



A Structural Model for Green Supply Chain Management relating the Antecedents of Green Supply Chain Management to its Adoption Practices

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A Structural Model for Green Supply Chain Management relating the Antecedents of Green Supply Chain Management to its Adoption Practices

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Abstract:

Organizations started realizing the importance of green supply chain management (GSCM) for competitive advantages and sustainable environments. This paper is proposing a structural model relating the antecedents of GSCM to the adoption practices and implementations of GSCM. It starts by identifying an important set of GSCM antecedents and another set of implementation types and adoption practices and defining an initial structural model. Then a rigorous statistical analysis study is performed on data set collected from Egyptian electrical and electronic sector using two statistical models. The first model is called measurement model containing the descriptive statistics of all variables under study, and factor analysis to reduce this large number of variables. The second model is called structural model since it shows the structural relationship between the GSCM antecedents as independent variables and the GSCM implementation types as dependent variables. This structural model is based statistically on both univariate model and multivariate model. As a result of this detailed study some hypotheses are supported, and others are not supported (rejected) and this leads to a final structural model for green supply chain management.

Key words: Green Supply Chain Management, GSCM antecedents, GSCM adoption practices, Structural Model, Univariate Model, Multivariate Model.

1. Introduction

Organizations started realizing the importance of supply chain for competitive advantage, and business executives. Moreover, managers recognized that the ultimate success of any enterprise is no longer built around a firm's capability and capacity, but on a supply chain's capability and capacity (Gupta V et al., 2013 and Chow et al. 2008). One of the reasons for the increased interest in supply chain management is that the green supply chain management is the term that refers to the way in which organizational innovations and policies in supply chain management respond to the need for a more sustainable environment (Elting J 2009, Sarivastava 2007 and Cheng Ling Tan et. al, 2016). This involves the minimization of a firm's total environmental impact from the start to the end of a supply chain, and also from the beginning to the end of a product life cycle. (Routroy S, 2009; Mochamad A, et al., 2018 and Djunaidi, M. et al. 2018,) identified that greening the different phases of a supply chain leads to an integrated green supply chain, which ultimately leads to competitiveness and economic performance by reducing the environmental risks and by improving efficiency. In spite of the importance of GSCM, there are a lot of barriers face its implementation. These barriers are: Lack of top level management commitment, Lack of integration of information technology system, lack of skilled human resource professionals in GSCM, Lack of government initiatives system for GSCM practitioners, Lack of knowledge, experience and training to personals in GSCM, Cost of implementation for GSCM Supplier's flexibility to change towards GSCM, and Lack of customer's awareness towards GSCM and green products (Dashore K and Nagendra S, 2013; Abhijit Majumdar, Sanjib Sinha , 2018; Sunil Dhull , M.S. Narwal , 2016; Syed Shakil Ahmed, Tauhima Akter and Yuchao Ma , 2018) .

The research problem is that there's only a few initiatives to adopt GSCM in many organizations in Egypt. The majority of GSCM barriers concentrate on the unawareness of the necessary antecedents to adopt GSCM. What makes the situation more difficult is the shortage of studies on GSCM antecedents. Though there are a lot of studies about traditional supply chain management, studies on green supply chain management implementation are few.

The reason behind this lack of implementation studies is ascribed to insufficient information about the way by which the greening implementation can be done. In order to define a way or an approach for implementing GSCM, it is necessary to clearly identify what its antecedents are.

This paper seeks to develop a structural model identifying the factors (antecedents) that are important for implementing a GSCM strategy and their impact in different adoption practices (implementation types). To achieve this purpose, this paper is following these steps:

- Identification of the most important GSCM antecedents based on an extensive literature review.
- Identification of main GSCM adoption practices and implementation types.
- Introduction of structural model relating the antecedents to adoption practices
- Deriving hypothesis from literature review
- Design of a survey (questionnaire) for data gathering concerning both GSCM antecedents, and GSCM adoption practices.
- Application of survey on Egyptian electrical & electronics sector.
- Use of different statistical analysis models to check the data validity and reliability, and to find the impact of GSCM antecedents on GSCM adoption practices in the proposed structural model.
- Deduction of the verified structural model that shows the relationship between GSCM antecedents and GSCM adoption practices

2. Literature review and theoretical framework

2.1 Literature review

The literature review is summarized in the following table.

Table1: literature review

Researcher's Name	Title	Main Topic	Conclusion & Comments:
Joseph Sarkis – 1999	How green is the supply chain: practice & research	The Gap between GSC research and GSC practices.	<ul style="list-style-type: none"> - Most of the literature has investigated small portions of the whole supply chain. With only a few empirical studies. - To truly address these emerging debates and issues, effective research agendas and methodologies will be required - So, it's a theoretical study addressing the relationship between academic research and empirical studies.
M.K. Chien & L.H. Shih – 2007	An empirical study: the implementation of green supply chain management practices in the electrical and electronic industry and their relation to organizational performances	Investigation of the green supply chain management practices adopted by the electrical and electronic industry in Taiwan.	<ul style="list-style-type: none"> - The implementation of GSCM practices has a positive effect on environmental and financial performance; that is, an increase in environmental performance will be accompanied by increased corporation profit and market share. - These conclusions effectively dispel the doubts of those corporations in Taiwan that have not yet implemented GSCM practices.
Stephan Vachon – 2007	Green supply chain practices and the selection of environmental technologies	Linking supply chain management to environmental technologies.	<ul style="list-style-type: none"> - Environmental collaboration with suppliers is positively associated with greater investment in pollution prevention technologies. - Environmental Collaboration with customers has no impact on the adoption
Jens Elting – 2009	Green supply chain management in manufacturing companies in New Zealand: a comparative case study analysis	Examining the factors which a company must consider when implementing Green Supply Chain Management (GSCM) practices.	<ul style="list-style-type: none"> - Each examined company is in a different situation with different factors influencing their environmental approach. - Nevertheless, one core characteristic should be to include the environmental strategy in the general company strategy to achieve consistency.

