THE CHALLENGE OF IMPLEMENTATION INDONESIA INDUSTRY 4.0 READINESS INDEX (INDI 4.0) IN INFRASTRUCTURE COMPANY
CASE STUDY: AT PT. HUTAMA KARYA (PERSERO)

Martin Hutagalung[1], Leo Aldianto[2]
[1,2] Master of Business Administration, School of Business and Management, Institut Teknologi Bandung, Indonesia
email: martin_hutagalung@sbm-itb.ac.id, leo.aldianto@sbm-itb.ac.id

ABSTRACT

This study examines the challenges faced by PT Hutama Karya (Persero) in achieving a score of 4.0 on the Indonesia Industry 4.0 Readiness Index (INDI 4.0), highlighting the gap between current industrial practices and the optimal outcomes set by the INDI 4.0 framework. Through qualitative and quantitative research methodologies, this study conducts an in-depth gap analysis across various domains such as management and organization, human resources and culture, products and services, technology, and company operations to evaluate the current state of digital transformation within the company. The findings indicate significant gaps in strategic alignment, technology adoption, and employee engagement with digital initiatives. These gaps contribute to the current INDI 4.0 score of 3.56, limiting the company's progress toward the desired level of industrial readiness. Additionally, survey results show a score of 3.25, indicating that PT Hutama Karya is still in the early stages of implementation with uneven technology adoption. Strategic recommendations are proposed to bridge these gaps, including enhanced strategic coordination, strengthened technology integration, and the development of a digital-supportive culture. These strategies are designed to facilitate a smoother transition to Industry 4.0 for PT Hutama Karya and provide a framework applicable to similar companies in the infrastructure sector. This research contributes to a broader understanding of the digital transformation challenges within the construction and infrastructure industry, offering a detailed roadmap for effective Industry 4.0 implementation.

KEYWORDS	*Digital Transformation, Infrastructure Companies, Industry 4.0, Gap Analysis, Technology Adoption, Construction Sector, Strategic Solutions*

INTRODUCTION

PT Hutama Karya (Persero) (PTHK) is a state-owned enterprise (SOE) that operates in construction services, development, and toll road services. PTHK is a construction company whose shares are 100% owned by the Government of the Republic of Indonesia through the Ministry of State-Owned Enterprises (MSOE) as the shareholder. To accelerate toll road development in Sumatra, the Government assigned PTHK through Presidential Regulation Number 100 of 2014, which was amended in Presidential Regulation Number 42 of 2024 concerning the Acceleration of Toll Road Development in Sumatra. This regulation mandates PTHK to expedite the operation of 24 (twenty-four) sections of the Trans Sumatra Toll Road ("JTTS") stretching approximately 2,700 kilometres from Lampung Province to Banda Aceh Province. The scope of the assignment includes funding, technical planning, construction implementation, operation, and preservation. (Perpres No.42, 2024). In receiving the task to operate toll roads in Sumatra, PTHK has transformed from a construction company into a Construction and Toll Road company. A construction service company and a toll road enterprise are two distinct business entities operating in the construction and infrastructure sectors. Although both operate within the same industry, the construction service company focuses more on providing construction services and project implementation, while the toll road enterprise is more involved in the development, operation, and maintenance of toll road infrastructure. (Didik Mulyanto et al., 2022). With the increase in business lines, and the increasing number of assets that will be managed to meet the needs of the organization and the challenges in its business processes, PTHK must ensure that at this time and in the future, it is always adaptive and can face existing challenges, including at this time, namely related to Technology Disruption. Technology disruption is interpreted as a fundamental change due to the development of digital technology systems, where digital technology begins to replace and change the role and work conducted traditionally / manually. (Kurniawan & Aruan, 2021). This development of digital technology is also referred to as the industry 4.0 revolution, characterized by the increasing use of the Internet of Things (IoT), which has disrupted various aspects of human life. Industry 4.0 is also marked by high connectivity of information systems and the emergence of various artificial intelligences that allow industries to operate with minimal human input. The concept of the industry 4.0 Revolution happening worldwide has resulted in revolutionary changes. Adapting to technology disruption involves transitioning from older technologies that relied more on physical processes to digital technologies that can produce entirely new, more useful, and more efficient outcomes in a short period of time.

Therefore, it is deemed necessary for PTHK to undergo changes through Digital Transformation, which is required for the future sustainability of the company's business. To ensure this transformation proceeds effectively, aligning with the aspirations of its shareholders—namely the state-owned enterprises—it is mandatory for PTHK to conduct an assessment using the Indonesia Industry 4.0 Readiness Index (INDI 4.0) to measure the industry's readiness to transition towards Industry 4.0. In 2022, according to the verification results of INDI 4.0, PTHK

scored 2.88, indicating there are still gaps that need to be addressed by PTHK to achieve a score of 3.0 in 2023, 3.5 in 2024, and 4.0 in 2025, which would indicate the company has fully transformed. Given the current conditions faced by PTHK, there is a need for strategies to support the success of digital transformation.

This research aims to evaluate PTHK level of readiness in the transition to Industry 4.0, identify key gaps that can hinder the digital transformation process, and formulate a comprehensive strategy that will help companies close these gaps. Designing new strategies and initiatives to ensure successful implementation and create added value for PTHK and other stakeholders.

In this research, the focus is on digital transformation and implementation of INDI 4.0 framework at PTHK. This research will include Gap analysis on INDI 4.0 implementation. Development of strategies to close existing gaps and to achieve INDI 4.0 targets by 2024 and beyond. Identify employee competency development needs and development programs needed to support digital transformation.

This research is limited to available and accessible data and information regarding digital transformation and implementation of INDI 4.0 framework at PTHK.

RESEARCH METHOD

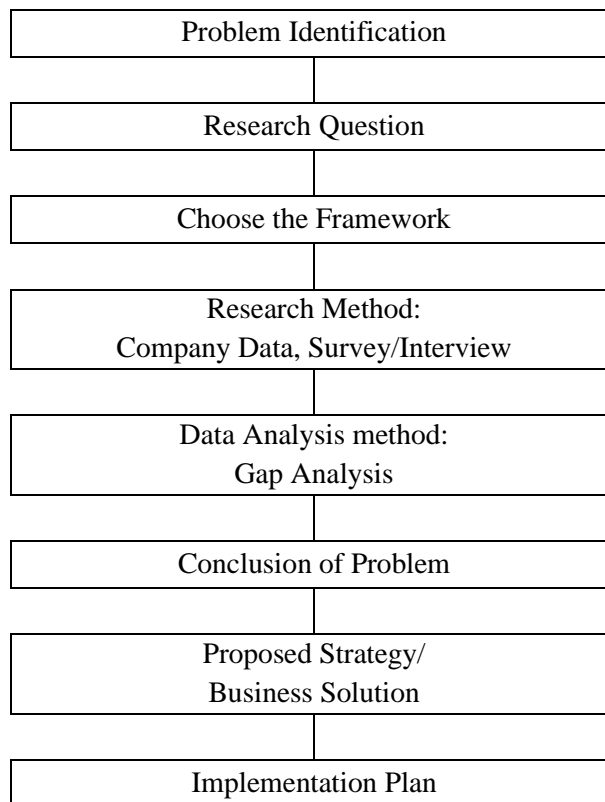This study will use steps as described below:

