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THE IMPACT OF DEMAND AND SUPPLIER ON WINE'S SUPPLY CHAIN PERFORMANCE

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ABSTRACT

The wine industry is one of the most important income sources in the autonomous community of La Rioja in Spain, and this report is aimed to identify and measure the effect of the latent variables such as *Demand*, *Suppliers*, *Quality and delivery time* on *Financial profits* for wineries. Latent variables were integrated by the observed variables, and a questionnaire was given to 64 wineries in La Rioja, Spain. A descriptive analysis appears for indicators and latent variables were related using structural equation modeling. The results indicate that there is not a direct effect between an efficient *Demand* forecasting and *Suppliers* on the *Financial profits* for wineries, but there are indirect effects through a *Quality and delivery time*, the most important variable being analyzed. Managers in wineries must focus their attention on *Quality and delivery time* to costumers, while having a direct relationship with suppliers.

PRACTICAL APPLICATIONS

Winery managers must make an effort to have a fast prediction of variants in the forecast and adjust the order to suppliers and production process so that the supply chain can be more agile and with quality and timely deliveries with the final result being the company's financial profit. An agile supply chain with quality products seems to be insignificant for managers in wineries.

INTRODUCTION

A supply chain (SC) is composed of several companies that are involved directly or indirectly with satisfying the customer's requests with a product or service. This definition includes not only the manufacturer of the finished products and the supplier components but also transporters, warehouses, retailers and even the customers themselves (Styles *et al*. 2012). For instance, for a wine company, the SC includes activities that are associated with a supplier's selection process, receiving raw materials in warehouses, the movement of parts within the production process, and distribution and delivery of wine to the final customers.

In an SC, there are flows of materials, information and financial resources (Sun and Wing 2005); however, a low level or suspension in material flow causes a number of problems along all subsequent activities (Lester 1998; Poolton and Barclay 1998); hence, synchronization and continuous flow are vital for companies.

In a consumable product, the SC is a complex network that integrates the same industrial SC components (global or transnational) with a well-defined production system, transportation and distribution, and even a waste recycling program (Hair *et al*. 1987; Giaquinta 2009). Particularly, the SC of fresh produce from agriculture is widely studied from a global point of view since their unavailability has serious consequences (Kock 2013). In the case of wine, it requires a continuous flow throughout the year; poor logistics applied to it surely demerits the quality (Liu *et al*. 2013). In other words, the freshness and safety of agricultural products are lost with time (Farrell 1957; Tastle and Wierman 2007).

These characteristics of perishable agricultural products cause major economic losses along food SC (Rouyendegh and Saputro 2014); therefore, they require special treatment in terms of:

- transportation, conducting periodic inspections on the way (Cho and Kim 2012) and effectively managing transport routes;
- storage technologies, where conditions of moisture, temperature and light are controlled for suitable storage (Meng *et al.* 2014).

The Role of Demand in SC

The SC begins with a forecast for demand by the manufacturer, who through market research aims to determine the levels of their product's consumption by the customer. The accuracy of these forecasts is vital since a failure can lead to the company buying the wrong materials, which means that the company must keep it in storage for long periods of time, with high maintenance costs and low inventory turnover (Zhao and Xie 2002).

Additionally, the demand for perishable products with a vegetable origin requires specific storage conditions; specifically, in the case of wine, it requires conditions of humidity, temperature and special light. This is due to the long time required for their manufacture and the storage process, which plays an important role in the final SC performance and quality obtained (Afonso *et al.* 2008).

Traditional techniques for demand forecasting can be qualitative or quantitative, the most traditional being the executive judgment, forecast surveys applied to customers, the Delphi method, sales force, analysis of time series and regression techniques – each one with their efficiency measurements and targeted to minimize the estimation error. However, recently new techniques have been used, such as machine learning (Haverila 2012) and vector regression methods (Afonso *et al.* 2008).

To reduce these errors in forecast estimations, the winemaker should focus on having good relationships with customers and potential demand should be communicated in advance, reducing uncertainty to a minimum. Some authors recommend that demand should be communicated in real time; nevertheless, that is possible only in highly automated production systems (Rbouh and Imrani 2014).

The Role of Suppliers in the SC

Once the producer has an estimation of demand, the second step in the SC is to identify suppliers. In the case of the SC of wine, grapes are usually intended for certain types of wine based on quality; however, there are many other components that are integrated into a simple bottle of wine, such as the glass bottle or container, seals, packages and labels, among others.

Some attributes that are often considered in a traditional supplier evaluation are related to quality and delivery time (Chai *et al.* 2013); although recently, environmental attributes are gaining importance (Meerschaert 2013) along the wine production process, where the most important considerations are the reverse logistics processes and the reutilization of glass or containers, and the energy consumed in the production of a single wine bottle (Yu *et al.* 2011).

In a supplier selection process, there are sometimes multiple vendors, and techniques must be used to simultaneously evaluate several attributes, among which the AHP (analytic hierarchy process) (Baker *et al.* 1994), TOPSIS (technique for order preference by similarity to an ideal solution) (Rouyendegh and Saputro 2014), goal programming (Kasirian and Yusuff 2012) and fuzzy logic combinations with other techniques (Arikan 2013) may be mentioned, among others.

Currently, there is some literature review reporting the state of the suppliers' selection process. For example, in Chai *et al.* (2013), a review of the most commonly used techniques appears, while Bonito (1990) makes a more specific review relating to multi-attribute techniques.

