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IMPACT OF INDUSTRY 4.0 ON GREEN INTELLECTUAL CAPITAL AND SUSTAINABLE DEVELOPMENT: MODERATING ROLE OF MANAGERIAL EMOTIONAL INTELLIGENCE (EI)

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Abstract

Purpose. This study examines the complex relationship between Industry 4.0 implementation, green intellectual capital, and sustainable development among the US marketing agencies. The growing need to understand how technological advances and sustainability initiatives interact in modern business drives the research. The objectives were to study the impact of Industry 4.0 implementation on green intellectual capital (green human, organizational, and relational capital), its impact on sustainable development, and managerial emotional intelligence is moderating role.

Design/methodology/approach. A quantitative study used an online survey on multiple social media platforms to collect data from 202 respondents.

Findings. Results showed a strong positive effect of Industry 4.0 implementation on green intellectual capital and sustainable development. Emotional intelligence drastically infuriates the sustainable development chain when management practices academic skills. These findings challenge theories about emotional intelligence's role in leveraging green intellectual capital for sustainable development, especially in Industry 4.0.

Originality. The study provides new insights into marketing technology adoption and sustainability.

Practical implications. Managers must strategically invest in Industry 4.0 technologies and green practices and rethink emotional intelligence in favor of technological adaptability and innovation.

Keywords: Emotional intelligence, industry 4.0 implementation, green intellectual

capital, sustainable development, Smart PLS 4.0

JEL Codes: F40, M14, M42, O30, Q56

Introduction

The emergence of Industry 4.0 has had a notable impact on the characteristics of intellectual capital, particularly in the areas of green relational capital (GRC), organizational (GOC), and human capital (GHC). Research like Ghobakhloo (2018) and Flores, Xu & Lu (2020) show how human capital is changing in the Industry 4.0 era and the need for new skills and methods in workforce management. Furthermore, studies on the sustainability component of Industry 4.0 by Bai et al. (2020) and Esmaeilian et al. (2020) highlight the significance of incorporating green practices in relational and organizational domains. Green intellectual capital plays a significant role in promoting sustainable development is found in the publications of Nagy et al. (2018) and Xu & Wang (2018).

Even with the increasing amount of research, there are still significant gaps in our knowledge of how Industry 4.0 specifically affects green intellectual capital in the context of marketing agencies (Oláh et al., 2020). Research on the broader effects of Industry 4.0 on environmental sustainability has been conducted in studies like Leng et al. (2020) and Oláh et al. (2020). Moreover, more research needs to be done on the connection between sustainable development and GIC in the marketing industry. While studies such as Ahmed et al. (2020) acknowledge the general importance of intellectual capital for sustainable growth, they need to adequately address the unique dynamics within marketing agencies, particularly in the rapidly evolving U.S. market. Although EI is important in many contexts, study by Jie et al. (2022) and Hu et al. (2023) modifies explicitly the relationship between green intellectual capital and sustainable development in marketing agencies.

Bai et al. (2020) and Ghobakhloo (2018), which provide a strategic roadmap for Industry 4.0 adoption in manufacturing, lay the groundwork for understanding how technological advancement affects organizational sustainability. However, they fail to address green intellectual capital in marketing. This oversight is notable given the growing importance of sustainability in marketing, as noted by Sony and Aithal (2020) and Shibin et al. (2020), who discuss sustainable supply chain management and SMEs. As Popkova and Sergi (2020) and Singh et al. (2022) have shown, human capital promotes innovation and sustainability, emphasizing the need for green intellectual capital research in digitally transformed marketing agencies. Additionally, Sohel Rana & Hossain (2023) and Sharif et al. (2023) examine the effects of intellectual capital on firm performance and environmental management, but the complex relationship between green intellectual capital and sustainable development in the marketing industry is unexplored. Ezzi, Jarboui, & Zouari-Hadiji (2020) and Flores, Xu, & Lu (2020) suggest that managerial EI improves corporate social responsibility and sustainability, but this relationship needs to be adequately studied. As discussed by

Batool, Mohammad, & Awang (2022) and Lo, Lin, Lin, & Lee (2022), EI's role in navigating Industry 4.0's challenges and opportunities highlights the need for focused research on its moderating role between green intellectual capital and sustainable development.

The study will make significant contributions to both academic and practical fields by analyzing the interactions between GRC, GOC, GHC, and managerial EI within this context. It will clarify the dynamics of sustainable development in the marketing industry, expand on the current understanding of green intellectual capital in the context of Industry 4.0, and emphasize the crucial role that EI plays in developing these ties. Based on the research gaps, problem statement and rational contributions, the study offers the research objectives:

1. To examine the effect of Industry 4.0 implementation on green intellectual capital (including GHC, GOC, and GRC) among the marketing agencies in the USA.
2. To examine the effect of green intellectual capital (including GHC, GOC, and GRC) on sustainable development among marketing agencies in the USA.
3. To assess the moderating role of managerial EI between green intellectual capital (including GHC, GOC, and GRC) and sustainable development among the marketing agencies in the USA.

1. Literature Review and Theoretical Framework

The literature review sections support the development of a theoretical framework (Figure 1). Hypotheses in the theoretical framework examine the relationships between Industry 4.0 implementation, green intellectual capital, and sustainable development, emphasizing EI's moderating role. Hypothesis 1 states that Industry 4.0 boosts GHC. Hypothesis 2 applies to GOC, and Hypothesis 3 to relational capital. The framework hypothesizes (Hypotheses 4, 5, and 6) that these three dimensions of green intellectual capital promote sustainable development. Finally, Hypothesis 7 suggests that EI, notably self-awareness and self-regulation, moderates the impact of green intellectual capital on marketing agency sustainability.

1.1. Resource-based view (RBV) theory

A strong theoretical framework for developing the relationship between Industry 4.0, intellectual capital, and sustainable development is offered by the company's Resource-Based View (RBV). RBV emphasizes the strategic significance of organizational resources and capabilities, as emphasized by David-West, Iheanachor & Kelikume (2018) and Sony & Aithal (2020), especially in the context of digital financial services and Industry 4.0 implementation in the Indian engineering industry. The resources—that include organizational skills, human capital, and technological assets—are essential for companies to establish and maintain a competitive edge. These resources are becoming more digitalized and

networked in the age of Industry 4.0, which makes the RBV especially important.

