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Challenges and Opportunities for Sustainability of Human Resource Development in Industry 4.0

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ABSTRACT – This study aims to analyze the challenges and opportunities for sustainability-focused human resource development in the industrial era 4.0. Based on the literature analysis, it was found that the main challenges include the lack of integration of sustainability in training programs, resistance to new technologies, and the lack of synergies between the government, private sector, and educational institutions. In addition, the competency gap between industry needs and workforce skills is also a significant obstacle. However, the industrial era 4.0 also creates strategic opportunities to integrate sustainability through technological innovations such as IoT (Internet of Things) and cyber-physical systems, multi-stakeholder collaboration, and the adoption of green human resource management principles. If taking advantage of these opportunities, organizations can improve workforce competencies while supporting long-term sustainability goals. This study provides important insights for policy makers and organizations to design HR training strategies relevant to the industrial era 4.0.

Keywords: Industrial Era 4.0, Sustainability, HR Training, Digital Technology, green human resource management, The Circular Economy.

A. INTRODUCTION

The development of Industry 4.0 has transformed various sectors, including Human Resource Management (HRM). This transformation is fueled by the integration of digital technologies that include automation, artificial intelligence, and big data analytics. However, sustainability-focused HR development in industry 4.0 still have significant challenges. Ghobakhloo (2020) showed that the adoption of digital technologies provides great opportunities, but it also requires the adoption of new skills that are often out of reach for most of the workforce.

In the perspective of sustainability, Bag et al. (2021) noted that the implementation of circular economy in industry requires human resources who are not only have technically competent but also able to understand sustainability principles. However, the development of these competencies is often inhibited by the lack of comprehensive policy support. Darmawan et al. (2020) also emphasized that employee loyalty and performance will be affected if companies do not provide relevant training.

Regulations concerning sustainability-based human resource development are also inadequate. Law Number 13 Year 2003 on Manpower, for example, does not provide a strong legal basis for integrating sustainability in workforce training. Fantini et al. (2020) emphasized that the lack of attention to regulations leads to an imbalance between available technology and workforce competencies.

According to Hecklau et al. (2016), the success of HR management in the industry 4.0 era is highly dependent on a systemic approach involving training, development, and continuous evaluation. Benesova and Tupa (2017) add that HR development in industry 4.0 requires education reform to create a workforce capable of meeting evolving technological requirements.

Another problem is the lack of coordination between the government, private sector and educational institutions to create sustainability-oriented training programs. Flores et al. (2020) pointed out that sustainability-focused workforce development requires synergy between various stakeholders. Such synergy remains a major challenge as each sector often works in a separate manner.

Kaasinen et al. (2020) identified that workforces in industry 4.0 often experience competency gaps caused by the lack of technology integration in the training process. This deficiency makes the workforce unable to utilize the full potential of digital technology,

and consequently productivity remains low despite substantial investment in technology.

Kadir et al. (2019) showed that ergonomic aspects and human factors in industrial design 4.0 are often ignored. This has resulted in work stress and a decrease in workforce's quality of life. Meanwhile, Agarwal et al. (2022) noted that the disruption presented by industry 4.0 technology creates additional challenges for the sustainability of HR management, especially in developing countries.

This issue becomes more complex with the lack of focus on sustainability in the existing training programs. Benesova dan Tupa (2017) explain that education and training is often only focused on technical skill without including sustainable principles. Ghobakhloo (2020) was emphasized that this strategy insufficient to fulling the future needs of the industry.

The imbalance between technological mastery and sustainability in human resource development indicates that regulatory need to reform. Hecklau et al. (2016) recommend a more adaptive framework to integrate technology and sustainability in training. But, until now, such a framework has not yet become a priority in national policy.

Another identified issue is the resistance from workforces toward new technology-based training. Darmawan (2024) show that the workforce often feels uncomfortable with most fast technological changes, especially if the training provided is not relevant to their needs. This creates an additional challenge for improving HR competencies.

Finally, Flores et al. (2020) noted that the development of sustainability-based HR competencies requires adjustments to organizational culture. Organizational cultures that are conservative often inhibit innovation in HR management.

While previous studies have addressed the challenges of industry 4.0, there is a gap in understanding about integrating sustainability in HR management. Studies on the synergy between technology, sustainability and HR development are limited. This paper makes a novel contribution by analyzing the regulatory and practical challenges to integrating sustainability into HR development in industry 4.0. It also offers a strategic perspective for creating more adaptive training models.