Measuring the Efficiency in SC

In order to remain competitive in these globalized days, companies need to improve their production processes at all times, thus requiring them to monitor their process and obtain as much information as possible in order to allow them –via appropriate analysis – to know where they are and consequently to obtain adequate metrics for better decision-making. The SC is not the exception, it needs to be extensively monitored to understand the situation in which it is located; hence, one of the most frequent activities in enterprises is to generate performance metrics and indices. The importance of assessing and measuring performance in SC is to establish a starting point in the reconfiguration of organizational and strategic goals; in addition, to differentiate its position from other competitors (Böhm *et al.* 2007).

A justification of these measures is that SC management has become an excellent source of competitive advantage for companies, with some authors arguing that, at present, companies are competing in their SC and not in their production processes; therefore, the financial objectives of the company must be linked to SC as well (Alomar and Pasek 2014).

Attributes Measured in SC Performance

A performance attribute is defined as a set of metrics that are used to express a competitive strategy, or it is the ability of the SC to deliver high-quality and timely products and services in precise quantities while minimizing costs (Böhm *et al.* 2007). Now, there are several types of metrics that can be generated in the SC, depending on the area where they are measured. For instance, in their work, Hassini *et al.* (2012) indicated that performance metrics should be generated in marketing, policies and regulations, technology for the movement of materials, product development, production process capability, procurement and operations, transportation and logistics, and environmental and social environment.

A simpler classification may be is to consider economic, environmental or social metrics (Zhu and Sarkis 2004; Searcy *et al.* 2007). The financial performance in the SC is the ultimate goal for a company and represents the most important metric. It refers to the economic output of a firm; information is often included in business models and indicates the achievement of economic goals (Chen and Paulraj 2004; Bozbura *et al.* 2007), e.g., sales growth, profitability and inventory turnover.

Nonfinancial performance metrics in the SC reflects operational efficiency in terms of flexibility, agility and customer service. Some authors inform us that in order to improve operational performance, it is necessary to focus on nonfinancial performance elements (Gunasekaran *et al.* 2004), and over time, high nonfinancial performance metrics will become financial benefits.

Every company should measure its SC for continuous improvement (Viswanadham and Samvedi 2013). Nonetheless, it should be mentioned that not all companies and sectors have the same metrics since their environments are different. For the wine industry, it is very peculiar as it is an agricultural product that requires special care in handling and transportation and must be studied since it is very important for the economy of La Rioja (Spain). The next paragraphs illustrate some details of that sector, which is the object of study in this research.

Rioja Wine in Numbers

One of the main products of agricultural origin in La Rioja is wine, and there is a Regulatory Council (RC) that administers the Denomination of Origin Rioja, which is a government agency responsible for controlling the quality of production and dissemination of relevant statistics related to wine production, among other activities. According to the 2013 annual report from RC, the surface of vineyard production (hectares) in their area was 62,153, and they are reporting sales of 277 million liters (355 million bottles), of which 250.7 million liters correspond to red wine. The sales are 63.1% in the domestic market and 36.9% engaged in export, with U.K., Germany, U.S.A. and Sweden consuming 70% of the total exports. Thus, the main market for La Rioja wine is the European Union and the U.S.A.

These wines produced in La Rioja are distributed mainly through two distribution channels, which are food and hospitality, the last one representing 77% of domestic sales of wines aged in oak barrels. Finally, it is important to indicate that in 2013, La Rioja region had a total of 225 wine growers, 37 wholesalers, 28 cooperatives and 134 growers, indicating the levels of importance of this industry for the economy in the Autonomous Community of La Rioja.

Research Problems and Objectives

In the previous paragraphs, the importance of precise demand forecasting and vendor relationships has been described because the SC performance metrics depend on them. In the specific case of wine's SC, although its production process is not very automated compared with other sectors, the SC is very important given the hygienic conditions required as it is a product for human consumption. Hence, the effects of an efficient demand forecast and supplier's relationships on the final product quality, delivery time and financial metrics should be studied further; besides, studies of this type in that sector are not known at present time.

Therefore, this paper is aimed to analyze the impact of wine's demand and its efficient forecast, as well as the relations with suppliers (independent latent variables) on the quality, delivery time and financial performance gained (dependent latent variables), which is done by a structural equation model since all variables studied are measured by several indicators.

Hypotheses

According to the problem described before, four latent variables are studied. The independent latent variables are *Suppliers* and *Demand*, which have an impact on two dependent latent variables: *Quality and delivery time* of products and finally in the *Financial profits* generated. These four variables are related among themselves, as illustrated in Fig. 1, in which each relationship between variables represents a hypothesis, a total of six. Those hypotheses are as follows:

H_1 In a winery, the proper *Demand* forecasting has a direct and positive effect on *Suppliers*' relationships for a continuous raw materials flow.

H_2 In a winery, the proper *Demand* forecasting has a direct and positive effect on *Quality and delivery time* for finished product.

