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RELATIONSHIP BETWEEN GREEN INTELLECTUAL CAPITAL, GREEN HUMAN RESOURCE MANAGEMENT, SUSTAINABLE SUPPLY CHAIN MANAGEMENT, AND SUSTAINABLE PERFORMANCE

Aliasghar ROUHOLAMIN[1*], Sahar VARPOSHTI[1], Armin ALAVIAN[1], Sara TALEBI[1]

[1*] Department of Management, Faculty of Administrative Sciences and Economics, University of Isfahan, Isfahan, Iran.

***Corresponding Author**
E-mail: a.rouholamin@ase.ui.ac.ir

ABSTRACT

As a powerful instrument that guides human resources, green human resource management can greatly assist organizations. Organizations can employ human resource administration methods to stimulate green intellectual capital, ecological supply chain supervision techniques, and sustainable outcome improvement to become green. This study aims to look at the link between green intellectual capital, green human resource administration, sustainable supply chain supervision methods, and long-term performance in the medical device business. The current study is a correlational study with a purpose and a descriptive-survey approach to data collecting. According to the study's findings, green human resource control has a substantial association with green intellectual capital and sustainable supply chain management techniques in the medical device business. According to the findings, green human resource management in the medical device business substantially affects environmental, social, and economic performance. Furthermore, findings indicated that sustainable supply chain management practices significantly relate to the medical devices industry's long-term, environmental, social, and economic performances.

Keywords: *Green intellectual capital, Green human resource management, Sustainable supply chain management practices, Sustainable performance.*

INTRODUCTION

Recently, green human resource management has become an interesting subject for researchers and employees (Li *et al.*, 2015). Due to globalization, the distribution channels of services and goods have become so complicated (Chin *et al.*, 2015). In recent years, some researchers have argued that the literature on sustainable supply chain management generally follows a bipolar view of forming a framework for sustainable supply chain management drivers, which pursues deductive executive research or case study approaches (Andalib Ardakani & Soltanmohammadi, 2019). There are many case studies on sustainable supply chain management; however, there are no transparency or criteria mentioned for case selection, data collection procedure, or the number of cases under study (Moretto *et al.*, 2018). A supply chain usually has five levels: supplier, producer, distributor, retailer, and end customer. There are three main and important conducts between the levels of the supply chain, including material flow, information flow, and financial flow. The significance and necessity of paying attention to these three flows are crucial

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to supplying chain management (Blanchard, 2010). A supply chain consists of steps and sections that directly or indirectly affect the supply of customer demand (Chopra & Meindle, 2004). In general, if the supply chain is defined by the points mentioned, we can define the supply chain management as the measures that we conduct to affect supply chain behavior and the results we want to achieve (Hugos, 2006). Simchi-Levi *et al.* (2008) introduce supply chain management as a set of activities to integrate the supplier, producer, warehouse, and store effectively so that the needs of the customers are served in a certain amount, at a certain time and place, with a minimum total cost and a high level of service. Choi *et al.* (2016) state that today, on the one hand, customers seek goods and services which meet their needs, and on the other hand, companies seek to create a competitive advantage and strive to be more sustainable in the market. The supply chain of the defense company is three-level, including suppliers, various organizations of the defense company, and its customers are all military and police forces (Choi *et al.*, 2016).

Green intellectual capital is the sum of all knowledge through which the organization can manage knowledge of its environmental processes to gain a competitive advantage (Huang & Kung, 2011). Through green intellectual capital, companies can distinguish themselves from the existing competitors and prevent newcomers from entering the market (Huang & Kung, 2011). A comprehensive review of the literature reveals that most researchers have considered three dimensions of intellectual capital: human, structural, and relational (Buenechea, 2017). In economic environments, green intellectual capital is more valuable and important than physical capital, which is considered a necessity for countries' scientific, technological, and economic development (Nakhaei & Ansari Al-Huda, 2020). Reasons for the importance of intellectual capital include the need for skilled and professional staff, finding customer value, and attention to concepts such as learning and innovation in the new economy (Ienciu *et al.*, 2011). Besides other branches of green management, green human resources have become the focus of a large and growing part of management, especially human resource management (Pavithradevi & Sandhya, 2016). Since an organization should coordinate all dimensions, resources, and substantive and existential components with environmental requirements, logically, it needs to align its most important assets and capital, namely human resources, with sustainable environmental management requirements (Margaretha & Saragih, 2013).

