

# Developing Green Performance Through Supply Chain Agility in Manufacturing Industry: A Case Study Approach

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## ABSTRACT

Global environmental issues have changed over time. For a company to survive, it is necessary to attract enough customers to generate profitability and because of high uncertainty in the environment, it requires a more rapid response to the needs of customers. Changing competitive conditions and increasing levels of environmental complexity have caused companies to consider agility conception. In the present study, we aimed to investigate the positive effects of supply chain agility on green performance in the Yazd ceramic tile manufacturing industry. To achieve this goal, after studying the literature review of each variable, a conceptual model with seven hypotheses was proposed. We used structural equation modeling (SEM) to explore these relationships. Thus, according to the findings of this study, supply chain agility positively influences green performance by mediating organizational strategy, customer satisfaction, and financial performance. Additionally, development of this relationship involves improvement in applying new technology (agility), setting goals (strategy), solving consumer problems (customer satisfaction), profitability (financial performance), and environmental policies (green performance). Copyright © 2017 John Wiley & Sons, Ltd and ERP Environment

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## Introduction

SINCE THE INDUSTRIAL REVOLUTION, ENVIRONMENTAL CONCERNS IN ALL SEGMENTS AND COMMUNITIES HAS GRADUALLY expanded. Several products that do not fit with environmental issues and perhaps would harm the environment are taken into consideration by consumers and anyone interested in the environment. To protect these concerns, many international firms have focused on producing green products. Furthermore, an increasing number of consumers are eager to use environmentally conscious products (Shan Chuang *et al.*, 2014). Indeed, firms are aware of environmental concerns (Martín-de Castro *et al.*, 2015; Wolfgang & Roud, 2016). In other words, due to

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the importance of environmental degradation as a major menace to human survival in the future, an increasing number of organizations have focused on green performance as a significant strategy to attain both environmental protection and economic growth. On the other hand, strategies of developing agile supply chains have some indications of green performance. Strategies of using an agile supply chain have both positive and negative impacts on green performance but by implementing alternative strategies we can decrease the negative impacts of supply chain agility. Therefore, it is important to pay attention to the potential effects that agile supply chain strategies would have on green performance (Vasco, 2006). In this research, we focused on this new approach to define corporate environmental performance and this conception that environmental performance is an important component of competitive advantage that many companies have accepted over several years. This paper shows an experimental research that aims to investigate the relationship between agility and green performance. In this study, we will review literature regarding agility and green performance. Then research hypotheses are developed. Next, hypotheses are tested with data collected and finally the research findings are discussed, and implications of this research are presented.

## Literature Review

According to the aim of this paper, in this section we briefly present the literature review on the subject of agility, green performance and its main metrics, and how agility of supply chain can affect green performance. At the end of this section, we will examine the hypothesis and finally draw the conceptual model.

### Agility

The early defenders of agility defined it as a system with notable capabilities to satisfy the changing needs of the markets speedily and flexibly (Youssef, 1994). Agility has also been defined in terms of definite activities and operational issues. Kidd (1994) describes agility as a combination of some companies so that each of them has their basic skills that lead them to contribute to a cooperative business procedure. This enables the organizations to get accustomed to and respond immediately to uncertain customer appeals (Kidd, 1994; Yusuf *et al.*, 1999). Yusuf *et al.* (1999) describe agility from a manufacturing aspect as a successful approval of competitive bases. Moreover, Kumar and Motwani (1995) define agility as a firm's ability to advance activities rapidly on the critical path, which is an important element of the firm's capacity for competing based on responsiveness (Mason-Jones & Towill, 1997, 1999; Mason-Jones *et al.*, 2000). Agile supply chains can be defined as comprehending market turbulence (Van Hoek *et al.*, 2001).