Moreover, the RBV is crucial in designing how intellectual capital contributes to Industry 4.0's sustainable development goal. Studies like Estensoro et al. (2022) and Gupta et al. (2018) highlight the temporary and permanent competitive advantages that result from utilizing information systems and the shift to advanced stages of Industry 4.0 in SMEs. Under RBV, intellectual capital—which includes knowledge, skills, and organizational learning—is an essential resource that implements sustainable practices. In the context of Industry 4.0, where the integration of cutting-edge technologies necessitates specialized knowledge and skills, this capital becomes even more important. Companies can better navigate the complexities of Industry 4.0 by concentrating on developing and applying intellectual capital, which will encourage innovation and sustainable practices that align with the Triple Bottom Line approach to sustainability.

The RBV framework offers insights into how SMEs use their unique resources to participate in sustainable supply chain management, as Jayashree et al. (2021) and Shibin et al. (2020) have discussed. These case studies demonstrate how small and medium-sized enterprises (SMEs) leverage their unique capabilities and assets to integrate Industry 4.0 technologies efficiently, enhancing operational sustainability. According to the RBV, SMEs' unique qualities—like flexibility, imagination, and subject-matter expertise—are essential for sustaining the supply chain. This viewpoint supports the notion that sustainable development results from a firm's strategic use of its resources and capabilities and from adopting new technologies.

1.2. Green Intellectual Capital and Sustainability

Modern business sustainability depends on green intellectual capital, which includes human, organizational, and relational capital. Flores, Xu, & Lu (2020) and Ghobakhloo (2018) emphasize that GHC—employee skills, knowledge, and competencies—is essential for innovation and adaptability, especially in Industry 4.0. According to Xu & Wang (2018) and Bai et al. (2020), organizational capital—culture, processes, and databases—encourages resource efficiency and innovation. GRC, which involves stakeholder and network relationships, improves sustainability by enabling collaboration and knowledge exchange, which is essential for addressing environmental and social issues (Esmaeilian et al., 2020; Oláh et al., 2020). These green intellectual capital dimensions work together to support and drive sustainable development in organizations navigating the complexities of modern business. Therefore, the study designs the research hypotheses below:

1.2.1. Industry 4.0 Implementation and GHC

The current literature provides strong evidence that implementing Industry 4.0 significantly and positively affects GHC in U.S. marketing agencies. Research such as Ghobakhloo (2018) and Flores, Xu, & Lu (2020) demonstrate how implementing Industry 4.0

technologies improves human capital by requiring and developing new competencies related to sustainability and digitalization. Integrating cutting-edge technologies like AI, big data, and IoT can significantly enhance human capabilities, making this evolution imperative in marketing agencies where creativity and innovation play a pivotal role. Furthermore, the move towards Industry 4.0 in business strategy strengthens the position of human capital in managing and interpreting complex data streams, which supports environmentally friendly business practices (Nagay et al., 2018). This is consistent with research by Xu & Wang (2018), which indicates that in the context of advanced manufacturing industries, intellectual capital—of which human capital is a crucial component—directly supports sustainable growth.

In addition, Scafarto, Ricci & Scafarto (2016) highlight how human capital can be leveraged to leverage intellectual capital for better firm performance. This situation is likely reflected in the marketing industry's adoption of Industry 4.0 technologies. Furthermore, the study on blockchain technology's application to sustainable supply chain management by Esmaeilian et al. (2020) shows how digital technologies can promote environmentally friendly behaviors, a vital part of GHC. Adopting this technology within marketing agencies creates an environmentally conscious workforce and gives workers the skills and knowledge they need to implement sustainable solutions successfully. This aligns with the findings of Bai et al. (2020), who posit that adopting Industry 4.0 technologies requires and enables a more environmentally conscious and productive approach to business processes, ultimately improving the GHC of organizations. So, both empirical data and sound reasoning support the idea that the adoption of Industry 4.0 benefits GHC in U.S. marketing agencies, which reflects how closely technology innovation and the growth of human capital are related in the current digital era. For this reason, the study offers a research hypothesis:

H1. Industry 4.0 implementation significantly and positively influences GHC among the marketing agencies in the USA.

1.2.2. Industry 4.0 Implementation and GOC

The implementation of Industry 4.0 has a significant and positive impact on GOC in U.S. marketing agencies. According to Bai, Dallasega, Orzes & Sarkis (2020) and Esmaeilian et al. (2020), integrating sustainable practices into organizational operations—primarily through cutting-edge technologies like blockchain—is a crucial component of Industry 4.0. The development of GOC, which includes environmentally friendly business procedures and practices, is directly aided by this integration. Studies like Leng et al. (2020) and Nagy et al. (2018) also highlight the revolutionary impact of Industry 4.0 on business strategies and supply chain management, pointing to a shift towards more sustainable and effective organizational processes.

According to Ghobakhloo (2018), organizational restructuring and process

optimization—two essential elements of GOC—are made easier and more necessary by adopting Industry 4.0 technologies. When businesses use technology to cut waste, increase resource efficiency, and adopt environmentally friendly practices, restructuring frequently results in more sustainable business practices. Moreover, Oláh et al. (2020) show how implementing Industry 4.0 positively affects the environment and increases an organization's green capital. Adopting Industry 4.0 technologies is a strategic move for marketing agencies in the United States, where digital competencies and environmental consciousness are becoming increasingly important. Finally, the study offers a research hypothesis:

H2. Industry 4.0 implementation significantly and positively influences GOC among the marketing agencies in the USA.

1.2.3. Industry 4.0 Implementation and GRC

Numerous academic studies support the hypothesis that implementing Industry 4.0 significantly and favorably influences GRC in U.S. marketing agencies. Esmaeilian et al. (2020) emphasize the importance of Industry 4.0 technologies, like blockchain, in encouraging sustainable practices inside businesses. This is crucial for creating GRC. The evaluation of Industry 4.0 technologies from a sustainability perspective in Bai et al. (2020) echoes this, emphasizing the technologies' potential to improve stakeholder relations that are transparent and environmentally responsible.