Green human resource management leads to the creation of social responsibility among them and guides them in such a way that it fulfills their duties and obligations instead of the environment (Sabet & Azizi, 2020). Green human resource management can result in the sustainable performance of organizations as one of the primary measures of green management (Rayner & Morgan, 2018). Masri and Jaaron (2017) argue that green human resource management relates to using human resource management measures that outline the organization's sustainable performance and increase employee commitment regarding environmentalism (Sobhatu, 2009). As a result of a shift in attitude toward performance from a conventional to a supportable perspective, performance now includes meeting financial goals and attaining social and ecological goals (Crutzen, 2011). Most research done on human resource management has ignored green human resource management and overlooked this vital factor. So, the present research seeks to answer this question: what are the relationships between

green intellectual capital, green human resource management, sustainable supply chain management practices, and sustainable performance in the medical device industry?

Literature Review

Green Human Resource Management

In the new millennium, the response of companies active in environmental issues goes beyond preventing pollution and reducing environmental damage (Renwick *et al.*, 2013). Organizations face increased ecology, social sustainability, and environmental performance (Ardito & Dangelico, 2018). According to Tang *et al.* (2018), green human resource management refers to human resource management practices that aim to encourage the kind use of environmental resources that enhances environmental performance in general and employees' awareness and commitment to environmental management in particular. Green Human Resources Management (GHRM) can be defined as a set of policies, practices, and systems that stimulate the green behavior of a company's employees to create an environmentally sensitive, resource-efficient, and socially responsible organization (Al-Swidi *et al.*, 2021). The growing role of sustainable development in the development of a modern company's competitive edge leads to the popularization of the question of how to incorporate ecological practices into the area of human resource policy – which is often referred to as Green Human Resources Management (HRM) (Garcia *et al.*, 2021). From the perspective of human resource management tasks and functions, green focuses on recruitment and selection, training and development, performance evaluation, reward management, work design, work analysis, human resource planning, safety, health, and employee management relations, environmental sustainable human resource management performance and the like (Paulet *et al.*, 2021). In the modern approach, green human resource management has explored areas such as staff empowerment, green coaching, and green knowledge capital management of human resources (Jamal *et al.*, 2021). Mishra (2017) states that green human resource management is performed throughout the human resource management process, including planning, recruitment, selection, training and development, compensation, and evaluation to preserve green goals (Jackson & Seo, 2010). Green human resource management research can be divided into traditional and modern (Jabbour *et al.*, 2010). In general, the main difference between traditional and modern aspects of green human resource management can be the horizontal development of an organization focusing on the concept of green in new aspects (Daily *et al.*, 2012). The purpose of green human resource management is to improve, maintain, and expand employee insight to contribute effectively to environmental conservation (Arulrajah & Opatha, 2014). Research on green human resource management has mainly focused on the two negatives (hard) and positive (soft) approaches to green human resource management (Ruchismita *et al.*, 2015). The negative and positive aspects of green human resource management encompass a set of practices, such as reducing harmful environmental effects, reducing pollution, reducing the use of non-recyclable materials, and playing the role of a green organizational citizen (ibid.) Nishii *et al.* (2008) believe that the training of green workers who are aware of their company's green values is emphasized by green human resource management strategies. According to past studies, green recruitment, green training and development, and green services remuneration can help increase green human resource management performance (Ercantan & Eyupoglu, 2022).

