills the gap in the literature related to the evaluation of institutional models at Railway Vocational Schools under the Ministry of Transportation of the Republic of Indonesia, which until now has never been studied in depth. Most previous studies have focused on the development of higher education systems in general, railway transportation technology, and the integration of Industry 4.0 technology, but none have specifically evaluated the institutional structure of vocational schools in the context of national railway education. This is important because the need for vocational education institutions that are adaptive and relevant to technological developments continues to increase, along with the acceleration of the Industrial Revolution 4.0.

Previous studies such as those conducted by Giesenbauer and Müller-Christ [4], Laiton-Bonadiez, et al. [5] and Lee, et al. [6] do provide a strong theoretical foundation in the development of educational systems and institutions. However, these studies are still limited to general or overseas contexts and have not integrated a comprehensive institutional evaluation approach in the railway vocational education sector. Therefore, this study is not only relevant but also urgent to be carried out to support improving the quality and effectiveness of vocational education institutions based on the latest technology.

The novelty of this study lies in the adoption of the United Nations Development Programme [1] Institutional Development theory as an evaluative framework for assessing institutional effectiveness in the digital era. This theory provides a comprehensive approach in analyzing internal and external institutional factors and how vocational institutions can strategically adapt to changes in the external

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environment. Thus, this study offers significant theoretical and practical contributions to the development of an institutional model of vocational education in Indonesia that is responsive to the challenges of the Industrial Revolution 4.0.

Institutional theory explains the relationship between organizations and their environment, and how organizational structures and processes are influenced by social norms, values, and rules. Scott [7] states that organizational decisions are often influenced by the institutional environment. Eaton [8] emphasizes that institutional development is a planned effort to create new institutions that are able to adapt to the social system. The classical view (Veblen, Commons) focuses on changes in community behavior, while the modern view (Esman, Siffin) emphasizes formal and informal organizations. Esman [9] calls institutional building a structural process to encourage changes in values, technology, social functions, and new relationship patterns for the sustainability of the organization. Technology and social innovation are drivers of changes in values and behavior. This theory emphasizes the importance of adapting to external pressures so that organizations gain legitimacy [10]. Therefore, institutional building requires organizations to build networks and adapt to external expectations for institutional effectiveness and stability.

The United Nations Development Programme [1] in Sulaiman [2] includes five elements: context, organizational capacity, stakeholder involvement, learning and adaptation, and institutional transformation. This theory is relevant in evaluating the institutionalization of railway vocational schools such as PPI Madiun in the era of the Industrial Revolution 4.0. A dynamic external environment, the need for increased internal capacity, synergy with industry, adaptability, and institutional transformation are the keys to realizing responsive, innovative, and sustainable vocational institutions in facing the challenges and needs of the modern industrial world.

3. Method

The qualitative research method with a case study approach was chosen to deeply understand the phenomena that occurred at the Indonesian Railway Polytechnic (PPI) Madiun in the context of facing the challenges of the Industrial Revolution 4.0. This method is considered appropriate because it allows for in-depth analysis of complex phenomena in real situations [11]. The case study approach facilitates the exploration of policies, organizational structures, and factors that influence the success or obstacles in implementing institutional models [12].

This research uses Creswell [13] purposive sampling technique, meaning that the researcher chooses individuals and places to be researched because they can specifically provide an understanding of the research problems and phenomena in the study.

This study uses data collection techniques in the form of observation, in-depth interviews, and documentation. The validity of the data is guaranteed through extended observation and triangulation of sources and time. Data analysis follows the Miles and Huberman model, which includes data condensation, data presentation, and concluding. This process aims to understand patterns, themes, and relationships between data to produce valid and accountable findings.