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Researcher's Name	Title	Main Topic	Conclusion & Comments:
Sirkanta Routroy – 2009	Antecedents and drivers for green supply chain management implementation in manufacturing environment	Proposing the antecedents and drivers of GSCM in a manufacturing environment.	<ul style="list-style-type: none"> - The GSCM implementation in the manufacturing environment needs efforts from all corners. - Greening the manufacturing supply chain may result in one or more benefits.
Jamal Fortes – 2009	Green supply chain management: a literature review	Reviewing the literature of the green supply chain management (GrSCM) over the last twenty years.	<ul style="list-style-type: none"> - There is a gap in the literature in terms of the stakeholder views towards green supply chain management. - Knowing the different stakeholders' views to greening initiatives requires qualitative study.
Ninlawan C., et., al – 2010	The implementation of green supply chain management practices in electronics industry	Examining the current green activities in computer parts' manufacturers in Thailand, and evaluating green supply chain management.	<ul style="list-style-type: none"> - Collaborative among important stakeholders in electronics industry must be strongly concerned. - Some important suggestions are noted here: promote eco-design, control hazardous substances, promote product service system.
Ashish Bhatija et., al – 2011	Study of green supply chain management in the Indian manufacturing industries: a literature review cum an analytical approach for the measurement of performance	Studying the various activities of the supply chain processes of the various Indian Manufacturing to find how much eco-friendly they are.	<ul style="list-style-type: none"> - [40 %] of Indian manufacturing sectors Use electronic processes to create efficiencies in sourcing and procurement - Cost and complexity are perceived as the biggest barriers to implementing GSCM. - Adoption of green practices is highest in those areas of the supply chain where there is a direct relation to cost savings and efficiency, - [64 %] of companies are not using e-tools extensively to support their supply chain Operations

Dr. Rania Ramadan Moawad & Dina Ramadan

Researcher's Name	Title	Main Topic	Conclusion & Comments:
Hariram Ranganath an & Harishkumar Premkumar – 2012	Improving supply chain performance through lean and green: a study at Volvo group India & Sweden	Contribution to a further understanding of the supply chain management, lean, green and their integration.	<ul style="list-style-type: none"> - A theoretical frame work is made so as to have a good understanding about the concepts and research work in the relevant area. - The empirical study at the industries has been done to examine their work practices with lean and green in their supply chain and the projects & initiatives.
Hassan M. Elbeheiry et.,al – 2012	Drivers and barriers facing adoption of green supply chain management in egyptian food and beverage industry	Identifying drivers and barriers of GSCM practices adoption in Egyptian Food and Beverage Industry (EFBI).	<ul style="list-style-type: none"> - Organization values is the main driver for adopting GSCM practices in EFBI while lack of resources and lack of governmental support represented the main barriers facing adoption of GSCM practices in EFBI.
Rajesh Kumar & Rituraj Chandraker – 2012	An overview of green supply chain management: operation and environmental impact at different stages of the supply chain	Emphasizing upon the application of Supply Chain Management and adding the 'Green ' component to it so as to stress upon the need of environment friendly systems.	<ul style="list-style-type: none"> - GSCM is inevitable if the Earth is to be kept green and appropriate methodology may be adopted by the industries/services to minimize the detrimental effect on the environment.
Arvind Upadhaya y – 2012	Antecedents and enablers of green supply chain practices	Describing the antecedents and enablers for green supply chain practices.	<ul style="list-style-type: none"> - Development of macro model of green supply chain practices with the inputs from literature. - The synthesis of ten core green supply chain practices with antecedents and enablers from existing body of literature enriched through empirical testing.
Muchiri Kangangi – 2013	Green supply chain implementation: best practices and challenges	Fnding the best practices that can applied in green supply chain strategies.	<ul style="list-style-type: none"> - For a successful and sustainable GSC - implementation n; and integration of systems between trading partners in the supply chain is required, senior management support is a must.
Kshitij Dashore	Green suuply	Evaluating the barriers	<ul style="list-style-type: none"> - The barriers' nature is complex

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Researcher's Name	Title	Main Topic	Conclusion & Comments:
& Nagendra Sohani – 2013	chain management: a hierarchical framework for barriers	to the implementation of the green supply chain management (GSCM) in an organization.	and interdependent; an Interpretive Structural Modeling (ISM) technique is applied to develop a structural model. Driving and dependence power analysis (DDPA) is used to classify and identify critical barriers.
Vishal Gupta et.,al – 2013	Green supply chain initiatives by IT companies in India	Exploring the green initiatives followed by the three major Indian IT companies to manage their supply chain.	- These green initiatives by the companies also distinguish them from their competitors and help them to improve their brand image.
Hsiao-Fan Wang & Surendra M. Gupta – 2013	Green supply chain management (product life cycle approach)	Identifying the importance of green engineering and management with respect to enterprise competence, environmental protection, and sustainability	- A strategy oriented operation module has been introduced, under this module, a method called CECF has been developed. - The introduced CECF is not only able to provide a promising solution to the "new user" problem, but it also facilitates marketing strategies to be performed.
Sayed Hashemi – 2014	A grey-based carbon management model for green supplier selection	Developing a grey-based carbon management model for supplier selection in a green supply chain	- A novel grey-based approach has proposed to deal with the supplier selection problem. - Also, it has proposed a novel group decision-making technique namely IGRA to deal with many problematic managerial situations.
M. K. Mishra et al. (2019)	Impact of SMEs Green Supply Chain Practice Adoption on SMEs Firm and Environmental Performance	to examine the impact of SMEs green supply chain practice adoption on SMEs firm and environmental performance in different Industry Associations and clusters in the SMEs domain in South India using two-step : - a measurement model to assess the validity and reliability of the measures, - then structural model was used to test the proposed hypotheses.	- The results indicate that green purchasing impacts on SMEs firm performance and environmental performance, and eco design impacts on SMEs firm performance.

