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NAVIGATING INNOVATION HORIZONS: A SYSTEMATIC LITERATURE REVIEW ON LEADERSHIP TRANSFORMATION AND TECHNOLOGICAL COMPETENCE IN INDUSTRIAL MANAGEMENT

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Abstract

The integration of green concepts into Industry 4.0 management significantly influences the reshaping of strategies and policies pertaining to leadership and technological competence. Effective green industrial management necessitates leaders who prioritize industrial environmental sustainability and possess proficiency in green technology. This systematic literature review aims to present a comprehensive overview of leadership and technological competence concepts and practices within the context of green industrial management. Employing a structured review method, the framework of this literature review provides insights into the transformative potential of green leadership on both human resources' green performance and the overall industrial environment. The study highlights the imperative for green leaders to enhance their proficiency in green technology to foster sustainable green innovation. The implications drawn from this research offer valuable guidance for green industry managers, aiding them in formulating strategies and policies that foster leadership transformation and enhance green technological competence within the industrial landscape.

Keywords: Sustainable Industrial Management, Digital Evolution, Environmental Management, Environmental Leadership, Eco-friendly Technology Proficiency, Sustainable Innovation

INTRODUCTION

The progress of the industrial world aligns with advancements in technology and information. The focus of Industry 4.0 revolves around research, innovation activities, architectural references, standardization, and security network systems (Fahmi et al., 2020). This digital industrial phenomenon poses various new challenges for all segments of society, contributing to the emergence of an information and knowledge society. To adapt to these changes, industry stakeholders must undergo management transformation to ensure the continuous advancement and development of industrial life. The fundamental concepts underscoring the importance of transformation encompass shifts in human behavior, competition, data, innovation, and value (Zhuravleva, N. A., & Poliak, 2022). Achieving optimal results in digital transformation requires enhancing the capabilities of organizational personnel in managing data and connectivity, analytics and intelligence, physical-world integration, and human-machine interaction (Fahmi et al., 2020).

Organizational leadership plays a crucial role in facilitating the success of the industrial management transformation process. The leader serves as a guide for the behavior of their subordinates, wielding significant influence on organizational outcomes. The leader's role is pivotal in supporting the attainment of organizational objectives. In the realm of digital industry management, a leadership style must align with the organization's needs and evolving management strategies. Traditional leadership paradigms must evolve into

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styles that are rooted in the digital landscape. Leaders need to exhibit innovation in guiding subordinates in utilizing digital infrastructure that enhances organizational performance. Managing the mindset and work approach of leaders in digital industry management necessitates a transformation commonly referred to as electronic leadership (e-leadership) (Fahmi et al., 2020).

The notion of green industrial management has found widespread application across both developed and developing nations worldwide. This management approach seeks to achieve economic prosperity while taking into consideration social and environmental dimensions, aligning with the objective of sustainable development. Green industrial management is rooted in the principles of sustainable development, emphasizing the creation of environmentally friendly products. A successful implementation of green industrial management necessitates a transformation in the characteristics of organizational leaders.

The concept of green leadership, within this context, is understood as leadership that is environmentally conscious, passionate, proactive, initiative-driven, and creative in its commitment to the well-being of both people and the planet. Green leaders embrace a mission of fostering balance between ecological and social support and development, encompassing both tangible and intangible aspects. Key characteristics of green leadership include possessing environmental insights and the ability to collaborate with all stakeholders, leading to tangible actions that can be measured both administratively and spatially (Morán-Ordóñez et al., 2020).

The presence of high-quality green leadership practices holds the potential to enhance the performance, knowledge, competence, and motivation of all employees, thereby contributing to the attainment of job satisfaction. Green leadership represents a shift in the orientation of organizational leadership towards transformational leadership patterns. Leaders in the green industry must adapt their skills to effectively manage environmentally friendly practices through the process of leadership transformation and mastery of green technology. Currently, there is a limited body of research that comprehensively explores the competencies associated with green leadership and green technology within environmentally sustainable industrial management.

This systematic literature review aims to provide an overview of the concepts and practices related to leadership and technological competence in green industry management. The review is particularly valuable for identifying developments in research outcomes, acknowledging potential gaps in current knowledge, and suggesting pertinent avenues for future research. By pinpointing potential gaps in the existing body of research, we present conclusions and recommendations to guide the development of further studies in this domain.

This review will concentrate on addressing the following research inquiries:

a) How industry participants define green leadership and green technology competencies.
b) The ways in which green technology competencies can bolster leadership qualities in the management of green industry.
c) The primary findings in research on leadership and technological competence within green industry management.

d) The limitations observed in research pertaining to leadership and technological competence in the context of green industrial management.

