IMPACT OF GREEN INTELLECTUAL CAPITAL ON CORPORATE SUSTAINABILITY WITH MEDIATING ROLE OF GREEN INNOVATION

MUHAMMAD ABU BAKAR IQBAL
Lecturer, Beaconhouse International College Faisalabad
Email: abubakariqbal85@gmail.com

DR RABIA ZAFAR
Assistant Professor, Environmental Science Department, Sardar Bahadur Khan Women's University Quetta

MUHAMMAD IMRAN
Lecturer in Economics, Ghazi University, DG Khan
Email: milodhi@gudgk.edu.pk

WAQAR AKBAR KHAN
PhD Scholar in Business Management,
School of Business Administration, Shandong University of Finance and Economics, Jinan, China.
Email: waqarakbarkhan@live.com

DR. SAIMA BATOOL
Associate Professor and Dean Faculty of Management Sciences, NUR International University, Lahore
Email: saima.batool@niu.edu.pk

DR. WASEEM SADIQ
Chairman/Lecturer, Department of Management Sciences, University of Baluchistan Sub Campus Mastung

Abstract
This study aims to explore the association between green intellectual capital and corporate sustainability with green innovation as a mediator in the context of manufacturing sector of Pakistan by deploying a resource-based approach. A quantitative research approach was adopted and data was collected through questionnaire from managers working in the manufacturing sector in Khyber Pakhtunkhwa, Pakistan. Pearson correlation matrix and regression is done by employing SEM and SPLS. The study's findings indicate significant associations and impacts of green intellectual capital and green innovation on the corporate sustainability of manufacturing firms in Pakistan. Furthermore, the outcomes indicated that green innovation mediates the relationship between green intellectual capital and corporate sustainability. Hence, it is strongly recommended that Pakistani firms should integrate green innovation practices into their operations to effectively pursue corporate sustainability

Keywords: Green Intellectual Capital, Corporate Sustainability Green Innovation, Khyer Pakhunkhwa

INTRODUCTION:

In recent years, there has been a growing recognition of the importance of corporate sustainability and environmental responsibility. Companies are increasingly realizing that integrating sustainability into their business models is not only crucial for mitigating environmental risks but also for ensuring long-term profitability and competitiveness. One key factor that can drive corporate sustainability is the concept of green intellectual capital, which encompasses the knowledge, skills, and intangible assets related to environmental sustainability within an organization (Mwemezi, 2023).

Green intellectual capital represents the expertise and capabilities that enable companies to develop and implement environmentally friendly practices, technologies, and strategies. It encompasses a wide range of knowledge, including understanding of environmental issues, sustainability best practices, and the ability to assess and manage environmental risks. By leveraging their green intellectual capital, companies can make informed decisions, optimize resource utilization, and engage stakeholders effectively, thus contributing to corporate sustainability (Toyyib et al., 2023).

However, the impact of green intellectual capital on corporate sustainability is not solely reliant on knowledge and expertise. It requires the mediating role of green innovation to translate intellectual capital into tangible outcomes. Green innovation involves the creation and adoption of new products, processes, and business models that have a positive environmental impact. It is through green innovation that companies can transform their intellectual capital into practical solutions that drive sustainability performance.

This research aims to explore the impact of green intellectual capital on corporate sustainability, with a specific focus on the mediating role of green innovation. By examining the relationship between these variables, this study seeks to shed light on how organizations can leverage their intellectual capital to enhance sustainability outcomes.

Understanding the dynamics between green intellectual capital, green innovation, and corporate sustainability is crucial for businesses seeking to establish a competitive edge in the rapidly evolving sustainability landscape. By identifying the mechanisms through which intellectual capital translates into innovation and sustainability performance, organizations can develop strategies to effectively leverage their knowledge and expertise.

The findings of this research will provide valuable insights for managers, policymakers, and researchers interested in promoting corporate sustainability. It will offer a deeper understanding of the role of intellectual capital and innovation in driving sustainable practices and provide practical implications for companies aiming to enhance their environmental performance.

Hence, this study aims to contribute to the growing body of knowledge on the relationship between green intellectual capital, green innovation, and corporate sustainability. By examining the mediating role of green innovation, it seeks to highlight the importance of leveraging intellectual capital to drive sustainable innovation and long-term business success in an environmentally conscious world.