### Green performance

According to Margaretha and Saragih (2013), nowadays 'being green' is a guideline. In fact, a green firm is environmentally sensitive, socially responsible, and resource productive (Sathyapriya *et al.*, 2013). By assessing a company's performance and considering its environmental sensitiveness and environmental management approach, we can name that performance as a company's environmental (green) performance that involves two fields: environmental performance and competitive advantage (Kucukoglu & Pinar, 2015). Some of the green firm's parts are as follows: written environmental policy, environmental management system, specific goals for improving its environmental performance, environmental purchasing policy, publication of environmental reports, policy of reducing use of unsustainable product indexes, environmental training and education and fossil fuel use diminishing policy (Ramus, 2002). Organizations that have better environmental performance can raise their overall image (Chen *et al.*, 2012). Consequently, green performance with the changing global environmental issues has attracted appreciable attention to sustainable development processes. The International Organization of Standardization (ISO) described ISO 14000 s in 1996. ISO 14000 s is an outline of internationally recognized standards for environmental organizational systems that focus on increasing organizational potentials to lead the environmental effects (Tickner, 1998; Bertolini *et al.*, 2007; Qi *et al.*, 2012). Hervani *et al.* (2005) believe that green performance elements are very important for success in green supply chain management (GSCM). Zhu *et al.* (2008) had a study in Chinese companies and suggested a method to evaluate green performance in these companies, as follows: pollution emission/waste, environmental (green) performance, environmental action efficiency, and environmental reputation. There is a growing approach to the studies that discuss environmental issues in the supply chain management (Sarkis, 1995; Green *et al.*, 1996; Geffen & Rothenberg, 2000; Bowen *et al.*, 2001; Florida & Davison, 2001; Handfield *et al.*, 2002; Zhu & Sarkis, 2004). But, the most attention has been placed on analyzing the relationship between

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green factors and environmental performance (Geffen & Rothenberg, 2000; Handfield *et al.*, 2002; Zhu & Sarkis, 2004; Rao & Holt, 2005; Lee & Klassen, 2008; Vachon & Klassen, 2008).

### Hypotheses

There is a new approach in management that considers a paradigm that involves both issues simultaneously, and it is more accommodated to a competitive situation. To support this approach we offer the following hypotheses:

**H1: *There is a relationship between agility and green product development (GPD).*** Since agility means a quick reaction to changes and because of the increasing popularity of environmentalism in the world, greening products have been incredibly enhanced. Hence, this situation would help firms to manage their market share and competitive advantage (Chang, 2012).

**H2: *There is a relationship between agility and organizational strategies.*** Fast environmental changes and increasing stress of competition (Chung *et al.*, 2012) have led managers to reconsider the fundamentals of their businesses (Urquidi & Ripoll, 2013). Hence, organizations must formulate their strategies efficiently (Singh *et al.*, 2010) while environmental conditions are changing and competition is increasing in business market (Baines & Langfield, 2003).

**H3: *There is a relationship between green product development and customer's satisfaction.*** According to Yakup and Sevil (2011), customer environmental knowledge and consciousness and great demand for green products have led companies to mention their green product in their packaging, advertisement, or manufacturing process to reach satisfied customers (Boztepe, 2012; Hur *et al.*, 2013). Factually, customers who are careful about the environmental impact of products are likely to buy green products (Rashid, 2009) and they will be more willing to pay a higher price for this variety of products (Sammer & Wustenhagen). Therefore, it is better for firms to obligate themselves to identify the customers' environmental requirements and develop green products to satisfy the quality assumption of customers (Yan & Yazdanifard, 2014) because if companies do not consider customer satisfaction, the total endeavors companies apply to the supply chain strategy would be inefficient and ineffective (Akhilesh, 2011).

**H4: *There is a relationship between organizational strategies and organizational innovation.*** Strategies would also have impact on firm innovation. Dyer and Song (1998) defined the innovation strategies as the new product and market development programs of organizations. Also, innovation has been known as a crucial factor of dynamic competition and firm efficiency (Schumpeter, 1934). Organizational innovation can influence company performance, Information exchange, work quality, learning quantity, and using new knowledge and technologies. According to institutional theory, when an organization recognizes innovation as an effective way to reply to market stress or gain competitive advantages, in fact it tends to create green capacities. It can be successful by developing different organizational supporting elements, such as training employees in environmental initiatives, top management support, creating green collaboration networks, R&D investments in green products or environmental production technologies, and also using environmental management systems (Huang *et al.*, 2016).

**H4b: *There is a relationship between organizational innovation and customer satisfaction.*** Several studies represent a positive relationship between innovation and customer satisfaction (Tatikonda & Montoya-Weiss, 2001; Langerak *et al.*,

2004; Luo & Bhattacharya, 2006). Nowadays, because of increasing environmental complexity, customers insist on using innovative products to adapt their behaviors to recent developments. On the other hand, organizations increasingly emphasize the innovation in products as an important factor to satisfy customer requirements (Christensen *et al.*, 2005).