Furthermore, Ghobakhloo's (2018) research on the strategic roadmap toward Industry 4.0 in manufacturing supports the hypothesis by indicating that advanced digital technologies can significantly enhance stakeholder collaboration and engagement. This is especially important for marketing agencies since their success depends on sustaining solid bonds with partners and clients. Leng et al. (2020) support this perspective by illustrating how blockchain-enabled sustainable manufacturing and product lifecycle management under Industry 4.0 promote better stakeholder relationships using increased transparency and ethical practices. Finally, the study offers a research hypothesis:

H3. Industry 4.0 implementation significantly and positively influences GRC among the marketing agencies in the USA.

1.3. Green Intellectual Capital and Sustainable Development

Current academic research strongly supports the relationship between GHC and sustainable development in U.S. marketing agencies. Insights into creating human capital 4.0 are offered by Singh, Agrawal & Modgil (2022). They emphasize aligning workforce knowledge and skills with Industry 4.0 requirements, which naturally incorporate sustainability practices. A workforce competence typology for Industry 4.0 is discussed by Flores et al. (2020), who further support this idea by emphasizing the critical role of environmentally

conscious skills and competencies in the current industrial revolution. GHC in the marketing agency context supports creative and flexible strategies and integrates sustainability into the foundation of business operations, promoting long-term sustainable development. Furthermore, Xu & Wang (2018) show the beneficial influence of intellectual capital on sustainable growth in the Korean manufacturing sector, highlighting the importance of GHC in advancing sustainable practices. Thus, GHC becomes a critical driver of sustainable development in the highly competitive world of American marketing agencies. Therefore, the study offers a research hypothesis:

H4. GHC significantly and positively influences sustainable development among the marketing agencies in the USA.

A study conducted in the Behavioral Sciences by Hu et al. (2023) on the relationship between employees' green behavior, the EI of green leaders suggests a positive correlation between sustainable practices, and leadership attributes. This is consistent with GOC because it highlights the leadership's role in cultivating a sustainable culture. Furthermore, Ahmed et al. (2020) emphasize the role of people in advancing sustainable initiatives in resource policy by examining the dynamic relationship between human capital and a sustainable environment. The results of this study support the notion that human-centered factors of organizational capital, such as sustainability-related knowledge and abilities, are essential for advancing sustainable development.

Furthermore, the International Journal of Production Economics article by Bai et al. (2020) explores the sustainability viewpoint of Industry 4.0 technologies. According to their findings, technological innovations that align with sustainable objectives can improve organizations' ability to be environmentally friendly. This is relevant to American marketing agencies because this industry's organizational capital mainly depends on technological competence. Comparably, Oláh et al. (2020) in Sustainability address Industry 4.0's effect on environmental sustainability, emphasizing how integrating technology into organizational procedures can lead to sustainable results. This strengthens the case that, in the context of contemporary marketing agencies, GOC—which includes both human and technological resources—is a key factor in sustainable development. Therefore, the study offers a research hypothesis:

H5. GOC significantly and positively influences sustainable development among the marketing agencies in the USA.

A thorough analysis of recent scholarly articles provides relevant insights that state that GRC significantly and favorably influences sustainable development among marketing agencies in the USA. In addition, Boohene, Gyimah, and Osei (2020), for example, stress the significance of social capital and how it interacts with EI in small and medium-sized businesses (SMEs), implying that networks and interpersonal relationships are vital

to organizational success. The impact of strong, sustainability-focused relationships on organizational outcomes is highlighted by this study, which highlights the idea of *"GRC."* Furthermore, Batool, Mohammad, and Awang (2022) investigate how human capital elements affect organizational sustainability in the Society and Business Review, concentrating on trust›s role as a mediator in the Malaysian hotel sector. According to their research, trust—a crucial component of relational capital—is crucial in improving sustainable organizational practices.

Additionally, in the banking sector, the study on sustainability by Giao et al. (2020) investigates the impact of EI on intentions to leave, with the influence of perceived organizational support. This study highlights the importance of EI in creating a positive work atmosphere, and it is a crucial component of GRC. Similarly, Lo et al. (2022) in Behavioral Sciences examine how EI affects nurses' intentions to leave and job satisfaction, emphasizing the importance of emotional components in sustaining positive and long-lasting organizational relationships. Therefore, the study offers a research hypothesis:

H6. GRC significantly and positively influences sustainable development among the marketing agencies in the USA.

1.4. Moderating Role of EI

An analysis of recent scholarly works is relevant to support Hypothesis H7, which posits that EI significantly and positively moderates the relationship between GHC and sustainable development in marketing agencies in the USA. In the context of knowledge, service, and leadership excellence, D'Souza, Irudayasamy, Usman, Andiappan, and Parayitam's (2021) study explores the relationship between psychological capital and EI. Their study demonstrates the critical role that EI plays in enhancing the advantages of human capital and raises the possibility that it may improve the effectiveness of GHC in promoting sustainable practices.

Additionally, the study by Batool, Mohammad, and Awang (2022) emphasizes the mediating function of trust within the organizational framework and concentrates on the impact of human capital factors on organizational sustainability. This study highlights the value of interpersonal factors—directly related to EI—in utilizing human capital to achieve long-term results. When taken as a whole, these studies offer strong evidence in favor of the hypothesis, showing that EI is not only a helpful attribute but also a crucial moderator that significantly improves GHC's effect on sustainable development in the fast-paced setting of American marketing agencies. Therefore, the study offers a research hypothesis:

H7. EI significantly and positively moderates the relationship between GHC and sustainable development among the marketing agencies in the USA.

RBV theory is supported by the research by Boohene, Gyimah, and Osei (2020), which clarifies the moderating function of EI about social capital and SME performance. According to this study, performance can be improved by applying EI in organizational settings, mainly GOC. This idea applies to sustainable marketing agency practices. Furthermore, Ezzi, Jarboui, and Zouari-Hadiji (2020) investigated the relationship between managerial EI and corporate social responsibility (CSR). Their findings suggest that having EI in leadership roles increases the efficacy of CSR programs, which is an essential component of GOC.

