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# Arcs of communication and small- and medium-sized enterprise performance

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Arcs of  
communication

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## Abstract

**Purpose** – The purpose of this paper is to analyse the information shared by SMEs with their main customers and suppliers and its implications on their performance.

**Design/methodology/approach** – The paper puts forward the concept of arcs of communication based on the frequency and direction of the information exchanged by SMEs with their main customers and suppliers. SMEs are classified by the arc of communication they belong to using data from a survey carried out in the Canary Islands (Spain). The Rasch Measurement Theory is applied.

**Findings** – The largest group of small- and medium-sized enterprises (SMEs) shares information frequently with both customers and suppliers (broad arc of communication). Differences were detected in the performance of SMEs belonging to this broad arc, as well as, in those firms that communicated frequently with their main suppliers (asymmetrical arc of communication towards suppliers). In both cases, these firms were better than their competitors in innovation.

**Practical implications** – This study demonstrates the need for better management of the links between SMEs and their suppliers and with their customers in accordance with their strategies, promoting a greater cooperative behaviour throughout the supply chain.

**Originality/value** – SMEs' customers and suppliers are their main sources of information compared to large firms, which have greater resources to search for and acquire information. This paper investigates the information exchanged by SMEs with their main customers and suppliers from a strategic focus by adding to the literature the concept of arcs of communication. It also has the added value of applying the Rasch Measurement Theory (Rasch, 1960/1980).

**Keywords** Performance, Supply chain, Information sharing, Small- and medium-sized enterprises, Arc of communication, Rasch measurement theory

**Paper type** Research paper

## Introduction

The information shared between customers and suppliers is a key aspect for the effective functioning and coordination of the entire supply chain (Damiani *et al.*, 2011; Kembro *et al.*, 2014; Lee and Whang, 2000; Stonkute, 2015). Even, for Yigitbasioglu (2010) and Raweewan and Ferrell (2018), among other authors, the exchange of information is “the heart, lifeblood, never centre essential ingredient, key requirement and foundation of supply chain collaboration”. Therefore, information becomes the main and most critical flow along the supply chain (Chopra and Meindl, 2001; Raweewan and Ferrell, 2018).

This information exchanged along the supply chain is especially important in the case of small- and medium-sized enterprises (SMEs), unit of analysis in this article. These firms have limited resources to access, assimilate and process information internally (Capó-Vicedo *et al.*, 2011). That is why, in these organisations, new knowledge is developed mainly through the relations of firms with their suppliers and customers. Then, the value of the information shared among members of the supply chain increases when SMEs are involved

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(Li and Lin, 2006) and increases even more if their supply chain has a high geographic dispersion (Huo *et al.*, 2014).

However, most studies on information exchange along a supply chain have focused on large firms (Hsu *et al.*, 2009; Rezaei *et al.*, 2015; Yigitbasioglu, 2010; Zhou and Benton, 2007) or on the use of information technologies (Fawcett *et al.*, 2007). Other studies have been focused on logistics and operational aspects (Montoya-Torres and Ortiz-Vargas, 2014; Rezaei *et al.*, 2015) rather than on the strategic ones. The strategic approach gives a broad picture of what is actually happening between a firm and its supply chain partners from the perspective of the information shared between them. Therefore, this paper fills a gap in the research on information sharing in the supply chain, as this topic is dealt with from a strategic approach and related to SMEs. Thus, its aim is to analyse the information shared by SMEs with their main customers and suppliers and its implications on their performance.

To attain this goal, this study adds the concept “arcs of communication” to the literature. Arcs of communication arise from the idea of arcs of integration from Frohlich and Westbrook (2001) and angles of integration from Thun (2010). An arc of communication is defined according to the intensity and scope of the information exchanged between firms along the supply chain. This study does not focus on the relationship of the focal firm just with its suppliers or its customers (dyadic relationship), like most of the existing literature does (Choi, 2010; Kembro *et al.*, 2014; Yigitbasioglu, 2010). This paper focuses on the relationship of the focal firm with both its main customer and its main supplier. In this way, this paper uses an approach closer to the reality of the supply chain, as recommended in the literature (e.g. Kembro and Näslund, 2014).

From an empirical perspective, this work considers SMEs as the object of analysis. In these organisations, it is usually the same person that makes strategic decisions, establishes communication with customers and/or suppliers and collects, analyses, synthesizes and interprets information. The role of people in external information sharing is very important in SMEs (Surowiec, 2015). Thus, from an operational, conceptual and methodological point of view, in this paper, the exchange of interpersonal information coincides with the exchange of inter-organisational information and with the person making the strategic decisions, a circumstance that does not happen in large firms.

Another contribution of this paper is in the methodological area with the use of the Rasch Measurement Theory (Rasch, 1960/1980). This methodology is considered as one of the most current and appropriate methods in the field of Strategic Management (Marcoulides, 1998) when meeting the needs for improvement in the measurement of directly unobservable constructs (Godfrey and Hill, 1995). Thus, this research fits within the collection of pioneering articles in applying this methodology to SMEs’ strategic management (e.g. García-Pérez *et al.*, 2014; Martin *et al.*, 2016; Yanes-Estévez *et al.*, 2018) and supply chain management from a strategic perspective (e.g. Yanes-Estévez *et al.*, 2010).