Figure 1 Research Design

The research begins by identifying the main factors contributing to the gap between the current level of digital transformation readiness and the desired level in PTHK. Conduct

The Challenge Of Implementation Indonesia Industry 4.0 Readiness Index (Indi 4.0)
In Infrastructure Company Case Study: At Pt. Hutama Karya (Persero)

9444

a thorough examination of the existing literature on digital transformation, Industry 4.0 implementation, and similar case studies to gain contextual insights and understanding. Data will be collected through a case study and gap analysis approach, which involves a detailed analysis of the current situation, and challenges faced by PTHK in the implementation of INDI 4.0. The collected data will be analysed to identify gaps in digital transformation readiness and to propose strategies to close those gaps. This research will also assess the impact of INDI 4.0 implementation on PTHK's operations and business processes. This research aims to contribute by providing targeted strategies and initiatives based on successful case studies and industry best practices, particularly tailored to the context of PTHK. Research methodology uses quantitative and qualitative methods. Quantitative to determine the Company's current state of readiness/maturity in facing Industry 4.0. Qualitative, to determine the priority pillars that must be improved, comparison of statements, opinions, arguments, facts of writing/sentences.

To assess PTHK's readiness for digital transformation, initial data collection on the company is crucial. This study leverages the methodology from INDI 4.0 as outlined in the Ministry of Industry Regulation No. 21 of 2020, ensuring no deviation from the substance of INDI 4.0. The required data for each pillar, as shown in Table III.1, are collected accordingly.

Further validation of the alignment between available documents and the implementation of INDI 4.0 at the company is conducted through a survey targeting the INDI 4.0 Transformation Team at PTHK. This team is tasked with overseeing and ensuring the success of the digital transformation. Data collection in this study employs survey methods as per the guidelines provided in the INDI 4.0 book published by the Ministry of Industry. The survey includes 23 questions related to the INDI 4.0 pillars, detailed in the 'Question' column of Table III.1, and additional questions encompassing seven company information queries and three transformation challenge queries. Data collection will involve a mixture of qualitative methods, document analysis and internal reports that have been owned by the company. In accordance with the research criteria requested in the INDI 4.0 Framework, the following data are needed for further analysis.

For a comprehensive analysis of a company's readiness in the implementation of Industry 4.0, a multi-dimensional approach should be used to assess various pillars of the organization, as outlined in the document. This involves collecting and analysing both quantitative and qualitative data across several key areas that have been clearly detailed in the assessment criteria. Data or documents that have been categorized according to the five predetermined pillars are then evaluated, scored, and assigned a maturity level. Each document is assessed using a maturity level from 0 to 4, where 0 indicates no implementation or readiness, and 4 indicates a high level of implementation or readiness. This assessment determines the company's overall maturity level in aspects related to Industry 4.0. Based on the scores, a gap analysis is conducted to identify areas lacking readiness or capability, which is essential for pinpointing improvement or development needs in the company's Industry 4.0 strategy. This value is derived by analyzing the parameters of each pillar and field according to the framework.

RESULTS AND DISCUSSION

The findings from the research highlight several critical gaps in PTHK approach to the implementation of Industry 4.0 standards. This analysis is supported by a mixed research strategy encompassing the collection of both qualitative and quantitative data. Methodologies such as interviews, surveys, and document analysis were employed to

gather comprehensive insights into the company's current practices and areas requiring improvement.

The present research conducted a survey of the INDI 4.0 Team at the PTHK to evaluate their readiness for digital transformation as part of the data analysis. The INDI 4.0 Team, comprising a set of predetermined members, was tasked with overseeing the entire process of activities. This team was also responsible for reviewing the recommendations from the previous assessment, mapping the gaps, and ensuring that all the necessary evidence was properly fulfilled. Furthermore, the team collaborated with other divisions to collect and coordinate the fulfilment of the evidence. The purpose of this survey was to identify the key areas requiring improvement and to measure the success of the implementation strategy based on feedback from the team members. The respondent consisted of 26 individuals, with the following details:

Table 1 Research Respondent

No	Respondent	No	Respondent
1	Eexecutive Vice President Division of Systems, IT & Technology Research	14	Vice President of Corporate Planning
2	Vice President of Information Technology	15	Vice President of Human Capital
3	Vice President of Digital Construction	16	Vice President of Legal
4	Vice President of Systems & Research	17	Manager of Risk Management Division
5	Manager of Systems & Research	18	Manager of Internal Audit Unit
6	Manager of Information Technology	19	Manager of QHSSE Division
7	Officer of Systems & Research	20	Manager of PBI & KPBU Division
8	Officer of Systems & Research	21	Manager of Toll Road Planning Division
9	Officer of Digital Construction	22	Vice President of Toll Road Operations and Maintenance
10	Officer of Information Technology	23	Vice President of Toll Road Construction
11	Officer of Systems & Research	24	Vice President of General Civil Division
12	Vice President of Accounting & Finance	25	Vice President of Building Division
13	Manager of Corporate Secretary	26	Vice President of EPC Division

Survey Result

The document or data analysis results show that PTHK currently stands at Level 4, according to the INDI 4.0 framework, which corresponds to a score range of 3.51 – 4.00. This score indicates that PTHK has effectively implemented Industry 4.0 practices. To reinforce these findings, a survey was subsequently conducted with the INDI 4.0 working team at PTHK, which consists of representatives from the employees tasked with ensuring the success of the company's digital transformation. The characteristics of the respondents are outlined in Table IV.1. This survey provides insights into the real implementation of Industry 4.0 from the perspective of those directly involved in the transformation at PTHK.

The Challenge Of Implementation Indonesia Industry 4.0 Readiness Index (Indi 4.0)
In Infrastructure Company Case Study: At Pt. Hutama Karya (Persero)

The INDI 4.0 scores from this survey were calculated using a weighted average method. Employing a weighted average in the analysis of survey results offers a more accurate and representative view of the opinions from different categories of respondents. This method is crucial in research aimed at understanding diverse perspectives based on respondents' roles or levels of involvement within the organization, especially in the context of implementing Industry 4.0 transformation. Thus, this analysis can yield more targeted recommendations for the improvement and development of the company's transformation strategy. The weighted average results provide values that more accurately reflect the significance of opinions from each respondent category. The survey results for each pillar are displayed in Tables IV.20 to IV.24.