**H5: *There is a relationship between organizational innovation and green performance.*** A company's performance would be affected by several factors and it is measured with different business outputs (Guoyou *et al.*, 2013). These outputs can be either an economical result such as increased income, greater profit margin, new investments, or different kinds of features which cannot be measured exactly. In the literature, there are some studies that investigated the relationship between innovation of companies and their environmental performance. Innovation has a positive relationship with green performance (Condong & Habidin, 2012). According to Chiou *et al.* (2011), who assessed green innovation within green supply chain management, green innovation influences environmental performance and competitive advantages. Hence, green innovation would affect environmental sensitiveness of company performance positively (Lin *et al.*, 2013; Cheng *et al.*, 2014).

**H6: *There is a relationship between customer satisfaction and financial performance.*** Certainly, customer satisfaction is a major facilitator of financial performance (Eklof *et al.*, 1999; Matzler *et al.*, 2004) since high levels of customer satisfaction lead to a decrease in price (Garvin, 1988). According to Anderson and Mittal (2000) and Chi and Gursoy (2009), there is a positive relationship between customer satisfaction and financial performance. Customer satisfaction and financial performance are identified by an increasing number of companies as creating higher levels of customer loyalty (Reichheld & Sasser, 1990). Customer satisfaction could lead firms to increase their revenues (Rust *et al.*, 2002). By establishing a stable customer base, companies can reduce the costs of attracting new customers. These companies can create customer satisfaction and gain the competitive advantage by discovering the customer desires (Lee *et al.*, 1999; Lytle & Timmerman, 2006). Thus, the company which attracts the highest customer satisfaction levels could enjoy the greatest economic benefits (Williams & Naumann, 2011).

**H7: *There is a relationship between financial performance and green performance.*** The theory that environmental performance is an important factor of competitive advantage is an acceptable subject by an increasing number of corporate leaders in recent years. The ability to develop new products, enter new markets, sell current products, and operate manufacturing facilities profitably depends on the continuous improvement in green performance (Monsanto, 1991). Mark and Cohen (1997) confirm the correlation between financial and environmental performance and suggest that an organization which is efficient at pollution control would also be efficient at production.

## Conceptual Model

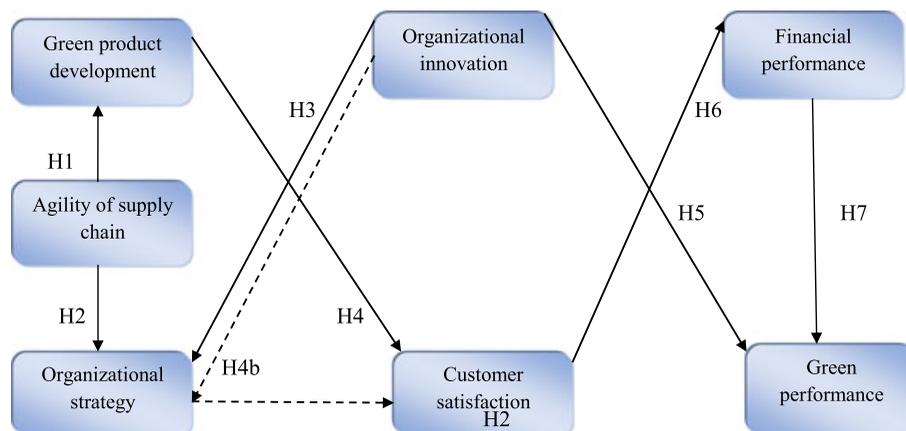
According to the reviewed literature, we can now draw the conceptual model. Figure 1 shows the conceptual model as follows:

As illustrated in Table 1, each of these variables has some dimensions.