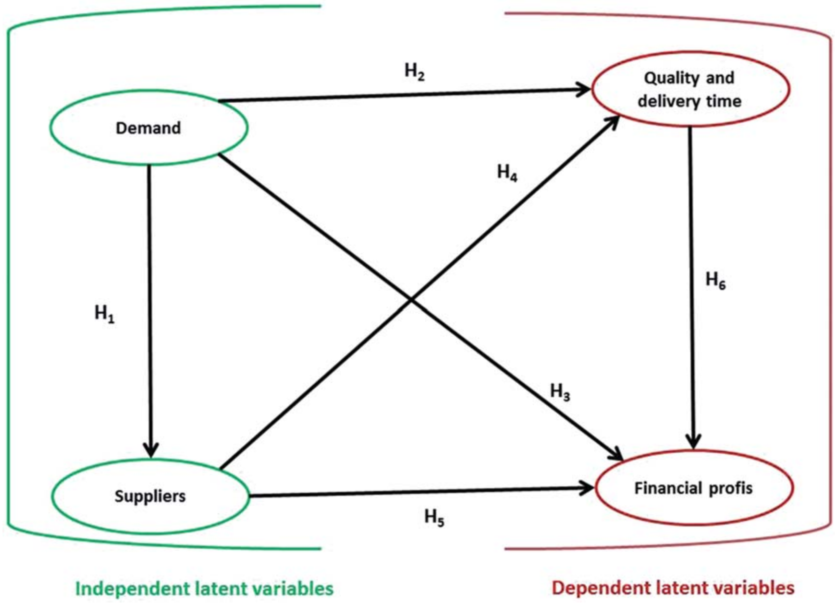

FIG. 1 PROPOSED MODEL

H₃ In a winery, the proper *Demand* forecasting has a direct and positive effect on the *Financial profits* obtained by the company.

H₄ In a winery, adequate relationships and communications with *Suppliers* has a direct and positive effect on *Quality and delivery time* for a finished product.

H₅ In a winery, adequate relationships and communications with *Suppliers* has a direct and positive effect on *Financial profits* for the company.

H₆ At a winery, the *Quality and delivery time* of the finished product has a direct and positive effect on *Financial profits* gained by the company.

MATERIAL AND METHODS

The methodology used in this work is divided into different stages, according to activities or tasks. These stages are explained in the next paragraphs.

Stage 1: Survey Development

This stage is focused on designing a questionnaire based on a literature review. The questionnaire contains three main sections: the first section contains the two independent latent variables that hereafter are called *Demand* and *Supplier*; the second section contains two dependent latent variables or benefits obtained, which in this case are the *Quality and delivery time* and *Financial profits*; and the third section contains some demographic questions. The integration for those latent variables is given in Table 1.

The final questionnaire is answered on a Likert-based scale on subjective assessments, with values between 1 and 5, where the lower value (1) indicates that the activity is never done or the benefit is never obtained, and the highest value (5) indicates that the activity is always executed or the benefit is always obtained.

Stage 2: Survey Application

For data collection, the sample is stratified and focused on wine industries that belong to La Rioja Origin Denomination, and for the survey application, three strategies were deployed. The first one consists of face-to-face interviews with industry managers that responded to our e-mails or calls and gave us an appointment for an interview. The second strategy was to e-mail the survey, with a first reminder after a week without a response and after three unsuccessful attempts, the case would be abandoned. The third strategy consists of sending a link to a specialized web page for surveys to every manager.

Stage 3: Capturing Information and Questionnaire Validation

At this stage, the information is captured and analyzed by using SPSS 21 software (SPSS, Inc., Mexico). Internal consistency of the questionnaire for each latent variable was done by using the Cronbach coefficient and composite reliability index, considering minimum cutoff values of 0.7 for both (Nunnally and Bernstein 1994). Additionally, some tests were performed to improve the quality of reliability in

TABLE 1. VARIABLES' DESCRIPTION

Latent variable	Item
Suppliers (Singh and Bhandarkar 1996; Garcia *et al.* 2012)	Providers always delivered me orders on time
	Suppliers always delivered me complete and accurate orders
	Supplier provide products according to quality standards
	There is communication with suppliers aimed to reduce failures
	There is coordination between supplier's production process and mine
	Suppliers are using information production systems as MRP, MRP II, SAP and RFID
Demand (Rosenthal and Rosnow 1991; Padukone and Subba 1993)	Demand is always informed by my customer in advance
	Demand is transmitted by my clients through information systems in real time
	Demand is "visible" in real time for my company, and for my suppliers
	Demand in finished product is very stable and does not affect production scheduling
Quality and delivery time (Priestman 1985; Singh and Bhandarkar 1996; Rexhausen *et al.* 2012)	We deliver our products using the just in time philosophy
	Our company always provides complete orders
	Quality in my finished product meets the customer specifications
	Product quality is satisfactory (no client complaints in the last 3 years)
Financial profits (Priestman 1985; Martínez-Jurado *et al.* 2014)	The marketing strategy in our company is focused on reducing total costs
	Our cash flow has improved over the last 3 years
	Our average sales growth has improved in the last 3 years

MRP, Material Requirement Planning; RFID, Radio Frequency IDentification; SAP, Systems, Applications and Products.

every latent variable in study, because when the elimination of some items is analyzed, the reliability often increases (Nunnally and Bernstein 1994).

This stage also includes a data screening process in order to detect missing values, which are replaced by their medians. However, it was always kept in mind that there should be a maximum of 10% missing values for every item. Moreover, the values in the database are analyzed for outliers or extreme values; in order to do this, a standardization process is executed for every item considering a standardized value as an outlier if their absolute value is bigger than 4 (Cenfetelli and Bassellier 2009).

The discriminant validity in latent variables was measured with the average variance extracted (AVE), and the minimum cutoff acceptable value for AVE is 0.5, while for the convergent validity assessment, the AVEs and correlations among latent variables were used (Kline 1998).

However, the structural equation model is based on regression analysis; thus, it is important to measure the collinearity among latent variables since if there exists a high collinearity among them, then the inverse matrix estimation is very difficult; and for measuring it, the full collinearity VIF (variance inflation factor) value was used, and the maximum cutoff value is 3.3 (Kline 1998; Kock 2013).

Furthermore, considering that the survey is answered in an ordinal scale using only assessments in a Likert scale and not measurements, then the Q-squared coefficient was used since it is a nonparametric measure traditionally calculated via blindfolding for predictive validity or relevance associated to each latent variable in the model. Acceptable predictive validity in connection with an endogenous latent variable was suggested by a Q-squared coefficient greater than zero (Kock 2013) and preferably must be similar to R-squared values.

