International Journal of Physical Distribution & Logistics Management

A Triple-A supply chain measurement model: validation and analysis

Juan A. Marin-Garcia, Rafaela Alfalla-Luque, Jose A.D. Machuca,

Received 21 June 2018
Accepted 25 June 2018

A Triple-A supply chain measurement model: validation and analysis

Juan A. Marin-Garcia
ROGLE-DOE, Universitat Politecnica de Valencia, Valencia, Spain
Rafaela Alfalla-Luque
Department of Financial Economics and Operations Management, University of Seville, Seville, Spain, and
Jose A.D. Machuca
Department of Financial Economics and Operations Management, University of Seville, Seville, Spain and UNIA, Seville, Spain

Abstract

Purpose – The purpose of this paper is to establish definitions and dimensions of Triple-A supply chain (SC) variables based on a literature review and to validate a Triple-A SC measurement model using a worldwide multiple informant sample.

Design/methodology/approach – Following a literature review, Triple-A SC variables (agility, alignment and adaptability) are conceptualized and a list of possible items is created for their measurement. An international 309 plant sample is used to validate the convergent and criterion validities of the composites proposed to measure Triple-A SC.

Findings – Contributions to the literature: clarification of Triple-A SC variable concepts; identification of key dimensions of Triple-A SC variables; development of a validated Triple-A SC measurement scale for future empirical research and industrial applications.

Research limitations/implications – A rigorously validated instrument is needed to measure Triple-A SC variables and enable researchers to credibly test theories regarding causal links between capabilities, practices and performance.

Practical implications – Proposal of a scale for use by managers of different functions to analyze Triple-A SC deployment in the company.

Originality/value – The only Triple-A SC scale used in the previous literature has serious limitations: scales were not taken from an extended literature review; data were collected from single respondents in a single country. This is the first validated Triple-A SC measurement model to overcome these limitations.

Keywords Competitive advantage, Agility, Adaptability, Supply chain, Alignment, Triple-A

Paper type Research paper

1. Introduction

In a globalized environment characterized by constant changes, intense competition, unprecedented levels of outsourcing and a growing need for customized products and services, companies are finding it increasingly difficult to improve performance and gain competitive advantages (Alfalla-Luque and Medina-Lopez, 2009; Christopher and Holweg, 2011). Global supply chains are more complex than ever before. In this context and based on his own experience in a number of companies, Lee (2004) stated that a supply chain (SC) needs three attributes to ensure a sustainable competitive advantage: agility, adaptability and alignment (the Triple-A SC): an agile SC "responds to short-term changes in demand or

This study has been conducted within the frameworks of the following projects: 'Acción especial SGUIT-2015 (SBAPA2015-06) HPM-(Project 2015/148 U.S.)-Junta de Andalucía (Spain); PAIDI Excellence Project P08-SEJ-0384-Junta de Andalucía (Spain); and DPI2009-11148- Spanish National Program of Industrial Design and Production.

International Journal of Physical Distribution & Logistics Management
Vol. 48 No. 10, 2018
pp. 976-994

0960-0035
DOI 10.1108/IJPDLM-06-2018-0233

supply quickly; handles external disruptions smoothly"; an adaptable SC "adjusts the SC's design to meet structural shifts in markets; modifies supply network to strategies, products, and technologies"; an aligned SC "aligns the interests of all the firms in the SC with their own." In a theoretical paper mentioning Lee's (2004) work, Ketchen and Hult (2007) state that the effectiveness of strategic SC management is closely linked to these three variables and that best SC's are distinguished from traditional SC's by their approach to agility, adaptability and alignment and their ability to pursue competitive priorities.

The search for a sustainable competitive advantage is essential for a company's survival and for maintaining and improving its long-term competitive position. Thus, confirming whether the Triple-A SC contributes toward this can have major managerial implications. However, as Lee (2004) did not develop or validate any scales for the Triple-A SC variables, empirical tests are needed to establish a set of scales to confirm or reject the theoretical hypothesis that underlies Lee's (2004) statement.

In the literature, definitions and measures of the Triple-A SC variables are scarce and diverse. Few empirical studies exist that separately validate each of these variables (e.g. Li *et al.*, 2009; Eckstein *et al.*, 2015; Skipworth *et al.*, 2015). To our knowledge, only Whitten *et al.* (2012) develops a Triple-A SC scale (construct), later used by Attia (2015). In both papers, Triple-A SC is a second-order construct that includes three first-order scales: agility, alignment and adaptability. The first-order scales' values are used as indicators to calculate an additive scale for Triple-A SC. These scales are developed based only on factors that Lee (2004) indicated as features of each variable. However, Whitten *et al.* (2012) call for additional investigations to overcome some of the limitations of their research: scales not taken from the literature; data collected from single respondents. Furthermore, the paper is focused on the USA alone, limiting any generalization of the results, and it gives no information about the full Triple-A SC scale validation process.

Consequently, little research has been developed on this topic (Alfalla-Luque *et al.*, 2018), and there is a lack of clear definitions and understanding of the Triple-A SC variable concepts and dimensions (Arana-Solares *et al.*, 2011). Therefore, a rigorously validated instrument to measure Triple-A SC variables is needed for researchers to credibly test theories about any causal links between capabilities, practices and performance. Measurement model specification is also essential for research to be replicated and compared.

The present study has two objectives: to establish definitions and dimensions of Triple-A SC variables, and to validate a Triple-A SC measurement model to overcome the above study's limitations. For this we use: items taken from the literature (based on a wide-ranging in-depth literature review); a worldwide multiple informant sample; assessment of scale content validity and criterion validity. This research contributes to the Triple-A SC literature by: clarifying Triple-A SC variable concepts, identifying key dimensions of Triple-A SC variables; developing a valid scale for measuring Triple-A SC for future empirical research.

The paper is organized as follows. Section 2 is a review of prior studies on the topic. Section 3 describes the methodology employed to achieve the objectives of the present study. Section 4 presents the results. Section 5 discusses the contribution of this research and makes suggestions for further research. Annexes cited in the text have been put in additional material downloadable from (https://figshare.com/s/0806a901a9029bb9bf3d).

2. Literature review

Several definitions and measures of agility, adaptability and alignment have been proposed in the manufacturing domain over the years. Later, the organizational and SC focus developed new approaches and each Triple-A variable was defined and measured taking into account the SC as a whole. So, these variables are now multidisciplinary and research exists that focuses on manufacturing, firm and strategic orientations; however, minimal research has been conducted in the SC domain (especially on SC adaptability and alignment) or used the same scales for different regions, countries and industries.

Our systematic literature review followed the following steps (Tranfield *et al.*, 2003; Medina-Lopez *et al.*, 2010; Durach *et al.*, 2017): identification of the field of study (research question) and period for analysis; selection of information sources; search; management and filtering of search results; analysis and reporting of the results. The field of study was defined according to the research objective. The analyzed period covered papers published up to 2016. Two main relevant academic databases, WoS and Scopus, were selected. Keywords used in combination with "supply chain" were: "agility"; "adaptability"; "align"; and "Triple-A." The snowball technique was applied to include as much of the relevant literature as possible. Content analysis was performed on the selected papers based on the objectives of this research.

The following subsections analyze Triple-A SC variable constructs and dimensions included in scales in the previous literature.

SC agility construct

According to Lee (2004), an agile SC reacts quickly to rapid or unexpected shifts in demand or supply. The agile SC is market sensitive, which implies the capability of interpreting and responding to real demand (Mason *et al.*, 2002). There is much ambiguity and confusion around both the definition of agility and its dimensions (Arana-Solares *et al.*, 2011; Gligor and Holcomb, 2012). SC agility has been analyzed as a broad, multidimensional concept bridging many disciplines (Li *et al.*, 2009) but the theoretical basis for understanding SC agility remains fragmented (Li *et al.*, 2008). Originally focused on the production domain, agility was oriented toward achieving reduced setup times and greater responsiveness to changes in product mix and volume (Scholten *et al.*, 2010). Later, agility was extended to the wider business and SC contexts. As their divergent views demonstrate, scholars in diverse disciplines emphasize distinct facets of agility (Li *et al.*, 2009). According to Lee (2004), three elements of SC agility can be highlighted: an environment that is volatile and unpredictable in the short term; changes in both demand and supply; and a fast response time. These elements are not unanimously included in any other authors' definitions, but the majority highlight speed as an important characteristic of agility in the SC, and most also agree that it responds to unexpected changes in the market (Christopher, 2000; Van Hoek *et al.*, 2001; Lee, 2004; Swafford *et al.*, 2006; Li *et al.*, 2008). Very few studies provide formal definitions of SC agility (e.g. Swafford *et al.*, 2006; Ismail and Sharifi, 2006; Li *et al.*, 2008; Arana-Solares *et al.*, 2011). A detailed analysis of agility from different scopes can be found in Agarwal *et al.* (2007), Li *et al.* (2008), Li *et al.* (2009), Arana-Solares *et al.* (2011), Gligor and Holcomb (2012) and Yusuf *et al.* (2014). So, SC agility can be defined as the ability to rapidly detect and respond to short-term changes in real demand and supply in order to generate or maintain a competitive advantage (Arana-Solares *et al.*, 2011).