Second, Lo, Lin, Lin, and Lee (2022) examined the relationship between EI, intention to leave an organization, and job satisfaction, highlighting the importance of this skill in managing human resources. According to their research, EI is critical in developing and preserving a productive and sustainable workforce—a prerequisite for GOC. In addition, the Singh, Agrawal, and Modgil (2022) study on human capital 4.0 in emerging economies sheds light on how organizational capital is changing in industry 4.0. It suggests that EI will become increasingly crucial to managing and utilizing this capital for sustainable development. Therefore, the study offers a research hypothesis:

H8. EI significantly and positively moderates the relationship between GOC and sustainable development among the marketing agencies in the USA.

Yaya's (2017) study sheds light on the relationship between EI and human capital growth, emphasizing how it affects productivity and job satisfaction in Nigeria's public university libraries. According to this study, EI is necessary for developing positive relational dynamics, which are vital to GRC and may help achieve sustainable development in organizational contexts. Furthermore, the study by Lo, Lin, Lin, and Lee (2022) emphasizes the significance of EI in managing and maintaining human resources by exploring the effects of EI on job satisfaction and turnover intention among nurses. According to their findings, relational capital can function more effectively in marketing agencies when EI supports long-term growth and sustainable practices.

Additionally, Ezzi, Jarboui, and Zouari-Hadiji's (2020) research delve into the moderating function of managerial EI concerning CSR and R&D investment, providing valuable perspectives on how leadership attributes can mold and enhance organizational strategies for sustainability. This study supports the idea that utilizing GRC for sustainable outcomes requires EI, especially at the managerial level. Likewise, Giao, Vuong, Huan, Tushar, and Quan (2020) investigate the influence of EI on intentions to leave the banking sector, emphasizing the moderating function of perceived organizational support. Therefore, the study offers a research hypothesis:

H9. EI significantly and positively moderates the relationship between GRC and sustainable development among the marketing agencies in the USA.

After the literature justifications and pieces of evidence, the study develops the research hypotheses:

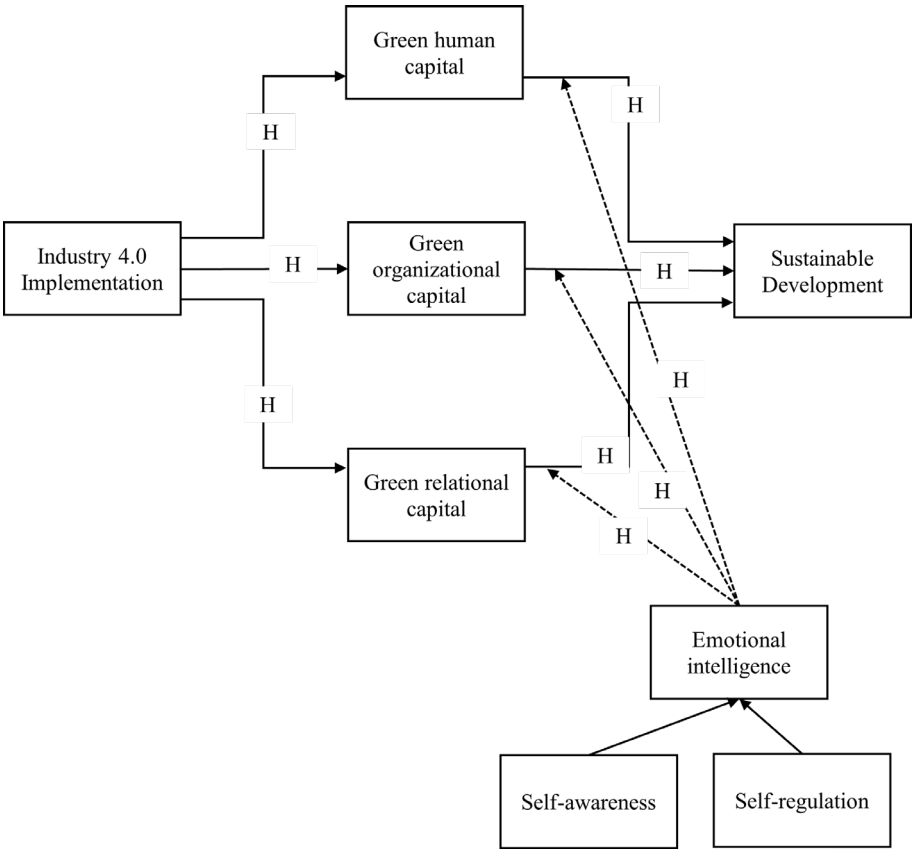

Figure 1. Theoretical Framework

2. Research Methodology

2.1. Research Design

This study employs a quantitative research design (Leavy, 2022) to address three key objectives methodically. Firstly, it examines the impact of Industry 4.0 implementation on green intellectual capital, encompassing GHC, GOC, and GRC, among marketing agencies in the USA. Secondly, the research explores the influence of this green intellectual capital

on sustainable development within these agencies.

2.2. Data Collection Procedures

The data collection procedure for this study was carefully designed to ensure a thorough understanding of the relationship between Industry 4.0 implementation, green intellectual capital, and sustainable development in marketing agencies in the USA. The primary data collection method was an online survey questionnaire made with Google Drive. The digital approach was chosen due to its effectiveness and broad audience reach, which align with the suggested practices of contemporary research methodologies. As the literature has shown, online surveys are increasingly valued for their low costs, quick distribution, and high response rates (Bloomfield & Fisher, 2019).

The survey was disseminated on several social media sites, such as Facebook, Twitter, LinkedIn, and WhatsApp, to increase reach and engagement. According to Palinkas et al. (2015), these platforms were selected because they are widely used by professionals in the business sector, especially in the USA. Through these digital platforms, the research ensured broad involvement from various participants, such as managers, stakeholders, and administrators employed by marketing agencies. This strategy aligns with Emerson (2015)'s criteria, emphasizing how social media can effectively reach specific professional groups for research.

The methodology used a convenient sampling to ensure diversity, but sample size and industry quotas are unknown. This approach emphasizes inclusivity across Washington, DC, agences (i.e., marketing, e-commerce, retailers, suppliers, manufacturers) to reflect the wide range of marketing agencies. The study targets front-desk officers and finance officers. The survey questionnaires were distributed on social media platforms by visiting professional sites and contacting them to answer the survey. Based on the idea that learning from agencies in a central economic hub would have significant implications for more general industry practices, this location was chosen (Emerson, 2015).