This paper is structured as follows. Following the introduction, the theoretical framework is described. In the third section, the methodology applied, data gathering, scales used and quality of measures are explained. In the fourth section, the results are given and the fifth section includes the discussion. Finally, the conclusions, implications and future lines of research are presented.

## Theoretical framework

### *Information shared with customers and suppliers: arcs of communication*

Following Kembro (2015), and given the strategic focus of this research, in this paper, the conceptual difference between data, information and knowledge is not considered as a determinant factor (Tuomi, 1999)[1]. Therefore, the term information sharing is defined in this work as “the exchange of data, information and/or knowledge between independent organizations” (Kembro *et al.*, 2014). In this way, and precisely “to streamline terminology and

avoid confusion” (Kembro and Näslund, 2014), the term “information sharing” will be used to describe an exchange of data and/or information and/or knowledge in its broadest sense.

Some of the literature on information sharing has focused on analysing its scope (Marshall, 2015) and with whom a firm exchanges information. Thus, most works focus on the relationship of the focal firm just with its suppliers or with its customers (dyadic relationship) (e.g. Choi, 2010; Kembro *et al.*, 2014; Yigitbasioglu, 2010). However, there are other studies that do not differentiate with which partner the information is exchanged (Bellamy *et al.*, 2014; Hult *et al.*, 2004, 2007; Ya’kob and Wan Jusoh, 2016).

Another important part of the information sharing literature has analysed the characteristics of the information exchanged. The studies carried out have used several features to classify it: the volume of information exchanged (high/low) and its range (strategic/operative) (Samaddar *et al.*, 2006); the intensity of the information exchanged (Kembro and Selviaridis, 2015; Yigitbasioglu, 2010); the information currency, accuracy, completeness, consistency and ease of access (Petersen, 1999); the accuracy, timelines, adequacy and credibility (Moberg *et al.*, 2002); and the information’s volume (depth and breadth) and quality (accuracy, relevance and timeless) (Watabaji *et al.*, 2016).

Moreover, numerous information-sharing studies have analysed the mechanisms used for information exchange and the impact on firms (Marshall, 2015). In this sense, utilising verbal communication to transfer knowledge is perceived as the easiest, fastest and most effective method of knowledge transfer (Riege and Zulpo, 2007), especially for SMEs. Face-to-face communication can increase the level of shared information (Rashed *et al.*, 2010), provide instant feedback and infuse personal feelings into the communication (Flynn *et al.*, 2016). In this sense, Gligor and Autry (2012) conclude that personal relationships in the supply chain are necessary to facilitate communication processes. They also say that their absence may impact negatively on the communication process, and therefore, on business performance. In addition, Nonaka *et al.* (2000) emphasise the need to exploit the direct conversations that firms have with customers and suppliers to discover new knowledge about them.

In short, not all the information exchanged has the same characteristics, and therefore, neither the same quality, nor the same quantity, nor uses the same channels, nor does it contribute the same to firms. Thus, in order to analyse information sharing from a strategic approach, and starting from the idea of arcs of integration by Frohlich and Westbrook (2001) and of angles of integration by Thun (2010), this paper puts forward the concept of arcs of communication. These arcs integrate, from the point of view of the information sharing characteristics, the frequency of information of different nature exchanged (Daley, 2009; Samaddar *et al.*, 2004; Storer *et al.*, 2002), high or low, and, from the point of view of the scope of information sharing, the direction of the exchanged information (Storer *et al.*, 2002), either towards the main customers or towards the main suppliers, or towards both. This leads to four arcs of communication (Table I).

In the broad arc of communication, there are SMEs that frequently exchange information with their main customers and suppliers. The narrow arc of communication includes SMEs

Frequency of information shared with supplier	High	High frequency of information shared with supplier and low with customer (ASYMMETRIC ARC)	High frequency of information shared with customer and supplier (BROAD ARC)
	Low	Low frequency of information shared with supplier and customer (NARROW ARC)	High frequency of information shared with customer and low with supplier (ASYMMETRIC ARC)
		Low	High
		Frequency of information shared with customer	

**Source:** Adapted from Frohlich and Westbrook (2001) and Thun (2010)

**Table I.**  
Arcs of  
communication

that rarely share information with their main customers and suppliers. The asymmetric arc of communication towards main customers contains SMEs that frequently share information with these customers; whereas the asymmetric arc towards main suppliers includes the firms that frequently share information with their main suppliers.

#### *Information shared with customers/suppliers and performance*

Many studies have demonstrated the need for inter-organisational and bidirectional information exchange so that the supplier–buyer relationship is successful (Gligor and Autry, 2012; Lotfi *et al.*, 2013; Marinagi *et al.*, 2015; Ya’kob and Wan Jusoh, 2016). Thus, the exchange of information is a way of coordinating the independent actors (the focal firm, its customers and its suppliers) to work together in order to gain the common goal of improved chain performance (Simatupang *et al.*, 2002). Therefore, abundant literature about supply chain management supports, either theoretically or empirically, the positive relationship between shared information and superior performance (e.g. Dobrzykowski *et al.*, 2015; Klein and Rai, 2009; Saha and Banerjee, 2015; Singh and Power, 2014; Yigitbasioglu, 2010)[2].

Sharing information about levels of inventory, improvements or development of new products, market trend forecasts or sales promotion strategies allows decisions to be made based on greater information. Thus, firms should consider their customers as allies in the development of new and improved products and use their suppliers’ knowledge about design and production to ensure a competitive advantage for a new product (Tseng, 2009).