LITERATURE REVIEW

The impact of green intellectual capital on corporate sustainability, with the mediating role of green innovation, can be understood through several relevant theories and concepts. Two key theoretical perspectives that provide insights into this relationship are the Resource-Based View (RBV) and the Dynamic Capabilities Theory.

The Resource-Based View (RBV) suggests that a firm's competitive advantage and performance are influenced by its unique and valuable resources and capabilities. In the context of green intellectual capital, organizations can gain a competitive advantage and drive corporate sustainability by leveraging their knowledge, skills, and intangible assets related to environmental sustainability. Green intellectual capital represents the expertise and capabilities that enable companies to develop and implement environmentally friendly practices, technologies, and strategies. By effectively utilizing their green intellectual capital, organizations can make informed decisions, optimize resource utilization, and engage stakeholders to enhance their sustainability performance.

The Dynamic Capabilities Theory complements the RBV by emphasizing an organization's ability to integrate, build, and reconfigure its resources and capabilities to adapt to changing environmental conditions. In the context of green intellectual capital, organizations with strong dynamic capabilities can continuously update their knowledge, adapt to emerging sustainability trends, and foster a culture of innovation to drive sustainability performance. Dynamic capabilities enable organizations to leverage their green intellectual capital to identify new opportunities, develop and implement green innovations, and respond effectively to environmental challenges.

Furthermore, the concept of absorptive capacity is relevant to understanding the mediating role of green innovation. Absorptive capacity refers to an organization's ability to acquire, assimilate, and apply external knowledge effectively. In the context of green intellectual capital, organizations with high absorptive capacity can absorb and internalize knowledge related to environmental sustainability from external sources such as research institutions, industry networks, and collaborations. This knowledge absorption facilitates the development of green innovation capabilities, enabling organizations to transform their intellectual capital into practical solutions that drive sustainability outcomes.

By integrating this theoretical perspective, this study aims to provide a comprehensive understanding of the impact of green intellectual capital on corporate sustainability with the mediating role of green innovation. It recognizes the strategic value of intellectual capital and its influence on sustainable practices within organizations. Moreover, it highlights the importance of dynamic capabilities and absorptive capacity in leveraging intellectual capital to drive green innovation and achieve corporate sustainability. This theoretical foundation will guide the empirical investigation, contributing to the body of knowledge on corporate sustainability and environmental management.

A study by Lester et al., (2023) explored the influence of green intellectual capital on corporate environmental performance. The research highlighted that organizations with higher levels of green intellectual capital, including knowledge, skills, and environmental expertise, exhibited superior environmental performance. The study emphasized the importance of leveraging intellectual capital to drive sustainable practices within organizations.

Another research by Jabbour, Jabbour, Govindan, Kannan, and Leal Filho (2018) examined the link between green intellectual capital and sustainable operations. The findings

indicated that green intellectual capital positively influenced the adoption of sustainable practices, such as energy efficiency measures, waste reduction, and eco-design. The study emphasized the role of knowledge and expertise in driving environmental improvements and sustainability performance.

Furthermore, research by Zhu, Geng, Sarkis, and Lai (2018) investigated the mediating role of green innovation in the relationship between green intellectual capital and corporate sustainability. The study found that green intellectual capital positively influenced green innovation, which, in turn, led to improved environmental and economic performance. The mediating effect of green innovation highlighted the importance of translating knowledge and expertise into practical solutions for sustainable development.

In a study by Orlitzky, Siegel, and Waldman (2011), the researchers examined the relationship between intellectual capital and corporate social responsibility (CSR). While not specifically focused on green intellectual capital, the findings indicated a positive association between intellectual capital and CSR performance. This suggests that intellectual capital, including knowledge related to environmental sustainability, can contribute to broader corporate sustainability efforts.

Additionally, research by Delgado-Ceballos, Navarro-García, and López-Martínez (2020) explored the role of green innovation as a mediator between intellectual capital and environmental performance. The study revealed that intellectual capital positively influenced green innovation, which subsequently enhanced environmental performance. The findings highlighted the importance of innovation in translating intellectual capital into tangible sustainability outcomes.

Overall, the literature supports the notion that green intellectual capital has a positive impact on corporate sustainability. Organizations that possess knowledge, skills, and intangible assets related to environmental sustainability are more likely to adopt sustainable practices, improve environmental performance, and achieve long-term economic success. Moreover, green innovation plays a crucial mediating role, acting as a bridge between intellectual capital and sustainability outcomes by enabling the practical application of knowledge and the development of environmentally friendly products, processes, and business models.