A convenient sampling technique was employed to identify the survey participants, with the first contact details obtained from the respective companies' websites. This strategy ensured that participants were chosen methodically and objectively, which was essential for the study's validity and reliability. Because it improves the findings, convenient sampling is frequently recognized in the literature as an easy participant selection technique (Williams, 2019). In order to ensure a targeted approach and focus on individuals most likely to provide pertinent and knowledgeable responses regarding the practices and trends in the industry, participant information was gathered via company websites. This identification and selection process for participants complies with Bloomfield & Fisher (2019) recommendations, which highlight how crucial precise and focused participant selection is for business research. In the end of the data collection process, the study obtained 217 survey responses but the complete versions were 202.

2.3. Measurement Scales

The study the valid and reliability scales from the previous done research. The validity and reliability of the measurement constructs were higher than 0.70; therefore, the study adopted those valid and reliable scales. The study adapted all survey items from the previous studies because this stance was done to test the existing theory, not building theory. Therefore, it was necessary to adapt the items according to US business sectors. The study adapted 8 items of Industry 4.0 implementation from the study of Jayashree et al. (2021), which includes 4 items for vertical implementation and 4 items for horizontal implementation for the management. The study adapted 4 items of GHC, 5 items of GOC, and 5 items of GRC from the study of Sharif et al. (2023) and Jirakraisiri, Badir and Frank (2021). As well, the study adapted 4 items of sustainable development from the study of Jirakraisiri, Badir and Frank (2021). In addition, the study adapted 10 items for managerial EI including 5 items for self-regulation and 5 items for self-awareness from the study of Gola and Martin (2020). All measurement scales were measured on 5-points Likert scales.

Within the survey, each scale explores a unique aspect of workplace dynamics in the age of digital transformation. For instance, *"helps employees to manage the tools and techniques"* delves into how Industry 4.0 influences employees› technical capabilities. The statement «*contribute strongly to, and are productive in, environmental protection*» evaluates the green human capital by assessing employees› engagement in environmental initiatives. Looking at green organizational capital, «*has a superior management system for environmental protection*» reflects the company›s structural commitment to ecological issues. The green relational capital is encapsulated by «*successfully satisfies its customers with the provided level of environmental protection*», indicating the company's external eco-friendly efforts. Lastly, emotional intelligence within the professional setting is represented by items like *"I am good at sensing what others are feeling at work"*, which assess an individual's ability to understand and respond to colleagues' emotions effectively.

2.4. Data Analysis

Social science research often uses IBM SPSS for data management and initial statistical analysis. Field (2018) says SPSS can handle large datasets and perform many statistical analyses. SPSS was chosen for the initial research phase because of its ability to assess sample characteristics and variable distribution, according to Cheah et al. (2020) and Al-Emran et al. (2019). After SPSS analysis, Smart PLS was used for structural equation modeling (SEM), a crucial statistical method for examining how external factors affect internal variables (Kamis et al., 2020; Ringle et al., 2015). Hair et al. (2020) state Smart PLS's partial least squares (PLS) path-modeling algorithm is ideal for predictive studies and non-normal data distributions. Its suitability for complex models with many indicators and variables makes it helpful for this research. PLS-based SEM was used to validate the research hypotheses, following Henseler et al. (2016) methodological advice.

3. Results and Findings

3.1. Demographic information

The demographic information presented in Table 1 offers the overview of the composition of participants in the study (see Table 1).

Table 1. Demographic information

Demographics	Subcategory	Frequency	Percent	Valid Percent	Cumulative Percent
Management Level	Medium Level Managers	135	66.8%	66.8%	66.8%
	Top Level Managers	67	33.2%	33.2%	100.0%
Employee Status	Front-desk Officer	113	55.9%	55.9%	55.9%
	Finance Officer	89	44.1%	44.1%	100.0%
Agency Age	1-05 Years	52	25.7%	25.7%	25.7%
	06-10 Years	123	60.9%	60.9%	86.6%
	11-above Years	27	13.4%	13.4%	100.0%
Total		**202**	**100.0%**	**100.0%**	

3.2. Assessment of Measurement Model

The measurement model presented provides a detailed overview of various constructs integral to the study of industry 4.0 implementation, green human capital, green organizational capital, green relational capital, self-awareness, self-regulation, and sustainable development. evaluating these constructs using loadings, average variance extracted (AVE), Cronbach alpha, and composite reliability is crucial for ensuring the validity and reliability of the constructs within the context of PLS-SEM. Scholars suggested that the value of AVE should be higher than 0.50, Cronbach alpha and composite reliability > 0.70 and Factor loadings > 0.70 (Padilla & Divers, 2016; Hair et al., 2020).

GHC exhibits higher loadings (0.774 to 0.898), an AVE of 0.736, and excellent reliability scores (Cronbach alpha of 0.879 and composite reliability of 0.917), demonstrating that the construct is measured with high precision and consistency. The constructs in the measurement model demonstrate sufficient levels of convergent validity, internal consistency, and reliability.

Table 2. Measurement model

Variables	Items	Loadings	AVE	Cronbach's Alpha	Composite Reliability
Industry 4.0 Implementation	INDUS1	0.796	0.583	0.821	0.875
	INDUS4	0.702			
	INDUS5	0.768			
	INDUS7	0.801			
	INDUS8	0.747			
GHC	GHC1	0.774	0.736	0.879	0.917
	GHC2	0.898			
	GHC3	0.877			
	GHC4	0.878			
GOC	GOC1	0.769	0.661	0.828	0.886
	GOC2	0.804			
	GOC4	0.812			
	GOC5	0.864			
GRC	GRC1	0.802	0.642	0.861	0.899
	GRC2	0.784			
	GRC3	0.796			
	GRC4	0.834			
	GRC5	0.789			
GRC	GRC1	0.802	0.642	0.861	0.899
	GRC2	0.784			
	GRC3	0.796			
	GRC4	0.834			
	GRC5	0.789			
Self-awareness	SELFA1	0.794	0.687	0.832	0.814
	SELFA5	0.861			
Self-regulation	SELFR3	0.821	0.716	0.868	0.910
	SELFR4	0.874			
	SELFR5	0.855			
	SELFR6	0.834			