## Methodology

The hypotheses of the present study were tested based on the collected data with structural equation modeling (SEM) by using partial least squares (PLS). SEM is a second-generation multivariate statistical analysis that has been

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**Figure 1.** Conceptual model [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

Variables	dimension	Authors
Agility of supply chain	The ability to change direction rapidly. Multi-product production systems.	Bloomfield <i>et al.</i> , 1994; Clarke, 1959; Mathews, 1973. Huang <i>et al.</i> , 2005.
Green product development	Taking good care of one's health. Having a healthy lifestyle caring about the planet's future.	Marchand and Walker, 2008; Jacob <i>et al.</i> , 2009; Huang and Rust, 2011; Lorek and Fuchs, 2013; Lin and Huang, 2012.
Green performance	Reengineering, technological upgrading, reduction in use of non-renewable resources, water, energy, solid waste, soil pollution, waste water emissions, emissions to air, noise, landscape damage, and the risk of severe accidents. Green policy.	Wagner and Schaltegger, 2004; Zhu and Sarkis, 2004; Videras and Alberini, 2000; Shang <i>et al.</i> , 2010; Lai <i>et al.</i> , 2011; Zhu <i>et al.</i> , 2007.
Organizational strategy	Access to the vastest possible markets.	Croteau and Bergeron, 2001
Organizational innovation	performing new ideas which create Value.	Leskovar and Bastic, 2007. Oslo Guide, 2005
Financial performance	Sales growth, return on assets, return on sales.	Li and Ye, 1999; Jones <i>et al.</i> , 2000.
Customer satisfaction	Create sustainable value for customers, Meet the expectations of customers, and respond to their needs.	Oliver, 1997; Giese and Cote, 2002.

**Table 1.** Review the components of the conceptual model

attracting attention in the environmental management (Murillo-Luna *et al.*, 2011; Pereira-Moliner *et al.*, 2012) and operations management areas (Peng & Lai, 2012). Additionally, SEM is a statistical technique to test and evaluate casual correlations in a more impressive way that includes two levels of analysis: the measurement model and the structural model. The measurement model clarifies how hypothetical constructs are measured in terms of the observed variables and the structural model checks the correlations among the constructs (Anderson & Gerbing, 1988). It is worth mentioning that in the first-generation methods, it was a necessity for the sample to be more than 200, whereas in PLS there is no limitation for sample size and it would run with fewer than 100 samples. For instance, Wold (1989) in his paper used a model with 27 variables with 10 samples to analyze (Lohmöller, 1989; Chin, 1998). According to Barkelay *et al.* (1995), the PLS minimum required sample size is equal to the largest amounts of the following two rules:

10 multiplied by the number of measurement model's parameters with the highest index through the measurement models and 10 multiplied by the greatest relationships in the main research model's structure which is related

to one variable. So according to the first rule and the highest index in our paper variables that is 6, we need to calculate 60 samples. Finally, we use data of 74 active ceramic tile firms in Yazd from a total of ceramic firms that consider environmental issues in their planning. To measure each of the key concepts in this research we use relative questionnaires (Appendix A).

### The Results of the Measurement Model

To estimate the reliability of the measurement, we used Cronbach's  $\alpha$  coefficients of each constructs' element. Table 2 outlines the Cronbach's  $\alpha$  coefficients for the measurement of reliability. In general, the minimum requirement of the Cronbach's  $\alpha$  coefficient is 0.7 (Hair *et al.*, 1998; Latan & Ghozali, 2012). Because the Cronbach's  $\alpha$  coefficients of the seven constructs are more than 0.7, the measurement of this study is acceptable in terms of reliability. In addition, it is important to verify whether the validity of the measurement is acceptable. There are two measurements to approve the validity of the constructs. First, this paper implements Fornell and Larcker's measure of average variance extracted (AVE). The AVE determines the amount of variance apprehend by a construct through its factors relative to the amount of variance as a result of the measurement error. To appease the requirement of the discriminative validity, the square root of a construct's AVE should be more than the relationship between the construct and other constructs in the model (Latan & Ghozali, 2012). For example, the square roots of the AVEs for the two constructs of organizational strategy and green production development are 0.898 and 0.884 in which are more than the correlation between them, 0.372 as shown in Table 3. This demonstrates that there is an adequate discriminative validity between organizational strategy and production development. The square roots of all constructs' AVEs in this study are all more than the relationship among all constructs in Table 1. Therefore, the discriminative validity of the measurement in this study is acceptable. Second, the AVEs for all seven constructs are more than 0.5 (Hair *et al.*, 2011; Latan & Ghozali, 2012) as illustrated in Table 2. It shows that the convergent validity of the seven constructs is acceptable. In sum, there are acceptable reliability and validity in the measurement of this study.