4. Results and Discussion

4.1. Result

4.1.1. Institutional Evaluation at the Indonesian Railway Polytechnic (PPI) Madiun

Institutional evaluation at PPI Madiun shows that this institution must pay attention to the external context, organizational capacity, stakeholder engagement, learning and adaptation, and institutional transformation to remain relevant and sustainable in the era of the Industrial Revolution 4.0. Through active involvement of various stakeholders and the implementation of continuous learning methods, PPI Madiun can ensure that it remains relevant and able to meet the needs of the ever-growing railway industry. The right institutional transformation will enable the institution to achieve its strategic goals and make a significant contribution to the development of competent human resources in the railway sector.

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4.1.2. Obstacles Faced in the Institutional Implementation of the Indonesian Railway Polytechnic (PPI) Madiun

Various obstacles faced in the implementation of the PPI Madiun institution. These obstacles include aspects of external context, organizational capacity, stakeholder involvement, learning and adaptation, and institutional transformation. To overcome these obstacles, a comprehensive strategy is needed, such as improving coordination with the government, strengthening collaboration with industry, digitalizing the learning process, and transforming a more innovative and adaptive organizational culture. By overcoming these obstacles, PPI Madiun can become a stronger vocational education institution and be able to produce superior human resources in the railway sector.

4.1.3. Institutional Model of Indonesian Railway Polytechnic (PPI) Madiun in Adapting to the Industrial Revolution 4.0

The PPI Madiun institutional model that is adaptive to the Industrial Revolution 4.0 must be based on the five main elements of the United Nations Development Programme [1]. By considering the external context, increasing organizational capacity, strengthening stakeholder involvement, implementing learning and adaptation, and carrying out institutional transformation, PPI Madiun can become a leading vocational education institution capable of producing professional workers in the railway sector. Digital-based transformation and strategic partnerships with industry will be the key to realizing PPI Madiun's vision in the Industrial Revolution 4.0 era. To face the Industrial Revolution 4.0, PPI Madiun needs to transform through collaboration with the Corporate Polytechnic. Steps that must be taken include updating the curriculum based on digital technology, improving the quality of lecturers and facilities, implementing the smart campus concept, and close partnerships with industry. This transformation will produce graduates who are ready to work and relevant to industry needs, making PPI Madiun a leading vocational education institution that supports technology-based economic growth.

4.2. Discussion

4.2.1. Institutional Evaluation at the Indonesian Railway Polytechnic (PPI) Madiun

The results of the institutional evaluation of the Indonesian Railway Polytechnic (PPI) Madiun show that to answer the challenges of the Industrial Revolution 4.0, this institution needs to strengthen its institutional foundations through five key dimensions, namely external context, organizational capacity, stakeholder involvement, learning and adaptation processes, and institutional transformation.

From the external context, PPI Madiun is required to adjust its development direction to national strategic needs and global trends in the rail-based transportation sector. The mismatch between the curriculum and the latest technology used by the railway industry is one of the main issues. One of the program managers said, *"We try to constantly adapt, but often the speed of industry development exceeds the ability of institutions to adapt structurally."*

Then, organizational capacity still needs to be improved, especially in terms of the availability of digital technology-based infrastructure and improving the competence of educators. This is directly related to the effectiveness of the implementation of vocational learning that is relevant to the world of work.

The involvement of stakeholders, including both from the government, industry players, to alumni, is also considered less than optimal. This strategic collaboration is the key to strengthening the link and match between education and job market needs. In an interview with one of the industry partners, it was stated that, *"We are ready to support PPI, but we need more intense communication and involvement from the start in curriculum development."*

Appropriate and sustainable institutional transformation will open up opportunities for PPI Madiun to become a pioneer in railway vocational education in Southeast Asia, especially in producing human resources who are not only competent but also adaptive to changes in technology and the market.