Sustainable development	SD1	0.787	0.702	0.858	0.904
	SD2	0.870			
	SD3	0.841			
	SD4	0.851			

3.3. Heterotrait-Monotrait (HTMT) ratio

The Heterotrait-Monotrait (HTMT) ratio is a criterion for assessing discriminant validity in variance-based structural equation modeling (SEM). According to Henseler, Ringle, and Sarstedt (2015), this method offers a more refined approach than traditional measures. Generally, an HTMT value below 0.85 indicates an adequate discriminant fact, though a more conservative threshold of 0.90 is often used in practice to ensure a more apparent distinction between constructs. HTMT ratio is evident that most constructs exhibit ratios below the conservative threshold of 0.90, suggesting a satisfactory level of discriminant validity. By following the assumptions, the study ensures the discriminant validity.

Table 3. Heterotrait- Monotrait (HTMT)

CONSTRUCTS	**1**	**2**	**3**	**4**	**5**	**6**	**7**
GHC	0.793						
GOC	0.684	0.694					
GRC	0.698	0.598	0.545				
Industry 4.0 Implementation	0.782	0.721	0.854	0.637			
Self-awareness	0.780	0.108	0.109	0.104	0.131		
Self-regulation	1.144	0.784	0.670	0.687	0.764	0.101	
Sustainable development	0.897	0.724	0.678	0.687	0.695	0.164	0.870

3.4. Testing of Model Fitness

Model fitness in Partial Least Squares Structural Equation Modeling (PLS-SEM) assesses a proposed model representing the data. It indicates the strength and usefulness of the model. However, It could indicate overfitting, where the model is too closely tailored to the specific dataset and may need to generalize better to other data, as highlighted in the works by Ramayah et al. (2018) and Cheah et al. (2020). The model shows a good fit for sustainable development and demonstrates a moderate to weak fit for others (Table 4). The perfect fit indicated for EI is atypical, and warrants caution. These results underscore the importance of critically evaluating model fitness in PLS-SEM, as discussed by Sarstedt and Cheah (2019), and ensuring that models fit the data well and appropriately reflect the complexity and nuances of the studied constructs.

Table 4. Model Fitness

Constructs	R-square	R-square adjusted
EI	1.000	1.000
GHC	0.378	0.375
GOC	0.504	0.501
GRC	0.291	0.287
Sustainable development	0.646	0.633

3.5. Assessment of path model

Understanding the relationships between variables is paramount in structural equation modeling (SEM). Variables are categorized as either exogenous or endogenous, with exogenous variables serving as independent variables that influence other variables in the model and endogenous variables acting as dependent variables influenced by these relationships. The results from the Smart PLS model indicate significant relationships among these variables. The direct impact of industry 4.0 implementation on green human capital is substantial and significant ($\beta = 0.615$, t-value = 10.544, $p < 0.000$), leading to the acceptance of hypothesis H1. A similar strong and significant relationship is observed between industry 4.0 implementation and green organizational capital, with a beta value of 0.710 and a very high t-value of 19.282 ($p < 0.000$), resulting in the acceptance of hypothesis H2. Furthermore, hypothesis H3, which posits a significant relationship between industry 4.0 implementation and green relational capital, is also accepted due to a robust beta value of 0.539 and a t-value of 10.265 ($p < 0.000$).

However, not all hypotheses find support in the studies. Hypothesis H4, which examines the relationship between GHC and sustainable development, is rejected due to a low beta value of 0.078 and an insignificant t-value of 1.270 ($p = 0.204$). In contrast, hypotheses H5 and H6, exploring the impact of GOC and GRC on SD, are accepted. GOC shows a beta value of 0.177 with a t-value of 2.761 ($p = 0.006$), and GRC shows a beta of 0.174 and a t-value of 2.908 ($p = 0.004$).

Table 5. Hypotheses Testing

Relationships	Direct Beta	Moderating beta	t-values	p-values	Decision
H1. INDIM -> GHC	0.615		10.544	0.000	Accepted
H2. INDIM -> GOC	0.710		19.282	0.000	Accepted
H3. INDIM -> GRC	0.539		10.265	0.000	Accepted
H4. GHC -> SD	0.078		1.270	0.204	Rejected
H5. GOC -> SD	0.177		2.761	0.006	Accepted

H6. GRC -> SD	0.174		2.908	0.004	Accepted
H7. EI x GHC -> SD		-0.103	1.699	0.089	Rejected
H8. EI x GOC -> SD		0.050	0.907	0.364	Rejected
H9. EI x GRC -> SD		-0.010	0.167	0.867	Rejected

Note: GHC = GHC, Sustainable development = SD, GOC = GOC, GRC = GRC, Industry 4.0 Implementation = INDIM, EI = EI

3.6. Effects of Moderation

The moderating effects of emotional Intelligence on the relationships between different types of intellectual capital (GHC, GOC, and GRC) and sustainable development were scrutinized. The analysis presented in the structural model highlights that EI does not have a statistically significant moderating effect on the relationship between GHC and Sustainable Development, as evidenced by the negative moderating beta (-0.103), a t-value (1.699) that falls short of the conventional threshold for significance, and a p-value (0.089) that exceeds the generally accepted level of 0.05. The moderating role of EI in the relationships between both GOC and GRC with Sustainable Development. The respective beta coefficients (0.050 and -0.010) indicate negligible effects, and the associated t-values (0.907 and 0.167) alongside p-values (0.364 and 0.867) do not support the hypotheses (see Figure 5).

Several factors explain why EI does not moderate the relationships between green intellectual capital and sustainable development in marketing agencies. Industry 4.0 implementation outweighs EI in its direct effects on green intellectual capital and sustainable development (Bai et al., 2020; Ghobakhloo, 2018). In the digital age, data and automated processes rather than manager skills often drive marketing agencies' decision-making, which may limit EI's influence (Sony & Aithal, 2020; Shibin et al., 2020). Self-awareness and self-regulation may not be as crucial in mediating the relationship between green intellectual capital and sustainable development as previously thought. Due to the complexity of sustainable practices, which require organizational culture and systemic support, the measures of EI used may have yet to adequately capture this (Popkova & Sergi, 2020; Singh et al., 2022).