Therefore, information is a prerequisite of firm performance (Gulati, 1998) and although organisations must use multiple sources of information in order to improve their results, the most important areas of knowledge for a firm come from customers and suppliers (Liao *et al.*, 2003). According to Corral de Zubielqui *et al.* (2018), collaborating buyers and suppliers are cognitively and organisationally proximate (Ferrerias-Méndez *et al.*, 2015), which facilitates mutual understanding and communication (Boschma, 2005; Knoblen and Oerlemans, 2006).

Furthermore, it should be noted that improvements in performance through information sharing are not immediate. Its success will depend on a multitude of factors, such as the incentives to transfer knowledge and not simply try to acquire knowledge from the other party for free (Dyer and Singh, 1998). In particular, some of the elements that act as determining factors or barriers in the exchange of information could be trust, the quality of the information, the dominant actor and the confidentiality of the information (Kembro *et al.*, 2017). In this sense, Panahifar *et al.* (2018) also add the secure sharing of information as the most determining factor in the information-sharing-centred collaboration.

#### *SME performance and the information shared with main customers/suppliers*

SMEs have limited competencies in marketing, strategy and acquisition of new knowledge and technology (Stonkute, 2015). Faced with these difficulties, the ability to obtain external information, particularly from other members of the supply chain, means that this information is perceived as particularly valuable and attractive (Li and Lin, 2006; Ya’kob and Wan Jusoh, 2016). In fact, one of the most common supply chain management practices in SMEs is information sharing (Surowiec, 2015). Thus, works like those by Ya’kob and Wan Jusoh (2016) and Fawcett *et al.* (2007) conclude that shared information has a positive relation with the results of SMEs. Therefore, SMEs should strategically implement information exchange practices in their supply chain to achieve a competitive advantage (Kumar *et al.*, 2016).

However, the existence of informal structures and the absence of formal strategic processes in SMEs mean that relationships are often established *ad hoc*, for example with suppliers (Adams *et al.*, 2012). Strategic information is usually obtained by a firm’s management in an informal manner (Levy and Powell, 2000). Perhaps, due to the high cost of implementing an Electronic Data Interchange (EDI) (Lee and Whang, 2000), the majority of SMEs are still using

phone, fax and personal visits as communication channels, as verified by Harland *et al.* (2007) in a longitudinal study of SMEs in different sectors. Above all, SMEs look for information sources that are reliable, from actors which they have maintained some relationship or shared a connection with (Lang *et al.*, 1997), or from other people they have frequently interacted with (Smeltzer *et al.*, 1988). Thus, it seems that SMEs mainly trust the information that has been verbally exchanged with suppliers, distributors and customers especially in complex situations (Welker *et al.*, 2008). In particular, the relationships between SMEs and their most important suppliers based on trust are usually the most fruitful sources of new knowledge and acquisition of competences (Capó-Vicedo *et al.*, 2004).

One of the results of SMEs most linked to information sharing with external agents is innovation (e.g. Corral de Zubielqui *et al.*, 2018; Gronun *et al.*, 2012). In particular, Hoffman *et al.* (1998) cite researchers who argue that high levels of interaction, especially with customers and suppliers, provide SMEs with access to new knowledge that could lead to future innovations. Corral de Zubielqui *et al.* (2018) conclude that direct effects of external knowledge transfer from customers and suppliers on innovation are significant and positive. Also, Didonet and Díaz (2012) verify the impact of the interactions of these enterprises with customers and suppliers in innovation.

Based on the above, this paper puts forward the following hypothesis:

- H1. SMEs that share information most frequently with their main customers and suppliers (broad arc of communication) will perform better than those that only share with either their main customers or their main suppliers (asymmetric arcs of communication) and better than SMEs that share information infrequently with their main customers and suppliers (narrow arc of communication).

## Research methodology

### *The Rasch measurement theory (1960/1980)*

The application of the Rasch Measurement Theory (Rasch, 1960/1980) in business administration and management is one of the most recent methodological contributions in this field (Fischer *et al.*, 2006; García-Pérez *et al.*, 2014; Oreja-Rodríguez, 2015; Salzberger and Sinkovics, 2006; Shea *et al.*, 2012; Yanes-Estévez *et al.*, 2018).

One of the distinctive characteristics of this methodology is that it focuses on individual analysis: each item and each SME are addressed individually instead of characterising the set of data. This gives rise to another advantage; it avoids the need to assume that the data follow a normal distribution (Engelhard, 1984).

One of the main advantages of the Rasch measurement models (Wright and Mok, 2004) is that they are the only methodological way available for building linear measurements (Bond and Fox, 2007) from ordinal observations (Fischer, 1995; Linacre, 2004).

Another advantage of the Rasch Measurement Theory (Rasch, 1960/1980) is that when applied, the researcher does not need to assume that the data follow a normal distribution (Engelhard, 1984) as happens with other techniques. As a result, several commonly accepted assumptions in the use of additive scales do not have to be made. For example, according to Fischer *et al.* (2006): all the items have the same impact on the scoring of the scale and all the categories keep the same distance from the next one.