The unidimensionality vs multidimensionality debate around SC agility has led to much confusion and ambiguity and it is uncommon for any two articles to adopt the same definition and construct (Gligor *et al.*, 2013). A number of studies highlight the urgent need to develop a set of measurements to explore the key drivers of SC agility (Agarwal *et al.*, 2007; Wu *et al.*, 2017). Our literature analysis reveals that some very diverse constructs, dimensions and items are used to measure SC agility. Some studies use unidimensional SC agility constructs (see Annex 1 in additional material). When built as a multidimensional construct, SC agility has between two (DeGroote and Marx, 2013) and six dimensions (Sangari and Razmi, 2015; Van Hoek, 2001), so the range of scales is very wide. Annex 1 summarizes the SC agility dimensions established in the main previous literature.

Therefore, some extremely heterogeneous focuses underpin SC agility research, which has been approached using different concepts, dimensions and measures. Of the numerous SC agility dimensions, those that measure the capacity to rapidly detect short-term changes in the market and rapidly respond to short-term changes in demand and supply stand out.

As Christopher (2000) states, the agile SC should respond rapidly to changes, both in terms of volume and variety. Considering the previous literature, the present study establishes the following dimensions of SC agility:

- Short-term market sensitivity: ability to rapidly detect short-term changes in real demand and supply.
- Volume flexibility: ability to adapt product volumes to rapidly respond to short-term changes in demand and supply.
- Variety flexibility: ability to adapt product range to rapidly respond to short-term changes in demand and supply.

SC adaptability construct

In a turbulent and complex market environment, adaptability is one of the key prerequisites for good business performance and a source of sustainable competitive advantages (Tuominen *et al.*, 2004). Adaptability refers to a willingness to reconfigure the SC when necessary, dispensing with legacy issues and the way that the SC previously operated (Lee, 2004). An adaptable SC depends on information systems to recognize market changes, and then reacts appropriately by, for example, moving to different facilities, using different suppliers or outsourcing (Ketchen and Hult, 2007); the more complex the environment that a company can deal with, the more adaptable it is, and the greater the possibility that it can survive over time (Tuominen *et al.*, 2004).

Some research exists that focuses on adaptability in the strategic and organizational domain (e.g. Katayama and Bennett, 1999; Tan and Tiong, 2005; Tuominen *et al.*, 2004) but very little research has been developed in the SC context (e.g. Schoenherr and Swink, 2015; Eckstein *et al.*, 2015). Several definitions of adaptability in different domains are given in Arana-Solares *et al.* (2011). Based on the previous literature, SC adaptability can be defined as the SC's ability to adapt its strategies, products and/or technologies to structural market changes (Arana-Solares *et al.*, 2011).

Empirical SC adaptability research is scarce. In some studies the SC adaptability construct is built as a unidimensional scale and very little research develops and validates a multidimensional construct (see Annex 2 in additional material).

Based on previous studies, the present research considers three main dimensions of the SC adaptability construct:

(1) SC organizational design: ability to change SC processes and structures in line with market changes.

(2) Use of technology: ability to introduce new technologies in processes, products and information systems based on the detection of technological cycles.

(3) Medium- and long-term market knowledge: ability to detect trends and possible medium- and long-term changes in the market in which the SC is operating (e.g. changes in customer tastes and needs; in the economy; in new competences; in regulations; in the product life-cycle; in the technological cycle; etc.).

SC alignment construct

SC alignment is an important, emerging issue (Wong *et al.*, 2012) but the current literature on this topic is both fragmented and largely theoretical (Skipworth *et al.*, 2015). The origin of this concept can be found in organizational and strategic alignment. Firms cannot be competitive if their business and information technology strategies are not aligned.

Alignment refers to ensuring that all SC participants' interests are mutually coherent (Lee, 2004). SC alignment implies strategic coordination and collaboration between SC members to manage intra- and inter-firm relationships and is related to the way that SC operations and activities should be managed to meet the demands of product/market speed and complexity through the synchronization and coordination of operations (Kehoe *et al.*, 2007). Incentives must therefore be organized so that all partners' interests are aligned. Considering the previous literature, SC alignment can be defined as the ability to share information, responsibilities and roles and incentives with SC members to synchronize and coordinate processes and activities (Arana-Solares *et al.*, 2011).

SC alignment is the way in which operations and activities along the SC should be managed to meet demands of product/market speed and complexity through the synchronization and coordination of operations (Kehoe *et al.*, 2007). It is produced when information, responsibilities and roles, and incentives are shared among SC members to synchronize and coordinate processes and activities (Arana-Solares *et al.*, 2011). Some previous research analyzes different independent dimensions of SC alignment, whereas in other papers SC alignment is built as either a unidimensional or a multidimensional scale (see Annex 3 in additional material). Multidimensional scales are developed through three basic dimensions (Arana-Solares *et al.*, 2011; Simatupang and Sridharan, 2005; Piplani and Fu, 2005), which the present study conceptualizes as follows:

- Incentive alignment: ability to clearly define each member's roles, tasks and responsibilities in chain processes to prevent any conflicts wherever possible.
- Information alignment: ability to coordinate each partner's interests with the SC's overall interests by defining relationships or agreements in which risks, costs and benefits are shared equitably.
- Process alignment: ability to share and exchange knowledge and important and correct information for the planning, controlling and decision-making that affect the whole chain.

Triple-A SC construct

Arana-Solares *et al.* (2011) propose dimensions and factors that characterize the Triple-A SC variables from a theoretical perspective. Very few papers focus on this topic empirically. Some analyze the three Triple-A SC variables in the same framework (Annex 4 in additional material) as individual independent unidimensional variables (Dong and Dong, 2013; Dubey *et al.*, 2015; Dubey and Gunasekaran, 2016) but do not validate the scales for the Triple-A SC variables.

Only Whitten *et al.* (2012) and later Attia (2015), building on the former, develop a Triple-A SC multidimensional construct based on common factors. Whitten *et al.* (2012) develop an empirical study based on a survey of 132 APICS members and propose a Triple-A measurement model with 12 items (initially 14, but 2 indicators omitted during the sample data optimization process). These 12 items are used to calculate first-order constructs of agility, adaptability and alignment. After their calculation, these constructs' values are used as indicators to calculate an additive Triple-A SC construct. All the model's goodness of fit indicators are above the cut-off values for a good fit. The paper does not present data for the full scale validation process as its objective is to prove the Triple-A SC-performance relationships. Broadening the scales' content validity is still pending, as are assessing whether the additive model adequately represents the Triple-A SC concept proposed by Lee (2004), and confirming discriminant validity, criterion validity, responsiveness and interpretability. In this respect, Whitten *et al.* (2012) indicate that their data collection from single respondents is a major limitation and call for additional studies with new samples and the adoption of SC agility, adaptability, and alignment scales taken from the literature, as Lee's (2004) methods are the sole basis for the scales that they use to secure Triple-A SC variables.

In his later work, Attia (2015) adopts the Whitten *et al.* (2012) Triple-A SC scales and analyzes data from 153 companies in the Egyptian textile industry to examine the effect of Triple-A SC-marketing strategy alignment on performance. In the sample, the internal consistency indices for the SC agility, alignment and adaptability scales are broadly acceptable; the SC agility, alignment and adaptability scales' internal consistency values and extracted variances are good, but the SEM model fit indices are only generally broadly acceptable. However, the author does not report any correlation between the Triple-A SC constructs. It is worth noting that the SC agility construct in this study has six indicators instead of the four used by Whitten *et al.* (2012) (the other two discarded during the sample data optimization process).