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4.2.2. Obstacles Faced in the Institutional Implementation of the Indonesian Railway Polytechnic (PPI) Madiun

This study found that institutional implementation at the Indonesian Railway Polytechnic (PPI) Madiun faces various structural and functional obstacles that affect the effectiveness of the institution in responding to the demands of the Industrial Revolution 4.0. The first obstacle lies in the external context, especially the dynamics of regulations and the rapidly changing needs of the railway industry. PPI Madiun often lags in aligning the curriculum and learning technology with industrial developments. A resource person from the leadership ranks said,*"We realize that industry needs are changing very rapidly, but institutional adaptation is still limited to rigid regulations and lengthy bureaucracy."*

Second, in terms of organizational capacity, limitations in modern infrastructure, competent teaching staff, and internal management are the main obstacles. This is exacerbated by the minimal active involvement of external stakeholders, such as industry and professional certification institutions, in designing applicable learning programs. One lecturer stated, *"We need more concrete support from industry, not only in the form of formal cooperation, but also involvement in the teaching and learning process."*

Third, the learning and adaptation process at PPI Madiun has not fully adopted a digital and responsive approach. Digital transformation is still in its early stages, and the organizational culture does not fully support innovation and flexibility.

To overcome these obstacles, a comprehensive strategy is needed, such as strengthening multi-actor collaboration, increasing human resource capacity, transforming organizational culture, and integrating digital technology. If these steps are implemented consistently, PPI Madiun has great potential to become a superior vocational education institution in the railway sector.

4.2.3. Institutional Model of Indonesian Railway Polytechnic (PPI) Madiun in Adapting to the Industrial Revolution 4.0

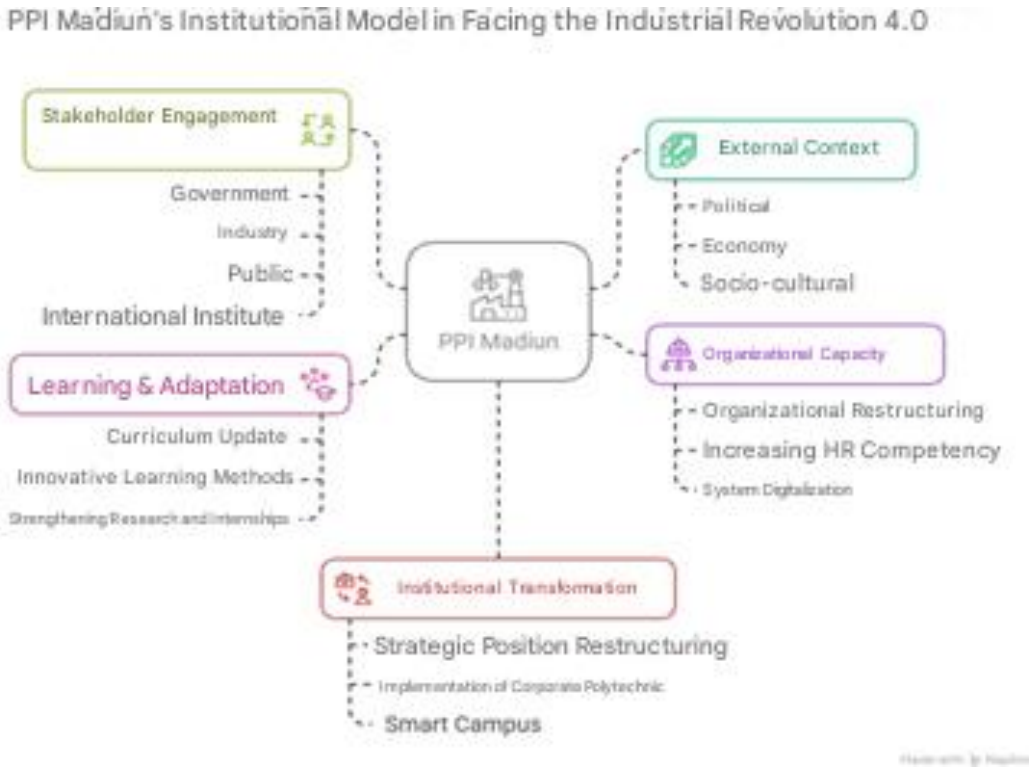

Figure 1.
Institutional Model of Indonesian Railway Polytechnic (PPI) Madiun in Adapting to the Industrial Revolution 4.0

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Indonesian Railway Polytechnic (PPI) Madiun has a strategic role in preparing professional personnel in the railway sector. In facing the Industrial Revolution 4.0, PPI Madiun must develop its institutions to be more adaptive, innovative, and responsive to technological developments and industrial needs. Based on the United Nations Development Programme [1] in Sulaiman [2] there are five main elements that can be a framework in designing an institutional model for PPI Madiun that is in accordance with the challenges of the digital era.