Based on the table mentioned above, a summary of the INDI 4.0 score calculation based on the perceptions of the transformation agents at PTHK is provided in Table 2

Table 2 score INDI 4.0 based on Survey

No	Pillar & Area	Score base on Survey	Average	Weight	Score
a	b	c	d	e	f = d x e
1	**Management and Organization**				
	Strategy and Leadership	3.52			
	Industry 4.0 Investment	4.00	3.61	17.5%	0.63
	Innovation Policy	3.31			
2	**People and Culture**				
	Culture	3.06			
	Openness to Change	3.65	3.56	30.0%	1.07
	Competency Development	3.96			
3	**Product and Services**				
	Product Customization	3.04			
	Data-Driven Services	4.00	3.35	17.5%	0.59
	Smart Products	3.00			
4	**Technology**				
	Cybersecurity	4.00			
	Connectivity	3.00	3.07	17.5%	0.54
	Smart Machine	3.00			
	Digitization	2.27			
5	**Company Operation**				
	Data storage and sharing	3.69			
	Smart supply chain and logistics	2.00	2.42	17.5%	0.42
	Autonomous/automated processes	2.00			
	Intelligent treatment system	2.00			
	SCORE INDI 4.0				**3.25**

The survey results indicate that PTHK currently holds an INDI 4.0 score of 3.25. According to the INDI 4.0 framework, this places the company at Level 3, which corresponds to a score range of 2.51 – 3.50. This level demonstrates that PTHK is in a mature stage of implementing Industry 4.0. At this stage, the company has begun to apply Industry 4.0 principles comprehensively, although not yet fully across all lines of operation.

Comparison And Discussion

A comparison between the results of the document analysis and the result of the survey shows some significant differences in the perception of the readiness of the company:

1. In the management and organizational pillar, a document analysis reveals that PTHK has a comprehensive strategy outlined in its RJPP, ITMP, and HCMP, with strong managerial support for the transformation towards Industry 4.0. Substantial investments have been made in technology and competence development, including training initiatives. Surveys indicate a high level of optimism regarding the company's commitment to digital investment; however, the implementation of innovation strategies and policies has not been fully maximized across all areas. While PTHK has taken a significant step in its transformation, there remains room for improvement in the implementation at the operational level.

2. In the People and Culture Pillar, document analysis indicates that PTHK has a strong organizational culture that supports digital transformation, as evidenced by the results of the AKHLAK and Employee Engagement surveys. However, the survey results suggest that the perceived organizational culture among employees is not yet fully aligned with the documented culture. The level of openness to change is high, but the implementation still faces challenges. The continuous competency development program is recognized and appreciated by the team, with survey scores nearly equal to the document analysis.

3. The document analysis suggests that product customization at PTHK is quite satisfactory, with numerous products tailored to meet customer needs, which is in line with the survey results indicating significant customization. According to the documents, the utilization of data in the services is already optimal, and the survey even assesses the use of data as highly beneficial for service enhancement. The integration of smart technology into the products is still in the initial stages, but there are already some implementations, with the survey indicating that the implementation of smart products still requires further improvement. Overall, the survey results are consistent with the document analysis, highlighting the need for further enhancement in certain areas.

4. In Technology pillar, the document analysis indicates that the implementation of PTHK's cybersecurity is satisfactory, with the organization holding the ISO 27001 certification and receiving a positive ITML assessment. However, the survey results suggest a higher evaluation of cybersecurity measures. The document review also reveals that the connectivity is adequate, but the survey notes challenges in optimization. The use of smart machines is deemed appropriate, yet the survey results suggest that the implementation is not fully optimized. Digitalization is ongoing, involving various domains, but the survey highlights significant challenges and uneven application, with a lower score compared to the documentary evidence.

5. In Company Operation, the document analysis indicates that the data storage and sharing system at PTHK is already in good condition, utilizing cloud technology and internal servers, while the survey assesses this system as running well and effectively, with a higher score. The use of smart technology

The Challenge Of Implementation Indonesia Industry 4.0 Readiness Index (Indi 4.0) In Infrastructure Company Case Study: At Pt. Hutama Karya (Persero)

9448

in the supply chain and logistics is evaluated positively in the documents, but the survey shows that the implementation in the field still faces many challenges, with a lower score. The implementation of automated processes is considered good in the documents, but the survey reveals that many processes are not yet fully automated. Smart maintenance still needs to be improved according to the documents, and the survey shows that this system is still in its early stages and requires many improvements, with a consistent score.

The analysis of documents and surveys shows gaps between documented policies and actual implementation. While there are good strategies and plans, operational-level realization and perception need improvement. Therefore, strategic recommendations focus on strengthening management support, internalizing culture, optimizing digitalization, and enhancing automated processes and smart supply chains. The next step is to conduct a gap analysis to identify specific areas for improvement and develop more targeted strategies to achieve Industry 4.0 transformation goals by 2025.

Gap Analysis

Gap analysis is a crucial process for identifying differences between actual and expected performance in an organization. In the context of PTHK's digital transformation towards Industry 4.0, the following is a detailed GAP analysis for each pillar based on document analysis, survey results, and the company's targets:
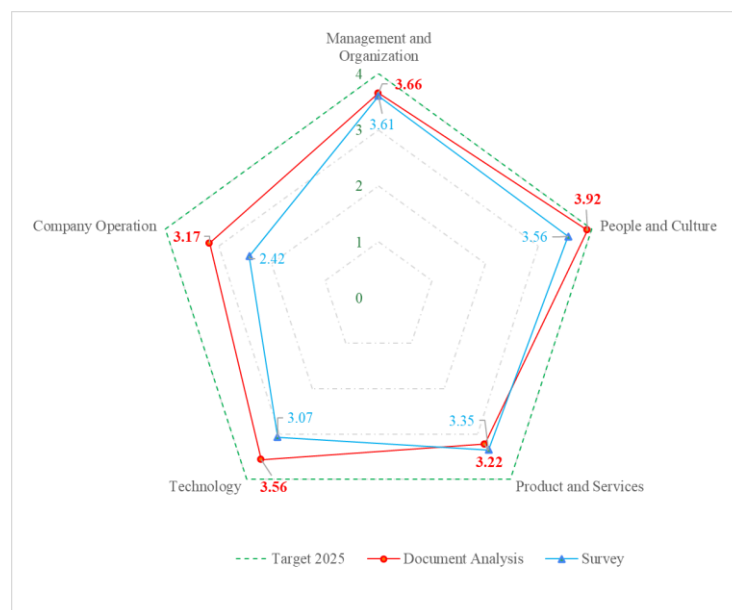

Figure 2. Gap Review INDI 4.0 PTHK

The assessment of the INDI 4.0 PTHK score has been presented in accordance with the results of document analysis and validated through a survey on the implementation by the transformation actors within the Company. As previously discussed, the Company has reached Level 4 based on documentary or evidence-based assessment, with a score of 3.56. However, the field survey

indicates that the score is currently at Level 3 with a score of 3.25, which means that PTHK is in the mature stage for the implementation of Industry 4.0.