Green Intellectual Capital

In recent decades, there has been an increasing emphasis on environmental conservation and the implementation of the principles of sustainable development (Diefa & Zaviar, 2010). Green intellectual capital refers to all intangible assets, knowledge, competencies, and relationships related to environmental protection or green innovation at a firm's individual or organizational levels (Chang & Chen, 2012). Most managers believe that green intellectual capital is the most important driver of the environmental performance of companies (Azizi & Fili, 2020).

Sustainable Supply Chain Management Practices

The supply chain includes all metrics linked to the transportation and transformation of items from the raw material stage (extraction) to delivery to the end-user and the information flow (Gölgeci & Kuivalainen, 2019). Supply chain management affects sustainable marketing. Finally, the green approach seeks to conserve nature and the environment from direct or indirect waste (Flint *et al.*, 2018). Supply chain management seems to be fundamental to the success of sustainable marketing performance (Adeel *et al.*, 2018). One of the sustainable competitive advantages for countries and companies is to make supply chain measures more efficient and effective (Stolze *et al.*, 2018). Thus, the supply chain should adopt a new strategy to improve its ability to respond and maintain resilience to change (Carvalho *et al.*, 2012). The supply chain agility approach creates a rapid and effective response to unpredictable changes in markets in terms of volume and variety of products (Agarwal *et al.*, 2007). Supply change management is essential for satisfying customer needs and gaining a sustainable competitive advantage (Igarashi *et al.*, 2013). In a supply chain, in addition to manufacturers and suppliers, there are shipping, warehouses, retailers, and customers (Chopra & Meindle, 2004).

Sustainable Performance

Sustainable performance is required to identify and measure the related key issues in the three conceptual dimensions of current human well-being, human well-being in the future, and human well-being everywhere. Current well-being measurement indicators can involve subjective and objective issues (UNECE.OECD, 2013). The features of sustainable performance indicators of value creation of the organization are: a) comparability and measurability, b) meaningfulness, c) comprehensiveness, d) continuity, e) transparency, and f) efficiency (Staniski & Arbkiuskas, 2009). Qualitative performance indicators should be used to general evaluate sustainable performance in companies and quantitative performance indicators should be used for a more detailed analysis of sustainable performance (ibid.). Quantitative sustainable performance indicators of a) economic indicators are the use of deterrent or innovative tools to reduce costs and economic performance to develop local infrastructure, b) environmental indicators are to reduce water and energy consumption, handle recyclable waste and improve product quality, c) social indicators are employees' engagement in decision making and staff training and d) communication indicators are to publish sustainability reports and information to consumers on how to use the product and dispose of waste in an environmentally sound manner (Sajadi & Bonabi Ghadim, 2014). Quantitative sustainable performance indicators of a) economic indicators include: investment in research and development and investment in deterrent environmental practices, b) environmental indicators include: costs to deal with the effects of airflow, energy consumption, use of recycled materials, and the degree of reduction of

perilous waste due to material change, c) social indicators include the number of working days lost by chance, and the percentage of employees who participate in training programs related to sustainable development (Staniski & Arbkiuskas, 2009). The evaluation process of sustainable performance consists of three primary steps planning, performing, and reviewing.

Hypotheses and Conceptual Model of the Research

The present study investigates the relationship between green intellectual capital, green human resource management, sustainable supply chain management practices, and sustainable performance. Studying the theoretical and experimental background of the research subject and respecting the results of research by Zaid *et al.* (2018) and Yang *et al.* (2018), the following hypotheses are developed for this research:

Main Hypothesis

There is a significant relationship between green intellectual capital, green human resource management, sustainable supply chain management practices, and sustainable performance in the medical devices industry.

