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Design and Evaluation of the Organizational Green Chain Model Based on Intellectual Capital in Iraq's Textile Industry

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A B S T R A C T

The aim of the present study is to design and evaluate an organizational green chain model based on intellectual capital in the textile industry of Iraq. This research is exploratory-applied in terms of its objective and descriptive-survey in terms of methodology. The research design follows a mixed-methods approach, combining both qualitative and quantitative methods. The statistical population in the qualitative section includes experts and managers in Iraq's textile industry as well as university professors. A total of 10 individuals were selected for interviews using a combination of snowball and random sampling methods. In the quantitative section, the statistical population includes employees in Iraq's textile industry. The population is considered unlimited; based on Cochran's formula, a sample size of 384 participants was determined. The data analysis tool in the qualitative section is thematic analysis, while in the quantitative section it is structural equation modeling using PLS software. The qualitative findings reveal that five main dimensions, along with their components, were extracted from expert interviews. These dimensions include green raw materials, green production processes, sustainable transportation, collaboration with green suppliers, and transparency in sustainable communication. In the quantitative section, the overall model fit, based on the GOF formula, was calculated at 67%, indicating a strong model fit. Additionally, the factor loadings in both first- and second-order constructs were greater than 0.40, confirming the validity of the confirmatory factor analysis.

Keywords: *green logistics, green chain, green intellectual capital, environment, textile industry.*

1. Introduction

The depletion of resources, various industrial pollutants, carbon dioxide emissions, flexible packaging, and the use of toxic substances have increasingly raised environmental concerns for manufacturing companies. Firms are under growing pressure from stakeholders and regulators to address sustainability. This pressure is particularly felt in the textile industry, which is a dynamic sector due to the competitive environment surrounding its products. The textile industry is one of the largest industries globally and has attracted significant attention from many countries and major global economies due to its contribution to employment and its prominent economic and social role. The textile industry is predominantly found in high- and middle-income countries (Motiei et al., 2020). Today, consumers demand high-quality textile products manufactured in facilities that are health-safe, environmentally friendly, and socially responsible (Judijanto et al., 2024; Jum'a et al., 2022; Zheng et al., 2024).

Monitoring environmental requirements, such as eco-friendly practices and environmental protection, creates social pressure to preserve the status quo, which helps many types of organizations adapt to globalization. Consequently, their level of acceptance in the business environment is increasing. Green chain practices may range from proactive environmental monitoring to active adoption of recycling, reduction, reuse, remanufacturing, reverse logistics, evaluation, renovation, and reconstruction, and can be more broadly embedded within the organizational framework (Gonzalez et al., 2022).

On the other hand, green intellectual capital consists of three dimensions. The first dimension, green human capital, refers to the knowledge, skills, abilities, experience, intelligence, creativity, and commitment of employees toward environmental protection. The second is green structural capital, which pertains to knowledge management systems, reward systems, IT systems, databases, operational processes, management mechanisms, environmental patents, and green innovation practices. The third dimension, green relational capital, represents interactive relationships between a business and its implementers, customers, and partners in environmental protection and green innovation (Chang & Chen, 2012). It enables companies to leverage green relationship networks to create new opportunities and enhance brand competitiveness.

Previous studies have confirmed the moderating role of intellectual capital in activities related to organizational performance. Other studies have placed more emphasis on specific dimensions of intellectual capital, such as human capital and relational capital. Kianto et al. (2017) demonstrated that when more intellectual capital is invested, the relationship between knowledge management practices and organizational performance becomes stronger (Kianto et al., 2017). Furthermore, several studies have explored the moderating role of green structural capital and green relational capital (Amores-Salvado et al., 2021).

In response to the growing environmental issues faced by logistics companies in emerging markets and the potential competitive advantages of the green chain, researchers have proposed a moderated mediation model involving the exploitation of green chain knowledge, green logistics management practices, green intellectual capital, and green logistics performance. Initially, researchers examined the effects of green chain knowledge on green logistics management practices (Yu et al., 2020). Most logistics companies still operate using traditional methods, focusing on procurement, distribution, storage, and inventory management (Van Vo & Nguyen, 2023), while overlooking activities such as marketing, new product development, finance, and customer service. Transitioning to green logistics requires companies to explore, learn, and acquire relevant knowledge from stakeholders. Consequently, logistics firms adapt these insights and incorporate them into environmental management activities such as green training, green transportation, green energy, green information processing, and distribution (Dzhengiz & Niesten, 2020).