According to the transformation roadmap of the company, the organization is required to achieve a readiness score of 4.0 by the year 2025, which implies attaining Level 4 and consistently implementing digitalization across all business processes. There exists a gap between the current score of the company and the target that must be reached. This encompasses a gap in fulfilling the necessary documentation to support INDI 4.0, as well as the implementation in the field. To mitigate this gap, improvements need to be made across all pillars of Industry 4.0. This section presents an analysis of the discrepancy between the company's current score and the established target.

Management and Organization

The management and organizational pillars, based on document analysis, received a score of 3.66, and based on survey results, they received a score of 3.61. According to the INDI 4.0 Framework, this score indicates that the organization has reached Level 4, which means that the management and organization have already implemented Industry 4.0. However, there are still gaps as follows:

A. Strategy and Leadership
    The document analysis indicates that the company has a comprehensive strategy reflected in its Long-Term Corporate Plan (RJPP), Information Technology Master Plan (ITMP), and Human Capital Management Plan (HCMP). This strategy encompasses all divisions of the company, with a focus on technology utilization and talent development. However, the survey results suggest that the implementation of this strategy has not been fully realized across all operational lines.
    Causes of the Gap:
    *   Lack of Effective Communication: The primary cause of this gap is the ineffective communication between top management and the operational divisions. When strategic plans are not communicated effectively, there can be discrepancies in understanding and implementation at the operational level.
    *   Lack of regular and thorough monitoring by top management, making it challenging to assess the effectiveness of strategy implementation and its alignment with the company's long-term goals.

B. Industry 4.0 Investment
    According to the document analysis, PTHK received a score of 3.50 in terms of Industry 4.0 investment. This means that the costs and investments to support the readiness for Industry 4.0 in the current year are relatively high, both for IT and non-IT areas. The realization of these investments is monitored and evaluated on an ongoing basis. However, the analysis of the impact of technology use has not been validated by external or independent parties. Meanwhile, the results of the field survey show that this area has already received a score of 4, where employees are already aware that the Company's investment to transform to Industry 4.0 is at level 4, but it is not

The Challenge Of Implementation Indonesia Industry 4.0 Readiness Index (Indi 4.0)
In Infrastructure Company Case Study: At Pt. Hutama Karya (Persero)

9450

accompanied by the creation of studies related to the analysis and impact of technology use on business processes.

Causes of the Gap:

- Lack of External Validation: The main reason for this gap is the absence of external validation for the investments made, which makes the impact evaluations less objective. External validation by independent experts or consultants could provide a more unbiased assessment of how effectively the investments are contributing to Industry 4.0 readiness.
- The information about the impacts of technology is not evenly distributed among employees due to ineffective internal communication. This discrepancy leads to a lack of shared understanding or visibility of the benefits and challenges associated with these technological investments.
- The company's focus is more on the implementation of technology rather than on the evaluation of its impact. This approach can lead to a scenario where technology is deployed without a thorough understanding of its effectiveness or without aligning it closely with the company's strategic goals.
- There are limitations in the methodology used for assessing the impact of technology investments. This deficiency results in insufficient data to support strategic decisions and affects employees' understanding of the benefits of technology investments.

C. Innovation Policy

The analysis of the document indicates that the innovation policy has been implemented and is running effectively, covering various fields and supported by a dedicated transformation team. However, in the field implementation, there are still some who believe that the current transformation team is not yet optimal, and the implementation of Industry 4.0 innovation has not been fully implemented in all areas of the company.

Cause of the Gap:

The rigid organizational structure and lengthy bureaucratic procedures can slow down the decision-making process and the implementation of innovations. This leads to an imbalance between the planning of innovation policies and their execution in the field. Additionally, the implementation of new technologies often faces unexpected technical challenges. Issues with integration, compatibility, and technology maintenance can hinder the adoption of innovations.

People and Culture

According to the document analysis, the Pillar People and Culture received a score of 3.92, while the survey results showed a score of 3.56. According to the INDI 4.0 Framework, this score places the organization at Level 4, indicating that the people and culture have already implemented Industry 4.0. However, there are still some gaps to be addressed, as follows:

A. Culture

Based on the document analysis, PTHK has a strong organizational culture that supports digital transformation, as evidenced by the results of the

AKHLAK survey and Employee Engagement. However, the perception of the organizational culture among employees may not yet fully align with the documented culture.

Cause of the Gap:

- Insufficient Socialization and Internalization of Cultural Values: Even though surveys like AKHLAK and Employee Engagement indicate a strong organizational culture, there may be insufficient efforts towards effectively socializing these cultural values among all employees. This includes regular, comprehensive communication and training to ensure that employees not only understand these values but also see their relevance and importance reflected in daily operations.
- Leadership plays a crucial role in reinforcing organizational culture. If divisional leaders are not fully committed to embodying and promoting these cultural values, it can lead to inconsistencies between the culture as documented and as experienced by employees. Leaders must actively demonstrate the cultural values in their management styles and decision-making processes.
- The difference in cultural perception among employees might be due to varying experiences in different parts of the organization. Some divisions might be more advanced in integrating cultural values into their operations, while others lag behind, leading to a mixed perception of the overall company culture.

B. Openness to change.

The document analysis indicates a high level of openness to changes, with positive AKHLAK survey results. The implementation and adaptation of changes still face some challenges, where most employees strongly support the changes and technological improvements in the company, but they may not necessarily be ready to support them by continuously learning about new technologies.

Cause of the Gaps:

- Resistance to Change: Despite a general openness to change, there can be inherent resistance among employees, especially when changes affect their routine or perceived job security. Resistance often stems from a lack of understanding about the benefits of the new technology or changes, fear of the unknown, or discomfort with adjusting to new ways of working.
- Another significant cause of the gap is the lack of adequate training and development opportunities related to new technologies. If employees are not properly trained or if they feel inadequately prepared to use new tools and systems, their readiness to support and engage with these changes diminishes.

C. Competency Development

The document analysis indicates that the organization has a continuous and effective competency development program, including digital training and workshops. The implementation of the competency development program is recognized and felt to be beneficial by the team, with scores almost equal to the document analysis. There is no significant gap, but it is necessary to

The Challenge Of Implementation Indonesia Industry 4.0 Readiness Index (Indi 4.0)
In Infrastructure Company Case Study: At Pt. Hutama Karya (Persero)

9452

ensure that the program continues and is adjusted to the latest needs. Regular evaluation is necessary to ensure that the competency development program remains relevant and effective.