This study aims to identify challenges in sustainability-focused HR development in the industrial era 4.0 and explore opportunities that can be utilized to improve the effectiveness of technology-based HR training and sustainability principles.

B. METHOD

This study uses a descriptive qualitative approach with a focus on analyzing the literature related to the challenges and opportunities of developing human resources focusing on sustainability in the industrial era 4.0. This approach is suitable for understanding the dynamics of HR management based on digital technology and sustainability, as explained by Creswell and Creswell (2018), who mentioned that qualitative studies are effective for exploring complex social phenomena.

The data sources in this study come from secondary data, including books, scientific journals, research reports, and policy documents related to HR development and sustainability. The data collection method was conducted through an in-depth literature study, as suggested by Bryman (2016), which emphasizes the importance of utilizing credible and relevant literature sources to gain comprehensive insights.

To ensure the validity and legitimacy of the data, this study used document triangulation techniques. Cooper and Schindler (2014) explain that document triangulation involves comparing and verifying information from various sources to ensure the accuracy and reliability of the data obtained. In this study, data from scientific literature, organizational reports, and relevant regulations were analyzed simultaneously to obtain objective results.

Data analysis was conducted using a descriptive-qualitative method, which included identifying key issues, grouping data by theme, and interpreting the results to answer the problem formulation. Denzin and Lincoln (2017) mentioned that this approach allows researchers to understand the interaction between technological factors, sustainability, and HR management in the industrial era 4.0 holistically.

The main guide in this analysis is the theoretical framework related to HRM in the industrial era 4.0, including studies on sustainability and digital technology adoption. Data obtained from scientific and policy literature was reviewed to identify key challenges as well as opportunities that can be optimized in sustainable HR development.

C. RESULTS AND DISCUSSION

Key Challenges in Sustainability of HR Development in the Industrial Era 4.0

Human resource development (HRD) in the industrial era 4.0 faces a number of complex and interrelated challenges. One of the main challenges is the lack of adaptation of digital technology in HR training programs. Romero et al. (2016) note that although the "Operator 4.0" concept is designed to create a symbiosis between humans and automation technology, the implementation of this concept in developing countries is often constrained by limited infrastructure and lack of technology-based training. The "Operator 4.0" concept is an approach that aims to create a harmonious symbiosis between humans and automation technology in a modern industrial environment. In the Industry 4.0 era, with advanced technologies such as artificial intelligence, Internet of Things (IoT), and robotics increasingly dominating the production process, the role of human operators has become very important. Operators not only serve as machine controllers, but also as the link between automated systems and more complex decision-making processes. This concept has emphasized the importance of effective collaboration between humans and machines to improve efficiency, productivity, and innovation.

However, the implementation of the Operator 4.0 concept in developing countries is facing significant challenges. One of the main obstacles is the limited existing infrastructure. Many developing countries are still grappling with basic issues such as unstable electricity access, limited internet networks, and inadequate technology facilities. This has hampered the industry's ability to adopt the automation technologies required to support the Operator 4.0 concept.

In addition, the lack of technology-based training is also a crucial issue. Many workforces in developing countries haven't the skills to operate in an environment that is increasingly saturated with advanced technology. Without proper training, they will struggle to adapt to new systems and utilize the full potential of technology. These limitations in technology-based education and training create a skills gap that can get in the way of industrial progress and reduce competitiveness in the global market.

Therefore, while the Operator 4.0 concept offers great opportunities to improve productivity and efficiency, infrastructure and training challenges in developing countries need to be resolved for the potential to be realized. Collaborative efforts between the government, private sector and educational institutions are essential to create an ecosystem that supports technological development and improves workforce skills, so that the Operator 4.0 concept can be effectively implemented and provide significant benefits to industry and society.

Kazancoglu and Ozkan-Ozen (2018) showed that another challenge is the lack of understanding of the new competencies required by industry 4.0. They mentioned that many organizations have failed to identify and prioritize relevant technical and managerial skills, such as programming, data analytics, and managing cyber-physical technologies. This problem is exacerbated by the lack of synergy between the government, private sector and educational institutions to design relevant training programs.

