Trust as a nucleus key for open innovation

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Abstract
This research aims to provide guidance for the management of supply chains to improve the likelihood and extent of open innovation, and the management of trust with regard to coupling the potential role of the customer, competitors and suppliers to increase supply chain performance. It is the purpose of this study to introduce a model for applying open innovation privileged in supply chains. Through the understanding of the level of open innovation inside the Egyptian organizations – namely the automobile industry – it will investigate if there is a difference in the level of trust held between different trust types. A survey using an extant study is undertaken at multinational automobile assembly lines in Egypt.

It involved one type of questionnaire completed by the middle managerial level. The presented model identifies a relationship between trust and open innovation in supply chains. Consequently, it could lead to the enhancement of customer satisfaction, an increase in internal customer performance and the development of innovative products. This explorative study also indicates that multinational automobile assembly lines working in Egypt are willing to apply the right amount of open innovation. The study is based on a relatively small sample of limited geographic scope (one country: Egypt), and of a short duration (one-year coverage). Future research should expand the geographic coverage to other parts of the world and prolong the duration. Internal resistance is more of a barrier than external resistance (customer, supplier or competitors) to open innovation. Thus, organizations should focus first on internal (functional) integration, and then move onto inter-organizational integration. Furthermore, people are more critical than technology in implementing open innovation. There is little empirical research on open innovation implementation. Practitioners and researchers should find value in this unique comparative study.

Introduction
Innovation is pivotal to survival and success in dynamic and complex organizational environments (Rowley, 2011). Open innovation allows the fostering of collaboration with customers, suppliers and other innovation sources, as well as assisting in competitor collaboration, to the benefit of everyone (Inauen & Wicki, 2011). According to Chesbrough (2003), companies would benefit more from integrating an open innovation strategy by making 'greater use of external ideas and technologies in their own business, while letting their unused ideas be used by other companies'. In theory, new ventures that would otherwise sit on a shelf and collect dust would flourish amidst open business models that reach beyond corporate boundaries to garner and commercialize valuable ideas, technologies, insights, capabilities and

assets from consumers, experts, external partners, and even competitors (Muller, Hutchins & Cardoso Pinto, 2012).

Conversely, open innovation models have emerged to support the creation of organizations with the ability to compete, and the opportunity to provide sustainable value to the environment (Chesbrough, 2003) and the internal organization. The notion of open innovation revolves around the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation respectively.

Consequently, trust plays a key role for assisting the process of smooth flow between different parties. Trust is identified as an important prerequisite for developing inter-organizational relationships that facilitate inter-firm knowledge exchange (Fukuyama, 1995). Beyond trust within organizations, the increasingly frequent cooperation and collaboration among organizations requires high degrees of trust among different parties (Niu, 2010). Therefore, investigating the role of trust in supply chains and its impact on collaboration provides a better insight into supply chain management (Ha, Park & Cho, 2011). Accordingly, this study focuses on improving that role of trust in open innovation as one of these newly explored topics.

Literature review

This section will shed the light on open innovation and trust previous literature.

Open innovation

Firstly, it is important to define the concept of open innovation to understand what it really means. Chesbrough defined open innovation as a paradigm that assumes that firms can, and should, use external and internal paths to market and ideas to advance their technology (Sloane, 2011; Chesbrough, 2006; Chesbrough 2003).

Innovation is widely recognized as one of the key areas for continued success (Christensen, 1997). Research has shown that competitive companies are rapidly increasing their investments in innovation (Buganza & Verganti, 2009). However, in difficult and dynamic economic markets, simple innovation is not enough: traditional research models, with their closed boundaries regarding all discoveries and internal knowledge, are not sufficient enough to support organizational growth (Bigliardi, Dormio & Galati, 2012).

Open innovation as a model and as a new paradigm was first introduced by Henry Chesbrough (2003). He defined it as 'the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively' (Chesbrough, 2006). Gassmann & Enkel (2004) structured open innovation in terms of three basic processes: the inside-out process; the outside-in process; and the coupled process.

Rigby and Zook (2002) pointed out four key benefits of open innovation: the inflow of lateral and new ideas that may lead to innovation; the outflow of ideas that may generate revenues, as well as attract new talent; the early exposition of an idea to the market that would allow firms to asses interest and gain important insights as to whether to increase investment; and the inflow and outflow of ideas that allows a company to identify, and focus on, its core innovative assets.