Sub Hypotheses

There is a significant relationship between green human resource management and green intellectual capital in the medical devices industry.
There is a substantial association between green human resource management and sustainable supply chain management practices in the medical devices industry.
There is a significant relationship between green human resource management and sustainable performance in the medical devices industry.
There is a substantial connection between green human resource management and environmental performance in the medical devices industry.
There is a significant relationship between green human resource management and social performance in the medical devices industry.
There is a substantial connection between green human resource management and economic performance in the medical devices industry.
A substantial affiliation exists between sustainable supply chain management practices and sustainable performance in the medical devices industry.
There is a significant relationship between sustainable supply chain management practices and environmental performance in the medical devices industry.
A substantial association exists between sustainable supply chain management practices and social performance in the medical devices industry.
A noteworthy association exists between sustainable supply chain management practices and economic performance in the medical devices industry.
There is a significant link between green intellectual capital and sustainable performance in the medical devices industry.
A noteworthy affiliation exists between green intellectual capital and environmental performance in the medical devices industry.
A noteworthy affiliation exists between green intellectual capital and social performance in the medical devices industry.

A major rapport exists between green intellectual capital and economic performance in the medical devices industry.

After explaining the main variables of the research subject and establishing a relationship between them based on theoretical and experimental background, the structural model of this research has been developed. The structural model of this research is presented in **Figure 1**.

MATERIALS AND METHODS

The present research investigates the effectiveness of scientific theories on the relationships between green intellectual capital, green human resource management, sustainable supply chain management practices, and sustainable performance in the medical devices company. Since the present research is done in real situations and with large samples, it is a survey type. Because it investigates the relationship between research variables, it is a correlational study. The statistical population of this research includes all 500 employees of the medical devices company. Using the formula, 217 employees of the medical devices company were obtained for the present study. The method of sampling was simple random sampling. A research-made questionnaire was used in the present research, consisting of 48 questions.

In the present study, to evaluate the face validity of the research questionnaire, the questions were given to several professors in the field of management to comment on the validity of the questionnaire. After reviewing and evaluating the questionnaires by professors and experts and making minor modifications, the face validity of the questionnaires was confirmed. To evaluate the construct validity of the questionnaire, factor loadings were used. To do factor analysis, it must be ensured that the available data can be used for analysis. Therefore, the KMO indicator and Bartlett test are used.

Table 1. Confidence statistics of research variables

Variable	Green intellectual Capital	Green human resource management	Substantiable supply change management practices	Sustainable performance
KMO	.706	.876	.894	.720
P. value	0.000	0.000	0.000	0.000

Table 2. Statistics of the adequacy of general model data

KMO		.612
Bartlett's Test of Sphericity	Chi-square	1.083
	df	6
	P. value	0.000

According to **Table 1**, KMO for each variable is above 0.6, and according to **Table 2**, the KMO for the general model is above 0.6. Furthermore, since the significance level of Bartlett's Test of the model is lower than 0.05, the KMO is confirmed.

After ensuring the appropriateness of the sample size, the communality values of the items were examined, and the items with values less than 0.3 were omitted from the questionnaire, as these items were not correlated with other items of the same component and did not explain that

component. To measure the reliability of the research tool, in addition to Cronbach's alpha, composite reliability was also calculated.

Data Analysis

Evaluation of the fitness of the model is done in three stages. The first is the determination of the reliability and validity of the measurement model. Secondly, the examination of the structural model was performed by estimating the path coefficient between the variables. In the third stage, the overall fit of the model is examined. Finally, the research hypotheses can be examined if the model had a good overall fit in the above three stages.

Evaluation of Measurement Model

Factor Loading Coefficients (R)

First, the model is tested based on factor loading coefficients. If R<0.3, the correlation between item and variable is weak, and the item is eliminated. If 0.3<R<0.6, correlation is acceptable, and if R>0.6, there is a strong correlation between the item and the variable. **Figure 1** shows the standardized structural model of the research. Results of the testing model reveal factor loadings above 0.4, which are desirable.