Stage 4: Descriptive Analysis

Once the validation process has been done, a descriptive analysis was applied to every latent variable in study in order to identify the central tendency and deviation measurements in the data. As a central tendency measure, the median or 50th percentile is obtained, where high values indicate that the activity was always executed in a demand forecasting process, in relationships with suppliers or always obtained as benefits indicated as quality in product or financial profits; while low values indicate that those activities are not executed or the benefits are not obtained as a consequence. Also, as deviation measure, the interquartile range (IR) is obtained (difference between 75th percentile and 25th percentile). High values in IR indicate that there was no agreement among questionnaire participants, while low values represent little dispersion in those items (Tastle and Wierman 2007), and therefore, a greater consensus among respondents.

Stage 5: Structural Equation Model

In order to prove the hypotheses stated in Fig. 1, the model was evaluated using the structural equation modeling (SEM) technique due to its widely and recent use in causal relation validations and specifically in supply chains (Ketkar *et al.* 2012). The SEM model is executed using WarpPls 4.0 software because its main algorithms are based on partial

TABLE 2. JOB POSITIONS AND YEARS OF EXPERIENCE

Years of experience	Employees in the company <50	51–100	100–500	>500	Total
<2	5	0	1	0	6
2 May	9	0	0	0	9
5 Oct	14	2	0	1	17
>10	28	3	1	0	32
Total	56	5	2	1	64

least squared, widely recommended for low sample size (Alcaraz *et al.* 2014; Avelar-Sosa *et al.* 2014).

Four model fit indices are analyzed: average path coefficient (APC), average R-squared (ARS), average variance inflation factor (AVIF) and average full collinearity VIF (AFVIF), as proposed by Kock (2013). For the APC and ARS, the *P* values are analyzed for determining the model efficiency, establishing a maximum cutoff *P* value of 0.05, which means that the inferences are done with 95% of confidence level, testing the null hypotheses that $APC = 0$ and $ARS = 0$, versus the alternative hypotheses that $APC \neq 0$ and $ARS \neq 0$; for AVIF and AFVIF, values lower than 3.3 are desirable.

For measuring dependence among latent variables, three different effects are measured in the structural equation model that appears in Fig. 1: (a) direct effect (appearing in Fig. 1 as arrows from a latent variable to another), (b) indirect effect (given for paths with two or more segments), and (c) total effects (the sum of direct and indirect effects), and with the aim to determine their significance, the *P* values associated to those β-values are analyzed, considering the null hypothesis: $\beta_i = 0$, versus the alternative: hypothesis $\beta_i \neq 0$. The hypotheses for β-values are tested at 95% confidence level.

The effect size is reported for every dependent latent variable, which is defined as the percentage of variance that explains an independent latent variable in a dependent latent variable and it is very important when two or more variables have a direct effect on each other (Cohen 1988; Preacher and Hayes 2004; Hayes and Preacher 2010).

RESULTS AND DISCUSSION

Sample Description

After three months (May 2014–July 2014) of dispatching the survey to local winery warehouses belonging to La Rioja Origin Denomination, a total of 64 valid questionnaires were analyzed. Forty-six were completed by male and 18 by female.

Table 2 illustrates the years of experience for responders and the company size according to the number of employees. It is observed that 56 individuals were from small companies that have less than 50 employees, representing 87.5%. However, only five companies have between 51 and 100 employees, and when these two categories are joined, 95.3% are small companies. Note that only one company is reporting more than 500 employees.

Observe that 32 responders have more than 10 years of experience in their job, representing 50%, and 17 had between 5 and 10 years. Joining those two categories, we conclude that 76.56% of responders had a lot experience in their job, given the reliability of the survey.

Survey Validation

Before using the data collected for any analysis, it was necessary to apply a validation process. Table 3 illustrates some indices for latent variables after a validation. Note that for every latent variable, the initial number of items (II) appears, which refers to the amount of items without a validation process and represents the model proposed in Figs. 1 and 2. The final number of items refers to the amount of items after a validation process and represents the final model in Fig. 3.

Concerning the composite reliability coefficients for latent variables, every value was bigger than 0.7, which was the minimum acceptable cutoff value; the minimum value in this index corresponds to *Suppliers* and *Quality and delivery time* and the larger to *Financial profits*. The reliability of this survey was confirmed by the Cronbach's alpha

TABLE 3. VALIDATION PROCESS FOR SURVEY

Index	Supplier	Demand	Quality and delivery time	Financial profits
R-squared coefficients	0.159		0.404	0.446
Adjusted R-squared coefficients	0.146		0.384	0.437
Composite reliability coefficients	0.835	0.844	0.835	0.872
Cronbach's alpha coefficients	0.736	0.75	0.732	0.706
Average variances extracted	0.561	0.579	0.564	0.773
Full collinearity VIFs	1.31	1.467	2.258	1.789
Q-squared coefficients	0.174		0.418	0.448
Initial number of items	6	4	4	3
Final number of items	4	4	4	2