Consequently, a validated Triple-A SC measurement model that overcomes the aforementioned limitations is needed to advance research in this field.

3. Methodology

The sample

Our empirical analysis uses the current fourth round database of the international High Performance Manufacturing Project (from 2016 database), obtained from 309 manufacturing plants (with over 100 employees) in three industries (automotive components (78), electronics (115) and machinery (116)) in 8 developed countries on 3 continents (Austria (8), Finland (17), Germany (28), Italy (29), Japan (22), Spain (25), Sweden (9), UK (13)) and six emerging (Brazil (21), China (30), Israel (26), Korea (26), Taiwan (30), Vietnam (25)). The unit of observation is the manufacturing plant. Plants in any given country belong to different parent corporations.

The survey

The items and scales used as measurement instruments in the HPM international survey were initially developed from an extensive review of the manufacturing practices literature. Each questionnaire in this research is tailored to the expertise of the focal informant following the key informant method (Bagozzi *et al.*, 1991). The various measurement scales and questions are listed in 12 questionnaires directed at different management positions in the plant. They are all answered by two different managers on each functional level except for the Plant Manager questionnaire, delivering a total of 23 surveys per plant. Responses for dependent and independent variables are given by different people. Many of the measurement scales are included in at least two different questionnaires to enable information triangulation and minimize variability caused by differences between individuals, thus guaranteeing greater instrument reliability. This gives a cross-section of the plants and thus prevents individual bias (Van Bruggen *et al.*, 2002; Sakakibara *et al.*, 1997) whilst simultaneously improving validity. The scale items and questions are in different orders in the questionnaires to prevent any respondent bias; items were therefore not grouped by scale in the questionnaires but randomly listed to prevent item proximity triggering any response patterns.

Operationalization

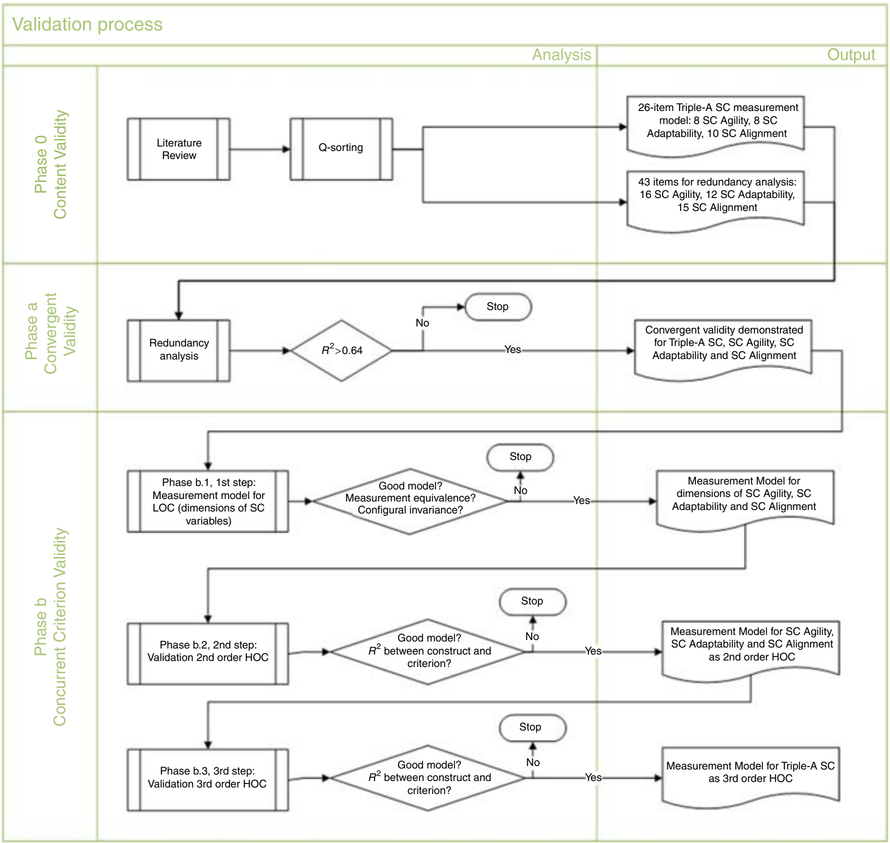
Triple-A SC variable items were measured on a 1–7 Likert scale requesting informants' perceptions (1 = strongly disagree, 4 = neither agree nor disagree, 7 = strongly agree). For each item, plant-level data were calculated as an average value of all the valid responses at the plant.

The proposed measurement model includes both first-order and higher-order composite constructs (Hair *et al.*, 2016). Based on the literature, several dimensions are also taken into consideration for each Triple-A SC variable, preventing too many items being loaded onto any single factor; the maximum weight may be influenced by the number of construct items and, therefore, affect the likelihood of their proving significant (Hair *et al.*, 2016). The SC agility, adaptability and alignment constructs are operationalized as a composite (aggregate multidimensional construct) with each based on three dimensions that are the first-order composites calculated from the measures taken from the questionnaires. Composites based on several items developed to adapt to the construct's theoretical aspects (Sarstedt *et al.*, 2016) enable the synthesization and measurement of complex concepts. The dimensions included in the questionnaire (and their corresponding items) are chosen to complement each other. In questionnaire design, each of these items represents a different aspect of the composite with which it is associated, meaning that none can be considered to be either redundant or replaceable by any other (Hair *et al.*, 2016). The Triple-A SC is modeled as a three-order composite (aggregate multidimensional construct).

Validation process

The validation process consisted of three phases: Content validity (Phase 0); convergent validity (Phase a); and concurrent criterion validity (Phase b). Proposed guidelines for composite measurement models were followed (see Figure 1).

Phase 0: content validity. To guarantee content validity, 69 possible Triple-A SC items were taken from a literature review. Items were subsequently classified using the Q-sorting technique (Hardin *et al.*, 2012); e.g., initially two authors separately assigned each of the 69 items to one of the three categories (SC adaptability, SC agility and SC alignment). The third author was withheld as an arbiter to settle any disagreements. Results were compared and



Notes: LOC, lower order constructs; HOC, higher order constructs

Figure 1.
Phases of the validation process

an agreed classification was proposed. No item required a decision by the external referee. The two authors then separately removed redundant items from the list in each category before coming to a joint agreement on the results, which were submitted to the third author for validation. The first outcome was the final 26 items in the measurement model (eight agility, eight adaptability, ten alignment), chosen as the most representative different and non-interchangeable indicators (Henseler *et al.,* 2016; Rigdon, 2012) to represent SC agility, alignment and adaptability dimensions in the sample (see Annex 5 in additional material). An alternative measure was needed for the Triple-A SC constructs in the Phase a measurement model validation process (see following section: convergent validity). As no Triple-A SC construct exists that can be considered "Gold Standard" and no agreed single item in the literature that can be used to measure the Triple-A SC or its components, a list of alternative items was drawn up and used to generate a second group of items for use in the redundancy analysis (see Annex 6 in additional material). These constructs were used to represent each of the "A's" as a single dimension (SC-Ag-RdOD, 16 items; SC-Ad-RdOD, 12 items; SC-Al-RdOD, 15 items).

Phase a: convergent validity was assessed with redundancy analysis (Hair *et al.*, 2016). R^2 was checked between the construct and its redundancy to ensure a value of 0.64 (equivalent to a path of 0.8). These analyses were conducted on both the Triple-A SC as a single construct, and the Triple-A SC variable (SC agility, adaptability and alignment) levels.

Phase b: concurrent criterion validity.