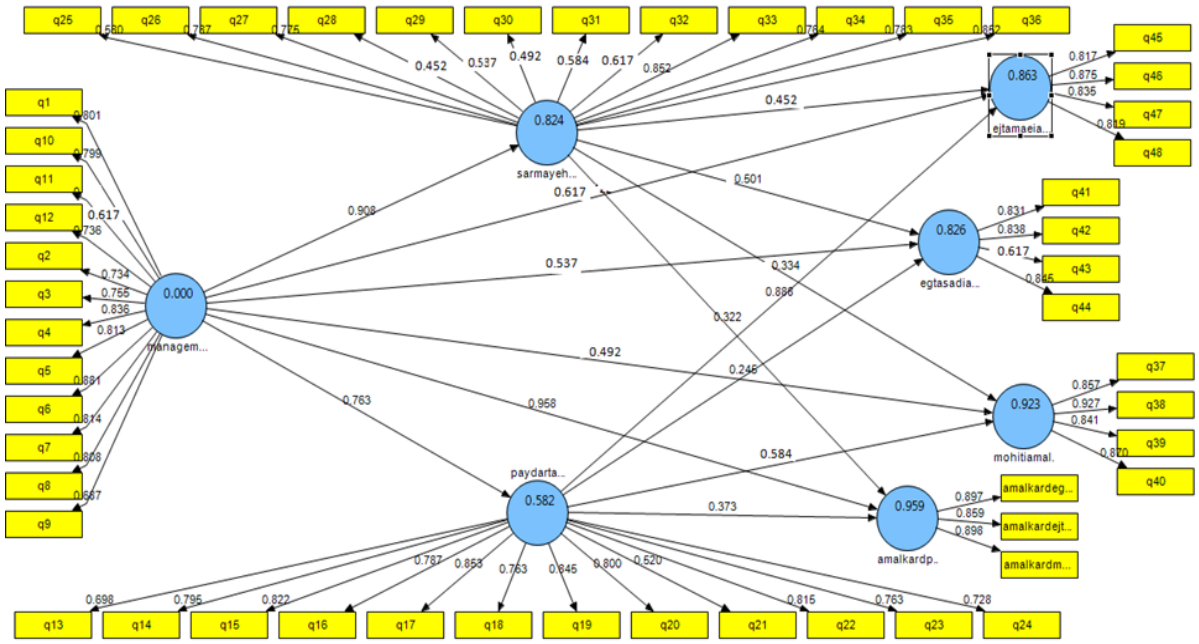

Figure 1. Standardized factor loadings of the structural model of the research

Cronbach's Alpha Coefficient

In this study, Cronbach's alpha of the questionnaire was measured by Smart PLS software. The closer this coefficient is to one, the more appropriate it is. In this study, the reliability of the questionnaire about variables and their items has been obtained at a very acceptable level.

Composite Reliability of the Measurement Model

The model's internal reliability is suitable if the composite reliability value for each variable is more than 0.7. The composite reliability of each research variable is described in **Table 3**. As can be seen in the table, all variables have composite reliability of 0.7 and above, and therefore in terms of composited reliability, the measurement model is approved.

Convergent Validity of the Measurement Model

The Average Variance Extracted (AVE) was used to determine the convergent validity of the model. This criterion indicates the degree of connection of a structure with its items that the higher it is, the greater the model fits. The AVE values for each variable are above 0.5, which means confirming the convergent validity of the measurement model.

Divergent Validity of the Measurement Model

Divergent validity is established when items measuring one variable differ from items measuring other variables. Acceptable divergent validity shows that one variable interacts more with its items than other variables. As shown in **Table 3**, all values on the prime diameter are larger than their below column values, indicating acceptable divergent validity of the model.