In a novel initiative, the present study utilizes green intellectual capital as a moderator in green chain activities. Managers are increasingly interested in green management activities due to their demonstrated capacity to encourage businesses to achieve environmental objectives. Several studies have shown that green supply chain management practices positively support environmental performance (Famiyeh et al., 2018). Green supply chain management is not only considered a means of environmental protection but also a valuable and potential method for achieving advancement, competitive advantage, and improved organizational performance. Companies must adopt modern and strategic approaches to achieve sustainable organizational benefits and competitive advantage in an increasingly competitive global market (Abbas & Tong, 2023). The concept of the green chain broadly refers to the integration of environmental safety approaches in supply chain management (Brandenburg et al., 2014).

This study, conducted in the textile industry based on environmental structure, aims to reduce environmental harm and enhance green products and services through reliance on intellectual capital. It can offer a suitable structure for green management practices in organizations. Indirectly, this study considers an environmentally friendly and relatively less harmful production cycle, so that the negative environmental impacts can be managed under the green chain framework. This is particularly beneficial for any organization seeking sustainability and, more specifically, for Iraq's textile industry.

This study seeks to answer the following question:

How can an organizational green chain model based on intellectual capital be designed and evaluated in Iraq's textile industry?

2. Methodology

The study involves the design of an organizational green chain model based on intellectual capital. In terms of purpose, the research is exploratory-applied, and in terms of method, it is descriptive-survey. The research is conducted using a mixed-methods approach, incorporating both qualitative and quantitative techniques. The statistical population in the qualitative phase consists of experts and managers in Iraq's textile industry as well as university faculty members. A total of 10 interviewees were selected using snowball and random sampling methods.

In the quantitative phase, the statistical population includes employees of the textile industry in Iraq. Since the population is considered infinite, the sample size was determined using Cochran's formula, resulting in a sample of 384 participants. For data analysis, thematic analysis was used in the qualitative section, and structural equation modeling (SEM) with PLS software was employed in the quantitative section.

The validity of the questionnaire was confirmed through review by a panel of management scholars. To assess reliability, Cronbach's alpha was used, and all components demonstrated reliability with alpha values greater than 0.70.

3. Findings and Results

An analysis of the experts' age revealed that university professors and academic experts had the highest average age at 50.21 years, while textile industry managers had the lowest average age at 39.66 years. In terms of work experience, university professors and experts had the most experience with an average of 18.33 years, while textile managers had less experience with an average of 12.26 years. Among the interviewees, 6 held Ph.D. degrees and 4 had Master's degrees.

The researchers first carefully read the interview transcripts and then extracted secondary codes. These secondary codes, derived from the primary codes obtained through the conducted interviews, are presented in the following table.

Table 1

Extracted Secondary Codes

Main Indicators	Axial Codes
Green Raw Materials	Use of renewable resources – Reduction in natural resource consumption – Focus on local value-added – Intellectual commitment to environmental protection – Proper waste management and recycling
Green Production Processes	Energy consumption optimization – Sustainable product design – Water resource management – Support for local primary production – Creation of green structural capital
Sustainable Transportation	Reduction of greenhouse gas emissions – Use of public transportation aligned with the chain – Transportation distance optimization – Promotion of hybrid vehicle use – Use of advanced routing systems
Collaboration with Green Suppliers	Sustainable supplier selection based on intellectual capital – Development of relational capital with suppliers – Measurement and reporting of supplier green performance – Supply chain risk assessment and management – Knowledge transfer and supplier empowerment
Transparency in Sustainable Communication	Supplier knowledge transfer and empowerment – Effective stakeholder communication across the chain – Sustainability reporting based on intellectual capital – Customer relationship management – Continuous green intellectual interactions with other organizations – Chain transparency

In this study, five main dimensions were identified: green raw materials, green production processes, sustainable transportation, collaboration with green suppliers, and transparency in sustainable communication. Moreover, from a total of 196 primary codes extracted from 10 interviews, 25 components were identified.

In terms of demographic characteristics of the quantitative sample (n = 384), 103 participants were between the ages of 25 and 35 (26.82%), 149 were between 35 and

45 (38.80%), 95 were between 45 and 50 (24.74%), and 37 were above 50 years old (9.64%). Regarding educational attainment, 129 participants (33.59%) held a Bachelor's degree, 156 (40.63%) held a Master's degree, and 99 (25.78%) held a Ph.D. As for work experience, 59 participants (15.36%) had 5 years or less of experience, 99 (25.78%) had between 6 and 10 years, 138 (35.94%) had between 11 and 15 years, and 88 (22.92%) had more than 15 years of experience.