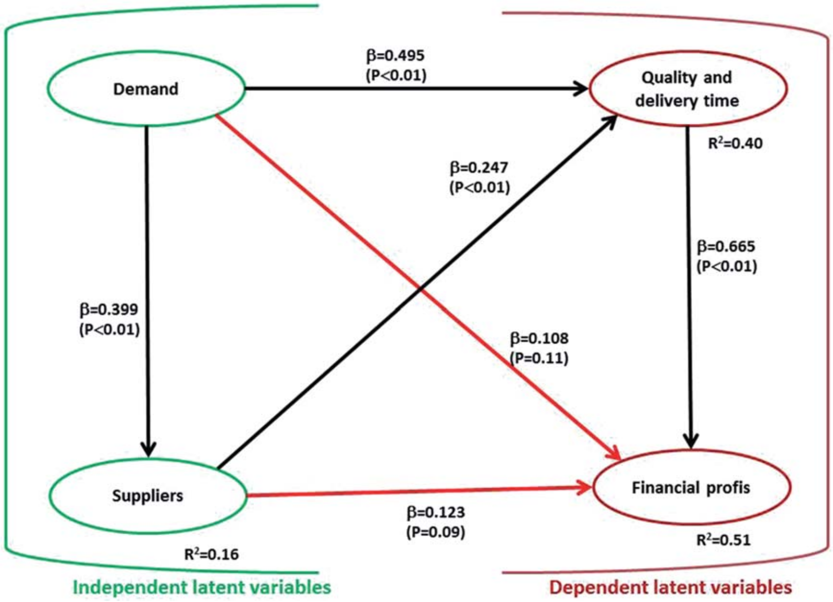

FIG. 2 INITIAL MODEL EVALUATION

coefficients since every value was also higher than 0.7; the minimum value in this index is *Financial profits* with 0.706 and the largest is *Demand* with 0.75, and this indicates that the questionnaire had good internal consistency. Regarding discriminant and convergent reliability, the average extracted variance possessed values greater than 0.5 for every latent variable, which was the minimum acceptable value; the minimum value in this index corresponds to *Supplier* with 0.561 and the largest to *Financial profits* with 0.773.

Also, in order to test the collinearity, the VIFs were lower than 3.3 in every latent variable; the minimum value corresponds to *Suppliers* with 1.31 and the maximum to *Quality and delivery time*, and this lets declare that there are no collinearity problems among latent variables. Likewise, note that in Table 3, the R-squared coefficients, adjusted R-squared coefficients (parametric tests) and Q-squared coefficients (nonparametric test) appear and all the values associated with latent variables have similar values; thus, we can state that the questionnaire had predictive validity.

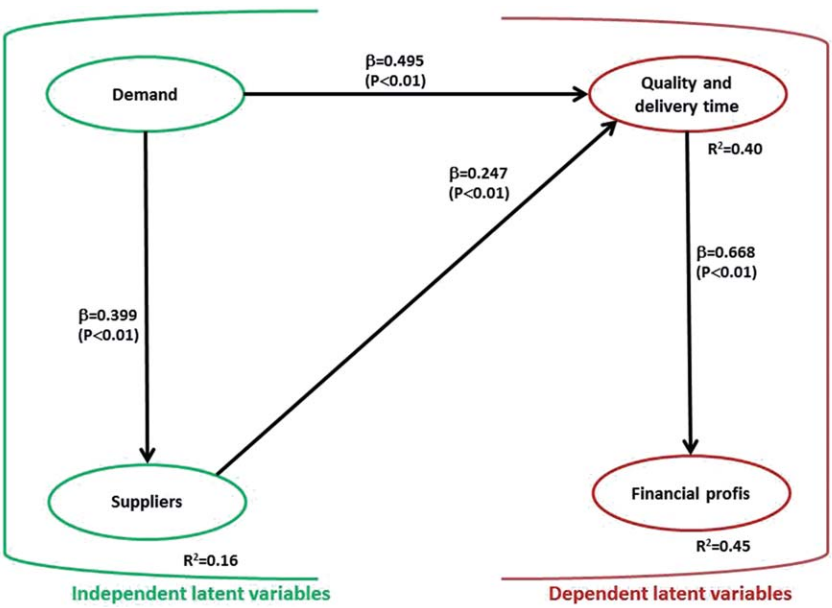

FIG. 3 FINAL MODEL EVALUATED

TABLE 4. CORRELATIONS AMONG LATENT VARIABLES FOR CONVERGENT VALIDITY

	Supplier	Demand	Quality and delivery time	Financial profits
Supplier	0.749	0.394*	0.427*	0.199†
Demand	0.394*	0.761	0.524*	0.394*
Quality and delivery time	0.427*	0.524*	0.751	0.653*
Financial profits	0.199†	0.394*	0.653*	0.879

Note: Square roots of average variances extracted shown on diagonal.
* Significant at 99.9%.
† Not significant at 95%.

Note that Table 4 illustrates the correlation among latent variables; this demonstrates that the questionnaire has discriminant and convergent validity because diagonal values representing square roots of AVEs are higher than any of the correlations involving the latent variable, checked by column and row. Also note that while one correlation value was very small and insignificant, the relation between *Suppliers* and *Financial profits* and this last relation is a surprise because that may mean that *Suppliers* do not directly contribute to better *Financial profits* for the company as was supposed in hypothesis H_5.

Descriptive Analysis

Table 5 illustrates a descriptive analysis for items in latent variables that passed a validation process and appears sorted in a descendent way, according to the median value. Items that do not appear in that table indicate that they are eliminated during the validation process.

For *Suppliers*, according to the information in Table 5, it is observed that the most important activity is *Supplier provides products according to quality standards* because it has the highest value in median, and the lowest value in median in this latent variable is *There is communication with suppliers aimed to reduce failures*. Here, it is important to observe that every item in this latent variable has values lower that four and the interquartile range is bigger than one.

Regarding the *Demand* from customers, the most important activity is *Demand is always informed by my customer in advance*, which indicates that communication and demand forecasting is a vital task. The last place in this latent variable is related to *Demand is "visible" in real time for my company, and for my suppliers* and that indicates that usually, production processes are not integrated between supplier, producers and customers. Note that in this latent variable, all items have values in median below four and the IRs are also bigger than one.