Items	Cronbach's $\alpha$	Average Variance Extracted
Agility of supply chain	.811	.639
Green product development	.762	.807
Organizational strategy	.719	.781
Customer satisfaction	.774	.593
Organizational innovation	.7	.574
Financial performance	.7	.638
Green performance	.762	.5

**Table 2.** The constructs' Cronbach's  $\alpha$  coefficients and AVEs

	Customer satisfaction	Financial performance	Green performance	GPD	Organizational agility	Organizational innovation	Organizational strategy
Customer satisfaction	.770						
Financial performance	.172	.779					
Green performance	.557	.448	.678				
GPD	.695	.0121	.522	.898			
Organizational agility	.584	.106	.397	.261	.799		
Organizational innovation	.328	-.064	.374	.274	.498	.758	
Organizational strategy	.591	.030	.411	.372	.712	.530	.884

**Table 3.** Discriminant validity Index

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	R <sup>2</sup>	CR
Customer satisfaction	.503	.583
Financial performance	.030	.763
Green performance	.363	.835
GPD	.068	.893
Organizational strategy	.281	.876
Organizational innovation	.507	.802
Agility of supply chain	---	.877

**Table 4.** R<sup>2</sup> and composite reliability

hypothesis	T values	Proposed effect	Results
H1: agility---GPD	2.005	positive	is supported
H2: agility---Strategy	7.959	Positive	is supported
H3: innovation---strategy	2.317	Positive	is supported
H4: GPD---customer satisfaction	5.258	Positive	is supported
H5: innovation---green performance	4.064	Positive	is supported
H6: customer satisfaction---financial performance	2.003	Positive	is supported
H7: financial performance---green performance	3.525	Positive	is supported

**Table 5.** Overview of the hypotheses tests

To determine composite reliability, the CR coefficients should be more than 0.7 that represents a good fit in terms of composite reliability (Hair *et al.*, 2011; Latan & Ghozali, 2012). In Table 4, values for each variable in the model have been reported, indicating an acceptable fit for research measuring models. The coefficient of determination (R<sup>2</sup>) is the most significant index to assessment structural model, which shows the influence of exogenous variables on the endogenous variables and three values of 0.19, 0.33, and 0.67 are considered as the criterion for weak, medium, and strong amounts of R<sup>2</sup> (Cohen, 1992).

### The Results of the Structural Model

Table 5 and Figure 2 demonstrates the path coefficients. So as it is shown all the paths estimated are acceptable and Figure 3 and Table 5 show the results of the structural model of this study so according to the Table 5 all of the hypotheses are supported in this study.

The empirical results show that if the company adopts new methods and tries to be agile and additionally focuses on the strategies which lead to customer satisfaction, it will achieve appropriate financial performance. Since customer satisfaction is one of the most important goals of any organization and satisfied customers will bring appropriate financial resources to the company, it will achieve appropriate financial performance. Subsequently, the organization that has a proper financial performance can take effective steps to the successful green performance.

Goodness of fit (GOF) statistics, which measure the overall statistical fitness of the tested model, have an effect near to 'large' (0.440) for our study. This means that our proposed model is valid. GOF calculation was done by multiplying the square root of AVE by average of R<sup>2</sup> (where AVE = 0.5; R<sup>2</sup>small = 0.02; R<sup>2</sup> medium = 0.13; R<sup>2</sup> large = 0.26), hence, GOF small, medium, and large = 0.10, 0.25 and 0.36 (Wetzels *et al.*, 2009; Latan & Ghozali, 2012).