Dr. Rania Ramadan Moawad & Dina Ramadan

Researcher's Name	Title	Main Topic	Conclusion & Comments:
M. S. Asif et al. (2020)	Adoption of green supply chain management practices through collaboration approach in developing countries. From literature review to conceptual framework	To analyze three strands of GSCM literature: Firstly, drivers and pressures for the adoption of GSCM were studied and three high priority drivers were selected for the conceptual model namely government regulations, customer demands and supplier performance. Secondly, the GSCM practices and their adoption benefits relevant to the developing countries were reviewed resulting in selection of four promising practices; eco-design, green purchasing, green manufacturing and reverse logistics. After that, the literature was reviewed on application of management theories in GSCM to testify the theoretical implications of the model.	<ul style="list-style-type: none"> - Presenting a conceptual model that coincides with the systems, institutional and diffusion of innovation theories and purposes high degree of collaborations among foreign and domestic firms, governments, customers and suppliers - Identifying the base practices and drivers exclusive to the developing countries. It also purposes a collaboration mechanism in a novel conceptual framework to integrate the foreign and domestic firms under common agenda of improving the environment.
Chieh-Yu Lin et al. (2020)	Adoption of Green Supply Chain Management among SMEs in Malaysia	to integrate the Diffusion of Innovation (DOI) theory and Technology, Organization and Environment (TOE) theory to examine the factors that affect the adoption of green supply chain management (GSCM) practices among SMEs in Malaysia. Twelve hypotheses were developed based on the integrating theories in technology adoption context.	<ul style="list-style-type: none"> - Research findings show that perceived relative advantage, perceived cost, top management support, complexity, compatibility, firms size, customer pressure, regulatory pressure and the quality of human resources are statistically significant factors influencing GSCM adoption among SMEs in Malaysia. However, observability and governmental support do not have significant effects on GSCM adoption intention.

2.2 Antecedents of GSCM

This paper identifies the most important GSCM antecedents based on literature review as follows:

A. Top level management commitment to GSCM.

Top management support and commitment is necessary for any strategic program success practices such as GSCM. (M.D. Singh, 2012; Shreejith B., 2012; Soh Hyun et al., 2017), (Chieh- yu lin et al, 2020)

B. Government support and regulations

Government regulation can encourage or discourage the adoption of innovation, as Government sets the environmental regulations for industry (Xianbing Lui 2011, B.-Y. Chang et al. 2013; Zhijun Feng et al. , 2018)

C. High organizational culture (organization's internal culture)

Management may encourage employees to learn green information. Organizations may provide rewards for green employees. Employees may be helped when they face green problems and may be provided support to learn green information (Yu Lin et al., 2008; Karen Wessels et al., 2018).

D. Customer's awareness towards GSCM and green products

A major antecedent of GSCM implementation is the awareness of customers about the benefits of green products, as Consumer's awareness about green products is important in guiding the green consumer purchasing behavior (B.P. Sharma 2015, Yi-Hui Ho et al. 2014)

E. Supplier involvement

Strengthen relationships with suppliers' results in lower inventory levels, costs and higher accuracy. Involvement of the suppliers in design process and technology affects overall performance of whole chain (Kannan et.al, 2010 and Juthathip Suraraksa et al., 2019)

F. Gaining integrated GSCM.

(Raganathan H and Premukar H, 2012 and Baofeng Huo, et al., 2019) argue that most firms implementing green supply chain practices

do not actually integrate environmental considerations into their supply chain management processes

2.3 GSCM Adoption practices (Implementation types)

The most important implementation types which considered here are:

Type 1-Green Manufacturing and Packaging:

For example, production focused on reducing waste, substitution of polluting and hazardous materials/parts, selection of cleaner transportation method, recycling and reusing packaging/container, and using ecological materials for primary packaging (Metters et al,2006), (M.S. Asif,2020).

Type 2- Environmental Participation:

For example, environmental training programs for employees, cross-functional cooperation for environmental improvements, commitment to green from upper management, Environmental Management System exists (King and Barker, 2007), (M.S. Asif, 2020).

Type 3- Green Marketing:

For example, sponsoring the environmental event with ecological organization, update label on packages, recuperation and recycling system, and update the website on environmental issues (Srivastava and Srivastava, 2006),

Type 4- Green Suppliers:

For example, suppliers' ISO 14000 certifications, supplier selection by environmental criteria, and collaborating green projects with suppliers (M.S.Asif, 2020), (Mishra et al, 2019).

Type 5- Green Stock:

For example, sales of excess capital equipment scrap and used materials (M.S.Asif, 2020), (Mishra et al, 2019).

Type 6- Green eco-design:

For example, design of products for reduced consumption of material/energy (Mishra et al, 2019).

2.4 Study hypotheses

The paper tests several hypotheses as follows:

- Hypothesis 1: There is a relationship between top level management commitment to GSCM, and GSCM adoption practices (Implementation)
- Hypothesis 2: There is a relationship between Government support & regulations, and GSCM adoption practices (Implementation).
- Hypothesis 3: There is relationship between High Organizational Culture (organization's internal culture), and GSCM adoption practices (Implementation).
- Hypothesis 4: There is no relationship between Customer's awareness towards GSCM & green products, and GSCM adoption practices (Implementation).
- Hypothesis 5: There is relationship between Supplier Involvement, and GSCM adoption practices (Implementation).
- Hypothesis 6: There is a relationship between Gaining Integrated GSCM, and GSCM adoption practices (Implementation).
- Hypothesis 7: There is a relationship between all the proposed antecedents and GSCM implementation as a whole.

3. initial structural framework

An initial structural framework is given in figure 1 showing both of the identified antecedents and adoption practices (Implementation types) to be studied and verified using statistical analyses.