In particular, this methodology analyses latent variables, which are not directly observable and happen to be the majority in management, by evaluating a series of items for a group of subjects (individuals, firms, etc.). What makes this methodology different from the rest is that it uses the same units of measurement for the item parameters (items on the information shared with its main customers and suppliers) and for the individual parameters (SMEs): this is known as joint measurement. Both parameters are simultaneously located on a linear continuum that represents the latent variable (information shared with customers and suppliers), and both can

be analysed at the same time. Lower measurements in the items show a higher frequency in the exchange of information of that nature, while higher measurements in the items show a lower frequency in the exchange of that information. On the contrary, SMEs with lower measurements develop a higher exchange of information with their customers and/or suppliers, while SMEs with higher measurements develop a lower exchange of information with them.

The model used in this study belongs to the Rasch family of measurement models (Wright and Mok, 2004) known as the Rasch–Andrich Rating Scale Model. This model was developed by Andrich (1978, 1988) specifically to deal with information from ordinal multiple category scales, like the ones used in this work. The parameters are estimated through a method of maximum verisimilitude using the Winsteps program (Linacre, 2007), which considers PROX and JMLE algorithms (joint maximum likelihood estimation).

#### *Sample characteristics and data collection*

This study uses a sample of SMEs in the Canary Islands (Spain), classified by number of employees and by segments established in the European Commission Recommendation of 6th May 2005 (DOCE 20.05.2003)[3]. Similar to business structures in other Spanish and European regions, in the Canary Islands (a geographical differentiated region) there is a clear predominance of micro-enterprises that represent 95.54 per cent of all firms, where 54.49 per cent of them do not have any salaried employees. Furthermore, 58.47 per cent of Canarian firms belong to the service sector, 25.40 per cent to the retail sector and the rest to the building and manufacturing sectors (DIRCE, 2013). Data were collected using a questionnaire[4] that was answered by managers during June and September 2011. The questionnaire included closed questions about the strategic behaviour of SMEs.

Faced with both economic and time constraints to gain access to the complete population under study, a non-probabilistic and convenience method of sampling was used (Neuman, 1997; Zikmund *et al.*, 2010). This method is recommended to obtain a number of questionnaires quickly and economically when other types of sampling are not possible (Zikmund *et al.*, 2010). The resulting sample comprised 77 SMEs of which 4 per cent were manufacturing firms, 14 per cent building and 82 per cent of firms belonged to the service sector. This sector structure is very representative of the Canarian economy, with a clear predominance of the service sector.

Service firms focus basically on information manipulation (Shing *et al.*, 2014)[5]. Therefore, the adequate management of information along the supply chain makes even more sense in service firms, the predominant sector in this study, which are also located in geographically differentiated and fragmented territories. Service firms, less studied in the literature on information sharing in supply chains, do not require such extensive transportation planning and performance or such physical manipulation as industrial firms, but instead focus on the manipulation of information and the development of relationships (Shing *et al.*, 2014). Thus, when we are faced with a service supply chain, the use of information generates the most basic and, at the same time, critical resource for performance such as facilitating the management of the service supply chain itself (Choi *et al.*, 2016).

In addition to being representative from the sectoral point of view, the sample used in this paper (77 SMEs) is sufficient to obtain, through the applied Rasch Measurement Theory, stable measurements of the items. According to Linacre (1994), stable item calibrations with  $\pm 1$  logit [6] and a confidence interval of 99 %, are achieved with a minimum sample size range between 27 and 61 surveys.

#### *Description of scales*

*Information shared with main customers and main suppliers.* Based on the work of McEvily and Marcus (2005), Chen and Paulraj (2004), Heide and Miner (1992) and Tan *et al.* (2002), we develop a multi-item scale to measure information shared with main customers and shared

with main suppliers. This includes items on strategic information (sharing priority and important information with main customers/suppliers or sharing future plans with main customers/suppliers) and items that gather information of a more operative nature (using information technology to communicate with main customers/suppliers), similar to the classification made by Daley (2009). The rest of the items show the reality of the inter-organisational relationships linked to the exchange of information of SMEs in which face-to-face contacts predominate (shares information informally when the occasion arises or information about events or changes with main customers/suppliers).

Thus, managers had to indicate how often they carried out the communication outlined in the list below, first with main customers, and then, with main suppliers, thus distinguishing from which particular external actor the information comes from (Corral de Zubielqui *et al.*, 2018). In this sense, frequency in communication has been defined as the amount and/or duration of contacts between actors (Mohr and Nevin, 1990). To quantify these contacts, a scale that ranged from 1 (infrequent) to 7 (very frequent) was used. Then, to avoid the loss of information with less used categories, the scale was later recalibrated with a range of 1 to 4.

Scale of information shared with customers and suppliers:

- your firm shares priority and important information with its main customers/suppliers (e.g. financial, production, product design, research, consumer and/or information about rivals);
- your firm shares information on future plans with its main customers/suppliers;
- your firm shares information with its main customers/suppliers about events or changes that could affect the other party;
- your firm shares information informally with its main customers/suppliers, besides that specified in the agreement between both parties; and
- your firm uses information technology (e.g. EDI, collaborative planning forecasting and replenishment, internet, databases of final consumers [...]) to communicate with its main customers/suppliers.

To evaluate the quality of the measurements of shared information, overall reliability of SMEs and the items on the scale[7], the overall validity of the model and of the individual for both SMEs and items are all considered using the indicators of the Rasch Measurement Theory (Rasch, 1960/1980).