After guaranteeing convergent validity, the second phase was to verify that the Triple-A SC measurement model was a good predictor of outcome criteria; e.g. this construct's measure should be correlated with other constructs that the literature has related to the Triple-A SC or its dimensions (concurrent criterion validity) (Jarde *et al.*, 2012). The criterion variables used (see Annex 7 in additional material) were:

- Collaboration, which is related to Triple-A SC in general (Kim *et al.*, 2013) and to SC agility (Wu *et al.*, 2017; Dubey and Gunasekaran, 2016) and alignment (Gligor and Holcomb, 2014; Agarwal *et al.*, 2007), especially. Measured by two items designed by the authors.
- Reconfigurability: "the ability of manufacturing systems to respond quickly to market changes (both expected and unexpected) through efficient, effective, fast configurations optimally fit for various purposes" (Ortega-Jimenez *et al.*, 2015). Reconfigurability is linked to SC agility, adaptability and alignment (Kabra and Ramesh, 2016; Wei and Wang, 2010). Measured by five items in this paper (Bi *et al.*, 2008; Molina *et al.*, 2005).
- Customer support and service has been related to the Triple-A SC and its dimensions by various authors (Wu *et al.*, 2017; Gligor *et al.*, 2015; Blome *et al.*, 2013; DeGroote and Marx, 2013; Kabra and Ramesh, 2016; Tan *et al.*, 2010). Here measured as a single item.

Validation consisted of several steps.

Phase b.1: The first step was to test the measurement model for collinearity issues, and then for the significance and relevance of the first step composite indicators (dimensions of SC agility, adaptability and alignment as lower-order constructs, LOC). Discriminant validity was also tested at LOC level. Correlations between composite LOC and the rest of constructs should be lower than 0.7 (Urbach and Ahlemann, 2010). Also, measurement equivalence was assessed between developed countries ($N1 = 151$) and emerging countries ($N2 = 158$) to ensure that the measurement model worked well in different contexts. This analysis was also by industry pairs comparison (automotive ($N3 = 78$); electronics ($N4 = 115$); machinery ($N5 = 116$)). For this we guaranteed configurational invariance (e.g. that each pair of samples used the same indicators). To verify compositional invariance, model fit needed to be adequate in each sample with no significant differences between and weights/loadings (tested by Henseler's MGA above 0.05 and below 0.95) (Henseler *et al.,* 2016; Rasoolimanesh *et al.*, 2016).

Phase b.2: The second step involved analysis of estimated correlations between the Triple-A SC constructs (SC agility, adaptability and alignment as higher-order constructs (HOC)) and the criterion variables, the level of R^2 adjusted and the size of the f^2 effect (< 0.02, no effect; 0.02–0.15, small; 0.15–0.35, medium; > 0.35, large) (see Hair *et al.*, 2016). To test discriminant validity, another check was made to determine whether correlations between composite HOC were below 0.7 (Urbach and Ahlemann, 2010).

Phase b.3: The same statistics were observed in the third step as in the second step with Triple-A SC as an HOC.

Method of analysis

Partial least squares (PLS-SEM) (with SmartPLS3 software (Ringle *et al.*, 2015)) were used for the analysis. PLS-SEM can be considered a more appropriate method than CB-SEM methods (LISREL, AMOS, EQS) when the model contains composite constructs, as in the present research. Recent research has shown that PLS results are less biased in this situation than when LISREL methods are used (see: Henseler *et al.,* 2016; Rigdon, 2012; Hair *et al.*, 2016). The parameters used to perform the analysis were as follows (Hair *et al.*, 2016):

- PLS algorithm, path weighting scheme, 300 iterations, stop criterion 10^{-7}, pairwise deletion missing data;
- Bootstrap, 5,000 subsamples, no sign changes, bias corrected and accelerated (BCa), one tailed, 5 percent; and
- 1000 permutations, two-tailed, 5 percent

All the composites were estimated as Mode A ("correlation weights"), as this provides more stable parameter estimations for composites for different samples and is more appropriate when: samples are medium-sized; when R^2 values for the outcome variables are expected to be moderate or low; and when the appearance of unexpected values (unexpected sign or insignificant) is sought due to suppression involving other predictors (Henseler *et al.,* 2016; Rigdon, 2012). The two-step method was used for HOC operationalization, with the first step being estimation of first-order construct Latent Variable Scores (LVS) and the second step using standardized LVS as indicators for the HOC (Hair *et al.*, 2016). Goodness of fit measures were also reported when appropriate (Hair *et al.*, 2016; Henseler *et al.,* 2016; Henseler *et al.,* 2016).

4. Results

Our literature review (phase 0) enabled to identify Triple-A SC dimensions and items, as summarized in Annex 5 in additional material.

First, the descriptive statistics were analyzed. The range of response values covered the full range of the scale and most of the indicators. Asymmetry and kurtosis were generally moderate or low. Approximately 26 percent of the indicators had absolute kurtosis values above 1. All indicators showed negative skewness and only 13 percent presented values below −1. In general, data showed a slight departure from normality, but PLS is sufficiently robust to this.

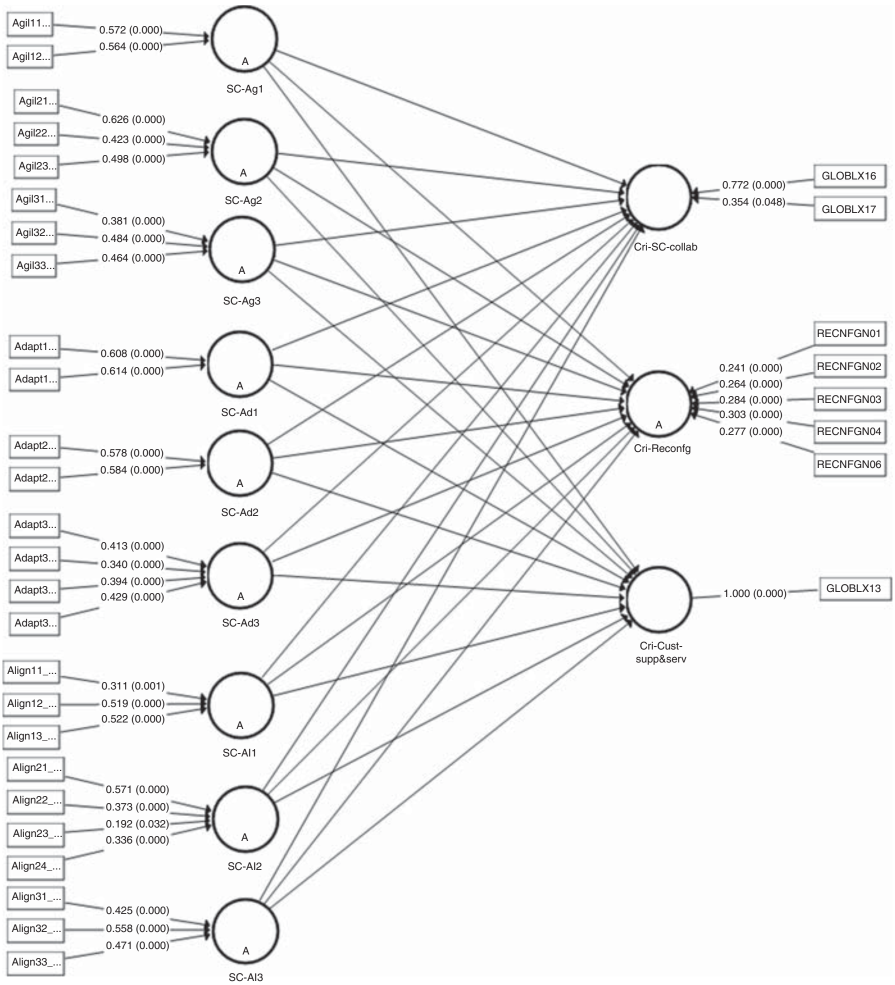
Phase a: convergent validity

The items included in the Triple-A SC measurement model explained an adequate amount of redundant construct variance (Annex 8 in additional material). The redundant construct R^2 confidence interval [0.765; 0.831] substantially exceeded the convergent validity cut-off point (0.64). The figure in Annex 9 (additional material) presents the model with a composite representing Triple-A SC as a single dimension (SC-TripleA-OD): path coefficient is 0.9 with the redundant composite (SC-TripleA-RdOD).

The analysis was repeated for each of the Triple-A SC variables as unidimensional constructs (Annex 8 in additional material). The R^2 confidence interval had a value of 0.64 in SC adaptability and alignment, which could be considered the limit for a sufficient degree of convergent validity. Although the value of the R^2 confidence level for SC agility did not reach 0.64, it was very close. The proposed scale can therefore be considered to have successfully come through this first phase of the analysis.