TABLE 5. DESCRIPTIVE ANALYSIS

	Percentiles			
Items	25	50 Median	75	IR
Suppliers				
Supplier provide products according to quality standards	3.15	3.83	4.56	1.41
Suppliers always delivered me complete and accurate orders	2.92	3.70	4.49	1.57
Providers always delivered me orders in time	2.86	3.63	4.38	1.52
There is communication with suppliers aimed to reduce failures	2.86	3.60	4.37	1.51
Demand				
Demand is always informed by my customer in advance	2.50	3.41	4.18	1.68
Demand is transmitted by my clients through information systems in real time	2.58	3.39	4.06	1.48
Demand in finished product is very stable and does not affect production scheduling	2.44	3.34	4.25	1.81
Demand is "visible" in real time for my company, and for my suppliers	2.24	3.07	3.81	1.58
Quality and delivery time				
Quality in my finished product meets the customer specifications	3.61	4.31	4.88	1.28
Our company always provides complete orders	3.33	4.16	4.80	1.47
Product quality is satisfactory (no client complaints in the last 3 years)	3.26	3.93	4.58	1.32
We delivery our products using the just in time philosophy	2.80	3.84	4.65	1.85
Financial profit				
Our cash flow has improved over the last 3 years	3.11	3.94	4.68	1.56
Our average sales growth has improved in the last 3 years	2.95	3.90	4.70	1.75

Regarding the latent variable *Quality and delivery time*, the most important activities are associated with the item *Quality in my finished product meets the customer specifications*, which indicates that companies believe that they are delivering quality products because it has the highest value in the median; here, it is important to note that two items in this latent variable have values above four. The lowest value in the median is associated to *We deliver our products using the just-in-time philosophy*. Also note that the lowest value in IR appears in the first item, indicating that it is really important.

Relative to the latent variable named *Financial profits*, the most important item is associated with *Our cash flow has improved over the last 3 years*, indicating that the economical revenue for companies is improving The lowest median value in this latent variable corresponds to *Our average sales growth has improved in the last 3 years*, but the difference between them is very low.

Structural Equation Model

This subsection is divided into others for a better understanding; however, some indices are given only for the final model.

Direct Effects in the Initial Model. The initial model that appears in Fig. 2 was executed using the software WarpPLS 4 according to the methodology previously described in the Materials and Methods section and every latent variable had integrated only the items that passed a validity test, because some were eliminated (see Table 3). The results obtained for this initial model appear in Fig. 3 and for every relation between latent variables that is indicated by an arrow; there is also a β value and the P value for their significance hypothesis test at a 95% confidence level. There are some black arrows that indicate that the relation between involved latent variables is statistically significant, but there are also red arrows indicating that the relations between involved latent variables are statistically nonsignificant (check the P values).

By interpreting the β values, we can conclude that when *Demand* increases its standard deviation by 1 unit, then *Suppliers*, *Financial profits*, and *Quality and delivery time* go up by 0.399, 0.108 and 0.495 unit, respectively. Note that according to the P value, the relation between *Demand* and *Financial profits* is bigger than 0.05, indicating that the relationship is statistically nonsignificant and appears in red, while other relationships are statistically significant and appear in black.

Analyzing the relations between *Suppliers* and other latent variables, one red line is observed, representing a nonsignificant relation with *Financial profits* because the P values are bigger than 0.05 (the maximum cutoff admissible) and that means that good relations and material procurement from suppliers do not guarantee economic revenue for the company. Remember that the correlation between these two latent variables was very low and appears as nonsignificant in Table 4 and this finding demonstrates that there is not a direct relationship. Nonetheless, suppliers have a relation that is statistically significant with *Quality and delivery time* because the P values are lower than 0.05, and that means that when *Suppliers* increases its standard deviation by 1 unit, then *Quality and delivery time* goes up by 0.247, indicating that suppliers have an important role in final product quality because they provide the raw material for wine industry, and in this case, the traditional phrase "garbage in, garbage out" can be applied. In addition to quality in components delivered by suppliers, if those orders are on time, then companies can have their own deliveries on time to customers, thus avoiding the bullwhip effect.

The last statistically significant relationship is between *Quality and delivery time* and *Financial profits*, because when the first latent variable increases in its standard deviation, then the second goes up by 0.665 and that means the company depends a lot on the quality and compromises with timely deliveries to customers.

Also note that in Fig. 2, for every dependent latent variable, a value for R^2 appears, indicating the amount of variance explained by independent latent variables. For example, *Demand* explains 16% to *Suppliers* because $R^2 = 0.16$, but *Demand* and *Suppliers* are explaining 40% to *Quality and delivery time* because $R = 0.40$. The other dependent latent variable is *Financial profits* that is explained by 51% by *Demand*, *Suppliers* and *Quality and delivery time* because $R^2 = 0.51$.

Final Model Evaluation

In an iterative process, the relations among latent variables with high P values (larger than 0.05) were eliminated one by one because they were statistically nonsignificant, first eliminating those with bigger P values. The new generated model and its parameters appear in Fig. 3 with all the parameters having been statistically significant and appearing in black with P values low than 0.05.

The general model fit indices for that final model are: APC = 0.340 with $P < 0.001$, ARS = 0.359 with $P < 0.001$, average adjusted R-squared (AARS) = 0.340 with $P < 0.001$, AVIF = 1.323 and AFVIF = 1.706, which are acceptable values because they ideally must be less than 3.3.