Following the evaluation of the measurement models, structural model, and overall model—according to the data analysis algorithm in the PLS method—the researcher proceeded to test the relationships between the variables. In this stage, standardized path coefficients and t-values for the hypotheses were examined. To confirm or reject the hypotheses, the t-value must be greater than 1.96 or less than -1.96. Values between these thresholds indicate that the calculated regression weights are not significantly different from zero at the 95% confidence level.

Figure 1

Research Model with Standardized Coefficients

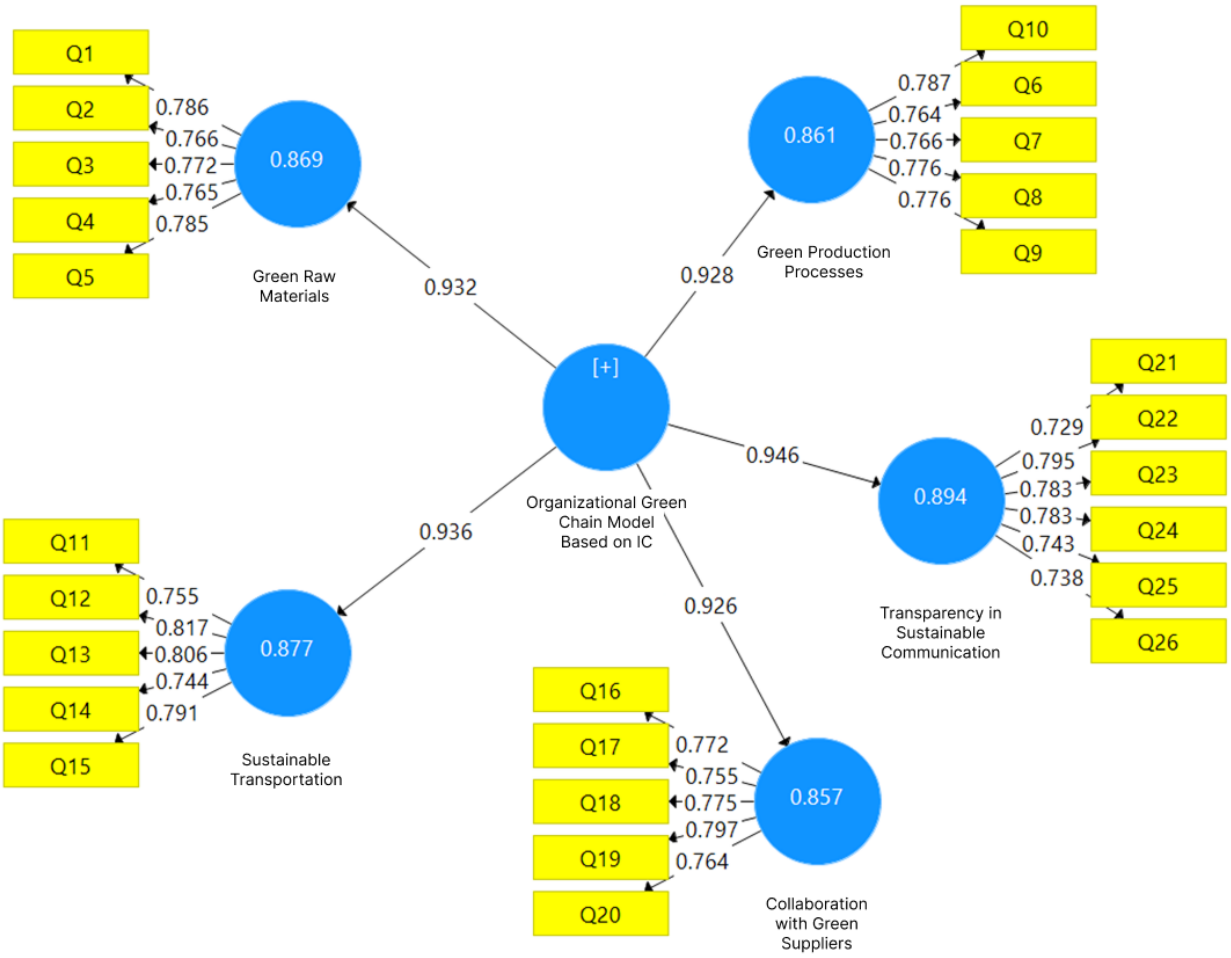

Figure 2

Research Model with t-values

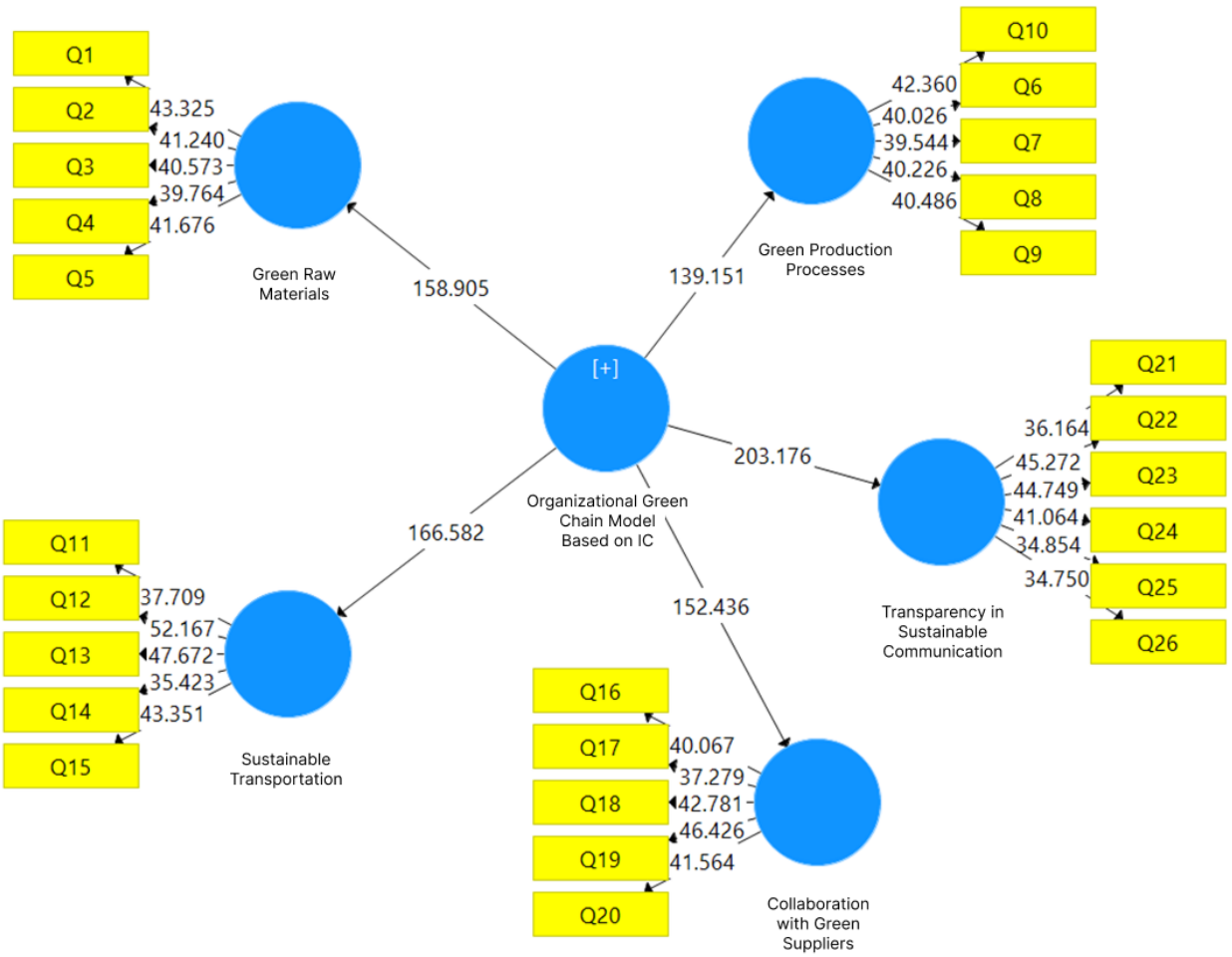

Table 2

Construct Reliability and Convergent Validity Indicators

Construct	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)	Convergent Validity Result
Sustainable Transportation	.842	.843	.888	.613	Confirmed
Transparency in Sustainable Communication	.855	.857	.893	.581	Confirmed
Green Production Processes	.833	.833	.882	.599	Confirmed
Organizational Green Chain Model Based on IC	.963	.963	.966	.521	Confirmed
Green Raw Materials	.834	.834	.883	.601	Confirmed
Collaboration with Green Suppliers	.831	.832	.881	.597	Confirmed

These results indicate that Cronbach's alpha and composite reliability values for all constructs exceed .70, ensuring the reliability of the collected data. Furthermore, the AVE for each construct is greater than .50, and composite reliability values exceed AVE values, confirming convergent validity.