Phase b: Concurrent criterion validity

Phase b.1: the following stage was to test the measurement model. The first step for this was a proposed model with a composite for each of the Triple-A SC variables: SC agility, adaptability and alignment (Figure 2). The nomological network was included to construct the



Notes: Measurement model weights and (*p*-value)

Figure 2.
Step1-Criterion assessment 1st step

specified model with the criterion validity composites. In the first step, the focus was on ensuring that no collinearity issues existed and assessing indicator significance and relevance.

The collinearity values of the outer model indicators and between the composites were low, with all VIF values below the 3.3 cut-off value (maximum VIF = 1.87). No great correlation was considered to exist between the dimensions that form each of the SC agility, adaptability and alignment composites or the criterion variables. Each presented low or moderate significant correlation with the other dimensions (Annex 10 in additional material). This was fully in line with the proposed composite measurement model and no collinearity issue prevented estimating this model with PLS. Moreover, discriminant validity was confirmed as no correlations above 0.7 were found.

All item weights were significant, including the Triple-A SC composites and criterion variables (Annex 11 in additional material). Furthermore, all indicator weights were fairly similar, indicating that (except for align23) none of the items dominated or was under-represented in composite LVS estimation. In addition, all the loadings (except in the case of align23) were above 0.5 and significant.

Lastly (Annexes 11 and 12 in additional material), the Henseler MGA values for all the weights of the Triple-A SC variable dimension indicators were within the limits that ensured that differences in weights were not significant (above 0.05 and below 0.95) between developed and emerging countries or the three industries (automotive, electronics and machinery). The results therefore confirmed the relevance of practically all the items in the measurement model. The proposed composites therefore presented satisfactory quality levels.

Completing the satisfactory evaluation of the measurement model, the goodness of fit statistics (Annex 13 in additional material) of the complete sample presented excellent values. SRMR was well below the 0.08 cut-off value and bootstrap test results were all satisfactory (SRMR, d_ULS and d_G values below HI95 percent). The developed and emerging country subsamples also presented adequate goodness of fit values when analyzed separately.

Phase b.2 and Phase b.3: In the second step (phase b.2), the LVSs of the Triple-A SC variable dimensions were used as indicators of the SC agility, adaptability and alignment composites. These are related to the criterion variable composites in the structural model (Annex 14 in additional material). The third step (phase b.3) was to estimate Triple-A SC LVS from SC agility, adaptability and alignment LVSs in step 2 (Annex 15 in additional material).

The three Triple-A SC variables were linked to the criterion variables (Table I). SC agility only had a significant relationship with reconfigurability. The SC adaptability

	Paths	CI BCa 5.0%	CI BCa 95.0%	f^2	CI BCa 5.0%	CI BCa 95.0%
SC-Ag-LVS → Cri-Cust-supp&serv-LVS	0.109	−0.015	0.228	0.009	0.000	0.040
SC-Ag-LVS → Cri-Reconfg-LVS	0.157	0.050	0.263	0.024	0.003	0.069
SC-Ag-LVS → Cri-SC-collab-LVS	0.084	−0.022	0.180	0.005	0.000	0.029
SC-Ad-LVS → Cri-Cust-supp&serv-LVS	0.124	0.018	0.238	0.011	0.000	0.040
SC-Ad-LVS → Cri-Reconfg-LVS	0.523	0.419	0.620	0.268	0.155	0.422
SC-Ad-LVS → Cri-SC-collab-LVS	0.159	0.058	0.267	0.020	0.002	0.055
SC-Al-LVS → Cri-Cust-supp&serv-LVS	0.148	0.044	0.250	0.021	0.002	0.062
SC-Al-LVS → Cri-Reconfg-LVS	0.003	−0.089	0.097	0.000	0.000	0.015
SC-Al-LVS → Cri-SC-collab-LVS	0.233	0.136	0.321	0.055	0.020	0.114
Triple-A-SC-LVS → Cri-Cust-supp&serv-LVS (#)	0.306	0.217	0.388	0.125	0.116	0.116
Triple-A-SC-LVS → Cri-Reconfg-LVS (#)	0.576	0.503	0.637	0.542	0.418	0.576
Triple-A-SC-LVS → Cri-SC-collab-LVS (#)	0.378	0.300	0.450	0.204	0.193	0.193

Note: (#) Third step results

Table I.
Step 2 – path coefficients and f^2 values for criterion validity

paths with the three criterion variables were significant with the strongest relationship with reconfigurability. SC alignment had a significant link with customer support and service and with SC collaboration especially, but there was no link with reconfigurability. The f^2 statistic was used to assess the contribution of the exogenous composites to explaining the endogenous latent variable R^2 value (Table I). SC adaptability's contribution to reconfigurability was observed to be moderate, while SC adaptability and alignment to SC collaboration, SC agility to reconfigurability and SC alignment to customer support and services were relevant but low. Considering the correlations between those constructs (Table II), the lack of significance of the paths from SC agility to customer support and service and SC collaboration on the one hand, and alignment paths with reconfigurability on the other, may have been due to suppression effects between the correlated variables (Ato and Vallejo, 2011). Repeating the analysis with each of the Triple-A SC variables separately confirmed the significant paths of all three with the three criterion variables. These results were confirmed by the analysis of the overall Triple-A SC effect commented below.

The last three rows in Table I enabled an analysis of the overall Triple-A SC effect on the criterion variables: All the paths were significant; Triple-A SC contribution to explanatory power (f^2) was high for reconfigurability and moderate for customer support and service and SC collaboration.

In other respects, adjusted R^2 was significant for all three endogenous composites (Annex 14 and 15 in additional material) with moderate values for reconfigurability and low for SC collaboration and customer support and services. All correlations were positive and significant with a level below 1 percent (Annex 16 in additional material). None of the correlations were above 0.7, so discriminant validity could be assumed in the second step. As the prior literature states the existence of a significant positive link, these results confirmed the three Triple-A SC variables' criterion validity as composites.

Additionally, the goodness of fit statistics estimated for the model in step 3 were adequate. The SRMR (0.117), d_ULS (0.289) and d_G (0.099) values were below HI95 percent Bootstrap values (0.184, 0.708, 8.815, respectively).

5. Discussion and conclusions

Triple-A SC is a relatively new area of research and the Triple-A SC scale is a complex and not very well-defined construct. Prior to Lee (2004), all research considered Triple-A SC variables separately and their definitions and measures vary greatly in the previous literature. Subsequently, very little empirical research has been developed on the topic and there are no clear definitions or understanding of the Triple-A SC variables concept (Arana-Solares *et al.*, 2011). Therefore, more empirical research is needed to progress in this field, with a clear definition and appropriate measures based on the previous literature. This study proposes a multidimensional Triple-A SC scale for future research. It identifies the

Table II. Step 2 – correlations between Triple-A SC variables and criterion variables

	Cri-Cust-supp&serv-LVS	Cri-Reconfg-LVS	Cri-SC-collab-LVS	SC-Ad-LVS	SC-Ag-LVS
Cri-Reconfg-LVS	0.186	–			
Cri-SC-collab-LVS	0.594	0.229	–		
SC-Ag-LVS	0.273	0.481	0.312	–	
SC-Ad-LVS	0.280	0.623	0.343	0.616	–
SC-Al-LVS	0.278	0.328	0.373	0.475	0.477
Triple-A-SC-LVS (#)	0.334	0.593	0.412	–	–

Notes: $n = 309$. (#) Step 3 – correlations. All correlations significant at 1 percent main dimensions of the Triple-A SC variables and can serve as the first step on a path of proactive management. It is not easy to find validated measurement models in prior SC agility, adaptability or alignment research as it usually focuses on testing structural models. It is even more difficult to find studies that validate measurement models or replicate them in different samples, as most authors construct their own questionnaires that are not reused in other research. Also, most studies give little or no information about the validation of their measurement models.

Thus a rigorously validated instrument was needed to measure the Triple-A SC variables to enable researchers to credibly test explanatory theories on relationships among competitive advantages, capabilities and practices. This study bridges the gap by developing and validating a framework for measuring the Triple-A SC. This framework validates a hierarchy of constructs, ranked from the LOC representing the dimensions of each of the second-order constructs (SC agility, adaptability and alignment) up to and including the validation of the third-order HOC (Triple-A SC). It also contributes to theory building by addressing the ambiguity surrounding Triple-A SC variable dimensions and definitions. Therefore, it is important to stress that this research has developed and validated a Triple-A SC measurement model that overcomes the limitations of previous works by Whitten *et al.* (2012) and Attia (2015): This article's distinguishing features are: scales obtained from the literature; data collected from multiple respondents; multiple country and industry sample; lastly and most importantly, full information given about the Triple-A SC scale validation process.