Product and Services

According to the document analysis, Pillar Product and Services received a score of 3.22, and based on the survey results, it received a score of 3.35. In accordance with the INDI 4.0 Framework, this score places the company at Level 3, which means that the company's products and services have already transformed to Industry 4.0. The existing gap is as follows:

A. Product Customization

The analysis of the documents reveals that the level of product customization is quite good, with many products that have been adapted to customer needs. The implementation in the field shows that most of the products have undergone significant customization. Currently, most of the product customization is still in the development stage.

Cause of the Gap:

Lack of System Integration for Real-Time Customization: The primary issue seems to be the lack of integrated systems that can facilitate real-time customization according to customer needs. Effective customization requires robust, flexible systems that can quickly adjust and respond to varied customer specifications. Without such systems, there can be delays and inefficiencies in customizing products to meet specific client requirements.

B. Data-Driven Services

The analysis of the documents indicates that the use of data in the services has been optimal. According to the results of the team's survey, the use of data is seen as highly optimal and beneficial for improving the services. There is no significant gap, but there is a need to continuously enhance the analysis and utilization of the data. An improvement in analytical technology and more comprehensive data collection is required to address this gap.

C. Smart Products

The analysis of documents and surveys indicates that the implementation of smart products still needs to be improved. PTHK has reached a maturity level of 3 in the field of smart products, with a score of 3.00. Their products can be viewed and tracked online or in real-time through applications, such as the construction product (BIM) and the toll road product (HK Tol App). These products have a dashboard or other digital features that can display real-time information for consumers. The products and services (projects) also come equipped with smart features that can be accessed by customers, who can also be offered optimization for ongoing projects. However, there is no analysis provided on the impact of these smart products.

Cause of the Gap:

The lack of a comprehensive impact analysis on smart products has led to a lack of understanding about the benefits and added value generated by this technology. This also makes it difficult to evaluate the success and effectiveness of the smart products that have been implemented. Although

products can be monitored online and in real-time, the deep integration of systems between various smart technologies is still lacking. This limits the ability to provide truly integrated and holistic solutions for customers.

Technology

Based on document analysis, Pillar Technology received a score of 3.56, and according to the survey results, it received a score of 3.07. According to the INDI 4.0 Framework, this score means that the company's technology has already reached Level 3, indicating that the company has transformed to Industry 4.0. The existing gaps are as follows:

A. Cyber Security

Based on the supporting evidence, the assessment of the IT Maturity Level in the field of cybersecurity resulted in a score of 3.5. To reach level 4, the ITML (COBIT 2019) score must be at least 4. PTHK has obtained the ISO 27001 certification. A particular area of focus in this domain is the awareness program, which has been consistently implemented, but only through email blasts.

B. Connectivity

The document analysis indicates that the company's connectivity is adequate. However, the survey reveals that the optimization of connectivity usage has not been fully achieved. PTHK has implemented technology to communicate with partners through various systems, such as the use of the HK Circle application and toll road operations. While there are automated systems in place, particularly for toll roads, there are limitations in the online systems and automatic reporting for projects. There is a need to establish an operational flow for toll road payments with partners, from customers to banks, as well as in other business processes between HK and its partners.

Cause of the Gap:

The infrastructure has not fully supported optimal connectivity across all operational lines. The document shows good connectivity, but its implementation in the field, especially in projects outside the city, still needs to be improved.

C. Smart Machine

The evidence indicates the usefulness of employing Building Information Modeling (BIM) and smart machines. Specifically, for a total of 15 smart machines, to attain the highest score in 4 criteria, the score must surpass 15. Document analysis shows that the use of intelligent machines is already good, but the implementation of intelligent machines has not been fully optimized.

Cause of the Gap:

*   The lack of comprehensive training programs for employees is a major contributing factor to the suboptimal implementation of smart machines. Employees may not have the necessary skills or knowledge to fully utilize these advanced technologies. Effective training is crucial to ensure that staff are equipped not only with operational knowledge but also with an understanding of how to leverage these technologies for maximum benefit.

The Challenge Of Implementation Indonesia Industry 4.0 Readiness Index (Indi 4.0) In Infrastructure Company Case Study: At Pt. Hutama Karya (Persero)

9454

- Employees may struggle with adapting to new technologies due to a variety of reasons, including resistance to change, discomfort with new workflows, or simply not understanding the full scope of benefits that these technologies can offer. This adaptation challenge can significantly hinder the effective utilization of smart machines in daily operations.

D.   Digitization

The document analysis indicates that the digitization process is ongoing. However, according to the survey results, the implementation of the digitization process still faces numerous challenges and has not been fully applied in all areas. The organization has established a clear business process flow for each division, and the digitization initiatives have been assigned a value range from greater than 50% to 75%, suggesting the widespread use of applications across all divisions.

Cause of the Gap:

The cause of this gap is due to the lack of adequate digital infrastructure in most PTHK projects located in remote areas, as well as suboptimal training. The documents indicate efforts towards digitalization, but the implementation on the ground still needs to be improved.

Company Operation

Based on the document analysis, Pillar Company Operation received a score of 3.17, while the survey results yielded a score of 2.42. There is a significant gap in several areas, including:

A.   Data Storage and Sharing

PTHK has cloud-based data storage and processing technology, utilizing Microsoft OneDrive and SharePoint for IT-based data storage, as well as BIM360 for OT-based data storage. The company has an on-premises data center infrastructure, with ownership of the data center and data recovery center located in different areas. Additionally, PTHK requires procurement contracts or licenses for Microsoft OneDrive/SharePoint and BIM360. The integration of cloud technology with BIM and optimal Microsoft 365 integration can also serve as an alternative to a private cloud solution. The analysis of the documents and implementation shows that the data storage and sharing system is already good and effective. There are no significant gaps, but it is necessary to ensure that the system continues to run well. This is because there is a need to continuously update and optimize the data storage and sharing technology. Although the documents indicate a good system, maintenance and improvement are still required.

B.   Smart Supply Chain and Logistics

The provided evidence indicates the effectiveness of using the application. The system employed has been in continuous use, and there have been periodic improvements to the HK Circle (9 out of 27 existing technologies). However, further analysis is necessary to assess the feedback regarding the development of the HK Circle application within the IT department, as well as to evaluate the overall effectiveness of the supply chain and smart logistics technologies employed. The document analysis shows that the use of smart

technology in the supply chain and logistics is already good. Based on the survey results, the implementation in the field still faces many obstacles and is not yet optimal, as the respondents only know that there are 3 technologies or systems that support smart supply chains at PTHK now.