Direct Effects in the Final Model. Direct effects have a similar interpretation as those in the initial model appearing in Fig. 2. Besides, it is important to note that there was

TABLE 6. TOTAL EFFECTS AND EFFECT SIZE

	From		
To	Suppliers	Demand	Quality and delivery time
Suppliers		0.40 ES = 0.159	
Quality and delivery time	0.247* ES = 0.110	0.594* ES = 0.353	
Financial profits	0.165* ES = 0.033	0.396* ES = 0.156	0.668* ES = 0.45

* Mean that the values are statistically significant.
ES, Effect Size.

only one change in the final model that appears in Fig. 3. That change appears in the R^2, explained by *Quality and delivery time* in *Financial profits* which in Fig. 2 was 0.51 and in Fig. 3 was 0.45, and that is because two trivial or nonsignificant relations were eliminated (from *Supplier* and *Demand*).

According to Fig. 3, only *Quality and delivery time* is explained by two independent latent variables, *Demand* and *Suppliers*, as 40% because $R^2 = 0.40$; but here it is important to express that value. According to the effect size for those variables, 11% come from *Suppliers* and 29% from *Demand*, given a total of 40, which indicates that companies must have the abilities for forecasting the *Demand* of having raw materials with quality and timely deliveries since these variables have more influence in variance explanation.

Sum of Indirect Effects in the Final Model. Two or more segments give the indirect effects among latent variables; thus, the same independent latent variable may have several indirect effects on other dependent latent variables across different segments.

For the final model, there are three indirect effects in the model and they are all statistically significant according to their associated *P* values. The first indirect effect is between *Supplier* and *Financial profits*, because when the first latent variable increases its standard deviation, then the second one goes up by 0.165 unit and it is expressed by *Quality and delivery time*; this indicates that companies need to have reliable suppliers for procurement of raw materials, but they need to convert those raw materials into quality product, which is delivered on time because the companies can never obtain economical revenue if they keep the raw materials stored in warehouses without putting them in the production process. *Demand* needs to be forecasted properly, but there must also exist an efficient raw material supply that needs to be converted into a final product with high-quality standards with timely delivery. Remember that the direct effect between those variables was insignificant in the initial model in Fig. 2 and does not appear in Fig. 3.

The second indirect effect is between *Demand* and *Quality and delivery time*, which has a low value but still is statistically significant and is shown by *Suppliers*, because when the first latent variable increases its standard deviation by 1 unit, then the second one goes up by 0.099 unit. Again, this indirect effect indicates that companies do not only need to have a proper *Demand* forecast for having *Quality and delivery time*, but companies need to also have an effective raw material supply through *Suppliers*.

The last indirect effect is between *Demand* and *Financial profits*, expressed by *Suppliers* and *Quality and delivery time*, and that means that the company may have an efficient forecasting process but if the production process does not give a quality and timely delivered product, then there is no chance to get *Financial profits*. Note that this last indirect effect has the biggest value, because when the first latent variable increases in its standard deviation, then the second goes up by 0.396, and this indirect effect is the largest in the final model.

Total Effects in the Final Model. Direct effects and the sum of indirect effects give the total effects among latent variables, and Table 6 illustrates those total effects, their *P* values and the effect size. The total effect is sometimes similar to the direct effect if there is not any indirect effect; moreover, the total effect is sometimes similar to the indirect effect if there is no direct effect.

According to the information in Table 6, all five relationships are statistically significant at 99%, including those that were not significant when direct effect is measured alone. Note that *Demand* has total effects on all other latent variables because it is the first latent variable in the model, and *Financial profits* has total effects on all other latent variables because it is positioned as the last latent variable in the proposed and final model.

By interpreting the information in Table 6, it can be indicated that *Demand* has a total effect on *Suppliers*, *Quality and delivery time* and *Financial profits*, because when independent latent variable increases its standard deviation by 1 unit, then the first dependent latent variable goes up by 0.396 unit, the second one goes up by 0.594 unit and the third one goes up by 0.40. This indicates that proper demand forecast is essential for the company and has direct or indirect effect along the supply chain.

TABLE 7. HYPOTHESIS TEST

Hypothesis	*P* value	Conclusion
H_1 In a winery, the proper *Demand* forecasting has a direct and positive effect on *Suppliers'* relationships for a continuous raw materials flow.	$P < 0.01$	Accept
H_2 In a winery, the proper *Demand* forecasting has a direct and positive effect on *Quality and delivery time* for finished product.	$P < 0.01$	Accept
H_3 In a winery, the proper *Demand* forecasting has a direct and positive effect on the *Financial profits* obtained by the company.	$P = 0.11$	Reject
H_4 In a winery, adequate relationships and communications with *Suppliers* has a direct and positive effect on *Quality and delivery time* for a finished product.	$P < 0.01$	Accept
H_5 In a winery, adequate relationships and communications with *Suppliers* has a direct and positive effect on *Financial profits* for the company.	$P = 0.09$	Reject
H_6 At a winery, the *Quality and delivery time* of the finished product has a direct and positive effect on *Financial profits* gained by the company.	$P < 0.01$	Accept

Nonetheless, an efficient *Demand* forecast cannot guarantee *Financial profits*, remember that the direct effect was statistically insignificant. The next step after the *Demand* forecasts is that *Suppliers* begin their role in the SC and they have total effects in subsequent latent variables. For example, when *Supplier* increases its standard deviation by 1 unit, then *Quality and delivery time* and *Financial profits* go up by 0.247 and 0.165, respectively.

