Green Performance and Technological Competence of Human Resources Based on Industrial Revolution 4.0

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ABSTRACT

Purpose: The green industrial revolution 4.0 has an influence on the strategic transformation of human resource performance and technology proficiency. Performance in the green arena necessitates a set of human qualities that are focused on industrial environment sustainability and technological expertise.

Methodology: The research model uses an analytical descriptive method. This research is qualitative and has the characteristics of library research, namely a series of activities related to library data collection methods. The researcher selected articles based on the four focused study topics.

Results: The findings show that the presence of an industrial revolution provides benefits for skill development and consumption reduction since, in this case, there are opportunities for e-commerce and the growth of a digital green economy for industry participants. By implementing green practices, both human resources and industrial environments may function better.

Implication: Valuable insights for green industry managers to formulate strategies and policies for transforming green technology competencies into green performance in industrial environments. This article provides a valuable reference for business players to consider implementing a green performance system that combines all communication, collaboration, critical thinking, creative, innovative skills in using resources and efficiency of natural resources.

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Introduction

Today, businesses prefer to build public natural resources by their activities, such as environmental protection, in addition to relying on their intangible assets, such as expertise, networks, processes, and information systems (Asiae, Bontis, et al., 2022). Due to the excessive use and exploitation of natural resources, the fast expansion of numerous businesses in practically every nation in the globe (Tan et al., 2007) for both corporate and consumer enterprises have caused environmental harm (Solvalier, 2010).
These days, the environment and the future of our world worry both businesses and consumers. A new framework that requires businesses to make their productive activities compatible with environmental preservation and effective management of natural resources has emerged as a result of growing social awareness of environmental degradation (Buysse & Verbeke, 2003). Environmental protection often receives a lot of attention, leading corporate organizations to devote time, energy, and resources into promoting environmentally beneficial conduct at work. Environmental concerns are a matter of widespread concern (Ong et al., 2020), and it can be difficult for businesses to compete while still upholding their environmental responsibilities. In 2020, Asbari and Fahmi et al. The digital industry is a phenomenon that presents new challenges for all components of society. This has an impact on the emergence of an information and knowledge society. Industry players need to make adjustments to existing changes, one of which is by carrying out management transformation. To ensure the survival of a more developed and growing sector, transformation is required. Changes in human behavior, competitiveness, data, innovation, and values are the fundamental ideas behind the significance of transformation (Natalia Aleksandrovna Zhuravleva and Milos Poliak, 2016). The ability of organizational staff to manage data and connection, analytics and intelligence, conversion to the physical world, and human-machine interaction must be developed if digital transformation is to produce the best results possible (Fahmi et al., 2020). For the industrial management transformation process to be successful, the involvement of the workforce is crucial.

The following research questions will be the main focus of this literature review:
1. How are green performance and green technology competency defined by industry players?
2. How can knowledge of green technology aid in managing the quality of employees in the green industry?
3. What are the main research results in the study of green performance and technological competency in green industry management?
4. What are the research's constraints on environmental performance in the period of the Fourth Industrial Revolution?