This study confirms multidimensionality of all the Triple-A SC variables. The dimensions detected in the previous literature for SC agility, adaptability and alignment have been analyzed separately. Analysis shows that all of the Triple-A SC variables' dimensions are relevant and significant. However, "variety flexibility" and, to a certain extent, "volume flexibility," are clearly much more important for SC agility than "market sensitivity in the short term," suggesting an area for future research to analyze the origins or implications of what has been detected with the present sample.

Our results confirm the presence of the three Triple-A SC variables (SC agility, adaptability and alignment) and that they are all similarly strong in the Triple-A SC construct (the weights of the three Triple-A SC variables are all significant and similar in size). This implies that there is no one predominant variable that masks the others, as they all make a relevant contribution to the Triple-A SC construct (third order). The proposed model confirms that the measurement model reproduces the relationships determined in theory, thus confirming its validity. Consequently, this research can be stated to have developed a third-order construct for the Triple-A SC that can be used in different samples in related research studies. The findings provide guidance for empirical research with parsimonious data.

The proposed scales have also been confirmed to behave in a reasonably stable way in two different subsamples (developed and emerging countries), with all but one of the nine of the Triple-A SC variable scales presenting partial measurement invariance. These results could be tested in future research by analyzing invariance in other contexts.

The implications of this paper are useful for researchers and practitioners. For researchers, the empirically validated measurement instrument is useful for studies of this topic. New constructs like these can be expected to evolve with future research efforts, allowing researchers to develop our understanding of the under-researched Triple-A SC – competitive advantages relationship. This validation lays solid foundations for further research on the topic and, therefore, for obtaining new empirical evidence that impacts practice. The study also provides managers/consultants with a tool to assess the state of the Triple-A SC in organizations. Furthermore, these constructs offer firms a way to analyze their position in relation to all the Triple-A variable dimensions and to take appropriate corrective actions to reduce or eliminate any problems that are detected. All the SC agility, adaptability and alignment dimensions have been found to be relevant and significant. Consequently, SC managers should first achieve market sensitivity in the short term, as well as volume and variety flexibility, to develop an agile SC. Second, to be adaptable, they should change SC processes and structure in line with market changes, introduce new technologies and detect market trends and any possible medium- and long-term changes. Third, incentive, information and process alignment are required between SC members to achieve SC alignment. If only one of the three Triple-A SC dimensions is achieved, whichever it is, there is no guarantee that any of the possible benefits that derive from a simultaneously agile, adaptable and aligned SC can be gained. The proposed model enables managers to identify critical dimensions, measure their Triple-A SC level and suggest improvement practices.

This study is not without its limitations. It should be replicated with new samples to establish proof of statistical generalizability, which suggests a path for further research. Also, although the composites in the present research are validated in relation to several outcomes, future studies need to examine this instrument's validity in an extended nomological model that includes antecedents and additional outcomes.

Future research on validation can also develop single items for the Triple-A SC variable dimensions so as to replicate this research and confirm the convergent validity of the measurement model tested here. The validated model will also enable further research to test the Triple-A SC – competitive advantage relationship, thus confirming or rejecting Lee's (2004) statement. Lastly, a battery of Importance-Performance Matrix Analyses (IPMA) could be conducted in the future to give practitioners practical suggestions as to which programs to implement in their firms to improve their organizations' results.

References

Agarwal, A., Shankar, R. and Tiwari, M.K. (2007), "Modeling agility of supply chain", *Industrial Marketing Management*, Vol. 36 No. 4, pp. 443-457.

Alfalla-Luque, R. and Medina-Lopez, C. (2009), "Supply chain management: unheard of in the 1970s, core to today's company", *Business History*, Vol. 51 No. 2, pp. 202-221, available at: https://doi.org/10.1080/00076790902726558

Alfalla-Luque, R., Machuca, J.A. and Marin-Garcia, J.A. (2018), "Triple-A and competitive advantage in supply chains: empirical research in developed countries", *International Journal of Production Economics*, Vol. 203, pp. 48-61.

Arana-Solares, I., Machuca, J.A.D. and Alfalla-Luque, R. (2011), "Proposed framework for research in the triple A (agility, adaptability, alignment in supply chains", in Flynn, B., Morita, M. and Machuca, J.A.D. (Eds), *Managing Global Supply Chain Relationships: Operations, Strategies and Practices,* IGI Global, Hershey, PA, pp. 306-321, doi: 10.4018/978-1-61692-862-9.ch013.

Ato, M. and Vallejo, G. (2011), "Los efectos de terceras variables en la investigación psicológica", *Anales de Psicología*, Vol. 27 No. 2, pp. 550-561, available at: http://digitum.um.es/jspui/handle/10201/26561

Attia, A. (2015), "Testing the effect of marketing strategy alignment and Triple-A supply chain on performance in Egypt", *EuroMed Journal of Business*, Vol. 10 No. 2, pp. 163-180, available at: http://doi.org/10.1108/EMJB-07-2014-0020

Bagozzi, R.P., Yi, Y.J. and Phillips, L.W. (1991), "Assessing construct-validity in organizational research", *Administrative Science Quarterly*, Vol. 36 No. 3, pp. 421-458.

Bi, Z.M., Lang, S.Y.T., Shen, W. and Wang, L. (2008), "Reconfigurable manufacturing systems: the state of the art", *International Journal of Production Research*, Vol. 46 No. 4, pp. 967-992, available at: http://doi.org/10.1080/00207540600905646

Blome, C., Schoenherr, T. and Rexhausen, D. (2013), "Antecedents and enablers of supply chain agility and its effect on performance: a dynamic capabilities perspective", *International Journal of Production Research*, Vol. 5 No. 4, pp. 1295-1318, available at: http://doi.org/10.1080/00207543.2012.728011

Christopher, M. (2000), "The agile supply chain: competing in volatile markets", *Industrial Marketing Management*, Vol. 29 No. 1, pp. 37-44, available at: http://doi.org/DOI:10.1016/S0019-8501(99)00110-8

Christopher, M. and Holweg, M. (2011), "Supply chain 2.0: managing supply chains in the era of turbulence", *International Journal of Physical Distribution and Logistics Management*, Vol. 41 No. 1, pp. 63-82.

DeGroote, S.E. and Marx, T.G. (2013), "The impact of IT on supply chain agility and firm performance: an empirical investigation", *International Journal of Information Management*, Vol. 33 No. 6, pp. 909-916, available at: http://doi.org/10.1016/j.ijinfomgt.2013.09.001

Dong, H. and Dong, S. (2013), "Study and application of supplier performance evaluation system based on the triple-a supply chain", *Applied Mechanics and Materials*, Vols 397-400, pp. 2636-2640, available at: http://doi.org/10.4028/www.scientific.net/AMM.397-400.2636

Dubey, R. and Gunasekaran, A. (2016), "The sustainable humanitarian supply chain design: agility, adaptability and alignment", *International Journal of Logistics Research and Applications*, Vol. 19 No. 1, pp. 62-82.

Dubey, R., Singh, T. and Gupta, O.K. (2015), "Impact of agility, adaptability and alignment on humanitarian logistics performance: mediating effect of leadership", *Global Business Review*, Vol. 16 No. 5, pp. 812-831, doi: 10.1177/0972150915591463.

Durach, C.F., Kembro, J. and Wieland, A. (2017), "A new paradigm for systematic literature reviews in supply chain management", *Journal of Supply Chain Management*, Vol. 53 No. 4, pp. 67-85, doi: 10.1111/jscm.12145.

Eckstein, D., Goellner, M., Blome, C. and Henke, M. (2015), "The performance impact of supply chain agility and supply chain adaptability: the moderating effect of product complexity", *International Journal of Production Research*, Vol. 53 Nos 9-10, pp. 3028-3046.