However, while the existing research provides valuable insights, there is still a need for further exploration and empirical evidence to deepen our understanding of the impact of green intellectual capital on corporate sustainability with the mediating role of green innovation. Future studies could consider different industries, organizational sizes, and geographical contexts to capture a broader perspective on this relationship. Additionally, longitudinal studies could provide insights into the long-term effects of green intellectual capital and green innovation on corporate sustainability performance.

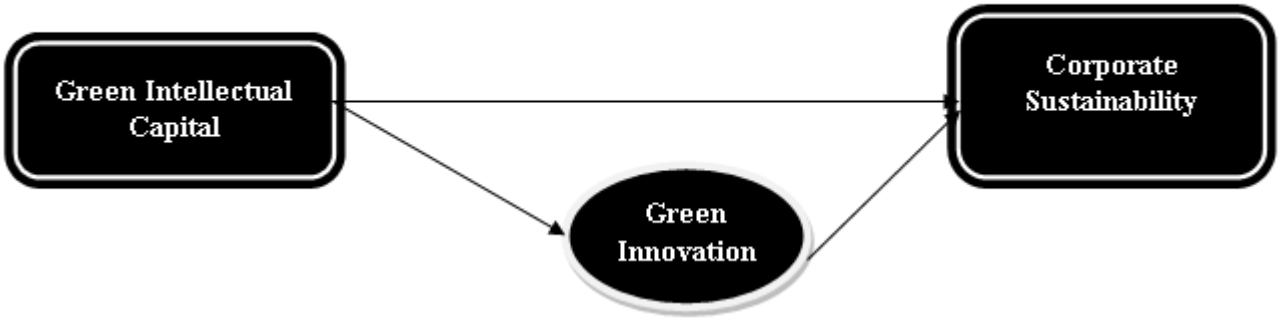
Hypotheses

H_1: There is a significant relationship between green intellectual capital and corporate sustainability.

H_2: There is a significant relationship between green intellectual capital and green innovation.

H_3: There is a significant relation between green innovation and corporate sustainability.

H_4: Green innovation mediates the relationship between green intellectual capital and corporate sustainability.



Conceptual Framework:

RESEARCH METHODOLOGY:

Research Design

Based on the Economic Survey for 2021-22, the manufacturing sector in Pakistan contributes 9.73% to the country's GDP and employs 16.1% of the workforce. Within the manufacturing sector, Large Scale Manufacturing (LSM) holds significant prominence, accounting for approximately 76.1% of the sector's share and contributing 9.73% to the GDP (Khattak, 2022; Latif, 2022). This research specifically targets the managerial staff of large scale manufacturing units located in Peshawar, Mardan, and Haripur, which are industrial cities in the Khyber Pakhtunkhuwa province.

To ensure the relevance of the study, the inclusion criteria focused on large scale manufacturing units with ten or more employees and an annual turnover exceeding PKR 800 million, as defined under the Factories Act 1934. Since Peshawar, Mardan, and Haripur are major industrial cities in the province, most of the industries are concentrated in these areas.

Convenience sampling was utilized to collect data from middle and top managers across various departments of the LSM units in these cities. Lower-level management staff were excluded due to their potential lack of awareness and limited exposure to the concept of "green" practices, considering factors such as lower literacy rates. Convenience sampling was chosen as a quick and efficient method to obtain basic information, as suggested by Sekeran and Bougie (2016, p. 247).

A total of 770 questionnaires were distributed, either through online platforms like Google Forms or as hard copies. Ultimately, 578 responses were received, but after screening for validity and completeness, 553 valid responses were selected as the final sample size for the study. This sample size meets the requirements outlined by Krejcie and Morgan (1970).

Data collection was conducted by surveying company managerial staff, including R&D Managers, Marketing Managers, Production Managers, HR Managers, and other relevant positions.

For data analysis, Structural Equation Modeling (SEM) was performed using Smart PLS 4 Software, as it is the preferred method for testing measurement dimensions and the structural model. Ringle et al. (2015) developed the PLS algorithms, which were utilized with bootstrapping set to 5000 subordinate samples, following the approach suggested by Jadoon et al., (2022).