**Literature Review**

Through advances, the industrial revolution has transformed human labor into automation and digitization (Suwardana, 2018). The idea of "Industry 4.0" initially surfaced in Germany and is predicated on the creation of "smart chains," which are networks of production, goods, components, factories, and people that communicate with one another (Magruk, 2016; Marsudi & Widjaja, 2019). This hypothesis proposes that a web-based network will assist smart factories at every stage of product production, from design through service and recycling. The hallmark of Industry 4.0, universality in industrial applications, including big data, inter-machine communication, and cyber-physical systems using full interoperability, decentralization, and virtualization, will undoubtedly have a different impact on a variety of phenomena than what was observed from the experience of the previous industrial revolution (Hendarsyah, 2019; Magruk, 2016). Substantial social and cultural transformation that affects the tenets or foundations of people's existence is referred to be a revolution (Murti Ningsih, 2019). Changes in a revolution may be planned or unforeseen, carried out with or without bloodshed. While the Industrial Revolution is a quick shift in the economic landscape, namely from agricultural economic activities to an industrial economy that employs machines to transform raw resources into ready-to-use goods. As a result of the Industrial Revolution, people now use machines instead of their hands to do tasks. The 4th industrial revolution was marked by a technical merging capable of removing physical, digital, and biological problems to economic activity. The Industrial Revolution as one of the world's important revolutions also had a very strong influence on Indonesia. Broadly speaking, the Industrial Revolution had both positive and negative influences. Schwab (2017) at the World Forum Economic conference stated that there are 5 clusters that will have an impact, namely: 1) Economic Sector; 2) Business Sector; 3) International Relations Sector; 4) Society Sector; 5) Individual Sector. User and Labor Behavior in Industry 4.0 Changes in the industrial environment will affect changes in behavior patterns that emerge in society, especially different generations that grow and develop in different environments. The differences are described as follows; 1)
Baby Boomer Generation: the generation born in 1946-1964, has the characteristics of a diligent work ethic, works hard for identity, and emphasizes quality. 2) Generation X: the generation born in 1965-1976, has the characteristics of a work ethic: work smarter not longer, skeptical, self-reliant. 3) Generation Y: the generation born in 1977-1995 has the characteristics of a work ethic: Ambitious, multi-tasking, highly entrepreneurial, and persistent, 4) Generation Z: generation born in 1996-now has the characteristics of a work ethic: hobby makes work, high entrepreneurship, and attaches importance to quality. Dizik (2017) reveals that the z generation is the generation that will fill professions that are currently uncharted, new professions with new characteristics will emerge in the future, the characteristics needed are as follows: being able to solve complex problems, requiring critical thinking skills, having creativity, being able to coordinate with others, having emotional intelligence, being able to make good decisions and policies, being service oriented, being able to negotiate and be flexible (Wangsa 2018). Building peace and synergistic collaboration for the expansion of the community's economy will be possible thanks to the industrial revolution, which prioritizes the ideals of community economic growth via empowerment. similar to Bourdeou's view, according to which economic capital is not the capital of all capital. However, improving a society's mental/character development has economic potential that may flow through the social structure and serve as the cornerstone for advancing the industrial revolution in a positive direction.

Green Technology Competence
The green industry is managed by applying the principles of sustainable development in accordance with developments in technological progress. Green technology competence is needed to carry out green innovations needed in the process of developing new products and services for industrial companies. According to Chen (2008) and Chen, Lai, and Wen (2006), green innovation benefits businesses by boosting productivity, strengthening reputation, helping to build new markets, and creating a first mover profit stream (Wong 2012). According to Yang et al (2017) and Chen and Chang (2012), green innovation creates new business models and modifies the laws of competition in the marketplace. The two main streams of the literature on green innovation are the first stream, which focuses on environmentally friendly goods, and the second stream, which focuses on environmentally friendly company operations or procedures (Rennings and Rammer 2009).

Industrial Management 4.0
Industry Management 4.0 brings radical changes to business process management. Business models are developed by utilizing digital-based technology infrastructure. Digital transformation is needed in all aspects of human life. The idea of business sector competitiveness encourages superior information and technological application. This progress is supported by the development of electronic business (e-business). The process of interaction and communication between humans can be carried out effectively and efficiently using information and communication technology. The condition of the business environment is more flexible, market response can be known quickly, allowing companies to respond to client requirements more swiftly. As a result, in the digital age, businesspeople must fast change to avoid left behind. Digital business models are needed to meet new concepts in the Industrial Revolution 4.0.