Table 3. Divergent validity of the model

Variable	Green Intellectual capita	Green human Resource management	Sustainable supply chain management practices	Sustainable performance	Environmental performance	Economic performance	Social performance
Green Intellectual capital	.765219						
Green human Resource management	.670600	.759019					
Sustainable supply chain management practices	.695550	.615235	.770669				
Sustainable performance	.666130	.638621	.608098	.884821			
Environmental performance	.652351	.721236	.751462	.652417	.874195		
Economic performance	.663258	.702351	.722147	.685236	.804756	.741043	
Social performance	.710524	710562	.700652	.694126	.736541	.702456	.836866

Evaluation of Structural Model

The structural or outer model represents the relationships between the latent variables of the model.

Significant t Values

Significant t values are the most basic criterion for determining the association between variables in a structural model. If t >196, the link between latent variables is statistically significant at 95 percent. The structural model with substantial t values is shown in **Figure 2**.

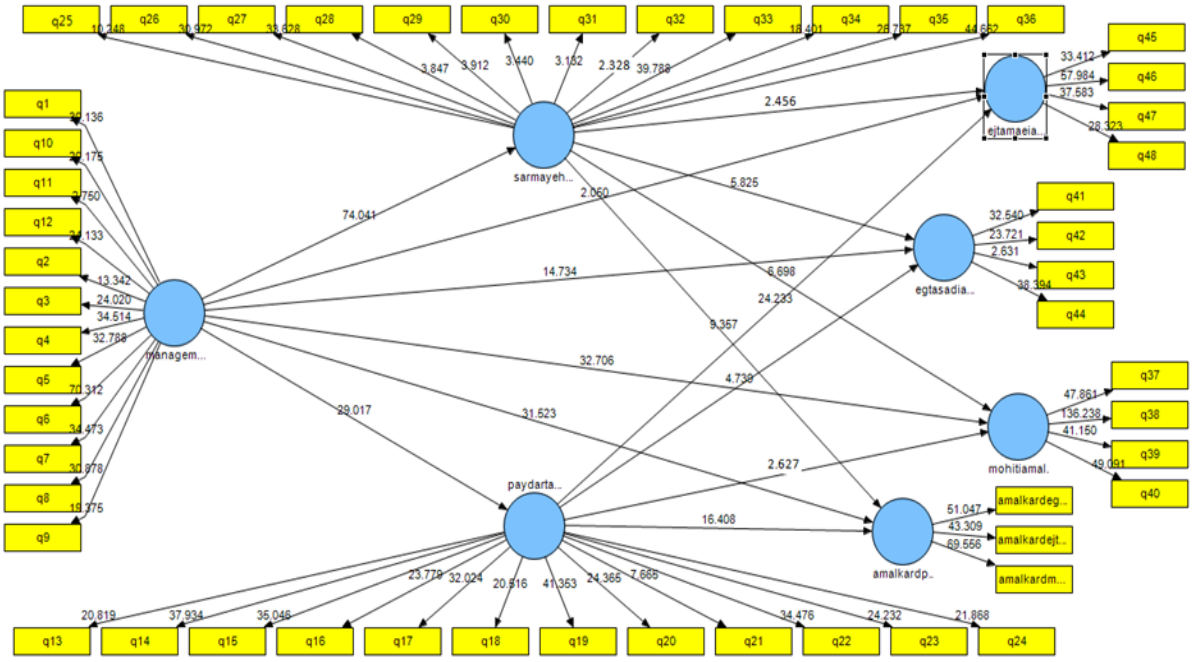

Figure 2. Structural model of the research with significant t values

R square (R^2)

R2 is only computed for the model's dependent variable; for the independent variable, the value of this criterion is 0. The bigger the value of the R2 coefficient associated with the dependent variable, the better the model fits. For small, medium, and large levels of R2, Chin (1998) suggests three criteria values: 0.19, 0.35, and 0.67. **Table 4** shows the R^2 coefficients of the dependent variable of the research.