To ensure data validity and reliability, several measures were employed. Cronbach's alpha (CA), rho (RHO), and Average Variance Extracted (AVE) were calculated, along with confirmatory factor analysis (CFA), as part of the SEM measurement model evaluation. Convergent validity was assessed by examining the factor loadings and average variance extracted. Discriminant validity was analyzed using the Heterotrait-Monotrait (HTMT) ratio.

The overall impact of the model was evaluated by calculating the coefficient of determination (R2). This provides an assessment of the model's ability to explain the variance in the dependent variable.

DATA ANALYSIS

Table 1 Demographic

		Frequency	Percent
Gender			
	Female	407	74%
	Male	146	26%
Age			
	Under 30 yrs.	38	07%
	31 to 40 yrs.	187	34%
	41 to 50 yrs.	203	37%
	51 & above	125	23%
Working Experience			
	Less than 10 yrs.	224	44%
	11 to 20yrs.	199	36%
	More than 20yrs.	110	20%
Education			
	Undergraduate	75	14%
	Graduate	254	46%
	Post Graduate	153	28%
	Others	71	13%
	Department		
	Production & Operations	175	30%
	Marketing & Sales	138	27%
	Human Resource	102	19%
	Finance	84	15%
	Others	54	10%

Table 2 Reliability and validity Analysis

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
CS	0.975	0.975	0.976	0.651
GIC	0.969	0.970	0.972	0.645
GI	0.864	0.866	0.894	0.512

Note: CS=Corporate Sustainability, GIC= Green Intellectual Capital, GI= Green Innovation

Table 3 Path Coefficients, t values and P values

	Original sample	Sample mean	Standard deviation	T statistics	P values
GIC -> GI	0.504	0.505	0.044	11.512	0.000
GI -> CS	0.410	0.411	0.044	9.409	0.000
GIC -> CS	0.402	0.404	0.041	9.807	0.000

Note: CS=Corporate Sustainability, GIC= Green Intellectual Capital, GI= Green Innovation
The updated version of the text reads as follows:

Table 3 above presents the beta coefficients and corresponding probability values for each coefficient. The structural model was analyzed using a resample bootstrapping approach with 5,000 samples, following the methodology suggested by Hair et al. (2019). The results indicate significant relationships between green intellectual capital (GIC) and three variables: GI (β=0.504, p<0.000), VC (β=0.395, p<0.000), and CS (β=0.402, p<0.000). These findings support hypotheses H1, H2, and H5, as the p-values for all three relationships are less than 0.05. Therefore, it can be concluded that GIC has a significant positive impact on VC, GI, and CS.

Furthermore, the PLS-SEM analysis confirms a substantial positive effect of GI (β=0.410, p<0.000) on CS in the manufacturing firms studied. Additionally, VC (β=0.494, p<0.000) is found to have a significant effect on CS, supporting hypotheses 3 and 4. In summary, the PLS-SEM findings provide support for hypotheses 3 and 4, in addition to hypotheses 1, 2, and 5. Based on these results, it can be concluded that all the hypotheses (H1, H2, H3, and H4) are supported.

Table 4 Mediation Analysis

	Original sample	Sample mean	S.D	T statistics	P values
GIC -> GI -> CS	0.207	0.208	0.032	6.384	0.000

Note: CS=Corporate Sustainability, GIC= Green Intellectual Capital, GI= Green Innovation

To examine the mediation relationship, we employed the bootstrapping method recommended by Preacher and Hayes (2008). The results, as shown in Table 7, reveal that the pathways GIC → GI → CS (β = 0.207, p < 0.05) are statistically significant. The p-values for the mediation relationships are below 0.05, indicating their significance. Consequently, H4, which suggests that green innovation acts as a significant mediator

between green intellectual capital and corporate sustainability, is supported by the findings.

DISCUSSION AND CONCLUSION

The results of this study contribute to the literature by shedding light on the factors that contribute to green innovation (GI) in large-scale manufacturing (LSM) firms in developing economies like Pakistan. The findings indicate a significant relationship between green intellectual capital (GIC) and corporate sustainability (CS), aligning with previous studies by Chen and Chang (2013), Chen (2008), Huang and Kung (2011), and Yong et al. (2019). The results demonstrate a strong association between GIC, GI, and CS, suggesting that GI effectively mediates the relationship between GIC and CS. This highlights the importance of GI for manufacturing companies in achieving CS and emphasizes the need to offer unique goods and services and improve processes to operate efficiently, especially in the face of increasing competition (Ullah et al., 2021a).