$$GOF = \sqrt{\text{communalities} \times \overline{R^2}} \quad (1)$$

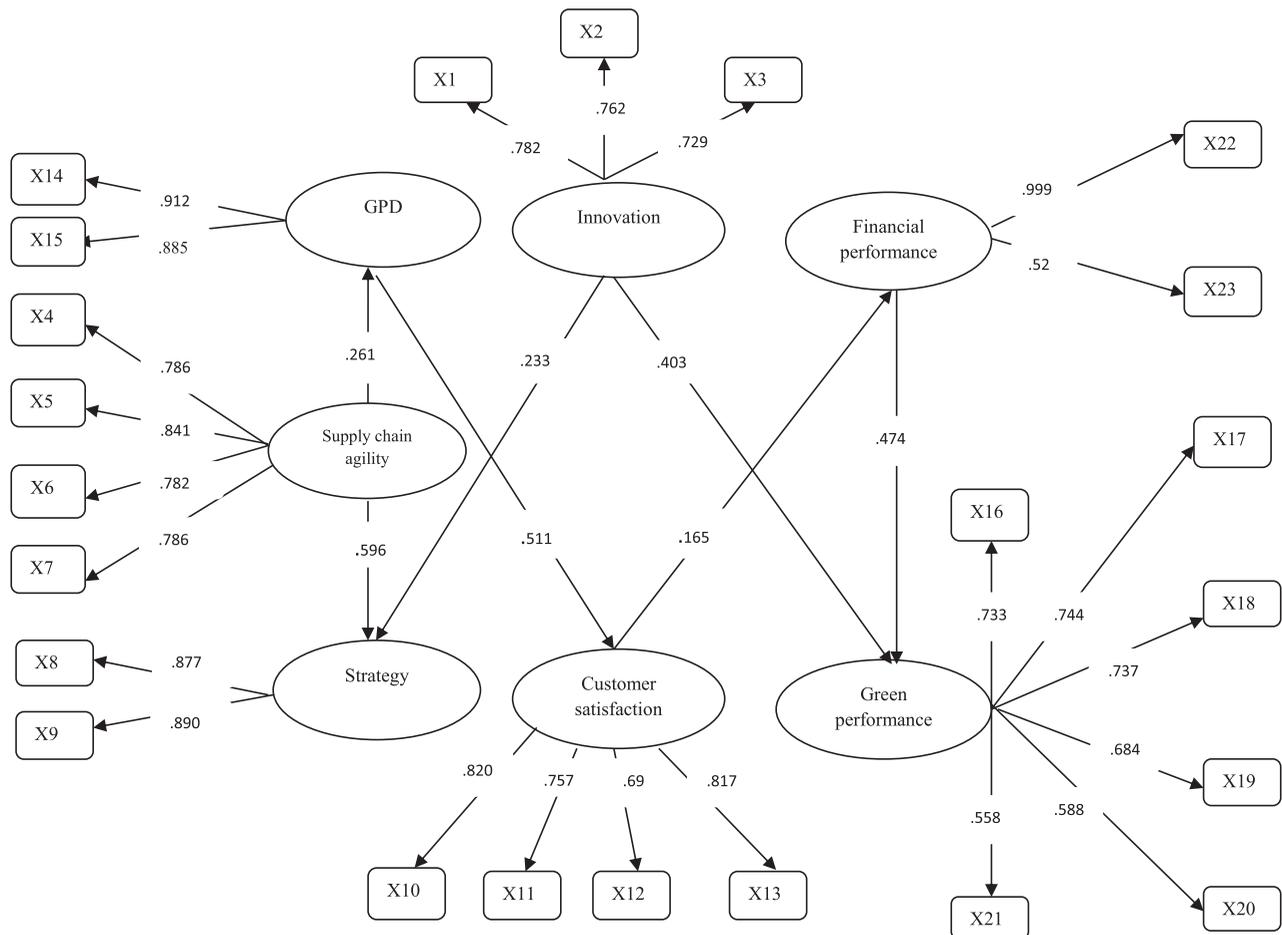


Figure 2. Structural model-path coefficients

## Discussion and Conclusions

This study investigated the positive effects of organizational agility on green performance by SEM. Although many previous studies have explored the issues of agility and its relation with other variables, no research has discussed its relation with green performance through organizational innovation, strategy, financial performance, green product development, and customer satisfaction. This study aimed to fill this gap and proposed a novel construct. The results of this study indicated that organizational agility is positively related to organizational strategy and green product development. Moreover, these two variables have a positive effect on customer satisfaction and organizational innovation. Organizational strategy mediation influences customer satisfaction and directly effects green performance. Additionally, customer satisfaction is related to financial performance and proper financial performance would cause appropriate green performance. All the direct and indirect relationships proposed in our conceptual model of this research were validated statistically. Accordingly, results of the present study are supported by the literature (Llanch *et al.*, 2013; Zhu *et al.*, 2013a) and highlight that the agility of firms can influence their green performance. Based on the empirical results, the more investment made in the firm's agility and considering strategy as a main variable in achieving customer satisfaction to gain proper financial performance, the better the green performance because the increase in green performance is a competitive advantage. Particularly, according to this paper's findings, in terms of agility, a company should focus on using new technology as a main dimension of being agile. Additionally, the way to set goals of strategies would be helpful for being successful in performing strategies. Solving customers problem as the main dimension of customer satisfaction, would lead to increase the profitability of the organization. Subsequently, the most important and effective factor that commits organizations to improve