Industry 4.0 management adopts green concepts to support sustainable development. This concept necessitates the application of green principles which are included in the formulation of the management strategy. The green concept was developed to answer the challenge of environmental degradation which has a broad impact on the lives of all mankind. Sustainability has three dimensions that are interdependent and related to one another, namely: the triple bottom line is a term that frequently refers to the environment, the economy, and society (Azeem, 2019). In implementing the sustainability paradigm, industrial companies must take responsibility for addressing the social and environmental impacts of achieving their economic goals. Managers of businesses in the green sector should create organizational environmental management based on high-quality worldwide environmental standards, such as conducting quantity analyses of key pollutants in the air, soil, and water, employing green management systems, and applying eco-labels. Green industry is defined as an industry with energy efficiency and
resource use as well as improving environmental quality. This leads to environmentally friendly economic growth, and actualization with an environmentally friendly lifestyle.

**Green Performance and Management**

The results of several studies on green management have led to a variety of conceptual concepts. Efforts to treat industrial waste are expected to increase additional sources of economic income for industrial companies. Green management focuses on management efforts to reduce the impact of environmental problems arising from organizational activities. Green management refers to the adoption of management techniques, policies, and ideologies that can enhance the well-being of consumers, workers, communities where they operate, and the environment (Azeem, 2019). Environmental plans completely fit with organizational goals and strategies (Dwyer, Lamond, Pane Haden, Oyler, & Humphreys, 2009). Hirsch proposes nine categories of green business conduct in order to describe the features of green management. According to Hirsch, businesses that adopt the "go green" philosophy will meet the following appropriate criteria.

a) Minimize and reduces regulatory risk, improves corporate branding and avoid expected regulation.
b) Minimize the environmental effect and harmful drug exposure of their clients.
c) Increasing the amount of material used in the production process that are reused and recycled.
d) Improving their own or their clients’ energy efficiency.
e) Increasing their resources’ or their customers’ productivity.
f) Establish a system to find possibilities for resource productivity, waste reduction and pollution avoidance across the facility or business.
g) Gather and publish more data than is necessary by law upon the company’s environmental performance and effect.
h) Provide stakeholder input into company environmental decisions more regularly than required by rules.
i) Financing and investment in eco-friendly goods and company ideas.

**Green Performance**

Green performance is the capacity to work and engage in environmental advocacy (Kardoyo, Feriady, Farliana, & Nurkhin, 2020). The goal of green performance is to strike a balance between social and ecological development and support, both physical and non-physical. The capacity to carry out pro-environmental labor and activities in support of their bosses' pro-environmental policies is a requirement for employees who exhibit green performance. In an endeavor to accomplish sustainable environmental goals, green performance can have an influence on the interaction between people and organizations.

The definition of Green Performance is a series of corporate strategies to generate, apply or convey knowledge of the improvement of organizational performance. Business player who has knowledge creation and knowledge transfer will have a positive influence on their performance. Companies that implement a strategy of caring for the environment will comply with the law and establish control over a proactive strategy, involving business actors both intentionally and voluntarily for the purpose of reducing energy use, waste and pollution. Concern for the natural environment is referred to as being "pro-environment." In addition, implementing green performance makes the company highly committed to carrying out its activities. The form of Green Performance criteria can be seen in table 1

<table>
<thead>
<tr>
<th>NO</th>
<th>Dimension</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Recruitment and Selection</td>
<td>Incorporate environmentally friendly elements in the recruitment and selection process; selecting employee candidates in such a way as to comply with the company's commitment to being environmentally friendly. Examples of environmentally friendly questions were not provided by the source because they were company secrets</td>
</tr>
<tr>
<td>2</td>
<td>Employee Training and Development</td>
<td>Coordinating regular workshops for training in environmentally friendly practices</td>
</tr>
</tbody>
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Tabel 1. Green Performance Criteria in the Company
Development: Competences; carry out employee exchanges to other similar companies so that these employees have the same knowledge and perception regarding green behavior; conduct employee development by inviting them to manage the environment in the company area.

3 Organizational Culture: Forming the personality of employees to behave environmentally friendly, namely by inviting employees to save electricity and water, asking employees to bring their own drinking bottles, paperless data and documents, and keeping the environment clean and green by carrying out activities in the form of reclamation (land restoration) and rehabilitation (planting return).