Gligor, D.M. and Holcomb, M.C. (2012), "Understanding the role of logistics capabilities in achieving supply chain agility: a systematic literature review", *Supply Chain Management-An International Journal*, Vol. 17 No. 4, pp. 438-453, available at: http://doi.org/10.1108/13598541211246594

Gligor, D.M. and Holcomb, M. (2014), "The road to supply chain agility: an RBV perspective on the role of logistics capabilities", *International Journal of Logistics Management*, Vol. 25 No. 1, pp. 160-179, available at: http://doi.org/10.1108/IJLM-07-2012-0062

Gligor, D.M., Esmark, C.L. and Holcomb, M.C. (2015), "Performance outcomes of supply chain agility: when should you be agile?", *Journal of Operations Management*, Vols 33-34, pp. 71-82, available at: http://doi.org/10.1016/j.jom.2014.10.008

Gligor, D.M., Holcomb, M.C. and Stank, T.P. (2013), "A multidisciplinary approach to supply chain agility: conceptualization and scale development", *Journal of Business Logistics*, Vol. 34 No. 2, pp. 94-108, available at: http://doi.org/10.1111/jbl.12012

Hair, J.F., Hult, G.T., Ringle, C.M. and Sarstedt, M. (2016), *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, 2nd ed., Sage, Thousand Oaks, CA.

Hardin, A.M., Chang, J.C.J. and Fuller, M.A. (2012), "Formative vs. reflective measurement: comment on Marakas, Johnson, and Clay (2007)", *Journal of the Association for Information Systems*, Vol. 9 No. 9, pp. 519-534.

Henseler, J., Hubona, G. and Ray, P.A. (2016), "Using PLS path modeling in new technology research: updated guidelines", *Industrial Management and Data Systems*, Vol. 116 No. 1, pp. 2-20, available at: http://doi.org/10.1108/IMDS-09-2015-0382

Henseler, J., Ringle, C.M. and Sarstedt, M. (2016), "Testing measurement invariance of composites using partial least squares", *International Marketing Review*, Vol. 33 No. 3, pp. 405-431, available at: https://doi.org/10.1108/IMR-09-2014-0304

Ismail, H.S. and Sharifi, H. (2006), "A balanced approach to building agile supply chains", *International Journal of Physical Distribution and Logistics Management*, Vol. 36 No. 6, pp. 431-444, doi: 10.1108/09600030610677384.

Jarde, A., Losilla, J.M. and Vives, J. (2012), "Methodological quality assessment tools of non-experimental studies: a systematic review", *Anales de Psicología*, Vol. 28 No. 2, pp. 617-628.

Kabra, G. and Ramesh, A. (2016), "Information technology, mutual trust, flexibility, agility, adaptability: understanding their linkages and impact on humanitarian supply chain management performance", *Risk, Hazards & Crisis in Public Policy*, Vol. 7 No. 2, pp. 79-103, doi: 10.1002/rhc3.12096.

Katayama, H. and Bennett, D. (1999), "Agility, adaptability and leanness: a comparison of concepts and a study of practice", *International Journal of Production Economics*, Vols 60-61, pp. 43-51, available at: http://doi.org/DOI:10.1016/S0925-5273(98)00129-7

Kehoe, D.F., Dani, S., Sharifi, H., Burns, N.D. and Backhouse, C.J. (2007), "Demand network alignment: aligning the physical, informational and relationship issues in supply chains", *International Journal of Production Research*, Vol. 45 No. 5, pp. 1141-1160, available at: http://doi.org/10.1080/00207540600635219

Ketchen, D.J. and Hult, G.T.M. (2007), "Bridging organization theory and supply chain management: the case of best value supply chains", *Journal of Operations Management*, Vol. 25 No. 2, pp. 573-580, available at: http://doi.org/10.1016/j.jom.2006.05.010

Kim, D., Cavusgil, S.T. and Cavitsgil, E. (2013), "Does IT alignment between supply chain partners enhance customer value creation? An empirical investigation", *Industrial Marketing Management*, Vol. 42 No. 6, pp. 880-889.

Lee, H.L. (2004), "The triple-a supply chain", *Harvard Business Review*, Vol. 82 No. 10, pp. 102-112.

Li, X., Goldsby, T.J. and Holsapple, C.W. (2009), "Supply chain agility: scale development", *International Journal of Logistics Management*, Vol. 20 No. 3, pp. 408-424, available at: http://doi.org/10.1108/09574090911002841

Li, X., Chung, C., Goldsby, T.J. and Holsapple, C.W. (2008), "A unified model of supply chain agility: the work-design perspective", *International Journal of Logistics Management*, Vol. 19 No. 3, pp. 408-435, available at: http://doi.org/10.1108/09574090810919224

Mason, S., Cole, M., Ulrey, B. and Yan, L. (2002), "Improving electronics manufacturing supply chain agility through outsourcing", *International Journal of Physical Distribution and Logistics Management*, Vol. 32 No. 7, pp. 610-620.

Medina-Lopez, C., Marin-Garcia, J.A. and Alfalla-Luque, R. (2010), "A methodological proposal for the systematic literature review", *Working Papers on Operations Management*, Vol. 1 No. 2, pp. 13-30, available at: http://dx.doi.org/10.4995/wpom.v1i2.786

Molina, A., Rodriguez, C.A., Ahuett, H., Cortés, J.A., Ramírez, M., Jiménez, G. and Martinez, S. (2005), "Next-generation manufacturing systems: key research issues in developing and integrating reconfigurable and intelligent machines", *International Journal of Computer Integrated Manufacturing*, Vol. 18 No. 7, pp. 525-536, available at: http://doi.org/10.1080/09511920500069622

Ortega-Jimenez, C., Machuca, J.A.D., Garrido-Vega, P. and Filippini, R. (2015), "The pursuit of responsiveness in production environments: from flexibility to reconfigurability", *International Journal of Production Economics*, Vol. 163, pp. 157-172, available at: http://doi.org/http://dx.doi.org/10.1016/j.ijpe.2014.09.020

Piplani, R. and Fu, Y. (2005), "A coordination framework for supply chain inventory alignment", *Journal of Manufacturing Technology Management*, Vol. 16 No. 6, pp. 598-614.

Rasoolimanesh, S.M., Roldán, J.L., Jaafar, M. and Ramayah, T. (2016), "Factors influencing residents' perceptions toward tourism development: differences across rural and urban world heritage sites", *Journal of Travel Research*, Vol. 56 No. 6, pp. 760-775, doi: 10.1177/0047287516662354.

Rigdon, E.E. (2012), "Rethinking partial least squares path modeling : in praise of simple methods", *Long Range Planning*, Vol. 45 Nos 5-6, pp. 341-358, available at: http://doi.org/10.1016/j.lrp.2012.09.010

Ringle, C.M., Wende, S. and Becker, J.M. (2015), "Smartpls 3. boenningstedt: SmartPLS GmbH", available at: www.smartpls.com (accessed July 2018).

Sakakibara, S., Flynn, B.B., Schroeder, R.G. and Morris, W.T. (1997), "The impact of just-in-time manufacturing and its infrastructure on manufacturing performance", *Management Science*, Vol. 43 No. 9, pp. 1246-1257.

Sangari, M.S. and Razmi, J. (2015), "Business intelligence competence, agile capabilities, and agile performance in supply chain an empirical study", *International Journal of Logistics Management*, Vol. 26 No. 2, pp. 356-380, available at: http://doi.org/10.1108/IJLM-01-2013-0012

Sarstedt, M., Hair, J.F., Ringle, C.M., Thiele, K.O. and Gudergan, S.P. (2016), "Estimation issues with PLS and CBSEM: where the bias lies!", *Journal of Business Research*, Vol. 69 No. 10, pp. 3998-4010, available at: http://doi.org/10.1016/j.jbusres.2016.06.007

Schoenherr, T. and Swink, M. (2015), "The roles of supply chain intelligence and adaptability in new product launch success", *Decision Sciences*, Vol. 46 No. 5, pp. 901-936, available at: http://doi.org/10.1111/deci.12163

Scholten, K., Sharkey Scott, P. and Fynes, B. (2010), "(Le)agility in humanitarian aid (NGO) supply chains", *International Journal of Physical Distribution and Logistics Management*, Vol. 40 Nos 8-9, pp. 623-635.

Simatupang, T. and Sridharan, R. (2005), "The collaboration index: a measure for supply chain collaboration", *International Journal of Physical Distribution and Logistics Management*, Vol. 35 No. 1, pp. 44-62.