Regarding overall reliability (Andrich, 1982), the measurements for shared information with customers reach satisfactory levels, between 0.91 (real) and 0.92 (model) for items and 0.94 (real and model) for SMEs. In shared information with suppliers, equally satisfactory levels are obtained, with items being between 0.89 (real) and 0.90 (model) and between 0.82 (real) and 0.84 (model) for SMEs.

To analyse the validity of the measurements, misfits were taken into account, both at the global level of the model, as well as at the individual level of firms and items. In both cases, validity is confirmed, as first, on a global level, the model's validity is adequate, with OUTFIT and INFIT[8] values close to the expected value of 1. Second, in the validity analysis at the individual level, significant misfits of SMEs with the model were dealt with on an individual basis until the required levels were reached (Linacre, 2002). These misfits mean that the estimations reflect a distorted image of the data (Linacre, 2009). Therefore, they must be dealt with when such measurements are not used merely in a descriptive manner.

The unidimensionality of the measurements that is required for the application of Rasch models is analysed through various indices: reliability and fit of data, correlation (Point-measure correlations or PTMEA) and Rasch-residual-based Principal Components Analysis (PCAR)[9].



Following this analysis, the unidimensionality of the measurements is confirmed, as the appropriate indices are obtained and the variance explained by the measurements is 72.1 and 79.4 per cent in the case of shared information with customers and suppliers, respectively.

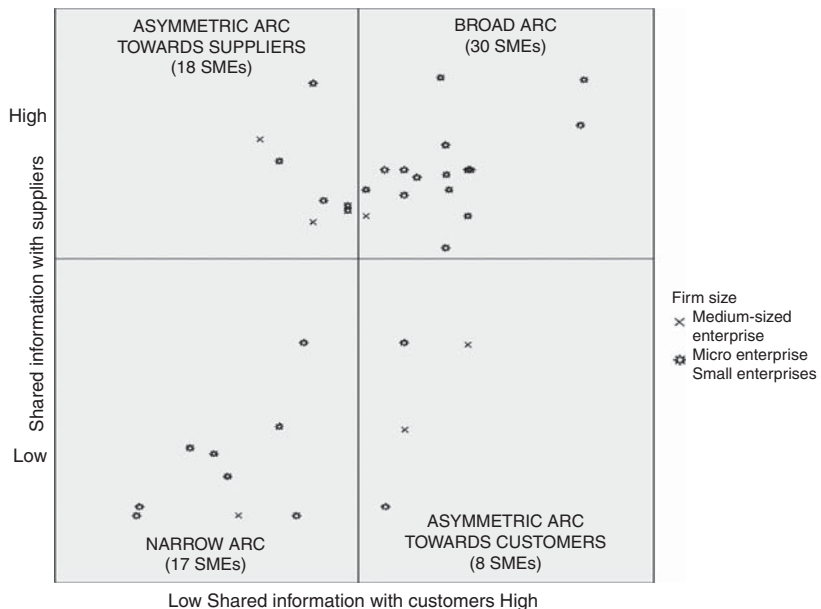
*Small- and medium-sized enterprise performance.* SME performance is considered from a subjective perspective and in relative terms with respect to competitors (e.g. Sengupta *et al.*, 2006; Zhou and Benton, 2007). Therefore, accountancy techniques do not have any influence, which is best in cases of multi-sector samples (Pertusa-Ortega *et al.*, 2009). Additionally, a multi-item indicator was used to obtain more detailed information and not limited to economic-financial performance. Thus, based on Lee and Miller (1996), managers indicated in what situation they felt their firms were compared to their competitors regarding innovation, growth, market share and profitability. The scale ranged from 1, if the manager perceived the indicators as being lower in their firm than in their competitors, to 7 if these indicators were much higher in their SME.

Following the above reasoning, the measurement validity was evaluated for the global model, reaching the suggested levels. Overall reliability also reached the required levels with values of 0.79 (real) and 0.83 (model) for the reliability of SMEs and 0.91 (real and model) for items.

**Results**

*Arcs of communication between SMEs and main customers and suppliers*

To classify the SMEs according to arcs of communication, two applications of the Rasch Measurement Theory (Rasch, 1960/1980) were carried out: one on the information shared with main customers items and another on the information shared with main suppliers items. For each of the two applications carried out, measurements were obtained for items (Table III) and for SMEs[10]. The graphical representation of the SMEs measurements about information exchanged with main customers and main suppliers, allows us to obtain a typology of SMEs depending on the arcs of communication (Figure 1)[11].



**Figure 1.** Typology of SMEs according to arcs of communication

The results show (Figure 1) that almost 40 per cent of SMEs in the sample (30 SMEs) have established frequent information exchange with their main customers and suppliers, and so they are in the broad arc. At the same time, 22 per cent of SMEs in the sample (17 SMEs) communicate either very little or do not communicate at all, neither with main customers nor suppliers, thus belonging to the narrow arc. Regarding the asymmetric arcs, SMEs communicate more with their suppliers (18 SMEs, 25 per cent) than with their customers (8 SMEs, 11 per cent). Thus, the SMEs that communicate frequently with their main customers and suppliers, or at least with one or the other, represent 76 per cent of the sample (56 SMEs). Of these, those that communicate frequently, at least, with their main customers represent 52 per cent of the sample (38 SMEs) and those that do it, at least, with their main suppliers represent 65.7 per cent of the sample (48 SMEs).