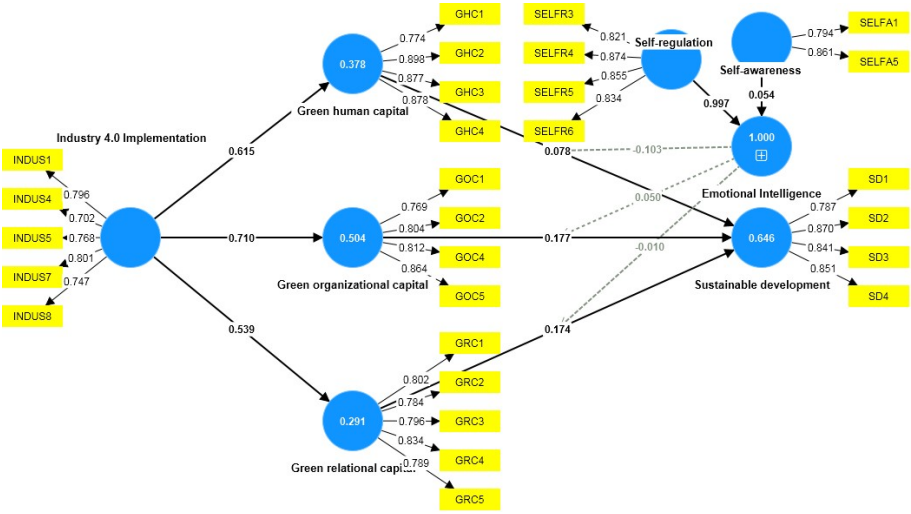

Figure 2. Measurement Model

4. Discussion

The research findings, which consider the moderating role of EI, provide a nuanced understanding of the dynamics between Industry 4.0 implementation, green intellectual capital, and sustainable development in marketing agencies. These findings mostly agree with previous research. The approved hypotheses (H1, H2, H3, H5, and H6) show a significant relationship between the application of industry 4.0 and different facets of GIC and how this capital affects sustainable development. This is consistent with studies highlighting the transformative impact of Industry 4.0 on organizational capabilities and sustainability practices, such as those conducted by Singh, Agrawal, and Modgil (2022) and Bai, Dallasega, Orzes and Sarkis (2020). The results validate the idea that Industry 4.0 innovations significantly improve green human, organizational, and relational capital, which in turn propels sustainable development. This idea is backed by Ghobakhloo (2018) and Bonekamp and Sure (2015).

On the other hand, the fact that the moderating effects of EI were rejected (H7, H8, and H9) shows an exciting departure from the results predicted based on earlier research. Research such as that conducted by Lo, Lin, Lin, and Lee (2022) and Boohene, Gyimah, and Osei (2020) indicated that EI (EI) modifies a great deal in a variety of organizational contexts. The present study's rejection of these hypotheses may be due to the distinct interaction between EI and GIC within the particular setting of marketing agencies undergoing digital transformation. This points to a more nuanced relationship than first thought,

perhaps due to the unique working conditions of marketing agencies or the particular difficulties associated with implementing Industry 4.0.

The results of the current study also cast doubt on the generalizability of EI moderating role in the relationship between sustainable development and green intellectual capital. Although studies by Jie, Poulova, Haider, and Sham (2022) and Yaya (2017) have shown that EI is frequently viewed as a positive attribute in organizational settings, its particular function in the context of Industry 4.0 and green intellectual capital within marketing agencies may differ from other sectors. This is because of the specific requirements of the marketing sector, where adaptability and technological know-how may be more important than EI when it comes to utilizing green intellectual capital for sustainable development.

The unexpected finding that EI did not moderate the relationship between green intellectual capital components and sustainable development calls for further reflection on EI's multifaceted role in organizational contexts. According to the literature, EI is essential to individual leadership and decision-making (Ezzi et al., 2020), but in complex organizational systems where collective intelligence and decision-making processes are equally important, EI may be diluted. In dynamic and fast-changing fields like marketing, technology-driven industry standards like Industry 4.0 and humanistic elements of organizational behavior like EI may not align as neatly as previously theorized. This suggests that modern marketing agencies' technological infrastructure and data-centric nature may buffer managerial EI or that EI metrics need to capture its nuances in these contexts (Popkova & Sergi, 2020; Singh et al., 2022). The green intellectual capital may operate on an organizational level that transcends individual emotional competencies, suggesting that EI should be conceptualized and measured as a collective construct rather than an individual trait.

Comparative studies show that EI and its relationship to green intellectual capital and sustainable development vary across cultural, economic, and regulatory contexts in India (Sony & Aithal, 2020). The importance of EI varies by industry's reliance on human decision-making versus automated processes (Ghobakhloo, 2018). International perspectives also show how different Industry 4.0 implementation approaches affect green intellectual capital and sustainability, as India's organizational cultures and environmental priorities vary (Shibin et al., 2020; Singh et al., 2022). This broader analysis could illuminate the contingent nature of the relationships studied and clarify the mechanisms.

5.1. Managerial implications

The study has several managerial ramifications for marketing firms operating in the United States, especially when considering the adoption of Industry 4.0 and the creation of green intellectual capital. First, the evidence suggests that marketing agencies should make strategic investments in cutting-edge technologies and digital transformation projects, given the strong correlation between the adoption of Industry 4.0 and the improvement of green intellectual capital (including green human, organizational, and relational

capital). By doing this, they can promote a more inventive, efficient, and sustainable work environment. This entails implementing new technology and ensuring that staff members receive the necessary training and assistance to adjust to these developments. To meet the demands of Industry 4.0, managers should prioritize upskilling and reskilling programs that improve the digital competencies of their teams. Agencies should also put much effort into creating a culture that values sustainability and supports actions that advance social and environmental responsibility.