Cause of the Gap:

There appears to be insufficient communication and training on the features and benefits of the smart supply chain systems employed by PTHK. The knowledge about these systems is confined mainly to those within the supply chain department, which suggests that the broader employee base is not fully aware or does not understand how to utilize these systems effectively. The document shows good initiatives, but realization on the ground still needs to be improved.

C. Autonomous/automated processes

Analisis dokumen menunjukkan bahwa 80% proses bisnis di PTHK sudah menggunakan sistem otomasi, namun belum terlihat bukti dukung dari efektivitas dari teknologi yang bersifat otonom tersebut. Sedangkan dari hasil survey menunjukkan bahwa proses otonom ini masih berkisar 50% diterapkan.

Cause of the Gap:

The primary causes of this gap are inadequate evaluation and monitoring of the autonomous process, which can lead to a lack of constructive feedback. Without proper monitoring, management cannot ensure that the autonomous technology is functioning properly and meeting the expected objectives. Despite initiatives for automation, the existing technological infrastructure may not be fully adequate to support the autonomous process. These limitations may include outdated hardware, unsuitable software, or a lack of competent experts. The team involved in implementing the autonomous process may not receive adequate training on the new technology. Without proper training, employees may struggle to effectively adopt and utilize the autonomous technology.

D. Intelligent treatment system

The maintenance approach adopted by PTHK encompasses corrective, preventive, and predictive measures, based on their established system. The company has already implemented a preventive maintenance system, grounded in supporting evidence, with periodic maintenance carried out on its assets, and the inclusion of screenshot data in the maintenance system for heavy equipment and IT equipment maintenance systems on the server. The preventive and corrective maintenance systems are functioning well but have not yet reached a comprehensive predictive maintenance stage. The implementation of a predictive maintenance system would enable early detection and proactive handling of potential issues, leading to continuous improvement.

Cause of the Gap:

The current causes of the gap may be that the existing technological infrastructure does not fully support the implementation of a predictive maintenance system. For example, there may be a lack of sensors and IoT

The Challenge Of Implementation Indonesia Industry 4.0 Readiness Index (Indi 4.0) In Infrastructure Company Case Study: At Pt. Hutama Karya (Persero)

9456

devices required to collect real-time data from machines and equipment. Management may believe that the preventive maintenance system is sufficient, while field personnel may face challenges that are not visible to management, such as a lack of resources or technological support.

Business Solution

This section outlines strategic solutions to address the issues identified in the previous analysis. These solutions are designed to align PTHK with the industry 4.0 framework, ensuring a comprehensive digital transformation across all organizational pillars.

Management and Organization

To bridge the gap in management and organizational strategy, PTHK needs to strengthen the implementation of its strategic initiatives by ensuring that all strategic plans outlined in the RJPP, ITMP, and HCMP documents are comprehensively applied across all divisions. Regular monitoring and evaluation must be conducted to assess the impact of these strategies on business operations. Additionally, it is crucial to enhance management commitment by cultivating a strong support culture for digital transformation initiatives. The transformation roadmap must be updated periodically and communicated to all stakeholders to ensure alignment and commitment.

Furthermore, PTHK must allocate significant resources for the development of technology and talent. Engaging external consultants to validate the impact of technology investments will ensure objectivity and credibility in the evaluation process. This will enable the company to ensure that its management and organizational strategies support sustainable digital transformation.

To adapt and lead in the industry 4.0 era, PTHK requires a comprehensive transformation in its management and organization. In alignment with the INDI 4.0 Framework, the company faces the need to develop a strategy that supports the transition to a Digital Constructing Company.
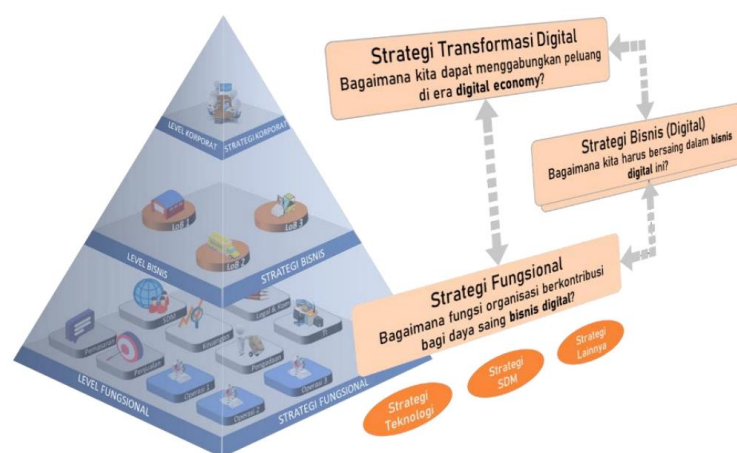

Figure 3 Digital Transformation Strategy

The concept of innovation can be classified in various manners, with some of these classifications exhibiting a degree of overlap. The objective of this communication is to elucidate the distinct approaches to innovation and how the different forms of innovations relate to the broader context. One method of classifying innovation is to do so based on two factors: the technology employed and the target market. The innovation matrix can be utilized to visually represent the most prevalent forms of innovation.
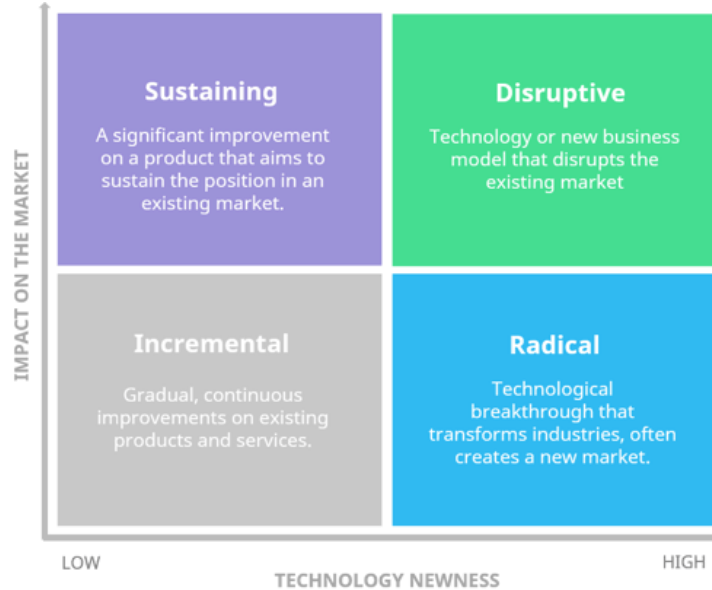
Figure 4 Innovation Technology Matrix (Kylliäinen, 2019)