Furthermore, the findings underscore the connection between GIC, GI, and CS, indicating that employees' knowledge, skill sets, creativity, and experience play a significant role in GIC. The results also reveal a positive relationship between GIC and CS, suggesting that a balance between human, structural, and relational capital promotes CS. These findings are consistent with the study by Yusoff et al. (2020), which found that GIC predicts sustainability, and support the Resource-Based View (RBV) hypothesis, which posits that intangible resources are associated with organizational success.

Moreover, the results highlight the significance of staff creativity in the GI process. They indicate that employees' talents, creativity, skills, and prior experience contribute to GI, providing companies with the diversity they need to adapt and actively participate in innovation (Shahzad et al., 2021b). Establishing a distinct position in the industry has become increasingly important due to heightened competition and workplace complexity, and innovation has been identified as a key means to achieve this goal. Currently, intangible assets are the most significant and productive assets for businesses (Khan & Ullah, 2021; Ullah et al., 2022).

IMPLICATIONS

The results of this study contribute to the literature by shedding light on the factors that contribute to green innovation (GI) in large-scale manufacturing (LSM) firms in developing economies like Pakistan. The findings indicate a significant relationship between green intellectual capital (GIC) and corporate sustainability (CS), aligning with previous studies by Chen and Chang (2013), Chen (2008), Huang and Kung (2011), and Yong et al. (2019). The results demonstrate a strong association between GIC, GI, and CS, suggesting that GI effectively mediates the relationship between GIC and CS. This highlights the importance of GI for manufacturing companies in achieving CS and emphasizes the need to offer unique goods and services and improve processes to operate efficiently, especially in the face of increasing competition (Ullah et al., 2021a).

Furthermore, the findings underscore the connection between GIC, GI, and CS, indicating that employees' knowledge, skill sets, creativity, and experience play a significant role in GIC. The results also reveal a positive relationship between GIC and CS, suggesting that a balance between human, structural, and relational capital promotes CS. These findings are consistent with the study by Yusoff et al. (2020), which found that GIC predicts

sustainability, and support the Resource-Based View (RBV) hypothesis, which posits that intangible resources are associated with organizational success.

Moreover, the results highlight the significance of staff creativity in the GI process. They indicate that employees' talents, creativity, skills, and prior experience contribute to GI, providing companies with the diversity they need to adapt and actively participate in innovation (Shahzad et al., 2021b). Establishing a distinct position in the industry has become increasingly important due to heightened competition and workplace complexity, and innovation has been identified as a key means to achieve this goal. Currently, intangible assets are the most significant and productive assets for businesses.

REFERENCES

[1] Ahangar, R. G. (2011). The relationship between intellectual capital and financial performance: An empirical investigation in an Iranian company. African Journal of Business Management, 5(1), 88-95.

[2] Akhtar, C. S., Ismail, K., Ndaliman, M., Hussain, J., & Haider, M. (2015). Can intellectual capital of SMEs help in their sustainability efforts. Journal of Management Research, 7(2), 82-97.

[3] Asiaei, K., Bontis, N., Barani, O., & Jusoh, R. (2021). Corporate social responsibility and sustainability performance measurement systems: Implications for organizational performance. Journal of Management Control, 32,85–126.https://doi.org/10.1007/s00187-021-00317-4

[4] Aljuboori, Z. M., Singh, H., Haddad, H., Al-Ramahi, N. M., & Ali, M. A. (2022). Intellectual Capital and Firm Performance Correlation: The Mediation Role of Innovation Capability in Malaysian Manufacturing SMEs Perspective. Sustainability, 14(1), 154.

[5] Bontis, N. (1998). Intellectual capital: an exploratory study that develops measures and models. *Management Decision*, *36*(2), 63–76. https://doi.org/10.1108/00251749810204142

[6] Elshamy, H. M., & Ahmed, K. I. S. (2017). Green fiscal reforms, environment and sustainable development. International Journal of Applied Economics, Finance and Accounting, 1(1), 48-52.

[7] Jadoon, A.I., Khan, F., Bukhari, N.T.S., Gilani,S.Z., Ishfaq, U., Ullah, M. (2022). Effect of

[8] Teacher-Student Relationship on Pro-Social Behavior and Academic Achievement of Secondary School Students. *Indian Journal of Economics and Business, 21(1),* 331-337.