Table 4. Communality values and R2 coefficients of dependent variables of the model

Research variable	Communality values	R^2
Green intellectual capital	.585560	.823742
Green human resource management	.576110	-
Sustainable supply chain management practices	.593931	.582165
Sustainable performance	.782908	.958835
Environmental performance	.723365	.923161
Economic performance	.549144	.826202
Social performance	.700345	.826601

Q^2 Criterion

This criterion, which is usually measured using the BF method, claims that the model should be able to provide a prediction of endogenous variable items. It should be noted that the BF method is used only for the endogenous latent variable operationalized as a reflective measurement model. Accordingly, if the value of Q^2 for a dependent variable is zero or less than zero, it indicates the relationship between the other variables in the model and that the dependent variable is not well defined. In **Table 5**, the Q^2 values of the model's dependent variable show that the model's predictive power for the dependent variable is large.

The General Model Fit

To measure the overall fitness of the model, only one criterion is used as GoF (Goodness of Fit). Given that this criterion depends on the communality average, the index can also be used when the measurement model is of the reflective type.

Also, the researcher did the measurement of the coefficient of determination (R2) to determine the fit of the structural model and Q2 criterion for the predictive model power and the, and the GoF criterion was employed for the measurement of the general model indicated in **Table 5**.

Table 5. R^2, Q^2, and GOF values

Variable	R^2			Q^2			GOF		
	.19	.33	.67	.02	.15	.35	.01	.25	.36
	small	medium	large	small	medium	large	small	medium	large
Green intellectual capital		.823742			.353764				
Green human resource								.72849	
Management		.582162			.354223				
Sustainable performance		.958835			.558960				
Environmental performance		.923161			.636282				
Economic performance		.826202			.385612				
Social performance		.826601			.622520				

The GoF value for the structural model of this research is calculated to be 0.72849, which indicates a strong and very suitable overall fit of the model. Given the strong fit of the general model, it is now possible to examine the research hypotheses.

Testing Hypotheses of the Model

The Main Hypothesis

H1: There is a substantial association between green human resource management and green intellectual capital in the medical devices industry.

Respecting H1, according to **Figure 2**, the path coefficient was calculated at 0.908, and given that the t value equals 74.041, it can be said that the coefficient is significant at the 95% significance level. Thus, H1 is confirmed.

H2: There is a substantial association between green human resource administration and sustainable supply chain control methods in the medical devices industry.

Respecting H2, according to **Figure 2**, the path coefficient was calculated at 0.763, and given that the t value equals 0.763, it can be said that the coefficient is significant at the 95% significance level. Thus, H2 is confirmed.

H3: A substantial association exists between long-term operation in the medical devices industry and green human resource administration.

Respecting H3, according to **Figure 2**, the path coefficient was calculated at 0.958, and given that the t value equals 31.523, it can be said that the coefficient is significant at the 95% significance level. Thus, H3 is confirmed.

H4: There is a substantial association between green human resource management and environmental performance in the medical devices industry.

Respecting H4, according to **Figure 2**, the path coefficient was calculated at 0.492, and given that the t value equals 32.706, it can be said that the coefficient is significant at the 95% significance level. Thus, H4 is confirmed.

H5: There is a substantial link between green human resource management and social performance in the medical devices industry.

Respecting H5, according to **Figure 2**, the path coefficient was calculated at 0.617, and given that the t value equals 2.060, it can be said that the coefficient is significant at the 95% significance level. Thus, H5 is confirmed.

H6: A substantial affiliation exists between green human resource administration and economic operations in the medical devices industry.

Respecting H6, according to **Figure 2**, the path coefficient was calculated at 0.537, and given that the t value equals 14.734, it can be said that the coefficient is significant at the 95% significance level. Thus, H6 is confirmed.

H7: A substantial rapport exists between sustainable supply chain control methods and sustainable operations in the medical devices industry.

Respecting H7, according to **Figure 2**, the path coefficient was calculated at 0.373, and given that the t value equals 16.408, it can be said that the coefficient is significant at the 95% significance level. Thus, H7 is confirmed.