People and Culture

The success of Digital Transformation towards Industry 4.0 within an organization is largely determined by the organization's digital readiness and capabilities in leadership, culture, and skills.(World Bank, 2021). To address the gap in human resources and culture, the organization must promote a digital culture throughout the entire organization. Programs that internalize the values of digital culture must be implemented at all levels. Surveys and feedback sessions should be conducted regularly to assess cultural alignment and address any discrepancies.
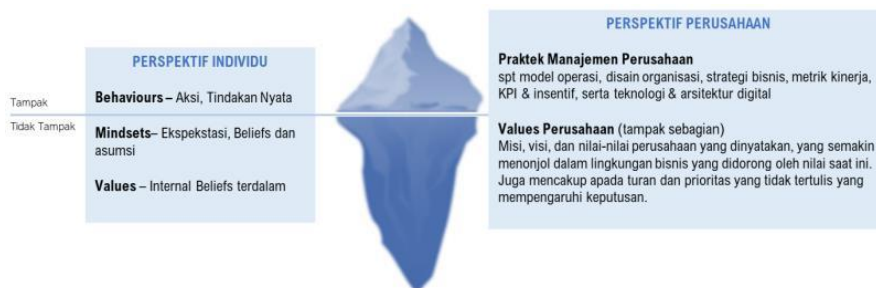

Figure 5 Culture Perspective

The Challenge Of Implementation Indonesia Industry 4.0 Readiness Index (Indi 4.0) In Infrastructure Company Case Study: At Pt. Hutama Karya (Persero)
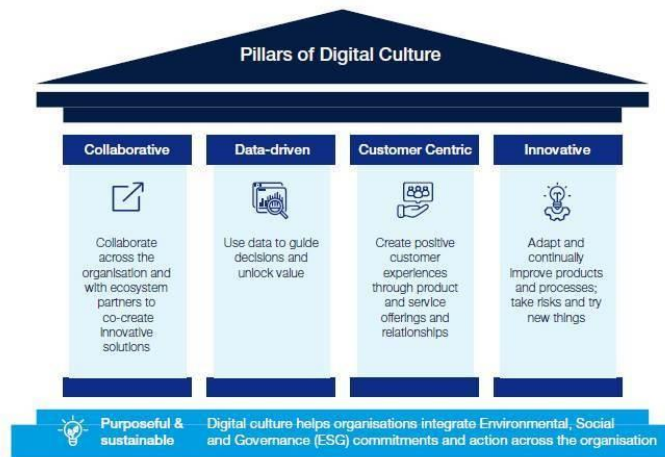
Figure 6 Pillar of Digital Culture (Smith & Heger, 2021)

To address the disparity in human resources and culture, PTHK must promote a digital culture throughout the organization. Programs that internalize the values of digital culture must be implemented at all levels. Surveys and feedback sessions should be conducted regularly to assess cultural alignment and address any discrepancies.
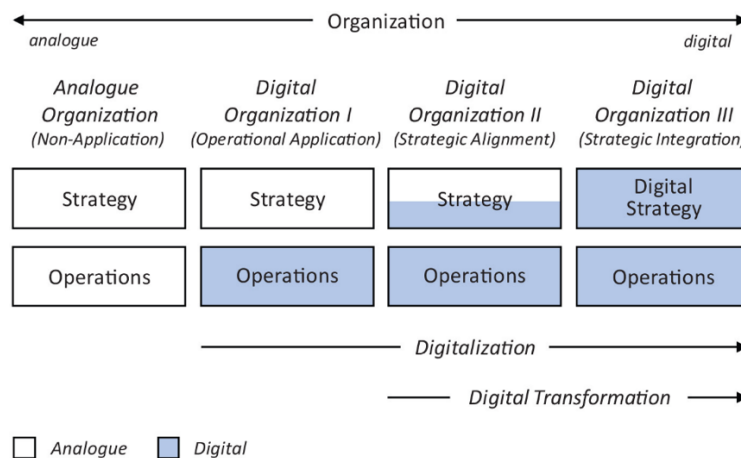

Figure 7 HC Digitalization (Strohmeier, 2020)

Product & Services

To augment the offering of products and services, the company must amplify its investment in research and development (R&D) to innovate and enhance their intelligent products. Partnering with technology providers and research institutions will ensure that the company remains at the forefront of technological advancements. The implementation of a systematic impact analysis is also necessary to assess the effectiveness and efficiency of the intelligent products. Data-driven insights should be utilized to optimize the features and functions of the products, ensuring they meet the needs and expectations of customers.The passage

emphasizes the importance of PTHK ensuring widespread implementation of smart products across all relevant projects and divisions. It states that training and support must be provided to employees to effectively use and manage smart technologies. This enables the company to align its products and services with technological advancements and customer needs.

Additionally, the text highlights the need for marketing and sales strategies in the digital economy to be aligned with the evolving 5A framework (Aware, Appeal, Ask, Act, Advocate) or Customer Journey Map. This poses a challenge for companies in the era of Marketing 4.0, as they must ensure consumers are aware of their branded products, develop interest, seek information, make purchases, and engage in repeat purchases and recommendations.
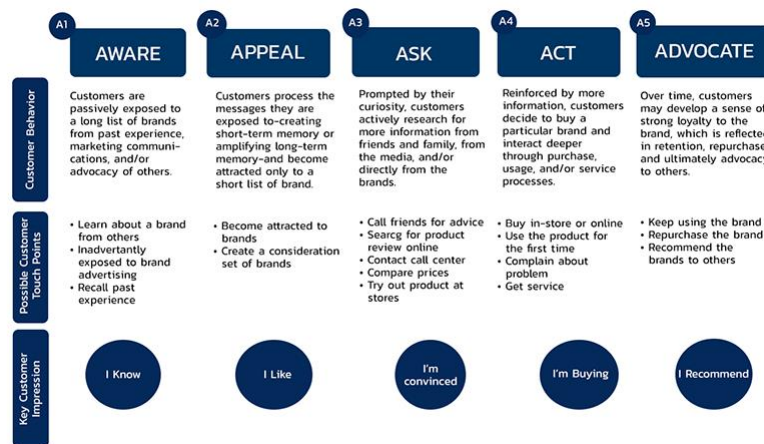

Figure 8 5A Framework (Philip Kotler et al., 2017)

Technology

To address the technological gap, the company must focus on improving digital infrastructure and investing in advanced technologies. Investments in modernizing IT and OT infrastructure are necessary to support sophisticated digital applications. Robust cybersecurity measures must be implemented to protect digital assets and data. Moreover, the company should adopt cutting-edge technologies such as AI, IoT, and machine learning to drive operational efficiency and innovation.

The company should establish pilot projects to test and refine the implementation of these technologies before widespread deployment across the organization. A framework for continuous improvement must be developed to regularly evaluate and enhance digital technologies. A culture of innovation should be fostered by encouraging experimentation and iterative development of digital solutions.