The characteristics of each group of SMEs (Table II) show that none of the medium-sized firms predominate in any of the arcs. The SMEs of all the arcs are mainly from “other services”, except the SMEs that communicate more with their main suppliers than with their main customers, which are mainly from the retail sector. SMEs are mainly between 11 and 20 years old, except those that communicate more intensively with their main customers, which tend to be the youngest (from 0 to 10 years old).

In addition, the measurements of the items obtained after the two applications of the Rasch Measurement Theory (Rasch, 1960/1980) indicate the characteristics of the information shared by the SMEs with their main customers and suppliers (Table III). In their relations with customers, SMEs seem to exchange more information about events or changes that may affect the other party and do so informally. However, when they interact with their suppliers they use more information technologies and also share information about events or changes that may affect the other party.

#### *Differences in SMEs’ performance according to their arcs of communication*

One of the most interesting aspects of this exploratory study on information sharing is the analysis of the implications for SMEs’ performance and the differences depending on the arc of communication they belong to. In order to achieve this, the Rasch Measurement Theory

	Narrow arc	Asymmetric arc towards suppliers	Asymmetric arc towards customers	Broad arc	Missing data
<i>Activity sector</i>					
Manufacturing	1 (5.9%)	–	1 (12.5%)	1 (3.3%)	–
Building	3 (17.6%)	2 (11.1%)	2 (25.0%)	3 (10.0%)	–
Retail	4 (23.5%)	9 (50.0%)	2 (25.0%)	12 (40.0%)	2 (50.0%)
Other services	9 (52.9%)	7 (38.9%)	3 (37.5%)	14 (46.7%)	2 (50.0%)
Total	17 (100.0%)	18 (100.0%)	8 (100.0%)	30 (100.0%)	4 (100.0%)
<i>Age</i>					
0–10 years old	5 (29.4%)	4 (22.2%)	4 (50.0%)	10 (33.3%)	1 (25.0%)
11–20 years old	7 (41.2%)	7 (38.9%)	1 (12.5%)	12 (40.0%)	–
21–30 years old	4 (23.5%)	4 (22.2%)	2 (25.0%)	2 (6.7%)	1 (25.0%)
Over 30 years old	1 (5.9%)	3 (16.7%)	1 (12.5%)	5 (16.7%)	2 (50.0%)
Missing data	–	–	–	1 (3.3%)	–
Total	17 (100.0%)	18 (100.0%)	8 (100.0%)	65 (100.0%)	4 (100.0%)
<i>Size</i>					
Micro-enterprise	8 (47.1%)	5 (27.8%)	2 (25.0%)	15 (50.0%)	2 (50.0%)
Small enterprises	8 (47.1%)	11 (61.1%)	4 (50.0%)	14 (46.7%)	1 (25.0%)
Medium-sized ent.	1 (5.9%)	2 (11.1%)	2 (25.0%)	1 (3.3%)	1 (25.0%)
Total	17 (100.0%)	18 (100.0%)	8 (100.0%)	30 (100.0%)	4 (100.0%)

**Table II.**  
Characteristics of  
SMEs according to  
arcs of communication

	Information shared with the main customers		Information shared with the main suppliers	
	Items	Measure	Items	Measure
	Your firm shares priority and important information with its main customers	1.26	Your firm shares information informally with its main suppliers, besides that specified in the agreement between both parties	0.51
	Your firm shares information on future plans with its main customers	0.59	Your firm shares priority and important information with its main suppliers	0.40
	Your firm uses information technology to communicate with its main customers	0.41	Your firm shares information on future plans with its main suppliers	0.23
	Your firm shares information informally with its main customers, besides that specified in the agreement between both parties	-0.57	Your firm shares information with its main suppliers about events or changes that could affect the other party	-0.51
	Your firm shares information with its main customers about events or changes that could affect the other party	-1.68	Your firm uses information technology to communicate with its main suppliers	-0.64
	Mean	0.00	Mean	0.00
	SD	1.03	SD	0.48

**Table III.**  
Measures of the items on the shared information

(Rasch, 1960/1980) is applied, particularly the differential item functioning (DIF)[12] that considers the four items used to measure SMEs' performance comparing all the possible combinations of SME groups according to their arcs of communication:

- Narrow arc (SMEs that share information infrequently with customers and suppliers) compared to asymmetric arcs (SMEs that either share information frequently with their main customers or with their main suppliers): LOW CUST\_SUPP[13] vs LOW CUST\_HIGH SUPP + HIGH CUST\_LOW SUPP.
- Broad arc (SMEs that share information frequently with main customers and suppliers) compared to asymmetric arcs (SMEs that share information frequently with either customers or suppliers): HIGH CUST\_SUPP vs LOW CUST\_HIGH SUPP + HIGH CUST\_LOW SUPP.
- Narrow arc (SMEs that share information infrequently with clients and suppliers) compared to the broad arc (SMEs that share information frequently with customers and suppliers): LOW CUST\_SUPP vs HIGH CUST\_SUPP.
- Broad arc (SMEs that share information frequently with customers and suppliers) compared to asymmetric arcs and narrow arc (rest of SMEs: SMEs that share information frequently with either customers or suppliers and those that share information infrequently with customers and suppliers): HIGH CUST\_SUPP vs rest of SMEs (LOW CUST\_SUPP + LOW CUST\_HIGH SUPP + HIGH CUST\_LOW SUPP).
- SMEs that share information infrequently with their customers compared to those that share frequently: LOW CUST vs HIGH CUST.
- SMEs that share information infrequently with their suppliers compared to those that share information frequently: LOW SUPP. vs HIGH SUPP.