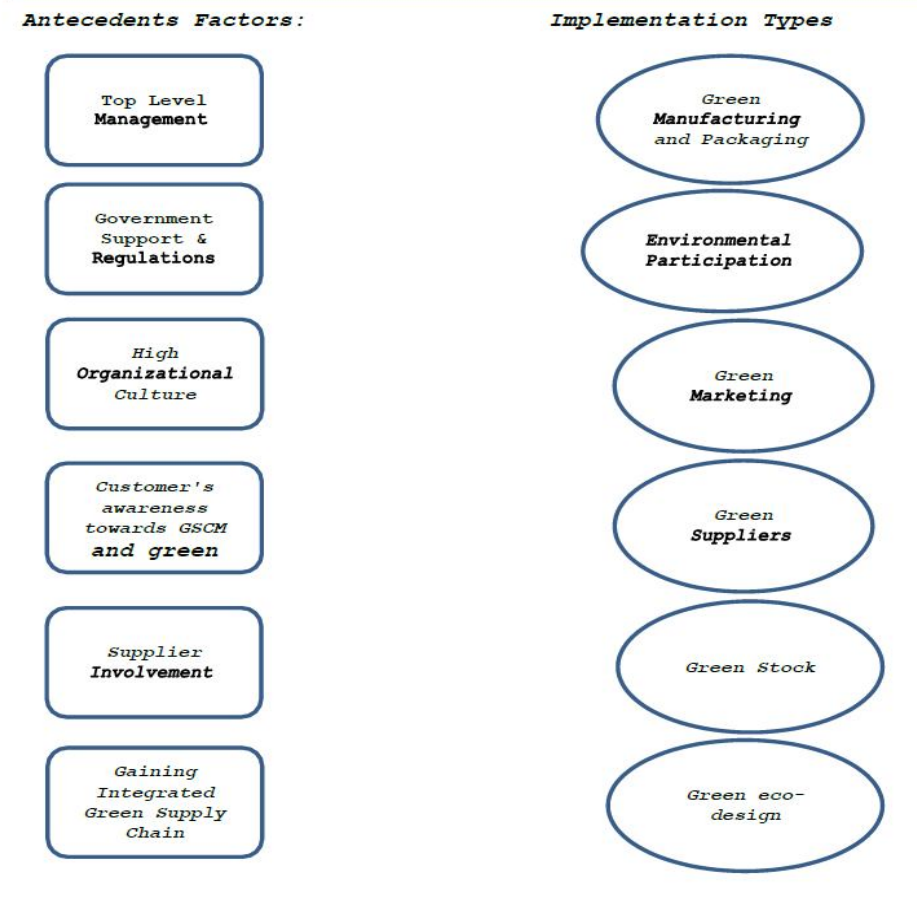


Figure 1: initial structural framework

4. Statistical analyses

4.1 Instrument development method:

Instrument development method for GSCM include three phases:

- (1) item generation,
- (2) reviewing the instruments of data collection, and
- (3) Statistical analysis for instrument validity.

Phase 1 which deals with item generation has to identify instruments that measure GSCM antecedents' factors and GSCM implementation types.

In Phase 2 of reviewing the instruments of data collection, the items were reviewed by three academicians and re-evaluated through structured interviews with three practitioners who were asked to comment on the appropriateness of the research constructs. Based on the feedback from the academicians and practitioners, redundant and ambiguous items were either modified or eliminated. New items were added wherever deemed necessary.

In phase 3, a statistical analysis was used to determine the validity and reliability of the GSCM instruments.

4.2 Data collecting and sampling unit:

This study sought to choose respondents who are expected to have the best Knowledge about the operation and management of the supply chain in his/her organization. Based on literature and recommendations from practitioners it was decided to choose managers who are at higher & middle managerial levels as respondents for the current study. The respondents were asked to refer to their major suppliers or customers for relevant questions. The final version of the questionnaire, measuring all the items on a five-point scale, was administrated to target respondents. The questionnaire starting by an introduction indicating the purpose and significance of the study were mailed to the target respondents. These target respondents are three organizations working in the sector of electric & electronic industry in Egypt. (Carrier, Power, Union-air).

There were 155 complete and usable responses. A significant problem with organizational-level research is that senior and executive-level managers receive many requests to participate and have very limited time. Because of this interdisciplinary research collects information from several functional areas, the size and scope of the research instruments were too large and time consuming to complete. This interprets the size of obtained number of responses.

Of all respondents, almost 20% are CEO/President/Vice President/Director, and about half are managers, some identified

themselves as supply chain manager, plant manager, logistics manager or IT manager in the questionnaire.

The areas of expertise were 30% purchasing, 40% manufacturing production, and 30% distribution/transportation/ sales. It can be seen that respondents have covered all the functions across a supply chain from purchasing, to manufacturing, to distribution and transportation, and to sales. Moreover, about 30% of the respondents are responsible for more than one job function, and they are expected to have a broad view of GSCM practice in their organization, among the variables of GSCM.

4.3 Overview of statistical analysis study:

The next section presents the statistical analysis study. This study includes two models. The first one is called measurement model and the second is called structural model.

The measurement model contains the followings:

- Descriptive statistics such as frequency tables, means and standard deviations.
- Factor analysis for dimension reduction.
- Data analysis validity to measure the reliability of each factor.

The structural model contains the following:

- Multivariate model to find the relationships between all the GSCM antecedents' components and all the GSCM implementation types.
- Univariate model to find the relationships between all the GSCM antecedents' components and the GSCM implementation as one dependent variable.

4.4 Results of statistical analysis study

4.4.1 Factor analysis results

As a result of factor analysis, the 6 antecedent factors, each having 6 items (questions) represented by 36 variables are reduced to only 11 components. The initial structural framework is modified after the statistical factor analysis phase for the purpose of dimension reduction to be as given in figure 2.