To assess the overall fit of the model—including both measurement and structural components—the Goodness-of-Fit (GoF) index was used. GoF is calculated using the formula:

$$GoF = \sqrt{(\text{average communality} \times \text{average } R^2)}$$

Based on the average values for communality and R^2, the GoF value was calculated at .67, indicating a strong model fit.

Table 3

Average Communality and Average R^2 Values for GoF Calculation

Construct	R^2	Communality
Sustainable Transportation	.877	.528
Transparency in Sustainable Communication	.894	.531
Green Production Processes	.861	.419
Organizational Green Chain Model Based on IC	–	.543
Green Raw Materials	.869	.564
Collaboration with Green Suppliers	.857	.473

Average R^2 = .510, Average Communality = .872, GoF = $\sqrt{(.872 \times .510)}$ = .67

Based on the above values, the GoF index was calculated to be .67, indicating a strong model fit.

This GoF value (.67) reflects a strong fit for the proposed model.

The relationships between the organizational green chain model based on intellectual capital and its dimensions were tested using path coefficients, t-values, and p-values. All relationships were found to be statistically significant:

Table 4

Structural Path Coefficients and Significance Values

Path	Factor Loading	t-value	p-value	Status
Green Chain Model → Sustainable Transportation	.936	166.582	.000	Confirmed
Green Chain Model → Transparency in Sustainable Communication	.946	203.176	.000	Confirmed
Green Chain Model → Green Production Processes	.928	139.151	.000	Confirmed
Green Chain Model → Green Raw Materials	.932	158.905	.000	Confirmed
Green Chain Model → Collaboration with Green Suppliers	.926	152.436	.000	Confirmed

The t-values for all paths exceeded the critical threshold of 1.96 ($|t| > 1.96$), indicating that all hypothesized relationships were statistically significant at the 95% confidence level. Thus, the model's structural validity is supported.

4. Discussion and Conclusion

This study was conducted with the aim of designing and evaluating an organizational green chain model based on intellectual capital in the textile industry of Iraq. Using the PLS method, the following central research question was addressed:

How can an organizational green chain model based on intellectual capital be designed and evaluated in Iraq's textile industry?

In explaining the findings, it can be stated that the use of green raw materials and environmental strategies throughout the chain can contribute to the reduction of pollution and waste. Accordingly, organizations can enhance environmental quality. This is directly linked to improved operational efficiency. Intellectual capital, which includes knowledge, experience, and innovation, can help organizations discover more optimal methods for utilizing and managing green resources. Such improvements in process efficiency can lead to cost savings and reduced resource consumption.

Another key outcome is enhanced competitiveness and differentiation. Organizations that operate within a green chain framework can position themselves as sustainable and responsible brands, which in turn can attract new customers and foster loyalty among existing ones. Moreover, organizational intellectual capital—comprising knowledge, skills, and experience—can drive innovation in collaboration with green suppliers. These collaborations may generate new methods for process optimization and waste reduction.

Such partnerships can also create shared value; both implementers and organizations benefit from resource optimization and cost savings. Close cooperation with green suppliers fosters long-term strategic relationships that build

trust and facilitate information exchange, thereby enhancing the efficiency of the green supply chain. In light of increasing legal and social requirements regarding environmental sustainability, collaboration with green implementers helps organizations achieve better compliance and mitigate legal risks.

Intellectual capital, particularly in the form of sustainability-related data analysis, can also support more informed decision-making in selecting green suppliers and provide a stronger basis for evaluating their performance.

This research is aligned with previous studies (Ali et al., 2024; Jihu, 2024; Pal et al., 2023; Zheng et al., 2024) all of which emphasize the strategic integration of green practices and intellectual capital in supply chain performance.

Accordingly, this article offers the following recommendations:

Training and Capacity Building of Employees: Intellectual capital in the textile industry can be enhanced through training programs focused on sustainability and green practices. An informed workforce can contribute innovative ideas for reducing waste and energy consumption.

Establishing Collaborations with Green Implementers: Ongoing, close relationships with implementers committed to green and sustainable technologies can improve the quality of raw materials and reduce environmental harm.

Adopting Sustainable Practices: Using recycled raw materials, plant-based dyes, and minimizing water usage in the production process can help reduce environmental impact and increase brand appeal.

Authors' Contributions

Authors contributed equally to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

In this research, ethical standards including obtaining informed consent, ensuring privacy and confidentiality were considered.

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