LITERATURE REVIEW

Industry 4.0 and Green Industry Management

Industry 4.0 instigates profound transformations in the management of business processes, shaping business models through the integration of digital technology infrastructure. The imperative for digital transformation extends to all facets of human existence. The pursuit of excellence in information and technology utilisation highlights the paradigm of competitive dynamics within industries. The development of electronic business, or e-business, supports this progress.

The efficacy of interaction and communication among individuals is significantly enhanced through the judicious use of information and communication technology. The business environment becomes more adaptable, with market responses swiftly discerned, enabling producers to promptly address the specific needs of customers. Consequently, entrepreneurs in the digital era must adapt swiftly to stay abreast of developments. Digital business models become indispensable in embodying the essence of the new Industry 4.0 concept.

Management in Industry 4.0 embraces a green ethos to champion sustainable development. This ethos entails the integration of green principles into the formulation of management strategies, designed to counter the pervasive environmental degradation affecting humanity. Sustainability, embodying interconnected dimensions of environment, economy, and society, often termed the triple bottom line (Abdullah et al., 2022), is the driving force behind this concept. Industrial enterprises, in adopting the sustainability paradigm, bear the responsibility of addressing both social and environmental impacts while pursuing their economic objectives.

Managers within green industrial companies play a pivotal role in advancing the organization's environmental management. This entails adhering to stringent global environmental standards, which include conducting thorough analyses of major pollutants in air, soil, and water, implementing green management systems, and adopting eco-labels. Within the sustainability framework, social responsibility encompasses aspects such as health and safety, equitable wages, training, non-discrimination, freedom of association, and gender equality (Abdullah et al., 2022). The distinguishing feature of the green industry lies in its efficient utilization of energy and resources, fostering an improved environmental quality. This not only fosters environmentally friendly economic growth but also encourages the adoption of a sustainable lifestyle.

Green Management and Leadership

Various studies have yielded diverse conceptual definitions of green management. One such definition, offered by (Wong et al., 2020), characterizes green management as a set of practices directed at creating environmentally friendly products and reducing environmental impact. This involves activities like green production, green research and development, and

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green marketing. This definition was further refined by researchers like (Sherman et al., 2020), who emphasized green management practices in industrial settings with the goal of waste reduction, thereby contributing to the organization's overarching objective of profitability. This link between environmental management and economic goals suggests that efforts to treat industrial waste can create additional economic opportunities for companies.

Green management, as it relates to environmental challenges arising from organisational operations, concentrates on management's attempts to reduce environmental effect. Claims that green management embraces ideas, guidelines, and procedures that improve the standard of living for clients, staff, the communities in which they operate, and the environment (Abdullah et al., 2022). Furthermore, (Dwyer et al., 2009) define green management as an innovative process permeating the entire organization, aimed at achieving sustainability, waste reduction, social responsibility, and competitive advantage. This involves embracing environmental goals and strategies fully integrated with organizational objectives, alongside continuous learning and development.

Highlighting specific characteristics of green business behavior, Hirsch identifies nine categories, asserting that companies embracing the green concept will fulfill legal requirements.

a) Directly mitigate their own regulated or unregulated environmental impacts to decrease regulatory risk, enhance the company's brand, and preemptively address forthcoming regulations;
b) Alleviate the environmental impacts of their customers and reduce their exposure to harmful substances;
c) Improve the reuse and recycling of materials utilized in the production process;
d) Improve their own or their customers' energy efficiency;
e) Boost the productivity of their or their customers' resources;
f) Establish systems to pinpoint opportunities for waste reduction, pollution prevention, energy efficiency, or resource productivity across the entire enterprise or facility;
g) Communicate more comprehensive information about the company's environmental impacts and performance beyond what is legally mandated;
h) Provide increased opportunities for stakeholder input into the company's environmental decision-making beyond legal requirements; and
i) Invest in and financially support green products and business models, as previously detailed.

A crucial element in organizational management is leadership. As per Soepardi, as cited by Mulyasa, leadership is defined as the ability to mobilize, influence, motivate, invite, direct, advise, guide, order, command, prohibit, and, if necessary, enforce discipline. The overarching objective of leadership is to inspire individuals, who function as assets in management, to effectively and efficiently work towards accomplishing administrative goals. At the core of management, leadership involves the coordination of organizational resources and is embodied by an individual presumed to possess the skills and expertise to guide the organization toward its objectives.