H8: A substantial association exists between sustainable supply chain control methods and environmental performance in the medical devices industry.

Respecting H8, according to **Figure 2**, the path coefficient was calculated at 0.584, and given that the t value equals 2.627, it can be said that the coefficient is significant at the 95% significance level. Thus, H8 is confirmed.

H9: A substantial relationship exists between sustainable supply chain management practices and social performance in the medical devices industry.

Respecting H9, according to **Figure 2**, the path coefficient was calculated at 0.886, and given that the t value equals 24.233, it can be said that the coefficient is significant at the 95% significance level. Thus, H9 is confirmed.

H10: A substantial association exists between sustainable supply chain management practices and economic performance in the medical devices industry.

Respecting H10, according to **Figure 2**, the path coefficient was calculated at 0.246, and given that the t value equals 4.739, it can be said that the coefficient is significant at the 95% significance level. Thus, H10 is confirmed.

H11: There is a substantial rapport between green intellectual capital and sustainable performance in the medical devices industry.

Respecting H11, according to **Figure 2**, the path coefficient was calculated at 0.332, and given that the t value equals 9.357, it can be said that the coefficient is significant at the 95% significance level. Thus, H11 is confirmed.

H12: A substantial affiliation exists between green intellectual capital and ecological performance in the medical devices industry.

Respecting H12, according to **Figure 2**, the path coefficient was calculated at 0.334, and given that the t value equals 6.698, it can be said that the coefficient is significant at the 95% significance level. Thus, H12 is confirmed.

H13: There is a substantial association between green intellectual capital and social performance in the medical devices industry.

Respecting H13, according to **Figure 2**, the path coefficient was calculated at 0.452, and given that the t value equals 2.456, it can be said that the coefficient is significant at the 95% significance level. Thus, H13 is confirmed.

H14: A substantial relationship exists between green intellectual capital and economic performance in the medical devices industry.

Respecting H14, according to **Figure 2**, the path coefficient was calculated at 0.501, and given that the t value equals 5.826, it can be said that the coefficient is significant at the 95% significance level. Thus, H14 is confirmed.

CONCLUSION

This research aims to look into the link between green intellectual capital, green human resource management, and sustainable supply chain administration strategies in the medical device industry and long-term success. The findings revealed that a) green human resource administration has a substantial relation with green intellectual capital and long-term supply chain management practices in the medical devices industry, and b) long-term supply chain control methods have a substantial relationship with sustainable, social, environmental, and economic performances in the field of medical devices c) green human resource administration has a substantial relationship with sustainable, social, environmental and economic performances in the field of medical devices) Human resource management has a significant relationship with the medical devices industry's sustainable, social, environmental, and economic performances. These results are consistent with the results of studies by Zeid *et al.* (2018) and Yang *et al.* (2018). So, it is suggested that if managers of a medical devices company create a broad and inspiring perspective, employees will feel proud, and their sense of belonging will increase. Managers treat employees in a way that promotes employees to a higher level of success, empowers them to improve their interests for the collective welfare, focuses on their abilities to assist personal growth, and develops their mental ability to solve problems in new ways. Optimum use of scanty environmental resources is also suggested, emphasizing the philosophy, policies, and measures that help organizations achieve their green goals. Human resources should be modified to be sensitive to laws, resources, regulations, proper use and extravagance, and other factors, resulting in peak and purposeful resource consumption and minimizing pollution. There are challenges in this subject, such as access to books, journals,

statistics, databases, and other resources in the country, making providing research services challenging. Unwanted variables might jeopardize the research's internal and external validity in various ways due to distinct research designs and techniques. It should be noted that it is difficult to completely manage or eliminate these types of variables in a behavioral science study. On the other hand, researchers make every effort to anticipate and detect these effects as much as possible and take all necessary precautions to minimize their impact.

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