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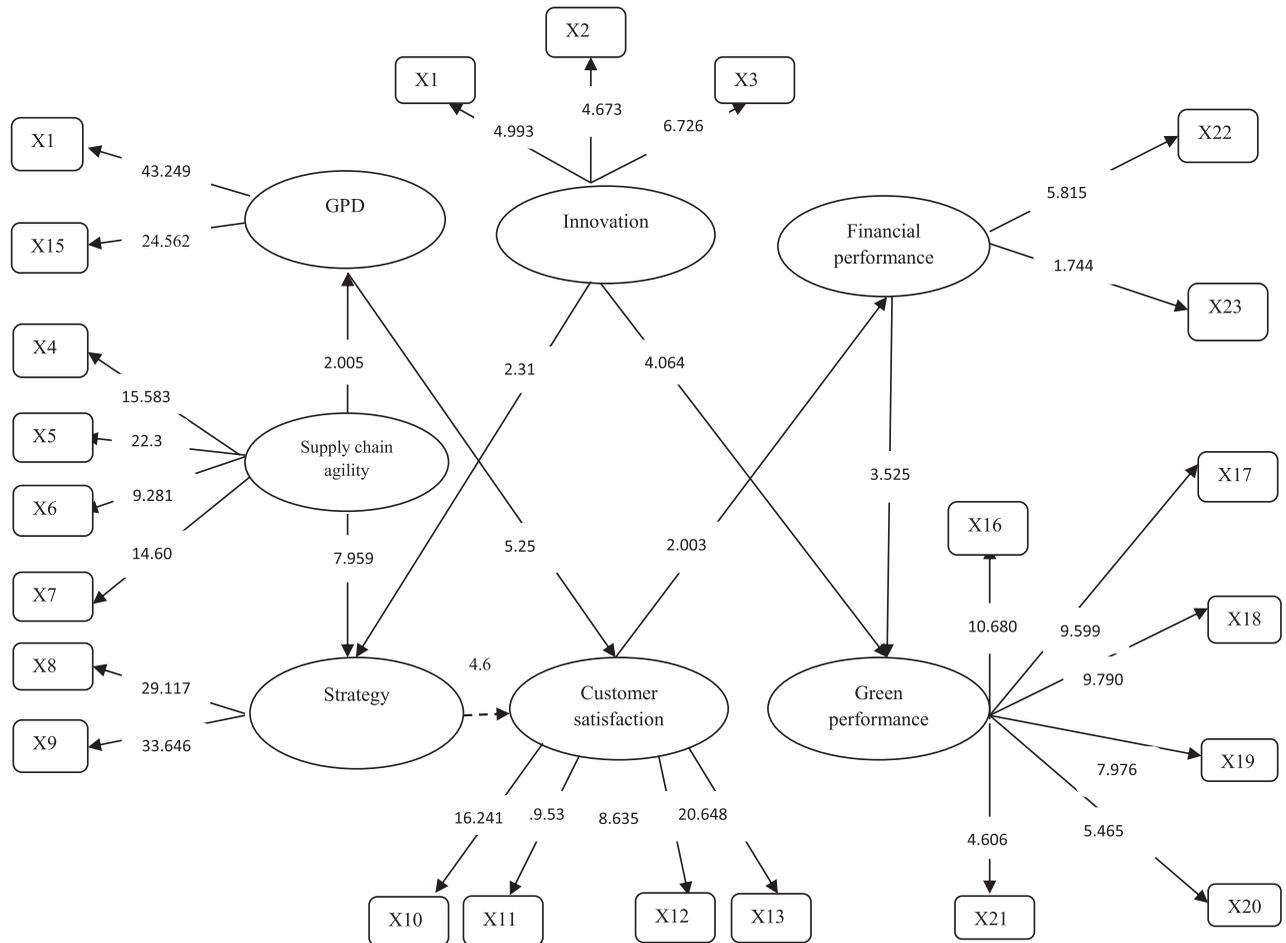


Figure 3. Structural model-T values

their environmental conditions is environmental policies. In general, our model showed an acceptable level of statistical adjustment (GOF), demonstrating that the conceptually formulated interrelationships are also relevant to organizational context. Our results extend the existing literature (Sheu & Talley, 2011). This paper contributes to the relevant literature as it highlights that an improvement in organizational agility is required to improve green performance.