Effective leadership involves employing management techniques such as organizing, inspiring, and cultivating trust or confidence among subordinates, thereby influencing the overall performance of all employees in pursuit of organizational goals. In the context of green management, a novel concept known as green leadership emerges. The success of green leadership is gauged by the leader's capacity to harmoniously manage economic, social, and environmental responsibilities, ultimately achieving comprehensive company performance.

Green leadership is characterized by an environmentally conscious, passionate, proactive, initiative-driven, and creative approach, emphasizing consideration for the well-being of both people and the universe (Morán-Ordóñez et al., 2020). It encompasses an individual's capacity to influence and rally organizational members to engage in pro-environmental activities (Kardoyo et al., 2020). Green leaders are driven by a mission to achieve equilibrium between ecological and social carrying capacity, encompassing both tangible and intangible aspects (Morán-Ordóñez et al., 2020). An essential skill for green leaders is the ability to formulate pro-environmental policies capable of influencing subordinates and mobilizing other individuals within the organization to support these initiatives.

The influence of green leadership extends to shaping the relationship between individuals and organizations, fostering collaborative efforts to attain sustainable environmental goals.

Green Technology Competence

The green sector follows the guidelines of sustainable development while keeping up with the rapid expansion of technology. In this situation, leadership calls for proficiency with green technology, particularly in promoting green innovations that are crucial to the creation of new goods and services for businesses in the industrial sector. Green innovation produces a number of advantages for businesses, such as increased output, improved brand recognition, assistance when entering new markets, and the chance to gain a competitive edge (Qu et al., 2022). Additionally, it changes the competitive environment in business and aids in the development of new business models (Zhao & Huang, 2022).

The literature on green innovation is divided into two streams: one that focuses on making products more environmentally friendly, and the other that emphasises making business processes or practises more environmentally friendly (Singh et al., 2020). In order to ensure that a product is more environmentally friendly than competitors or conventional innovations, green product innovation entails coordinated efforts in design, production, and marketing (Huang et al., 2021).

METHOD

This comprehensive literature review examines articles pertaining to green leadership, green technology competence, and green industry management. The chosen papers, which come from famous publishers including Elsevier, Emerald, Springer, Taylor & Francis, Wiley, and SAGE, are research-focused. Reputable databases including Web of Science,

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Scopus, and Google Scholar were used to search for papers. Keywords like "green leadership," "green technology competence," "green industrial management," and "green management" were used.

The researcher methodically evaluated study articles to compile data on a variety of occurrences after narrowing in on the subject of the research inquiry. The procedures for doing a literature review were followed by the study approach used, as described by (Hasan et al., 2022).

RESULTS AND DISCUSSION

Drawing from the examination of six reviewed articles, insights into the progress of research outcomes concerning green leadership transformation, green technology competence, and green industry management have been obtained. A condensed overview of the analytical findings is presented in Table 1.

Table 1. Results of Systematic Literature Review

No	Source	Research Results
1	Zhao, W., & Huang, L. (2022)	In Chinese manufacturing organizations, green transformational leadership, green human resource management (HRM), and green innovation exert considerable influence and exhibit a direct correlation with sustainable business performance.
2	Du, Y., & Yan, M. (2022)	a) Green transformational leadership significantly and positively influences employee take-charge behavior, with personal initiative playing a mediating role. b) Green organizational identity moderates the positive impact of green transformational leadership on employees' personal initiative, consequently shaping their responsible behavior.
3	Qu, X., Khan, A., Yahya, S., Zafar, A. U., & Shahzad, M. (2022)	a) Green core competence has a positive and significant impact on green innovation performance, with green absorption capacity acting as a mediating factor in the relationship between green core competence and green innovation. b) Green organizational culture plays a partial moderating role in the

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		connection between green absorptive capacity and green innovation..
4	Çop, S., Olorunsola, V. O., & Alola, U. V. (2021)	Green transformational leadership positively influences both green work engagement and green team resilience.
5	Huang, S. Y., Ting, C. W., & Li, M. W. (2021)	The green transformational leadership exhibited by the CEO significantly predicts favorable shifts in green engagement within the top management team. This, in turn, predicts the adoption of environmental proactive strategies.
6	Singh, S. K., Del Giudice, M., Chierici, R., & Graziano, D. (2020)	Green Human Resource Management (HRM) practices mediate the impact of green transformational leadership on green innovation. Indirectly, via the pathway of green innovation, green HRM contributes to corporate environmental performance.