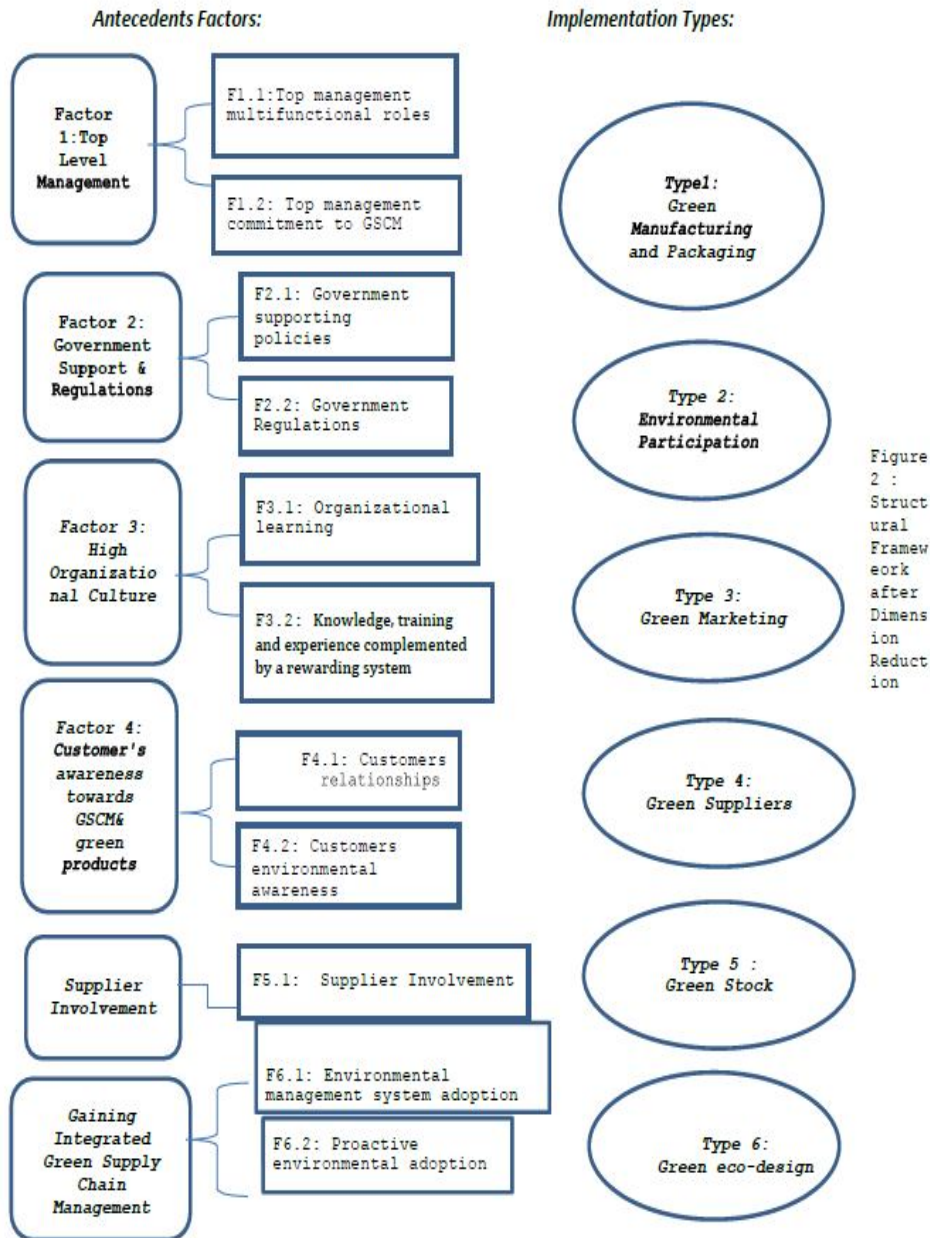


Figure 2: Factor analysis results

4.4.2 Results for the structural model:

4.4.2.1 Hypothesis testing:

Hypothesis 1: There is a relationship between top level management commitment to GSCM, and GSCM adoption practices (Implementation):

- H1a: Top management multifunctional roles, has a significant impact on GSCM adoption practices & implementation.
- H1b: Top management commitment to GSCM, has a significant impact on GSCM adoption practices & implementation.
- This hypothesis is tested using the multivariate test model:
- The relation between **FAC1-1** (Top management multifunctional roles) and type 5 is accepted as the significance value = 0.005, so it is accepted at 0.05 level, but the relation between this antecedent and the other implementation types is not accepted as their significance values > 0.05.
- The relation between **FAC1-2** (Top management commitment to GSCM) and types: 1,5,6 is accepted as their significance value < 0.05, but the relation between this antecedent and the other implementation types is not accepted as their significance values > 0.05.

Hypothesis 2: There is a relationship between Government support and regulations and GSCM adoption practices (implementation):

- H2a: Government supporting policies has a significant impact on GSCM adoption practices & implementation.
- H2b: Governmental regulations, has a significant impact on GSCM adoption practices & implementation.
- This hypothesis is tested using the multivariate test model:
- The relation between **FAC2-1** (Government supporting policies) and types 1,2,3 is accepted as the significance value is < 0.05, so it is accepted at 0.05 level, but the relation between this antecedent and the other implementation types are not significant as their significance

values > 0.05.

- The relation between **FAC2-2** and type 1 is accepted as the significance value = 0.01, so it is accepted at 0.05 level, but the relation between this antecedent and the other implementation types are not significant as their significance values > 0.05.

Hypothesis 3: There is relationship between High Organizational Culture (organization's internal culture), and GSCM adoption practices (Implementation).

- H3a: Organizational learning has a significant impact on GSCM adoption practices & implementation.
- H3b: Knowledge, training and experience complemented by a rewarding system, has a significant impact on GSCM adoption practices & implementation.
- This hypothesis is tested using the multivariate test model:
- The relation between **FAC3-1** (Organizational learning) and type 2 is accepted as the significance value = 0.048, so it is accepted at 0.05 level, but the relation between this antecedent and the other implementation types are not significant as their significance values > 0.05.
- The relation between **FAC3-2** (Knowledge, training and experience complemented by a rewarding system) and all the implementation types is not accepted, as their significance values > 0.05.

Hypothesis 4: There is no relationship between Customer's awareness towards GSCM & green products, and GSCM adoption practices (Implementation).

- H4a: Customers' relationship has a significant impact on GSCM adoption practices & implementation.
- H4b: Customers Environmental Awareness has a significant impact on GSCM adoption practices & implementation.

- This hypothesis will be tested using the multivariate test model:
- The relation between **FAC4-1** (Customers' relationship) and all the implementation types is accepted as their significance value < 0.05 .
- The relation between **FAC4-2** (Customers Environmental Awareness) and type 3, 4, 6 is accepted as their significance values < 0.05 , but the relation between this antecedent and the other implementation types are not accepted as their significance values > 0.05 .

Hypothesis 5: There is relationship between Supplier Involvement, and GSCM adoption practices (Implementation).

- H5: Supplier involvement has a significant impact on GSCM adoption practices & implementation.
- This hypothesis will be tested using the multivariate test model:
- The relation between **FAC5-1** (Supplier involvement) and all the implementation types is not accepted as their significance value > 0.05 .

Hypothesis 6: There is a relationship between Gaining Integrated GSCM, and GSCM adoption practices (Implementation).

- H6a: Environmental Management System Adoption has a significant impact on GSCM adoption practices & implementation.
- H6b: Proactive Environmental Strategy has a significant impact on GSCM adoption practices & implementation.
- This hypothesis is tested using the multivariate test model:
- The relation between **FAC6-1** (Environmental Management System Adoption) and all the implementation types is not accepted as their significance value > 0.05 .
- The relation between **FAC6-2** (Proactive Environmental Strategy) and all the implementation types is not accepted as their significance value > 0.05 .