1. External Context

The external context includes the political, economic, social and cultural environment that influences the PPI Madiun institution:

1. Political Environment: Government policies related to vocational education and railway infrastructure development are important factors. Regulations that support the application of technology in vocational education must be integrated into the management strategy of PPI Madiun.
2. Economic Environment: Budget constraints in vocational education require more efficient financial management and the search for alternative sources of funding, such as partnerships with industry.
3. Social Environment: Public perception of vocational education needs to be strengthened by demonstrating the quality of graduates who are ready to work in the railway industry.
4. Cultural Environment: Education at PPI Madiun must adapt to the work culture of the railway industry, which requires high discipline and punctuality.

2. Organizational Capacity

Organizational capacity reflects PPI Madiun's ability to carry out its functions effectively and efficiently:

1. Organizational Structure: PPI Madiun needs to build a flexible and digital-based organizational structure to support transparent and accountable governance. Establishment of new units to support performance such as the Railway Technology Development Center and the Vocational Business Incubation Center.
2. Human Resources: The competence of teaching staff and administrative staff must be improved through continuous training related to railway technology, big data, and the Internet of Things (IoT).
3. Financial System: PPI Madiun must adopt a digital-based financial management system to improve efficiency, accountability, and transparency in the use of funds.
4. Information Systems: Implementation of Learning Management System (LMS) and cloud-based academic information system will support real-time integration of learning and administration.

3. Stakeholder Engagement

Collaboration with stakeholders is essential in improving institutional effectiveness:

1. Government: Cooperation with the Ministry of Transportation and the Ministry of Education in developing industry-based vocational education policies.
2. Private Sector: The railway industry, such as PT INKA, PT KAI and other railway operators, can be involved in curriculum development, training and recruitment of graduates.
3. Civil Society: Community participation can be strengthened through community-based education programs and socialization of the importance of vocational education in the world of work.
4. International Institutions: PPI Madiun can collaborate with international railway educational institutions and industries for technology transfer and academic exchange programs.

4. Learning and Adaptation

To remain relevant in the era of the Industrial Revolution 4.0, PPI Madiun must continue to innovate:

1. Curriculum Evaluation: The curriculum must be updated regularly to keep up with technological developments in the railway sector, such as artificial intelligence (AI), IoT, and digital-based railway systems.

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2. Learning Methods: Implementation of dual system learning methods based on technology, such as e-learning, augmented reality (AR), and virtual reality (VR), to improve the technical skills of cadets.
3. Research and Development: Increasing research and development capacity in the field of railway technology to produce innovations that can be applied in the industry.
4. Internship and Work Experience Programs: Strengthening real-life project-based industrial internship programs to enhance cadets' practical skills and work experience.

5. Institutional Transformation

Institutional transformation is needed to ensure the sustainability of PPI Madiun in facing the Industrial Revolution 4.0:

1. Adaptive Organizational Structure of institutional development in accordance with the needs of the Industrial Revolution 4.0. requires an organizational structure that is adaptive to change. The changes in organizational structure are related to changes in function and nomenclature which will later have a crucial role in ensuring institutional effectiveness, namely:
    1. Deputy Director for Academic and Cadet Affairs Responsible for the development of industry and technology-based curriculum, including digital learning systems and cadetship.
    2. Deputy Director for Administration and Finance Manages financial resources, education fund management, and seeks alternative funding.
    3. Deputy Director for Industrial Development and Cooperation Facilitate strategic cooperation with the railway industry to support internship programs and the implementation of the Dual System and Alumni.
2. Industrial Development and Cooperation Sector the Industrial Development and Cooperation Sector at PPI Madiun has a strategic role in bridging the relationship between academics and the railway industry to ensure that graduates are ready to face challenges in the Industrial Revolution 4.0 era.
    1. This division is responsible for establishing partnerships with the railway industry, both nationally and internationally, to increase industry involvement in education. This partnership includes providing internship facilities, joint research, and developing training programs that are in line with the needs of the labor market.
    2. In addition, this field coordinates internship programs and industrial certification for cadets so that they gain hands-on experience and have professionally recognized competencies. Internships and certifications are an important part of increasing the competitiveness of graduates. To encourage innovation, this field also plays a role in the development of industry-based research, such as automation and digitalization of railway transportation. Finally, this field strengthens the alumni network and industrial relations to open wider job opportunities for PPI Madiun cadets and ensure that graduates can contribute optimally to the industry.

5. Conclusion and Suggestions

5.1. Conclusion

Institutional evaluation at the Indonesian Railway Polytechnic (PPI) Madiun highlighted the importance of five main aspects: external context, organizational capacity, stakeholder engagement, learning and adaptation, and institutional transformation. The obstacles faced include the inconsistency of the curriculum with technological developments, limited facilities, and less than optimal collaboration with industry. To overcome this, PPI Madiun needs to implement a comprehensive strategy, such as digitalization of learning, strengthening cooperation with the government and industry, and innovative organizational culture transformation. In responding to the Industrial Revolution 4.0,

The institutional model of PPI Madiun is directed at strengthening the five elements of the United Nations Development Programme [1]. Digital transformation, application of the concept of *smart campus*, improving the quality of human resources, and partnerships with corporate polytechnic become

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a strategic step. Curriculum updates based on digital technology and close cooperation with industry are expected to produce competent and work-ready graduates, making PPI Madiun a leading vocational institution in supporting the railway sector and technology-based economic growth.

5.2. Suggestion

Based on the analysis conducted, there are five important recommendations to improve the institutional effectiveness of the Indonesian Railway Polytechnic (PPI) Madiun. First, strengthening organizational capacity is needed so that PPI Madiun becomes a resilient, adaptive vocational institution that is able to face changes in industry and regulations. Second, alternative funding strategies are a solution to budget constraints by encouraging industry partnerships, grants, and performance-based financing schemes. Third, the implementation of an integrated management information system is important to improve efficiency, transparency, and accountability in academic and administrative management. Fourth, technology-based learning models such as *e-learning*, *VR*, and *AR* needed to adjust learning methods to the development of the Industrial Revolution 4.0. Fifth, collaboration with industry through internship programs, co-teaching, and curriculum development based on industry needs is very important in increasing the relevance and work readiness of cadets. These five recommendations complement each other in realizing PPI Madiun as a leading vocational education institution that is highly competitive, responsive to technological developments, and able to produce competent human resources that are relevant to the needs of the railway sector.

5.3. For Further Researchers

Based on the analysis of challenges and opportunities at PPI Madiun, there are three important research recommendations to be developed. First, the Industry Collaboration Model in Learning and Practicum, which highlights the importance of strategic partnerships between vocational schools and industry in the form of internships, co-teaching, and curriculum based on the needs of the work world. Second, the Effectiveness of the Dual System Program, which combines theoretical learning and industrial practice. This research can examine the implementation, challenges, and strategies to improve the effectiveness of this system, as well as compare it with best practices from other countries. Third, the Sustainable Funding Model, which explores alternative sources of funding such as private partnerships, grants, and performance-based financing schemes to support the independence and sustainability of the institution. These three topics are important in realizing PPI Madiun as a superior vocational education institution, highly competitive, and responsive to the dynamics of the ever-growing railway industry.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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