4 Performance Management: Providing facilities that support the implementation of Green Performance within the scope of the company; provide sanctions for employees who violate applicable regulations or policies such as giving verbal warnings or giving SP (Monition Letters)

Source: Processed data, 2022

The Green Performance activities are as follows; 1) Choose environmentally friendly materials for product development or design, 2) When developing or designing a product, choose materials from sources that conserve energy and resources, 3) Always use recyclable materials, 4) Processes in product manufacturing effectively reduce emission of hazardous substances and waste, 5) Process in product manufacturing effectively reduces energy consumption, 6) Uses environmentally friendly materials such as non-polluting and non-toxic materials.

Methodology
The research model employs an analytical descriptive approach because this method is used to investigate ongoing occurrences and link to current situations. This study is qualitative in the characteristic of library research, meaning a sequence of actions connected to library data gathering methods. Systematic literature review explores articles related to green performance, green technology competency, green industry management. The articles reviewed are research articles taken from leading publishers such as Elsevier, Emerald, Springer, Taylor & Francis, Wiley and SAGE. The article search databases are web of science, scopus, and google scholar. The search keywords for the article are "Green innovation and environmental performance", "green technology competence", "green industry management", "green management", "green work environment". The researcher conducts a review to summarize the evidence about several phenomena according to the overall focus of the research question. The initial article search returned as many as 90 articles. Furthermore, the selected articles were selected according to the research objectives by reading the title and abstract. The result is that the number of articles is 30 articles. The researcher chose again from 30 articles based on four focus research questions, and finally total of 20 articles were reviewed.

Results And Discussion
Results
Regarding the findings of this literature analysis, it is clear that many studies focus on sustainability, this study focuses solely on green performance. Yusliza (2020) discovered that green performance influences economic, environmental and social performance favorably. The relevance of green performance as an intangible resource for firms in achieving sustainable performance as a competitive advantage for future research. Manufacturing industries in both emerging and developed nations may enhance their net output capacity by applying this method.

Intellectual capital is what happens when an employee's cognitive talents and abilities are utilised to generate value (Stewart, 2010). Employees can use their intellectual capital as a non-tangible competitive advantage. Knowledge, potential, and ability are also included.

According to the survey, green performance management and pay, as well as green recruiting, training and engagement define green human resource management methods. Fourteen semi-structured interviews
with chief executive officers, operations managers and human resource managers in various facets of the West Bank heath industry were also done by Mousa and Othman (2019).

Examined information from 204 industrial workers in China, job descriptions recruiting, selection, performance evaluation and rewards are all part of green human resource management that there is a link between green human resource management and environmental performance. Green organizational culture facilitators properly mediate the interaction between sustainable human resource management and environmental performance. Roscoe (2019).

Five hundred and ten of small and medium manufacturing business provided information for Malik (2020) data collection. Human resource managers and directors were the respondents. The analysis and description of green jobs, green training and green performance evaluation had little impact on sustained performance, according to the data (p = 0.327, 0.478 and 0.299 respectively). As opposed to order human resource management techniques, where green rewards (p = 0.040), green recruitment selection (p = 0.007) have a substantial beneficial impact on sustainable performance. Data were gathered from 221 nurses in France by Paille (2020) the study’s target population consisted of nurses and nursing assistants. According to the findings, when taken individually and collectively, green human resource management strategies improve an individual’s environmental performance. These practices include employee engagement (b=15, t=3.88, p=0.001), training (b=15, t=3.88, p=0.001), selecting (b=27, t=3.54, p=0.005) and performance management (b=15, t=2.49, p=0.135). The impact of green human resource management on environmental performance cannot be mitigated by perceived organizational environmental support. Data from 220 employees of 110 hotels in Vietnam were gathered by Pham (2020) to gather data managers, deputy managers or supervisors from a variety of departements including housekeeping, food and beverage, maintenance, front office and administration (or HR) were chosen. The study’s findings indicated that while green performance management did not have an impact on environmental performance, green engagement and training did. Employees’ dedication to the environment is unable to mitigate the impact of green human resource management including green training, green engagement and green performance management, on environmental performance. Information was acquired from 206 hotel human resource managers in Malaysia were gathered by Shafaei (2020) the result describes the link between environmental performance and green human resource management (β = 0.29; p 0.01). In the United Arab Emirates, 309 manufacturing SMEs (head of operations, HR manager, production manager provided information for Singh (2020) data collection.