Hypothesis 7: There is a relationship between all the proposed antecedents and GSCM implementation as a whole.

- **This hypothesis is tested using the univariate test model:**

The relation is accepted between the implementation as a whole and these antecedents' factors: *FAC1_1* (Top management multifunctional roles)

,*FAC1_2*(Top management commitment to GSCM),*FAC2_1* (Government supporting policies),*FAC2_2* (Governmental regulations),*FAC3_1* (Organizational learning),*FAC4_1* (Customers' relationship),*FAC4_2* (Customers Environmental Awareness; as their significance value < 0.05. But the relation between the implementation and the other antecedents' factors is not accepted as their significance value > 0.05.

4.4.2.2 Parameter Estimation of the Multivariate Model:

- We can conclude from the previous study that the factors ' components (independent variables) which have a significant effect on the dependent variables (implementation types from type 1 to type 6) are the following:

FAC1_1 (Top management multifunctional roles),

FAC1_2 (Top management commitment to GSCM) *FAC2_1* (Government supporting policies) *FAC2_2* (Governmental regulations)

FAC3_1 (Organizational learning)

FAC4_1 (Customers' relationship)

FAC4_2 (Customers Environmental Awareness)

Therefore, we consider only these 7 factors' components in the multivariate analysis

- This method will consider the impacts of all the independent variables on the dependent variables.
- This method will also produce a linear model for each dependent variable as a function of its corresponding inputs; it means it has to estimate the parameters (coefficients) associated with input variables.

The final structural model obtained is:

- *Type 1 (Green Manufacturing and Packaging)=*
 $0.374 \text{ FAC1_2 (Top management commitment to GSCM)+}$
 $0.347 \text{ FAC2_1 (Government supporting policies)+}$
 $0.374 \text{ FAC2_2 (Governmental regulations)+}$
 $0,275 \text{ FAC4_1 (Customers' relationship).}$
- *Type 2 (Environmental Participation) = 0.313 FAC2_1 (Government supporting policies) + 0.230 FAC3_1 (Organizational learning) + 0.649 FAC4_1 (Customers' relationship).*
- *Type 3 (Green Marketing) = 0.731 FAC2_1 (Government supporting policies) + 0.357 FAC4_1 (Customers' relationship). + 0.312 FAC4_2 (Customers Environmental Awareness).*
- *Type 4 (Green Suppliers) = 0.265 FAC4_1 (Customers' relationship) + 0.391 FAC4_2 (Customers Environmental Awareness).*
- *Type 5 (Green Stock) = 0.375 FAC1_1 (Top management multifunctional roles), + 0.472 FAC1_2 (Top management commitment to GSCM) + 0.327 FAC4_1 (Customers' relationship).*
- *Type 6 (Green Design) = 0.559 FAC1_2 (Top management commitment to GSCM) + 0.495 FAC4_1 (Customers' relationship) + 0.341 FAC4_2 (Customers Environmental Awareness).*

4.4.2.3 Parameter Estimation of Univariate Model:

In this study, we consider the GSCM implementation as a one dependent variable. To produce this model, we used the univariate analysis method.

IMPLEMENTATION = $0.751 \text{ FAC1_1 (Top management multifunctional roles) + 1.416 FAC1_2 (Top management commitment to}$

GSCM) + 1.407FAC2_1 (Government supporting policies) + 0.922FAC2_2 (Governmental regulations), + 0.313FAC3_1 (Organizational learning) + 2.273FAC4_1 (Customers' relationship) + 1.559FAC4_2 (Customers Environmental Awareness).

4.4.2.4 Final Detailed Structural Model:

The relation between the dependent variables (type 1, type 2, type 3, type 4, type 5 and type 6) with the independent variables (: FAC1_1, FAC1_2, FAC2_1, FAC2_2, FAC3_1, FAC3_2, FAC4_1, FAC4_2, FAC5_1, FAC6_1, FAC6_2.) is shown in figure 3.

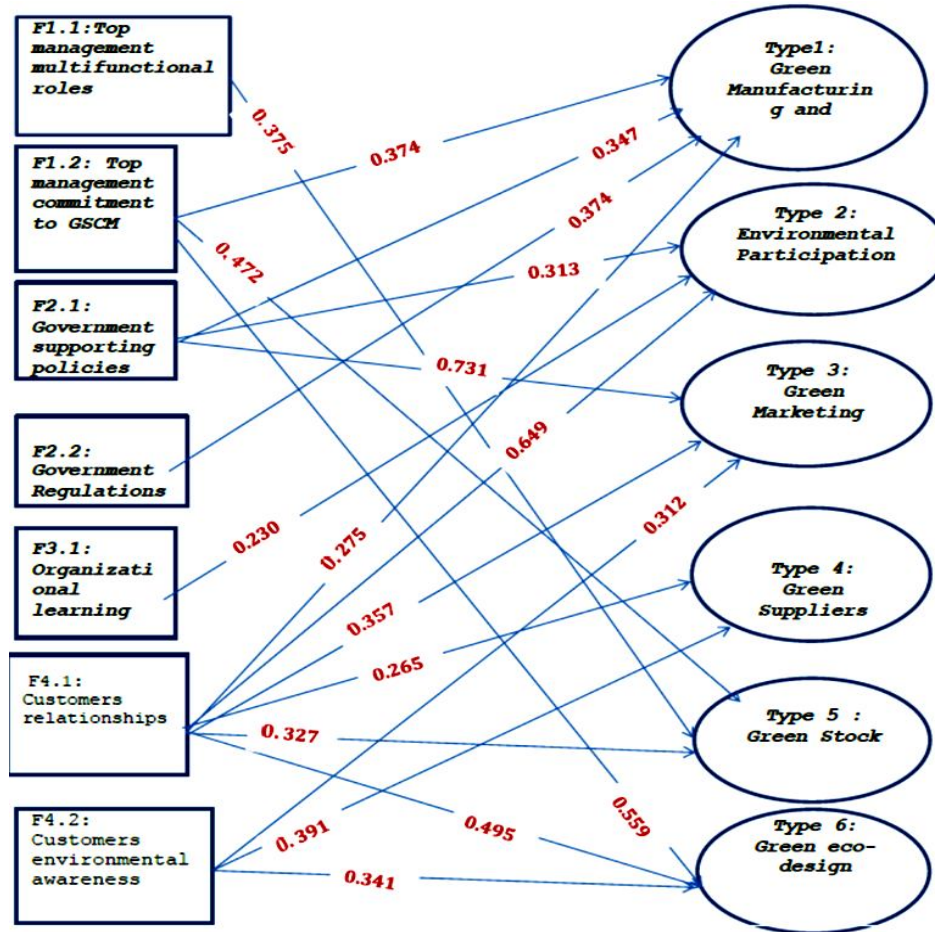


Figure 3: Final Detailed Structural Model

4.4.2.5 Final Integrated Structural Model:

The relation between the dependent variable: IMPLEMENTATION with the independent variables (factors' components): FAC1_1, FAC1_2, FAC2_1, FAC2_2, FAC3_1, FAC3_2, FAC4_1, FAC4_2, FAC5Is shown in figure 4.