Explanation of Green Leadership and Competence in Green Technology within Industrial Management

Leadership stands as a crucial factor capable of impacting the success of an organization's environmental management procedures. Green leadership, as indicated by (Kardoyo et al., 2020), holds substantial sway over support for environmental policies, environmental responsibility, green awareness, and green self-efficacy. However, its influence on organizational identity is deemed insignificant. The concept of green leadership is intricate and varied, intricately tied to the organizational context. In a broad sense, research findings indicate that green leadership embodies the essence of a transformational leadership style with an environmentally friendly orientation.

The transformational leadership style, elucidated by (Du & Yan, 2022), is characterized by a leadership framework grounded in trust and commitment. This style positively shapes the motivation, identity, and goal attainment of followers by cultivating their confidence, self-efficacy, and self-esteem. Expanding on this, green transformational leadership is delineated as a form of leadership that not only motivates subordinates to reach green objectives but also inspires them to surpass anticipated levels of environmental performance (Du & Yan, 2022).

Enhancing Leadership in Green Industry Management through Support for Competence in Green Technology

Leaders in the green industry aspire to establish a regenerative economy that harmonizes ecology and commerce (Singh et al., 2020). The organization's mission is centered on sustainability, with a specific focus on waste reduction, manifested as a

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comprehensive company-wide program. Effective leadership in green industry management necessitates a leader capable of aligning their competencies and behaviors with the standards of a green organization. This transformative shift in green industry leadership is often referred to as green transformational leadership (GTFL).

The objective of the green industry is to produce eco-friendly goods and services, which calls for a creative leader skilled in creating goods and procedures to boost overall business performance and competitive advantage. According to (Singh et al., 2020), GTFL is defined as leadership behaviour with the primary goal of inspiring, motivating, and empowering employees while fostering their personal development in order to achieve the organization's environmental goals. GTFL encourages staff members to learn new things (Wong et al., 2020) and get involved in activities related to green processes and product innovation. This helps businesses launch environmentally friendly goods and services and improve their environmental performance (Qu et al., 2022; Sherman et al., 2020). Green technology competence emerges as a crucial skill that leaders must cultivate to design business processes using green management. The commitment to green product and service innovation extends from top leaders to all leaders within the organizational hierarchy.

Findings on Leadership and Technological Competence in the Management of Green Industries

The concept of green transformational leadership aligns with research findings concerning leadership within industrial organizations operating in the realm of green management. The interrelationship among green transformational leadership, green innovation, and corporate environmental performance has been established. Green transformational leadership exhibits the potential to positively enhance the sustainable business performance of industrial organizations. Additionally, a positive correlation has been identified between green team resilience, green work engagement, and green transformational leadership. Personal initiative and employee take-charge behavior act as mediating factors in the domain of green leadership practices. Furthermore, green organizational identity moderates the favorable impact of green transformational leadership on employees' personal initiative, subsequently influencing their conscientious behavior.

Competence in green technology entails the capacity of green leaders to innovate and enhance the products and services of the company. Proficiency in green technology is instrumental in significantly bolstering the success of these initiatives. Green industry management is characterized by its distinctive feature of augmenting the added value of green innovation within products and services. Green leaders must possess proficiency in the research and development of the company's green technology (green R&D) to integrate green values into the products and services of green industrial management.

Constraints in the Examination of Leadership and Technological Competence within Green Industry Management

This study identifies limitations, including the lack of established techniques for measuring the performance of green leadership and green technology competencies. The

absence of standardized monitoring and evaluation tools for industry owners and stakeholders hampers the assessment of the quality of a leader's green leadership. Additionally, the lack of comprehensive definitions for green leadership and green technology competencies poses challenges for developing scales and questionnaires aimed at measuring the green management practices of industrial companies. The diverse interpretations of green organizational management further contribute to the absence of a comprehensive definition for the dimensions used to measure a leader's green technology competence in the context of green industrial management.

CONCLUSIONS

The concept of green leadership within green industrial organizations shares a unified vision and mission. The vision of green leadership involves formulating strategies and policies that enhance the company's competitive advantage and overall performance by achieving a balance among economic, social, and environmental goals. Green technology competence is defined as the capability of green leaders to enhance the value of green innovations incorporated into products and services. The conjunction of green leadership and mastery of green technology competencies can shape green innovation in the realm of green industrial management. Green innovation manifests through the active involvement of employees and stakeholders in advancing green performance.

The endorsement of upper management fosters the development of strategies and policies for implementing green industrial management. Consequently, this influences the resilience of the green team in executing the environmental conservation program of the industrial organization.

The systematic literature review's implications offer both theoretical and practical insights for industry managers and stakeholders involved in enhancing leadership practices and green technology competencies within the domain of green industry management.

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