In Malaysia 206 hotels with three, four and five stars totaled the data that Yusoff (2020) gathered. According to the findings, there is a substantial correlation between environmental performance and green training and development (β = 0.154, p <0.05), green recruits (β = 0.259, p <0.05), and green development (β = 0.132, p < 0.10). Green performance rating, however was not shown to be substantially associated to environmental performance (β = 0.001, p > 0.10). Directors of human resources, directors of supply chains and senior managers made comprised the 74 respondents who prvided the data for Longoni (2018) study. Up to 29.7% of them are SMEs, 69% are manufacturers and the remaining 29% are service providers. According to the findings, green human resource management significantly improves both financial performance and environmental performance. From 87 green hospital managers, Rawashdeh (2018) gathered data. The reason hospital administrators were chosen was because it was believed that they had a solid understanding of green human resource management techniques, environment initiatives and employee responses to them. At 214 academic and non-academic members of public and private higher education institutions in Pakistan’s major cities, Gial (2019) gathered data. The findings indicated that green human resource management and environmental performance had a favorable correlation (r = 0.489). The link between environmentally responsible human resource management and environmental performance is mediated by environmental passion.In Phuket Thailand, there are 14 hotels with 276 workers total, including 138 green hotels and 138 non-green hotels. Kim (2019) gathered data from these 276 employees PLS-SEM data analysis, demonstrated that green human resource management improved environmental performance in non-green hotels (effect size = 0.243; t = 3.127; p <0.01) and (effect size =
0.144; \( t = 2.323; p <0.05 \) as well as the combined sample. With green hotel samples, green human resource management has no discernible impact on environmental performance. In green hotels, the relationship between green human resource management and environmental performance is entirely mediated by sequential mediators of employees’ organizational commitment and green behavior, whereas in non-green hotels, the relationship is partially mediated by both sequential mediators of organizational commitment and single mediators of employees’ green behavior. Employees and environmentally responsible conduct of employees. Two hundred and seventy-eight respondents who were chain managers and human resource managers from Ghanaian manufacturing firms, provided data for Agyaben and Mensah (2020) study. According to the study’s findings, supply chain environmental cooperation was able to moderate the impact of green human resource management on business performance (\( \beta = 0.384 \)), while green human resource management alone had a favorable impact on company performance (\( \beta = 0.212 \)). In the United Arab Emirates (UAE) 111 manufacturing workers who are experts in their specialities participated in data collection by Almemari (2021). The data were examined using a variety of statistical techniques, including the t-test, Analysis of Variance (ANOVA) and Pearson’s correlation. Green human resource management (GHRM) and sustainable performance characteristics are positively correlated, according to Pearson correlation studies. Environmental performance, economic performance and social performance all have favorable correlations with GHRM: \( r = 0.887, 0.764, \) and 0.780, respectively. When compared to relationships with other aspects of sustainable performance, those with GHRM and environmental performance are recognized as having the strongest associations. Five hundred and sixty workers of Egypt’s small tourist enterprises including travel agencies, restaurant and hotels were surveyed by Elshaer (2021) for their data. Proactive and task-related pro-environmental behavior can effectively mediate the link between green human resource management and environmental performance. Delmonico an colleagues (2018) in order to adopt green performance management, organizations must find a methodical approach. Consequently, implementing uniform green performance management standards is a top goal for certain firms. Saswattecha (2015) the most significant part of green performance management for managers and staff. As a result, performance management system must provide clear, green performance indicators. Yusliza (2019) examining the green performance outcomes of members who do not fulfill environmental management indicators or are in accordance with green goals is an additional technique to assess green performance. In the words of Barney (2017) the resource-based perspective places emphasis on certain set of resources and competencies that can help an organization achieve a long-term competitive advantage.