Shamim et al. (2016) stated that resistance to change is also the main obstacle in the implementation of technology-based training. Employees often feel uncomfortable with rapid technological change, especially if the training provided is not relevant to their needs or doesn't involve inclusive methods. This situation is also reinforced by Werdati et al. (2020), who noted that the lack of social support and adequate remuneration can demotivate employees to participate in new training programs.

In the scope of sustainability, Guzmán et al. (2020) note that visionary leadership and strong managerial skills are necessary to encourage the implementation of sustainability-based training programs. However, many organizations still do not have a leader with these competencies, so the implementation of sustainability strategies is often only partial and not integrated with the organization's vision. Rojak (2024) emphasized that transformational leadership has an important role to play in developing organizational commitment. Transformational leaders not only motivate and inspire organizational members but are also able to align individual goals with the organization's vision for sustainability. In both the education and business sectors, the lack of leaders with transformational capabilities means that sustainability implementation is likely to be hampered by internal resistance and lack of collective support.

Nuraini et al. (2024) state the importance of reliable information systems to support the

implementation of sustainability-based programs, especially in micro, small and medium enterprises (MSMEs). The implementation of effective information systems can help organizations manage resources more efficiently and ensure accountability in the implementation of sustainability strategies. However, the adoption of these technologies still challenges, including the lack of competent human resources to operate the systems. This suggests that the lack of integration between strong leadership and technological support can be a main barrier to the implementation of a comprehensive sustainability strategy. Therefore, to drive sustainability, organizations need not only visionary leadership but also adequate technological and system support. The synergy between transformational leadership capabilities, organizational commitment, and adaptive information systems can be the key to success in implementing sustainability strategies in a more effective and integrated manner.

According to Darmawan et al. (2021), one of the biggest challenges in sustainability-based HR management is the lack of awareness of the importance of a psychological perspective to face Society 5.0. The transformation to the digital era requires not only technological mastery, but also mental and emotional adaptation from a workforce. This is relevant to the findings of Wulandari and Darmawan (2024), who mentioned that emotional intelligence plays an important role to improve employee performance, including to manage the transition to a technology-based work environment.

Another challenge is the technology gap between organizations that have adopted advanced technology and those that still use manual systems. Longo et al. (2017) note that human-centered approaches in industry 4.0, such as "smart operators," often cannot be implemented effectively if they are not accompanied by investments in adequate infrastructure. This gap creates significant obstacles to creating competent and sustainable human capital.

Kipper et al. (2021) added that the challenges of HR development in the industrial era 4.0 also involve a lack of access to scientific information about the competencies needed. They noted that the policymakers and organizations often do not have a clear roadmap of relevant skills for the digital era. As a result, training programs are tend to be generic and do not cover industry-specific needs.

Eddine et al. (2023) emphasize that knowledge management and quality of work life are two very important aspects in developing employee commitment to technological changes that occur in the work environment. In the context of digital transformation, employee commitment is key to ensuring that the changes implemented can be accepted and carried out properly. When employees feel that they have access to relevant knowledge and the quality of their work life is taken care of, they tend to be more open and ready to adapt new technologies.

However, in many organizations, knowledge management and improving the quality of work life are not yet a priority. This can be due to a whole range of factors, including a lack of understanding of their importance, limited resources, or a greater focus on other aspects of the business. As a result, many employees feel disengaged or unsupported in the face of technological change. This internal resistance comes in response to uncertainty and concern about the impact of change on their jobs.

An organization's inability to effectively manage knowledge and improve the quality of work life can slow down the digital transformation process. When employees feel unprepared or unsupported, they may decline to participate in initiatives related to new technologies. Therefore, it is important for organizations to prioritize knowledge management and pay attention to quality of work life as part of their digital transformation strategy. By creating an environment that supports and empowers employees, organizations can reduce resistance and accelerate the adoption of new technologies, there by achieving the transformation goals.

Mardikaningsih (2024) notes that the effectiveness of sustainability-based HR management is strongly influenced by the organization's ability to apply the principles of Green Human Resource Management (GHRM). However, many organizations have not integrated GHRM into their HR strategy, causing sustainability management to be unoptimal.

Finally, Rojak (2024) showed that HR transformation in the industrial era 4.0 requires strong organizational commitment and a transformational leadership approach. Without this commitment, training and development programs are likely to lose their way and fail to make a significant impact.