### Implications for Practitioners

For practitioners, for example businessmen who are interested in improving the green performance of firms, our study raises some implications that they might wish to consider. It may be important to begin the search for better green performance by investing in agility, satisfying customers, and improving financial performance. Finally, special attention should be given to the GP practices that have competitive advantages for firms.

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## Appendix A. Variables questionnaire

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dimension		Organizational innovation
Manufacturing innovation	1	The company has always been a pioneer in supplying new services
	2	In this company the personnel are taught to be innovative.
	3	In this company financial resources are available to the staff for research and new projects
	4	This company compared to other companies, is the best one in supplying new products and services.
Processing innovation	5	The company always creates changes in the service delivery process.
	6	new technologies will be used in our company earlier than other similar companies,
	7	The company has always been pioneer in offering new service processes and procedures
	8	The employees prefer to perform their duties in accordance with the old ways
Administrative innovation	9	the company to manage better the organization, constantly use new management systems (such as recruit, hire and new evaluation systems)
	10	The company has always been pioneer in offering new management systems (such as recruit, hire and new evaluation systems)

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## Developing green performance through supply chain agility

dimension		Organizational innovation
	11	The company is conservative in introducing modern management systems (such as systems to recruit, hire new evaluation system).
dimension		Supply chain agility
flexibility	1	We can make profit in the different volumes of production activities
	2	We can make many different products in our own factory
Using new technology	3	Achieving manufacturing new technology is the basic need for survival in the market.
	4	The maximum potential of manufacturing new technology is exploited
Sensitivity to market and customer	5	Our customers give us feedback about the quality and delivery performance
	6	Our customers are actively involved in the process of new products attitude
	7	products are made according to the client Instead of the standardization
	8	We are trying to increase customer satisfaction levels
	9	The supply chain is order-driven rather than being forecasting-driven
	10	Improving responsiveness to market requirements is a key priority for us
Supply chain agility	11	Information integrity
	12	Process integration
	13	Collaborative relationships in the network
	14	quick respond to customer
dimension		Organizational strategy
planning	1	Our organization has a planned strategy
	2	I am satisfied are with the strategic planning process
	3	Our organization has a process for strategic planning and uses it
	4	Our organization has a fixed planning cycle
	5	there Is a specialized committee or board that monitors the execution of the defined corporate strategy
objectives	6	The organization planning objectives ensure an appropriate organizational structure to run the planning process
	7	Survivability of the firm is the strategies objective
	8	Risk management is the strategies objective
dimensions		Customer satisfaction
delivery	1	Customers are satisfied overall with the service you received
	2	Customers are satisfied with the speed in which the service was delivered
communications	3	Customers are satisfied with the ease of contacting the person they needed
	4	Customers are satisfied with the clarity of information
Quality of work	5	Customers are satisfied with the relevant knowledge of the staff they dealt directly with
	6	Customers are satisfied with the works undertaken
Solving the problems	7	Customers are satisfied with the way problems are resolved
imensions		Green product development
Product development	1	the Company uses substitute instead of polluting and destructive materials

dimension		Organizational innovation
packaging	2	Product development focuses on reducing resource consumption and waste production During production and distribution
	3	Product development focuses on reducing resource consumption or waste generation during the time consumer uses the product
	4	Product development focuses on production without the use of undesirable chemicals material
	5	Company to develop its products, as far as possible, benefits from the latest environmentally friendly methods
	6	Product packaging is done without the use of undesirable chemicals
	7	Product packaging is manufactured from recycled materials
	8	recyclability is mentioned in product packaging
	9	Company to package their products, as far as possible, benefits from the latest environmentally friendly methods
	dimensions	
1		our company has an environmental policy committing it to a program of environmental improvement
2		our company has undertaken a review of the environmental impact of its activities
3		Our company has an action plan in place to reduce our adverse environmental impacts
4		The Company consider environmental issues in its performance evaluation
5		The Company never been prosecuted for violating environmental laws
profitability	6	The company is committed to its environmental responsibility
		Financial performance
Market share	1	High corporate profitability rate
	2	The growth rate of corporate profits is acceptable
	3	High market share growth
	4	The company has competitive advantage relative to other competitors