**Discussion**

**Definition of Green Performance and Green Technology Competence in Industrial Management**

The effectiveness of an organization's environmental management system may be influenced by Green Performance, which is a crucial resource. On organizational identity, it has a little effect, albeit Kardoyo (2020). Environmental policies, environmental responsibility, green awareness, and self-confidence in the environment all have a significant influence on the job that is done. In general, the research results show the definition of green performance as the meaning of a person’s transformational abilities with an environmentally friendly approach. Work that is driven by its leaders to accomplish green goals and urge employees to perform environmentally beyond what is anticipated is referred to as green transformational performance (Du, 2022).

**Support for green technological competency in enhancing the integrity of green industry management personnel**

Green industry leaders have a vision to realize a restorative economy by bringing together ecology and commerce (Hawken, 1993). An inventive worker is required in the green industry to develop new processes and products that will boost competitive advantage and overall business performance. The green industry aspires to generate goods and services that are ecologically friendly. Encourage employees to learn new skills albeit Le and Lei (2018), Han (2016) and get them involved in eco-friendly processes and product innovation-related activities so that businesses can market eco-friendly goods and services in the words of Andriopoulos and Lewis (2010) and enhance their environmental performance albeit Dranev
Research Results on green performance and technological competency in green industry management

Green performance can affect sustainable business performance in industrial organizations. Green team resilience and green work engagement are positively impacted by green performance. The favorable impact of green organizational performance on employees’ individual initiatives is moderated, which in turn affects their responsible conduct. Competence in green technology promotes green performance when conducting innovation activities and creating goods and services for businesses. Mastery of green technology will greatly support the success of this activity. A distinctive quality of green industry management is a growth in the value added of green innovations into products and services. For green industry management goods and services to incorporate green values, green performance leaders must possess the necessary skills in the field of green technology research and development.

Limitations in Research on green performance in the Industrial Revolution 4.0 era

In recognition of the Industrial Revolution, people now use machines instead of their hands to do tasks. Schwab (2017) at the World Economic Forum said that there is a revolution in industry 4.0, was characterized by a technological fusion that was able to dissolve the barriers governing economic activity from a physical, digital, and biological standpoint. In context with the aforementioned, the study's limitations include the lack of green performance measuring tools and green technology know-how that would help industry owners' and stakeholders' monitoring and evaluation efforts in determining the standard of a leader's green performance. The creation of measures and questionnaires to evaluate industrial businesses' green management will benefit from a thorough definition of green performance and competency in green technology, which has not yet been discovered. The different interpretations of green organizational management have an impact on the lack of a comprehensive definition of the components of a worker's green technology competency.

Conclusions And Recommendations

Conclusion

In this era, new literacy is required by using in-depth data analysis and drawing conclusions related to communication skills, teamwork, critical thinking, creative and innovative resource use, efficiency of natural resources, along with its social implications. Green innovation is shown by the involvement of workers and stakeholders in the development of green performance. The existence of support from top management encourages the emergence of policies and strategies for implementing green industry management. This will have an impact on the resilience of the organization's green team in carrying out industrial organizations' environmental preservation programs.

The implications of this systematic literature review provide theoretical and practical insights for industry managers and stakeholders when it comes to establishing green performance standards and green technological proficiency within the scope of green industry management throughout the Fourth Industrial Revolution. This research provided valuable for transforming green technology competencies into green performance in industrial environments.

Recommendations

This systematic literature review has several limitations, including: it only reviews 20 articles published in 2018 to 2022, so the results may not be optimal. Research on transformational workers and green performance needs to be continued. There is a need for a comprehensive conceptual definition that can be followed by various types of organizations and industry players. Measurement of green performance from the aspect of green technology competence has not been carried out, this is very important for developing managerial practices in green industry management.
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