Opportunities to Integrate Sustainability in Technology-based HR Training in the Industrial 4.0 Era

The industrial era 4.0 opens up great opportunities to integrate sustainability in HR training through innovative technology-based approaches. One significant opportunity is the development of training models that utilize Internet of Things (IoT) technologies and cyber-physical systems to improve learning efficiency and effectiveness. According to Guzmán et al. (2020), these technologies enable more integrated training, where the worker can learn with simulations that are close to real work situations, so that the skills learned are more relevant to the needs of the organization.

Hecklau et al. (2016) state that sustainability in training can be achieved by developing adaptive learning approaches. This opportunity is increasingly relevant as technological advances allow organizations to design training based on the specific needs of each individual. This way, workers can obtain skills that match the demands of the industry, while understanding how their contributions support sustainability.

According to Flores et al. (2020), sustainability-oriented HR development can also be integrated through strategic partnerships between organizations and educational institutions. In the era of industry 4.0, this collaboration enables the development of training curriculum that includes aspects of sustainability and advanced technology. This opportunity can be utilized to bridge the skills gap between the existing workforce and industry needs.

Fantini et al. (2020) noted that Operator 4.0 solutions designed for modern industries can be adapted to a human-centered training approach. This approach not only improves workers' technical competencies but also supports sustainability goals through more efficient resource management. This opportunity aligns with the need to develop a workforce capable of adapting to advanced technologies while still maintaining sustainability principles.

Benesova and Tupa (2017) emphasized the importance of investing in sustainable education and training to prepare the workforce for the challenges of industry 4.0. Sustainability-oriented education can be delivered via e-learning-based training programs that not only provide flexibility but also reduce environmental impacts, such as paper use and physical travel.

Kaasinen et al. (2020) identified opportunities for increased workforce engagement through the implementation of Operator 4.0 solutions. These technologies enable workforce to take a more active role in sustainability-based work processes, for example by using smart devices to monitor energy efficiency in the workplace. This initiative can be applied more broadly to encourage HR engagement in sustainability goals.

Bag et al. (2021) point out that the adoption of circular economy as a sustainability principle can be a strategic opportunity in HR training. Circular economy-based training enables workers to understand how to manage resources efficiently and minimize waste. This initiative can be implemented by involving the private sector to design relevant training programs.

Kadir et al. (2019) noted that ergonomic aspects and human factors in industrial design 4.0 can be utilized to create a more sustainable training environment. Organizations can use ergonomic approaches to improve the comfort of workers during training, resulting in more optimal training outcomes.

Nuraini et al. (2024) highlight the significant opportunities that arise from implementing accounting information systems (AIS) to support sustainability efforts within organizations. One of the key advantages of integrating such technology is its potential to improve transparency and accountability in managing financial resources, which are crucial components of sustainable business practices. By utilizing AIS, organizations can not only streamline their financial processes but also ensure that their financial activities are conducted in a transparent manner, allowing stakeholders to easily access and verify financial data.

The implementation of AIS in the context of sustainability goes beyond just improving internal operations; it serves as a tool for fostering a culture of responsibility and ethical conduct. For example, these systems can track the allocation of resources toward sustainable projects, monitor the environmental and social impacts of business decisions, and generate reports that align with sustainability goals. This is particularly important as companies are increasingly expected to report on their environmental, social, and governance (ESG) performance to meet the growing demands of regulators, investors, and consumers for greater accountability.

Furthermore, AIS can be used as a platform for training employees, particularly those involved in financial management, on how to effectively manage resources in a way that aligns with sustainability principles. Training workers on the proper use of these systems not only enhances their technical skills but also helps them understand the broader impact of their financial decisions on the organization's long-term sustainability goals. By empowering employees with the right tools and knowledge, organizations can ensure that financial practices are in line with sustainable development, leading to more informed decision-making processes across all levels of the company.

The integration of accounting information systems to support sustainability offers numerous benefits for organizations. It not only improves financial transparency and accountability but also facilitates training that equips employees with the necessary skills to manage resources sustainably. By adopting such systems, organizations can create a more accountable and ethical financial framework that supports their sustainability objectives, ultimately contributing to a more sustainable future.