Company Operation

To optimize the company's operations, PTHK must focus on improving data management, automation, and maintenance processes. Advanced data storage and processing solutions must be implemented to ensure efficient and secure data

The Challenge Of Implementation Indonesia Industry 4.0 Readiness Index (Indi 4.0)
In Infrastructure Company Case Study: At Pt. Hutama Karya (Persero)

9460

management. Cloud technology should be leveraged to enable real-time data access and collaboration across the organization.

PTHK must expand the scope of autonomous and automated processes to achieve higher operational efficiency. Employees must be trained on the management and optimization of automated systems. Additionally, the company must transition from a preventive maintenance system to a predictive one to enhance asset reliability and lifespan. IoT sensors and advanced analytics must be utilized to monitor equipment health and predict maintenance requirements.

Implementation Plan & Justification

The implementation plan to ensure that PTHK can close the gap towards Industry 4.0 and reach level 4, which indicates that the industry has partially implemented Industry 4.0 and is highly prepared to undergo a widespread transformation to Industry 4.0.
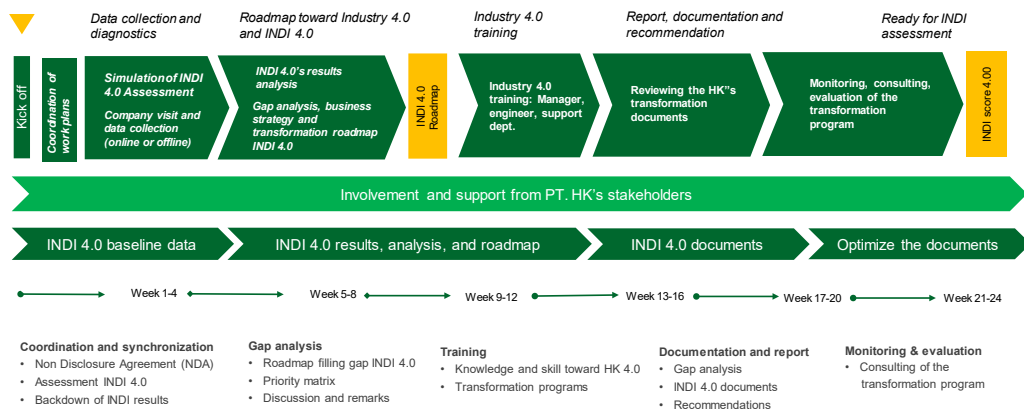

Figure 9 Implementation Plan

Based on the implementation plan shown in Picture IV.10, the implementation plan for the PTHK digital transformation program is designed to ensure that all activities focus on closing the gap between evidence and implementation, as well as to ensure the quality and sustainability of the program. To achieve this goal, the plan recommends the assistance of consultants who are experts in the field of digital transformation. The plan is as follows:

Figure IV. 1 Mentoring & Training Program Work Plan

This plan will certainly cost money as shown in the following table:

Table IV. 1 Justify Budged

No	Service	Output	Time	Budged
A	INDI 4.0 Assessment Assistance Services	The achievement of the INDI 4.0 PTHK 4.0 target value by the year 2025.	5-7 Month Paraliel	Rp. 500.000.000/Package
	Assistance in making roadmaps (Impact Plan INDI 4.0	The roadmap impact plan aims to address the gaps in fulfilling INDI 4.0 and the company's transformation to Industry 4.0. It ensures that the INDI 4.0 value of PTHK experiences an increase in accordance with the targets set by the shareholders.		
	INDI 4.0 Gap Fulfillment assistance services	Ensuring the fulfillment of the INDI 4.0 gap that has been established in the roadmap is achieved by the year 2024.		
	Review of PTHK Digital Transformation	Providing input towards the improvement and adjustment of the transformation roadmap in accordance with the company's requirements.		
B	Awareness Industry 4.0	Ensuring shared understanding and engagement of all employees regarding the company's Industry 4.0 transformation program, understanding the general stages of the transformation process, and gaining insights into best practices from companies that have already undergone transformation.	3 Hours	Rp. 9.000.000/Package
C	Industry 4.0 Transformation Manager Training	Manager/Head of department with knowledge of Industry 4.0 transformation, who can plan, supervise, and evaluate Industry 4.0 implementation projects comprehensively and effectively.	5 Day	Rp. 5.000.000/Person
	Industry 4.0 Transformation Engineer Training	Ttechnical engineer who has the knowledge to guide the transformation towards Industry 4.0 and can implement projects in a detailed and measurable manner	4 Day	Rp. 4.000.000/Person
	Industry 4.0 Training for Supporting Department	The organization is seeking individuals who hold managerial or departmental leadership positions within non-technical departments. These candidates should possess an open-minded approach to the company's transformation program and demonstrate the capability to develop and execute work plans that support the preparatory, implementation, and evaluation stages of the company's transition to Industry 4.0.	3 Day	Rp. 3.000.000/Person

CONCLUSION

The purpose of this research is to evaluate the readiness of PTHK in facing the digital transformation towards Industry 4.0, identify the gaps that hinder the transformation process, and develop a strategy to bridge these gaps. Based on the results of document analysis and surveys, several key conclusions can be drawn.

Firstly, the level of PTHK's readiness for Industry 4.0, based on the analysis of documents and surveys, indicates that PTHK scored 3.56 on the Indonesia Industry 4.0 Readiness Index (INDI 4.0). This score suggests that the company has begun the digital transformation but has not yet achieved full readiness. This score reflects that PTHK is in the initial implementation stage of its Industry 4.0 strategy,

The Challenge Of Implementation Indonesia Industry 4.0 Readiness Index (Indi 4.0)
In Infrastructure Company Case Study: At Pt. Hutama Karya (Persero)

9462

where most business processes have adopted basic digital technologies, but are not yet fully integrated and optimized.

Secondly, the gap analysis identifies several key obstacles that hinder the progress of PTHK's digital transformation. For example, the document analysis shows that PTHK has an innovation policy in place, but the survey results reveal that its implementation is not yet optimal across all areas or departments, resulting in a score of 3.25 in this assessment. This score indicates that although there are initiatives and policies that support innovation, the implementation still faces challenges, such as a lack of resources, resistance to change, and inadequate training.

Thirdly, to bridge these gaps and support the success of the digital transformation, a strategy is required that includes enhancing strategic coordination, strengthening technology integration, and developing a culture that supports digitalization. PTHK needs to strengthen management commitment, develop a strong digital culture, and increase investment in R&D and advanced technologies to ensure a smoother transition to Industry 4.0. These conclusions address the research questions by showing that while PTHK has taken important steps in the digital transformation, there are areas that require significant improvement to achieve full readiness.

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The Challenge Of Implementation Indonesia Industry 4.0 Readiness Index (Indi 4.0)
In Infrastructure Company Case Study: At Pt. Hutama Karya (Persero)

9464