Finally, once *Demand* has been predicted and correct supply orders are given to *Suppliers*, then the raw material enters into a production process to generate the appropriate product with high quality and makes timely deliveries to customers because only by selling final or finished products can the company obtain economic revenue. This indicates that it is not enough to make a proper forecast of *Demand* and make the appropriate orders to *Suppliers*, but an efficient quality process is also required in order to generate economic profit, because when *Quality and delivery time* increases its standard deviation by 1 unit, then the *Financial profits* go up by 0.668.

CONCLUSIONS

Conclusions are given concerning two main features: the conclusion related to the six initial hypotheses given before and the industrial implications for the winery industry in La Rioja, Spain.

Conclusions Related to the Proposed Hypotheses

H_1 There is enough statistical evidence to validate that proper *Demand* forecasting has a direct and positive effect on *Suppliers* because when the first latent variable increases its standard deviation, the second one goes up by 0.399 unit.

H_2 There is enough statistical evidence to validate that proper *Demand* forecasting has a direct and positive effect on *Quality and delivery time* because when the first latent variable increases its standard deviation, the second one goes up by 0.495 unit. Additionally, there is an indirect effect of 0.099 (see Table 6), given a total effect of 0.594 (see Table 7).

H_3 There is not enough statistical evidence to validate that proper *Demand* forecasting has a direct and positive effect on *Financial profits* gained by companies because the *P* value for the parameter's hypothesis test is bigger than 0.05, which is the maximum admissible value. However, there is an indirect effect between these variables with a value of 0.396 (see Tables 6 and 7).

H_4 There is enough statistical evidence to validate that proper *Supplier's* relationship has a direct and positive effect on *Quality and delivery time* because when the first latent variable increases its standard deviation, the second one goes up by 0.247 unit (see Table 6).

H_5 There is not enough statistical evidence to validate that proper *Suppliers'* relationships have a direct and positive effect on *Financial profits* gained by companies because the *P* value for the parameter's hypothesis test is bigger than 0.05, which is the maximum admissible value. However, there is an indirect effect between these variables, because when the first one increases its standard deviation by 1 unit, the second one goes up by 0.165 (see Tables 6 and 7).

H_6 There is enough statistical evidence to validate that proper *Quality and delivery time* obtained in a wine production process has a direct and positive effect on *Financial profits* because when the first latent variable increases its standard deviation in 1 unit, the second one goes up by 0.668 unit (see Table 7 and Fig. 3).

For a better understanding of the hypothesis, a summary is given in Table 7.

Industrial Implications Related to Findings

In the model initially proposed in Fig. 1, it is assumed that the SC for wineries in La Rioja in Spain begins with a proper demand forecasting, and then the producer, based on the information obtained, proceeds to generate purchase order for raw materials from different component suppliers, which are introduced into a production process to generate quality and to make timely deliveries of finished products in order to obtain the maximum economic benefits possible. Six working hypotheses were proposed, which can conclude the following:

(1) The proper *Demand* forecasting is vital in wineries, as it is the beginning of the wine's SC. The manager will try to minimize uncertainty in demand forecast.

(2) An error in the *Demand* estimation process results in an inadequate purchase order request for raw materials since there is a direct relationship between *Demand* and *Suppliers* (see H_1). Buying unsuitable raw materials means that companies invest money that will not enter into a production process, which will generate a slow inventory turnover and low return on investment as they remain stored in warehouses with subsequent administrative and storage costs (see H_3). However, if that inappropriate raw material enters into the production process, then the expected quality of finished products may be different than originally designed (see H_2), and a final product will be in storage awaiting a new customer.

(3) A significant direct effect between *Demand* forecasting and *Financial profits* obtained by the company was expected (see H_3), but this hypothesis was rejected; however, there are indirect effects with the *Suppliers* and the *Quality and delivery time*, which means that the proper demand estimation is not enough if companies do not purchase the proper raw materials and give an adequate production process.

(4) Producers must have agreements with *Suppliers* for *Quality and delivery time* in requested raw materials (see H_4), as they are always looking to integrate those *Suppliers* into their production processes as partners in the SC.

(5) According to hypothesis H_5, there is a direct relationship between *Suppliers* and *Financial profits* obtained by the company, but that relationship is not statistically significant, so it has been rejected. Nonetheless, there is an indirect effect between these two variables, expressed by the *Quality and delivery time*, which means that companies really need to deliver quality products on time to earn some *Financial profit*, and it is not enough to make the appropriate purchase orders if raw materials are not processed properly. Remember that quality is obtained in a production process.

(6) Producing a quality product that is delivered on time to the customer is the only existing way for wineries for gain some *Financial profits* (H_6), as the impacts of demand and suppliers were not statistically significant according to H_3 and H_5. Note that the amount of variance explained in *Financial profits* was 51% in the initial model evaluated in Fig. 2, which was explained by *Demand*, *Suppliers* and *Quality and delivery time*. However, by eliminating the non-significant relationships, it has only been explained by *Quality and delivery time* and this variable is explaining 45% in *Financial profits* (Fig. 3). This means that the other two deleted relationships (*Suppliers* and *Quality and delivery time*) explained only 6% of the variance and that is why those relationships were insignificant.

Future Research

Since the wine industry is a mainstay for the economy in La Rioja in Spain, we have only reported the impact of demand and the suppliers in financial profits in this paper. In order to continue this research, future research will focus on two main objectives: (1) The first objective is aimed toward the analysis of variables associated with the production process, which are highly standardized and targeted at the customer and their effect on SC performance; and (2) the second objective seeks to measure the impact of human resources on the SC performance, which would let suggestions be made on improvements in educational programs.

However, the authors have successfully applied the methodology of structural equations in the maquiladora industry in Mexico for causal models in lean manufacturing tools, and then that methodology could be applied to the local industry of Spain.

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