Wulandari and Darmawan (2024) emphasized the importance of integrating emotional intelligence in HR training in the industrial era 4.0. By emphasizing the importance of interpersonal skills, this training can create a workforce that is not only technically competent but also able to support collaboration and sustainability in the workplace.

These opportunities confirm that the integration of sustainability in HR training not only enables the improvement of individual competencies but also supports the long-term goals of organizations and industries in the era of industry 4.0.

D. CONCLUSIONS

The study provides some key conclusions on the challenges and opportunities for sustainability-focused human resource development in the Industrial era 4.0. First, key challenges include the lack of sustainability integration in training programs, resistance to new technologies, lack of sustainability leadership, and competency gaps between industry needs and workforce skills. The lack of synergy between the government, educational institutions and the private sector is also a main obstacle to creating relevant training programs.

On the other hand, the industrial era 4.0 also opens up great opportunities to integrate sustainability principles in HR training. The use of digital technologies such as IoT, cyber-physical systems, and online-based learning platforms allows organizations to optimize training. Strategic collaboration between various parties also provides an opportunity to develop a relevant training curriculum that supports sustainability principles. The application of circular economy principles and GHRM are potential strategies that can increase the effectiveness of sustainability-based HR management.

Organizations and governments need to enhance the regulatory framework that supports sustainability-based HR development in the industrial era 4.0. This regulation should include incentives for companies that implement sustainability-oriented training. Investment in technological infrastructure to support digital-based training is needed, especially in areas that are not yet covered by technology.

Organizations also need to leverage technologies that include virtual simulations and data analytics to identify specific training needs. Training programs should be flexibly designed to be customized to the needs of individuals and specific industry sectors. Organizational leaders need to develop transformational leadership skills to drive the integration of sustainability in the work culture.

To support long-term sustainability, collaboration between the government, private sector and educational institutions needs to be enhanced. This synergy can include the development of sustainability-based curriculum, certification programs, and the development of competency models relevant to the Industrial era 4.0. Engaging the workforce in sustainability initiatives through relevant training will increase their commitment to organizational goals.

REFERENCES

Agarwal, V., K. Mathiyazhagan, S. Malhotra, & T. Saikouk. 2022. Analysis of Challenges in Sustainable Human Resource Management due to Disruptions by Industry 4.0: An Emerging Economy Perspective. *International Journal of Manpower*, 43(2), 513-541.

Bag, S., G. Yadav, P. Dhamija, & K. K. Kataria. 2021. Key Resources for Industry 4.0 Adoption and its Effect on Sustainable Production and Circular Economy: An Empirical Study. *Journal of Cleaner Production*, 281, 1-12.

Benesova, A. & J. Tupa. 2017. Requirements for Education and Qualification of People in Industry 4.0. *Procedia Manufacturing*, 11, 2195-2202.

Bryman, A. 2016. *Social Research Methods 5th Edition*. Oxford University Press, United Kingdom.

Cooper, D. R. & P. S. Schindler. 2014. *Business Research Method 12th Edition*. McGraw Hill, New York.

Creswell, J. W. & J. D. Creswell. 2018. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches 5th Edition*. SAGE Publications, Thousand Oaks.

Darmawan, D. 2020. The Quality of Human Resources, Job Performance and Employee Loyalty. *International Journal of Psychosocial Rehabilitation*, 24(3), 2580-2592.

Darmawan, D., Febriyanti, A. A. G. S. Utama, S. Aisyah, Marasabessy, D. A. Larasati, F. W. Roosinda, & I. Aziz. 2021. *Psychological Perspective in Society 5.0*. Zahir Publishing, Yogyakarta.

Darmawan, D. 2024. Distribution of Six Major Factors Enhancing Organizational Effectiveness. *Journal of Distribution Science*, 22(4), 47-58.

Denzin, N. K. & Y. S. Lincoln. 2017. *The SAGE Handbook of Qualitative Research 5th Edition.* SAGE Publications, Thousand Oaks.

Eddine, B. A. S., D. Darmawan, R. Mardikaningsih, & E. A. Sinambela. 2023. The Effect of Knowledge Management and Quality of Work Life on Employee Commitment. *Journal of Human Sciences*, 10(1), 87-100.

Fantini, P., M. Pinzone, & M. Taisch. 2020. Placing the Operator at the Centre of Industry 4.0 Design: Modelling and Assessing Human Activities within Cyber-physical Systems. *Computers & Industrial Engineering*, 139, 1-7.