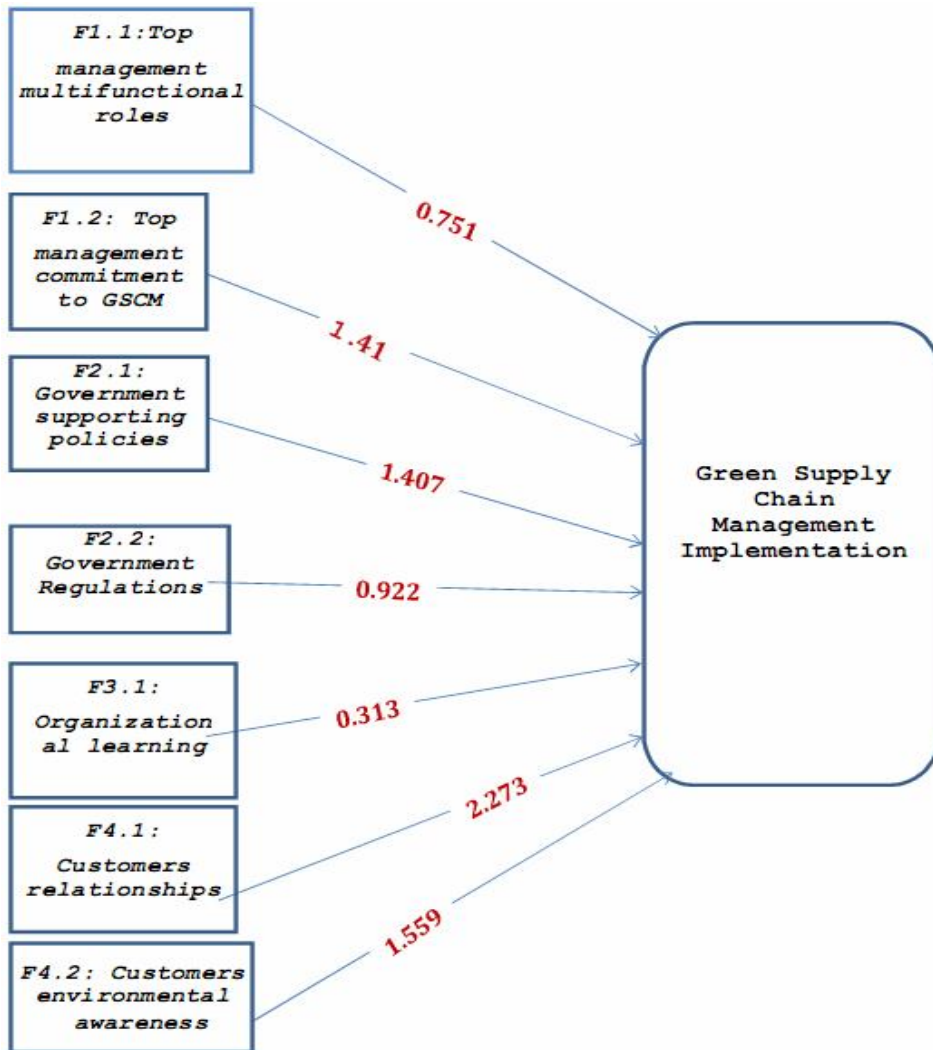


Figure 4: Final Integrated Structural Model

5. Conclusions

5.1 Main findings

The main finding of this study is that eight hypotheses out of twelve hypotheses are supported statistically and only four hypotheses are not supported.

The accepted hypotheses are:

- Top management multifunctional roles, has a significant impact on GSCM adoption practices & implementation.
- Top management commitment to GSCM, has a significant impact on GSCM adoption practices & implementation.
- Government supporting policies has a significant impact on GSCM adoption practices & implementation.
- Governmental regulations, has a significant impact on GSCM adoption practices & implementation.
- Organizational learning has a significant impact on GSCM adoption practices & implementation.
- Customers' relationship has a significant impact on GSCM adoption practices & implementation.
- Customers Environmental Awareness has a significant impact on GSCM adoption practices & implementation.
- The relation is accepted between the implementation as a whole and these 7 antecedents' factors only: FAC1_1, FAC1_2, FAC2_1, FAC2_2, FAC3_1, FAC4_1 and FAC4_2.

The rejected hypotheses are:

- Knowledge, training and experience complemented by a rewarding system, has not a significant impact on GSCM adoption practices & implementation.
- Supplier involvement has not a significant impact on GSCM adoption practices & implementation

- Environmental Management System Adoption has not a significant impact on GSCM adoption practices & implementation
- Proactive Environmental Strategy has not a significant impact on GSCM adoption practices & implementation
- Limitations of the study are:
 - The findings and results cannot be generalized as the questionnaire focuses only on the electrical & electronics sector, so it does not encompass the other different sectors.
 - The questionnaire addresses only six antecedents which were mentioned in the paper as the important ones.

These results are convenient because as the environmental awareness is increasing, firms are facing heavy pressure from different stakeholders including government and customers to mitigate their harmful effect on the environment. Internal management is a key critical success factor for enterprises to adopt green practices. Pressure employees bring about, encouragement and support from environmental-protection motivate senior management. Customers' relationship and environmental awareness play an important and effective part .Indeed; developing nations' firms are facing heavy pressure to adopt green practices in their business operations of supply chain to meet their customers' demand so that they can be competitive in the market. Governments should establish strict environmental laws to control climate change, global warming and pollution; and firms are required to reduce their supply chain's negative effect on environmental sustainability. Hence, it becomes more and more important for firms in supply chain to have conformity with regulations.