Second, marketing agencies must incorporate sustainability into their main strategies, given the influence of green intellectual capital on sustainable development. This is more than just following environmental laws; it is integrating sustainable practices into every facet of company operations, from internal procedures to marketing campaigns. Managers are responsible for establishing an environment in which green initiatives are valued and rewarded. This could entail creating eco-friendly marketing plans, highlighting eco-friendly goods and services, and participating in CSR initiatives. By doing this, agencies improve their brand image and gain a competitive edge in the market, in addition to helping to preserve the environment.

Finally, the study's conclusions about EI non-significant moderating role in the connection between green intellectual capital and sustainable development offer a chance to reconsider EI's place in the digital age. In the context of Industry 4.0, marketing agency managers should consider other factors that have a greater impact on leveraging green intellectual capital for sustainability, even though EI is still crucial. This can entail emphasizing data-driven decision-making, technological adaptability, and cultivating an environment that values ongoing innovation. Supervisors should strike a balance between their staff's technical and emotional skill-building, understanding that in the rapidly changing digital environment, a blend of the two is required to attain long-term success and expansion.

5.2. Limitations and future directions

The study's geographic and sectoral focus is one of its main limitations. Because the study is limited to marketing agencies in the USA, the results may be less applicable to other countries or sectors of the economy. The study used a convenient sampling technique so there might be biasness, the findings could not be generalized. Variations in the cultural, economic, and regulatory contexts may significantly affect how Industry 4.0, green intellectual capital, and sustainable development interact. Furthermore, while a quantitative approach can yield insightful statistics, it may need to include the more nuanced understanding that qualitative techniques, like case studies or interviews, can provide. This methodological decision might restrict our ability to fully understand individual's subjective experiences and perceptions within the framework of these intricate relationships. As well, the moderating effects were not significant so a qualitative study may explore the factors behind this insignificant moderation of EI.

Future studies should focus on overcoming these constraints. A more thorough

understanding of the phenomenon would result from expanding the study to include a variety of industry sectors and diverse geographic locations. This broader scope would improve the findings' external validity by enabling comparisons across various cultural and economic contexts. Furthermore, adding qualitative research techniques could provide a more in-depth understanding of the human aspects of the data, including the attitudes, drives, and difficulties that people have adjusting to Industry 4.0 and putting green initiatives into practice. Subsequent research endeavors may investigate the function of additional plausible moderating factors, like organizational culture or leadership style, in the correlation between green intellectual capital and sustainable development. This would offer a more comprehensive understanding of the elements that affect the practical application of sustainable practices in the digital transformation age.

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Survey Questionnaire:

Section A: Demographic Information

Please provide your answer by using the tick (✓) mark

1. Management level: □ Medium level managers □ Top level managers
2. Employee status: □ Front-desk officers □ Finance officers
3. Agency age □ 1-5 Years □ 6-10 Years □ 11 and above Years

Section B: Survey Items

To what extent do you agree or disagree with the statements given below. Please answer each question by using the tick (✓) mark between the range of 1 to 5. The given scale represents the following values:

- **Strongly Disagree (SD) 1**
- **Disagree (D) 2**
- **Neutral (N) 3**
- **Agree (A) 4**
- **Strongly Agree (SA) 5**

	Industry 4.0 implementation	**SD**	**D**	**N**	**A**	**SA**
	While implementing Industry 4.0, our organization's technological integration…….					
	helps employees to manage the tools and techniques.	1	2	3	4	5
	enhances employees' innovation performance.	1	2	3	4	5
	enables the creation of various products.	1	2	3	4	5
	allows in improving the product quality.	1	2	3	4	5

	While implementing Industry 4.0, our organization's technological integration....					
	makes the inventory-related information visible throughout the supply chain.	1	2	3	4	5
	helps to maintain a smart product order management system.	1	2	3	4	5
	allows building cloud-based customer service data management.	1	2	3	4	5
	assists for early market entrants.	1	2	3	4	5
	Green human capital					
	Compared to major competitors, the employees of your company ...					
	contribute strongly to, and are productive in, environmental protection.	1	2	3	4	5
	are adequately competent in environmental protection.	1	2	3	4	5
	perform well in pursuing environmental product/service performance.	1	2	3	4	5
	cooperate well and work in teams to ensure environmental protection.	1	2	3	4	5
	Green organizational capital					
	Compared to major competitors, your company ...					
	has a superior management system for environmental protection.	1	2	3	4	5
	has formed a committee to make progress on key issues in environment protection.	1	2	3	4	5
	makes an adequate investment in environmental protection facilities.	1	2	3	4	5
	has a high percentage of employees working on environmental management.	1	2	3	4	5
	smoothly runs operations in environmental protection.	1	2	3	4	5
	Green relational capital					
	Compared to major competitors, your company ...					
	designs its products/services in compliance with its customers' environmental desires.	1	2	3	4	5
	successfully satisfies its customers with the provided level of environmental protection.	1	2	3	4	5
	cooperates persistently with upstream suppliers on environmental protection.	1	2	3	4	5

	cooperates persistently with downstream clients/channels on environmental protection.	1	2	3	4	5
	.cooperates persistently with strategic partners on environmental protection.	1	2	3	4	5
	Emotional intelligence					
	When I feel good, I can easily tell whether it is due to being proud of myself, happy or relaxed at my workplace.	1	2	3	4	5
	I do not always understand why I respond in the way I do work.	1	2	3	4	5
	When I am feeling low, I easily make a link between my feelings with work and a situation that affected me.	1	2	3	4	5
	I find it difficult to explain my feelings to others even if I want to work.	1	2	3	4	5
	I am good at describing my feelings at work.	1	2	3	4	5
	When I am angry, I find it easy to calm myself down at workplace.	1	2	3	4	5
	My emotions inform me about changes in the work I should make in my life.					
	I am good at sensing what others are feeling well for work.					
	Quite often I am not aware of people's emotional state.					
	Most of the time, I understand why the people in my department feel the way they do.					
	Sustainable performance					
	Learning to use online business is easy for me.	1	2	3	4	5
	It is easy to use Internet to accomplish my business tasks.	1	2	3	4	5
	Overall, I believe online business is easy to operate.	1	2	3	4	5
	In my opinion, it is desirable to operate online business.	1	2	3	4	5
	I think it is good for me to operate online business.	1	2	3	4	5
	Overall, my attitude towards operationalizing online business is favorable.	1	2	3	4	5