Table IV shows the significant differences between the groups of SMEs according to their arc of communication and their performance. These differences are related to innovation, i.e. managers of SMEs only perceived that they were better than their competitors in innovation based on their arc of communication. This becomes particularly obvious when SMEs in the broad arc are compared with SMEs in the narrow arc. In addition, if we also

compare those SMEs in the broad arc of communication with the rest of SMEs (which include SMEs of the narrow arc together with the SMEs of the asymmetric arcs), differences in innovation are also obtained. In both cases, the SMEs in the broad arc are perceived better in innovation than the SMEs in the narrow arc and the rest of SMEs. This difference is also perceived in those SMEs that communicate with their suppliers compared to those who do not communicate as much with them. In these cases, the exchange of information with main customers and suppliers, or at least with suppliers, results in greater innovation in these firms than in their competitors. The other combinations between arcs and performance indicators did not show significant differences. These results allow us to partially support the proposed hypothesis.

### Conclusion

SMEs are characterised by limited management skills in creating and maintaining cooperative activities (Chun and Mun, 2012). Therefore, they need to change their attitude and create a new business culture that encourages knowledge sharing, especially with customers and suppliers. Such circumstances seem to occur in the two most numerous arcs of communication of the SMEs in the sample which exchange information intensely with their customers and their suppliers or just with their suppliers. This fact is beneficial in both cases as these firms obtain improvements in innovation. This importance of exchanging information mainly with suppliers to innovate coincides with a substantial body of the literature, for example the work of Capó-Vicedo *et al.* (2004) and that of Corral de Zubielqui *et al.* (2018).

Therefore, the frequent exchange of information with main suppliers (arc in which the retail sector dominates while in the other arcs other services do), using mainly information technologies, is notably useful for the development of capacities for planning and managing supplies (purchase logistics of firms). This fact is very important, considering that many of these suppliers could be located in geographically separated areas from the SMEs. Although stock management is probably well structured and relatively simple, these tasks are sensitive to the internal and external uncertainty of the supply chain (Daley, 2009), particularly in a supply chain that is highly dispersed geographically, like the Canary Islands (Spain).

The adequate management of the flow of information along the supply chain makes even more sense in service firms, the predominant sector in this study, which are also located in geographically differentiated and fragmented territories. Service firms, less studied in the literature on information sharing in supply chains, do not require such extensive transportation planning and performance or such physical manipulation as industrial firms, but instead focus on the manipulation of information and the development of relationships (Shing *et al.*, 2014). Thus, when we are faced with a service supply chain, the use of information generates the most basic and, at the same time, critical for performance such as facilitating the management of the service supply chain itself (Choi *et al.*, 2016).

	DIF measure	DIF SE	DIF measure	DIF SE	DIF size	Prob.
Innovation	Broad arc (HIGH CUST_SUPP) -1.22	0.24	Narrow arc (LOW CUST_SUPP) -0.22	0.29	-1.00	0.0124
Innovation	Broad arc (HIGH CUST_SUPP) -1.22	0.24	Rest of SMEs -0.43	0.19	-0.79	0.0127
Innovation	Low supp -0.14	0.25	High supp -1.07	0.19	0.93	0.0039

**Table IV.**  
Significant differences:  
arcs of communication  
and SME performance

The rest of SMEs in the sample do not achieve major differences in their performance by information sharing. Thus, managers should be clear that a valuable resource for an organisation, like knowledge, is not only internal. On the contrary, firms' knowledge is supported by a knowledge chain model which includes customer, supplier and, even, competitor knowledge (Tseng, 2009). Therefore, these SMEs do not include a strategic vision of supply chain management and do not pay attention to the concepts, systems, tools and methods of an effective and efficient supply chain (Arend and Wisner, 2005, Vaaland and Heide, 2007). In this same sense, Hong and Jeong (2006) state that, in practice, the percentage of application of supply chain linkages in SMEs is low due to knowledge deficiency.

In particular, the cost and complexity of implementing information exchange systems along the supply chain are important barriers to improving performance (Fawcett *et al.*, 2007), especially in the case of SMEs with their lack of resources and skills (Surowiec, 2015). Thus, the poor implementation of supply chain management by SMEs leads to worse performance than when large firms establish inter-organisational relationships in their supply chains (Arend and Wisner, 2005; Vaaland and Heide, 2007). In this sense, Rezaei *et al.* (2015) and Surowiec (2015) point out the existence of a negative relation between the supply chain management and the SME performance.

### **Practical implications**

One of the managerial implications of this paper is the recommendation for an appropriate strategic management of the links SMEs have with their main customers and suppliers. Without a greater implication in their supply chain or a more in-depth information-sharing strategy as large firms have, SMEs will achieve fewer advantages from sharing (Arend and Wisner, 2005). Thus, information sharing will make a smaller contribution to their performance. More importantly, if that exchange of information goes beyond the information on orders and focuses on strategic information, all involved parties will obtain benefit from it (Klein and Rai, 2009).