Providing the right education about sustainability and GSCM to the companies' employees and stakeholders would raise their knowledge, awareness and their commitment in the implementation process. This would consequently support the companies in reducing the resistance to change which is one of the most challenging barriers.

5.2 Comparison of research findings with previous studies

Table 2: Comparison between research findings & previous studies

Author	title	Antecedents	Practices
Sirkanta Routrooy – 2009	Antecedents and drivers for green supply chain management implementation in manufacturing environment	1-Top management commitment 2-Government's initiative 3- Customer Awareness	1- Green design 2- Green operations 3- Green sourcing 4- Green packaging 5- Reverse Logistics 6- Environmental management system (EMS) 7- Green innovation
Arvind Upadhyay , 2012	Antecedents and Enablers of Green Supply Chain Practices	1-Addressing environmental consideration 2-Strong upstream-downstream cooperation and integration 3-Application of continuous improvement models 4- Internal improvement of product or processes 5-Developing green standards and specifications for design 6-Resale of assets via online disposition avenues	1- Environmental certification 2- Pollution prevention 3- Life cycle assessment (LCA) 4- Design for the environment 5- Reverse logistics 6- Internal environmental management 7- Green purchasing 8- Cooperation with customer including environment requirement 9- Investment recovery 10- Eco-design practices
The Researcher r, 2017	Antecedents of Green Supply Chain Management Implementation	1- Top management multifunctional rules (FAC1-1) 2- Top management commitment to GSCM (FAC1- 2) 3- Government supporting policies (FAC2-1)	1-Green Manufacturing and Packaging (Type 1) 2-Environmental Participation (Type 2) 3- Green Marketing (Type 3) 4- Green Supplier (Type 4) 5- Green Stock (Type 5) 6- Green eco-design (Type 6)
		4-Government Regulations (FAC2-2) 5-Organizational learning	

Dr. Rania Ramadan Moawad & Dina Ramadan

Author	title	Antecedents	Practices
		(FAC 3-1) 6- Knowledge, training and experience complemented by a rewarding system (FAC3- 2) 7- Customer's relationships (FAC4-1) 8- Customers environmental awareness (FA C4-2) 9- Supplier Involvement (FAC5-1) 10- Proactive environmental adoption (FAC 6-1) 11- Environmental management system adoption (FAC6-2)	

6. Recommendations & Further Research Directions:

As the green supply chain management is a new area in electrical & electronics sector in Egypt, much research is still at the theoretical level and little has been proved within this sector. Therefore, it is also too early to investigate the long-term benefits for the sustainable development but just only the perception of these companies.

6.1 Managerial Implications:

Egypt can be a potential market for recycling e-waste due to the massive quantities generated from the consumption in the electronic and electrical sector. Thus, some recommended actions are provided for the stakeholders within the supply chains of electronic and electrical industries in Egypt for e- waste recycling and green supply chain management support to assure a clean environment.

These recommended actions can be formulated in the following action plans:

Table 3: Managerial Implications (Action Plans)

Action	Responsible	Procedure
1- Establishment of institutional framework	Egyptian government	<ul style="list-style-type: none"> - Setting up policies, legislations, and enforcement means, - Developing a cost-recovery mechanism. - Creating programs for capacity building and awareness for the GSCM.
2- Policy and planning of GSCM strategy	Public & private sectors top management	<ul style="list-style-type: none"> - Strategy planning. - Strategy implementation & control.
3- Finance and cost recovery arrangements	Governorates	<ul style="list-style-type: none"> - - Allocate their respective e- waste budget, with limited portion of the waste handling fees to be collected through the electricity bill.
4- Encouraging suppliers' involvement	Manufacturing organizations	<ul style="list-style-type: none"> - Selecting suppliers based on their green practices. - involving Suppliers in GSCM improvement/development process. - Providing Suppliers with environmental and economic benefits from the GSC initiatives.
5- Increase customer's awareness towards GSCM & green products	Media	<ul style="list-style-type: none"> - Promotion programs. - Awareness programs about the features that green products provide. - Obtain relevant and helpful information from customers on how to comply with their - environmental requirements

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نموذج هيكلية لإدارة سلسلة التوريد الخضراء يربط بين متطلبات
إدارة سلسلة التوريد الخضراء وممارسات التطبيق

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الملخص:

بدأت المنظمات تدرك أهمية إدارة سلسلة التوريد الخضراء للوصول الي المزايا التنافسية والبيئات المستدامة. تقترح هذه الورقة نموذجاً هيكلياً يربط بين متطلبات سلسلة التوريد الخضراء وممارسات تطبيقها. تبدأ الورقة بتحديد مجموعة مهمة من المتطلبات ومجموعة أخرى من ممارسات التطبيق ثم تحديد نموذج هيكلية أولي. يتم بعد ذلك إجراء دراسة تحليلية إحصائية دقيقة على مجموعة البيانات التي تم جمعها من قطاع الكهرباء والإلكترونيات المصري وذلك باستخدام نموذجين إحصائيين. يُطلق على النموذج الأول اسم نموذج القياس وهو يحتوي على الإحصائيات الوصفية لجميع المتغيرات قيد الدراسة، وعلى تحليل العوامل لتقليل هذا العدد الكبير من المتغيرات. أما النموذج الثاني فيطلق عليه اسم النموذج الهيكلية لأنه يوضح العلاقة الهيكلية بين متطلبات سلسلة التوريد الخضراء كمتغيرات مستقلة وممارسات التطبيق كمتغيرات تابعة. يعتمد هذا النموذج الهيكلية إحصائياً على كل من النموذج أحادي المتغيرات والنموذج متعدد المتغيرات. وفقاً لهذه الدراسة التفصيلية، فقد تم قبول بعض الفرضيات ورفض البعض الآخر وتم التوصل للنموذج الهيكلية النهائي لإدارة سلسلة التوريد الخضراء.

الكلمات المفتاحية: إدارة سلسلة التوريد الخضراء، متطلبات سلسلة التوريد الخضراء، ممارسات تطبيق سلسلة التوريد الخضراء، النموذج الهيكلية، النموذج أحادي المتغيرات، النموذج متعدد المتغيرات.