Flores, E., X. Xu, & Y. Lu. 2020. Human capital 4.0: A Workforce Competence Typology for Industry 4.0. *Journal of Manufacturing Technology Management*, 31(4), 687-703.

Ghobakhloo, M. 2020. Industry 4.0, Digitization, and Opportunities for Sustainability. *Journal of Cleaner Production*, 252, 1-21.

Guzmán, V. E., B. Muschard, M. Gerolamo, H. Kohl, & H. Rozenfeld. 2020. Characteristics and Skills of Leadership in the Context of Industry 4.0. *Procedia Manufacturing*, 43, 543-550.

Hecklau, F., M. Galeitzke, S. Flachs, & H. Kohl. 2016. Holistic Approach for Human Resource Management in Industry 4.0. *Procedia CIRP*, 54, 1-6.

Kadir, B. A., O. Broberg, & C. S. Conceição. 2019. Current Research and Future Perspectives on Human Factors and Ergonomics in Industry 4.0. *Computers & Industrial Engineering*, 137, 1-12.

Kaasinen, E., F. Schmalfuß, C. Özturk, S. Aromaa, M. Boubekeur, J. Heilala, P. Heikkilä, T. Kuula, M. Liinasuo, S. Mach, R. Mehta, E. Petäjä, & T. Walter. 2020. Empowering and Engaging Industrial Workers with Operator 4.0 solutions. *Computers & Industrial Engineering*, 139, 1-13.

Kazancoglu, Y. & Y. D. Ozkan-Ozen. 2018. Analyzing Workforce 4.0 in the Fourth Industrial Revolution and Proposing a Road Map from Operations Management Perspective with Fuzzy DEMATEL. *Journal of Enterprise Information Management*, 31(6), 891-907.

Kipper, L. M., S. Iepsen, A. J. Dal Forno, R. Frozza, L. Furstenau, J. Agnes, & D. Cossul. 2021. Scientific Mapping to Identify Competencies Required by Industry 4.0. *Technology in Society*, 64, 1-9.

Longo, F., L. Nicoletti, & A. Padovano. 2017. Smart Operators in Industry 4.0: A Human-Centered Approach to Enhance Operators' Capabilities and Competencies within the New Smart Factory Context. *Computers & Industrial Engineering*, 113, 144-159.

Mardikaningsih, R. 2024. Organizational Effectiveness and Green Human Resources Management. *Bulletin of Science, Technology and Society*, 3(1), 6-13.

Nuraini, R., B. Gardi, & D. Darmawan. 2024. Application of Accounting Information Systems in Micro, Small, and Medium Enterprises. *Bulletin of Science, Technology and Society*, 3(1), 21-30.

Romero, D., P. Bernus, O. Noran, J. Stahre, & A. Fast-Berglund. 2016. The Operator 4.0: Human Cyber-physical Systems & Adaptive Automation Towards Human-automation Symbiosis Work Systems. *IFIP Advances in Information and Communication Technology*, 488, 677-686.

Rojak, J. A. 2024. The Relationship of Transformational Leadership and Organizational Commitment in Higher Education. *Bulletin of Science, Technology and Society*, 3(1), 14-20.

Shamim, S., S. Cang, H. Yu, & Y. Li. 2016. Management Approaches for Industry 4.0: A Human Resource Management Perspective. *IEEE Engineering Management Review*, 45(4), 180-188.

Werdati, F., D. Darmawan, & N. R. Solihah. 2020. The Role of Remuneration Contribution and Social Support in Organizational Life to Build Work Engagement. *Journal of Islamic Economics Perspectives*, 1(2), 20-32.

Wulandari, W. & Darmawan, D. 2024. The Influence of Emotional Intelligence on Salesperson Performance. *Jurnal Manajemen Bisnis dan Terapan*, 2(2), 124-132.

Nuraini, R., D. Darmawan, R. Mardikaningsih, M. Hariani, & S. N. Halizah. 2022. Keberlanjutan Kelestarian Lingkungan: Peran Kunci Lokus Kendali Internal dan Wawasan Lingkungan Dalam Mendorong Perilaku Pro-Lingkungan. *TIN: Terapan Informatika Nusantara*, 3(3), 116-122.