[9] Chaudhry, N., Bilal, A., Awan, M., & Bashir, A. (2016). The role of environmental

[10] consciousness, green intellectual capital management and competitive advantage on financial performance of the firms: An evidence from manufacturing sector of Pakistan. Journal of Quality and Technology Management, 13(II), 51-70.

[11] Kumar, R. (2011). *Research Methodology, a step-by-step guide for beginners 3rd Edition. SAGE Publication Ltd.*

[12] Khattak. S. M. (2022). Hospital Wastes Causes Air Pollution, Case Study Of Hospital Wastes

[13] Disposing Process In Peshawar City. *International Journal of Contemporary Issues in Social Sciences, 1(2),* 47-55.

[14] Khan, K. M., Ullah M. (2021). Mediating Role of Ethical Leadership Between Employees

[15] Empowerment and Competitive Edge: A Case of Commercial Banks in Pakistan. *Humanities & Social Sciences Reviews*, *9(2),* 219-231. https://doi.org/10.18510/hssr.2021.9223

[16] Latif, H. M. (2022). Framework To Improve The Performance Appraisal of Healthcare

[17] Assistants during Covid-19 and Another Pandemic ERA. *International Journal of Contemporary Issues in Social Sciences, 1(2),* 32-46.
[18] Lester, B. M., Vicshell I. V.L., Ortiz, Sian. V.R.D., & Robles. D.V.(2023). Effects of Home
[19] Environment to the Academic Performance of the Grade 10 Students At Sto. Nino National High School, Cagayan, Philippines. *International Journal of Contemporary Issues in Social Sciences, 2(1), 31-44.*
[20] Li, D., Zhao, Y., Zhang, L., Chen, X., & Cao, C. (2018). Impact of quality management on Green Innovation. *Journal of Cleaner Production*, *170*, 462–470. https://doi.org/10.1016/j.jclepro.2017.09.158
[21] Lindman, M., Pennanen, K., Rothenstein, J., Scozzi, B., & Vincze, Z. (2016). THE VALUE SPACE: HOW FIRMS FACILITATE VC. *Emerald Insight*, *22*(3).
[22] López-Gamero, M. D., Zaragoza-Sáez, P., Claver-Cortés, E., & Molina-Azorín, J. F. (2011). Sustainable development and intangibles: Building sustainable intellectual capital. *Business Strategy and the Environment*, *20*(1), 18–37. https://doi.org/10.1002/bse.666
[23] Meng, J. (2015). Sustainability: a framework of typology based on efficiency and effectiveness. *Journal of Macromarketing*, *35*(1), 84-98.
[24] Mwemezi, P. (2023). Decentralization in Delivering Public Social Services: A Critical Review in
[25] Secondary Education In Tanzania. *International Journal of Contemporary Issues in Social Sciences, 2(1),1-8.*
[26] Toyyib, O. M., Mustapha, Enikanselu, H. A., & Adebayo. (2023). Assessment of the Political
[27] Participation and Representation of Physically Challenged Persons in the Politics of Ondo State of Nigeria: 1999-2018. *International Journal of Contemporary Issues In Social Sciences, 2(1),* 68-78.
[28] Ullah, M., Alam, W., Khan,Y., Joseph,V., Farooq,M.S., Noreen,S. (2022). Role of Leadership in
[29] Enhancing Employees Performance: A Case Of Board of Intermediate and Secondary Education, Peshawar. *Journal of Contemporary Issues in Business and Government*, *28(1),* 183-193.
[30] Windsor, D. (2017). VC Theory: Literature Review and Theory Assessment. Retrieved from https://doi.org/10.1108/S2514-175920170000004%0D
[31] Wu, J., Xia, Q., & Li, Z. (2022). Green Innovation and enterprise green total factor productivity at a micro level: A perspective of technical distance.Journal of Cleaner Production, 344, 131070. doi:10.1016/j.jclepro.2022.131070.
[32] Yong, J. Y., Yusliza, M. Y., Ramayah, T., & Fawehinmi, O. (2019). Nexus between GIC and green human resource management. *Journal of Cleaner Production*, *215*, 364–374. https://doi.org/10.1016/j.jclepro.2018.12.306
[33] Yusoff, Y. M., Omar, M. K., & Kamarudin, M. D. (2019). Practice of GIC. Evidence from Malaysian manufacturing sector. *IOP Conference Series: Materials Science and Engineering*, *469*(1). https://doi.org/10.1088/1757-899X/469/1/012008