One of the ways to improve could be to establish common objectives and strategies among the parties involved in developing a whole or chain system vision. This is a key factor in information sharing (Samaddar *et al.*, 2006) and involves building communication systems for the effective exchange of information (Hsu *et al.*, 2009). They could even create virtual teams with their main customers and suppliers. These teams could allow joint commitment, a feeling of mutuality, trust and creativity, and rapid decision making to operate within a supply chain with geographically separated members (Gunasekaran and Ngai, 2004). This may be the case of the Canary Islands, or anywhere in the world where the main customers and suppliers may be located both near a firm and in geographical areas further away from it. In short, if a firm's supply chain is managed as a system and coordinated through knowledge-based collaboration, the firm will improve its performance and the supply chain as a whole will improve its effectiveness (Singh and Power, 2014).

Along these lines, public administrations should also become involved. For this, public administrations should create and promote common meetings and debating points like trade fairs, conferences, etc., given that trust between firms is necessary to have the will to share information and develop a joint vision. This is best achieved with face-to-face encounters (Fawcett *et al.*, 2007). They could also help to train SME managers/entrepreneurs in human resources practices (Surowiec, 2015), in new information technologies and in professional social networks, such as LinkedIn or Online Public Forums, which would allow them to be in touch and informed.

### **Future research lines**

The results point to the need to review the processes of dissemination and application of information within SMEs once it has been obtained by managers. In this sense, it could

be determined whether SMEs have difficulties with internal knowledge integration (Singh and Power, 2014). Likewise, one could begin to reflect and resolve the absence of a systematic process of knowledge management that characterises many SMEs (Wang and Yang, 2016).

Moreover, it is important to analyse if the kind of information shared by SMEs with their customers and suppliers (e.g. operational, tactical and strategic) is aligned with the strategy of the firm and its supply chain. This could be another way of explaining the performance of SMEs.

As well as shared information, another important characteristic to consider in inter-organisational links is the trust between the members of a chain. Additionally, future approaches could include the uncertainty of the business environment, the uncertainty of the supply chain (Flynn *et al.*, 2016, raise several types of uncertainties) or the geographical dispersion of the chain as determinants in the relationship between shared information and SME performance

Finally, comparisons could be made with SMEs located in other geographical areas, with other cultures, other political conditions and, in general, other environments; but which also have supply chains characterised by their distance and spatial fragmentation (high geographical dispersion) as in the Canary Islands.

In short, the exchange of information in itself is not enough to improve performance but also depends on the quality of this information (Li and Lin, 2006), on socio-economic dynamics and the nature of the inter-organisational relationships (Mason *et al.*, 2006), among other aspects. As recommended by Yigitbasioglu (2010) and Wong *et al.* (2012), it would be necessary to adapt the exchange of information to certain contingency factors.

## Notes

1. The conceptual debate between data, information and knowledge could be relevant when dealing with approaches from information systems, organisational learning or knowledge management. In addition, it must be taken into account that even from a semantic point of view these terms are not clearly differentiated. For example, for Lotfi *et al.* (2013), the term “information sharing” can also be called “knowledge sharing”. In Kembro and Näslund (2014), the main definitions of “information sharing” in supply chains can be consulted as a further reflection of the lack of uniformity in this regard.
2. Lotfi *et al.* (2013) and Simichi-Levi *et al.* (2009) list the benefits of information sharing along the supply chain.
3. Micro-enterprise (0–9 employees), small enterprise (10–49 employees) and medium-sized enterprise (50–250 employees).
4. Collaboration Agreement between Universidad de La Laguna and Confederación Provincial de Empresarios de Santa Cruz de Tenerife (Santa Cruz Regional Business Confederation).
5. In Wang *et al.* (2015), an extensive review of the operational models of service supply chains is given.
6. The logit is the measurement unit used in the Rasch Measurement Theory.
7. The Rasch Measurement Theory (Rasch, 1960/1980) and its application through the Winstep program provide a reliability index for individuals, and another for item reliability. Both indices are expressed in model and real terms, which respectively represent the upper and lower limits of the interval in which the true reliability is found (Linacre, 2004).
8. OUTFIT values reflect the sensitivity of the model to unexpected behaviours that affect responses to items that are far from the measurements. INFIT values are sensitive to unexpected behaviours that are close to the measurements (Wright and Mok, 2004). Both can be expressed in terms of MNSQ (mean-square) and ZSTD (standardized z values).

9. Point-measure correlations (PTMEA) is the correlation between the observations of an item and the corresponding measure of the items (Linacre, 2009). Rasch-residual-based Principal Components Analysis (PCAR) shows the contrast between opposite factors, not the load on a factor (Linacre, 2009).
10. Due to limited space, the sample measurements were not included but are available if the reader is interested.
11. To operationalise the arcs of communication, the mean of each of the Rasch Measurement Theory applications was identified by dividing the high and low communication with main customers and suppliers, since the logits of both applications are not equivalent. In this way, we understand that communication carried out by SMEs with main customers and/or suppliers (SMEs Rasch measurement) is high when it has occurred with a greater frequency than the mean of the sample of SMEs. By contrast, this communication is low, when the frequency of the information exchanged by the SME with its main customer or supplier has been lower than that carried out by the sample mean.
12. Differential item analysis (DIF) is an additional study tool provided by the Rasch Measurement Theory (Rasch, 1960/1980). The analysis of the residuals derived from the process of fitting data to the model allows the presence of differential items in a sample group to be noted. The estimation of DIF is carried out using a hypothetical test to determine if the differences in the location measurements of the items of each subsample are significant. In this case, we check if items corresponding to the dimensions of SME performance behave differently depending on the SMEs groups based on their arc of communication.
13. SUPP = suppliers; CUST = customers.

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