Skipworth, H., Godsell, J., Wong, C.Y., Saghiri, S. and Julien, D. (2015), "Supply chain alignment for improved business performance: an empirical study", *Supply Chain Management-An International Journal*, Vol. 20 No. 5, pp. 511-533, available at: http://doi.org/10.1108/SCM-06-2014-0188

Swafford, P.M., Ghosh, S. and Murthy, N. (2006), "The antecedents of supply chain agility of a firm: scale development and model testing", *Journal of Operations Management*, Vol. 24 No. 2, pp. 170-188, available at: http://doi.org/10.1016/j.jom.2005.05.002

Tan, K.C., Kannan, V.R., Hsu, C.C. and Leong, G.K. (2010), "Supply chain information and relational alignments: mediators of EDI on firm performance", *International Journal of Physical Distribution and Logistics Management*, Vol. 40 Nos 5-6, pp. 377-394, available at: http://doi.org/10.1108/09600031011052831

Tan, V. and Tiong, T.N. (2005), "Change management in times of economic uncertainty", *Singapore Management Review*, Vol. 27 No. 1, pp. 49-68.

Tranfield, D., Denyer, D. and Smart, P. (2003), "Towards a methodology for developing evidence-informed management knowledge by means of systematic review", *British Journal of Management*, Vol. 14, pp. 207-222, available at: http://doi.org/10.1111/1467-8551.00375

Tuominen, M., Rajala, A. and Möller, K. (2004), "How does adaptability drive firm innovativeness?", *Success Factors, Competitive Advantage and Competence Development*, Vol. 57 No. 5, pp. 495-506, available at: http://doi.org/DOI:10.1016/S0148-2963(02)00316-8

Urbach, N. and Ahlemann, F. (2010), "Structural equation modeling in information systems research using partial least squares", *Journal of Information Technology Theory and Application (JITTA)*, Vol. 11 No. 2, pp. 5-40, available at: http://aisel.aisnet.org/jitta/vol11/iss2/2

Van Bruggen, G.H., Lilien, G.L. and Kacker, M. (2002), "Informants in organizational marketing research: why use multiple informants and how to aggregate responses", *Journal of Marketing Research*, Vol. 39 No. 4, pp. 469-478.

Van Hoek, R.I. (2001), "Moving forward with agility", *International Journal of Physical Distribution and Logistics Management*, Vol. 31 No. 4, pp. 290-300.

Van Hoek, R.I., Harrison, A. and Christopher, M. (2001), "Measuring agile capabilities in the supply chain", *International Journal of Operations and Production Management*, Vol. 21 Nos 1-2, pp. 126-148, available at: http://doi.org/10.1108/01443570110358495

Wei, H.L. and Wang, E.T.G. (2010), "The strategic value of supply chain visibility: increasing the ability to reconfigure", *European Journal of Information Systems*, Vol. 19 No. 2, pp. 238-249, available at: http://doi.org/10.1057/ejis.2010.10

Whitten, G.D., Green, K.W. and Zelbst, P.J. (2012), "Triple-A supply chain performance", *International Journal of Operations and Production Management*, Vol. 32 No. 1, pp. 28-48.

Wong, C., Skipworth, H., Godsell, J. and Achimugu, N. (2012), "Towards a theory of supply chain alignment enablers: a systematic literature review", *Supply Chain Management-An International Journal*, Vol. 17 No. 4, pp. 419-437, available at: http://doi.org/10.1108/13598541211246567

Wu, K., Tseng, M., Chiu, A. and Lim, M.K. (2017), "Achieving competitive advantage through supply chain agility under uncertainty: a novel multi-criteria decision-making structure", *International Journal of Production Economics*, Vol. 190, August, pp. 96-107, available at: https://doi.org/10.1016/j.ijpe.2016.08.027

Yusuf, Y.Y., Musa, A., Dauda, M., El-Berishy, N., Kovvuri, D. and Abubakar, T. (2014), "A study of the diffusion of agility and cluster competitiveness in the oil and gas supply chains", *International Journal of Production Economics*, Vol. 147, Part B, pp. 498-513, available at: http://doi.org/10.1016/j.ijpe.2013.04.010

Further reading

Agarwal, A., Shankar, R. and Tiwari, M.K. (2006), "Modeling the metrics of lean, agile and leagile supply chain: an ANP-based approach", *European Journal of Operational Research*, Vol. 173 No. 1, pp. 211-225, available at: http://doi.org/DOI:10.1016/j.ejor.2004.12.005

Braunscheidel, M.J. and Suresh, N.C. (2009), "The organizational antecedents of a firm's supply chain agility for risk mitigation and response", *Journal of Operations Management*, Vol. 27 No. 2, pp. 119-140, available at: http://doi.org/10.1016/j.jom.2008.09.006

Charles, A., Lauras, M. and Van Wassenhove, L. (2010), "A model to define and assess the agility of supply chains: building on humanitarian experience", *International Journal of Physical Distribution and Logistics Management*, Vol. 40 Nos 8-9, pp. 722-741.

Khan, A.K. and Pillania, R.K. (2008), "Strategic sourcing for supply chain agility and firms' performance. a study of Indian manufacturing sector", *Management Decision*, Vol. 46 No. 10, pp. 1508-1530, available at: http://doi.org/10.1108/00251740810920010

Lee, H.L. (2002), "Aligning supply chain strategies with product uncertainties", *California Management Review*, Vol. 44 No. 3, pp. 105-119.

Lin, C.T., Chiu, H. and Chu, P.Y. (2006), "Agility index in the supply chain", *International Journal of Production Economics*, Vol. 100 No. 2, pp. 285-299, available at: http://doi.org/10.1016/j.ijpe.2004.11.013

Liu, H., Ke, W., Wei, K.K. and Hua, Z. (2013), "The impact of IT capabilities on firm performance: the mediating roles of absorptive capacity and supply chain agility", *Decision Support Systems*, Vol. 54 No. 3, pp. 1452-1462, available at: http://doi.org/10.1016/j.dss.2012.12.016

Qrunfleh, S. and Tarafdar, M. (2013), "Lean and agile supply chain strategies and supply chain responsiveness: the role of strategic supplier partnership and postponement", *Supply Chain Management-An International Journal*, Vol. 18 No. 6, pp. 571-582, available at: http://doi.org/10.1108/SCM-01-2013-0015

Seggie, S.H., Kim, D. and Cavusgil, S.T. (2006), "Do supply chain IT alignment and supply chain interfirm system integration impact upon brand equity and firm performance?", *Journal of Business Research*, Vol. 59 No. 8, pp. 887-895, available at: http://doi.org/10.1016/j.jbusres.2006.03.005

Sharifi, H. and Zhang, Z. (1999), "A methodology for achieving agility in manufacturing organization: an introduction", *International Journal of Production Economics*, Vol. 62 Nos 1-2, pp. 7-22.

Swafford, P.M., Ghosh, S. and Murthy, N. (2008), "Achieving supply chain agility through IT integration and flexibility", *International Journal of Production Economics*, Vol. 116 No. 2, pp. 288-297, available at: http://doi.org/10.1016/j.ijpe.2008.09.002

Tse, Y.K., Zhang, M., Akhtar, P. and MacBryde, J. (2016), "Embracing supply chain agility: an investigation in the electronics industry", *Supply Chain Management-An International Journal*, Vol. 21 No. 1, pp. 140-156, available at: http://doi.org/10.1108/SCM-06-2015-0237

Tuan, L.T. (2016), "Organisational ambidexterity and supply chain agility: the mediating role of external knowledge sharing and moderating role of competitive intelligence", *International Journal of Logistics-Research and Applications*, Vol. 19 No. 6, pp. 583-603.

Um, J. (2016), "The impact of supply chain agility on business performance in a high level customization environment", *Operations Management Research*, Vol. 10 Nos 1-2, pp. 10-19, available at: http://dx.doi.org/10.1007/s12063-016-0120-1

Yusuf, Y.Y., Gunasekaran, A., Adeleye, E.O. and Sivayoganathan, K. (2004), "Agile supply chain capabilities: determinants of competitive objectives", *European Journal of Operational Research*, Vol. 159 No. 2, pp. 379-392, available at: http://doi.org/10.1016/j.ejor.2003.08.022

Corresponding author
Juan A. Marin-Garcia can be contacted at: jamarin@omp.upv.es