The concept of open innovation encompasses different dimensions, and most studies agree on identifying two main dimensions: the inbound and outbound dimensions (Bigliardi, Dormio & Galati, 2012). Laursen and Salter (2006) introduced the notion of breadth and depth analysis to the level of innovation practices within organizations. Ebersberger et al. (2010) expanded this approach through capturing open innovation practices on seven dimensions: external sourcing (breadth and depth); search (breadth and depth); collaboration (breadth and

depth); and protection (breadth). West, Vanhaverbeke and Chesbrough (2006) suggested five levels of analysis of open innovation: individual and groups; implications for firms; inter-organizational value networks; industry or sector; and national institutions and innovation systems. Ili et al. (2010) focused on the industrial level of analysis and defined four dimensions: external sources for innovation; operations and processes; external exploitation; and personal opinion on future trends on the firm's and industrial level. Gassmann, Enkel and Chesbrough (2010) found that open innovation is based on different research streams, and they organized them into nine perspectives: spatial; structural; user; supplier; leveraging; process; tool; institutional; and cultural. Hällbrant and Ingvarsson (2012) identified four different dimensions from the previous scholars: formal; informal; physical; and structural.

Trust

Numerous authors have attempted to define trust as an initial element for enterprises success (Lindgreen, 2003; Geyskens & Steenkamp, 1995; Gulati, 1995; Ganesan, 1994; Ring & Van de Ven, 1994; Moorman, Zaltman & Deshpande, 1992; Anderson & Narus, 1990; Shapiro, 1987; Bagozzi, 1974). Barber (1983) noted that the word 'trust' is commonly used 'freely and earnestly', and also argued that words often used as synonyms sometimes incorporate one or more of these meanings leading to 'a verbal and conceptual morass'. Mayer, Davis and Schoorman (1995) argued that 'several terms have been used synonymously with trust, and this has obfuscated the nature of trust. Amongst these are co-operation, confidence and predictability'.

Trust is not a singular concept: many different forms play an important role, but all involve taking a risk (Farrior, 2005). Johnson and Grayson (1999) propose four types of trust: generalized; system; process-based; and personality-based. Lindgreen (2003) argued that there are three types of trust: system; process-based; and personality-based. Svensson (2001) argues that the importance of trust can be explained by the fact that it is seen as a phenomenon that contributes to the strength of interpersonal relationships, intra-organizational relationships and inter-organizational relationships in supply chains.

Trust is moreover a multidimensional concept (Corazzini, 1977) that has been found to contain various dimensions that make up the construction. There has been a wide range of publications that propose different dimensions of trust (Coleman, 1990; Gambetta, 1988; Zaltman & Moornan, 1988; Swan & Trawick, 1987; Hart et al., 1986; Jackson, 1985; Luhmann, 1979; Zand, 1978; Deutsch, 1960; Strickland, 1958). These dimensions can be categorized into five according to the conceptual framework of trust dimensions developed by Swan and Trawick (1985): dependability/reliability; honesty; competence; customer orientation; and friendless. These five dimensions were later used by Svensson (2001) to measure companies' perceived trust towards suppliers and customers in supply chains.

Trust is seen as central to a successful relationship; it leads to higher levels of loyalty from the bargaining partner and thus to increased profitability, because it encourages partners to cooperate, seek long-term benefits and refrain from opportunistic behaviour (Lindgreen, 2003; Geyskens & Steenkamp, 1995; Morgan & Hunt, 1994; Anderson & Weitz, 1992).

Purpose and theoretical approach

This study aims to provide guidance for the management of supply chains to improve the likelihood and extent of open innovation, and the management of trust with regard to coupling the potential role of the customer, competitors and suppliers to increase supply chain performance. It is the purpose of this study to introduce a model for applying open innovation privileged in supply chains. Through the understanding of the level of open innovation inside the Egyptian organizations – namely the automobile industry – it will investigate if there is a difference in the level of trust held between different trust types.

As a result, this research will answer the following core question: How dose trust plays a key role in supply chains' willingness to apply open innovation?

Based on the nature and the purpose of this study, a qualitative research method was applied to the essay format; the numerical scoring and grading was studied using a quantitative approach; the two result pools were then joined together. In addition, the study's model is an interview guide spread over a period of one year submitted to multinational automobile assembly lines companies working in Egypt. It involved one type of questionnaire, provided across middle managerial level to inspect the goodness of fit of the research model.

The study hypotheses are:

'H_1': There is a difference in the level of trust between customers, suppliers and competitors.

'H_2': There is a difference in the level of trust between inter-organizational and correlated interpersonal.

'H_3': There is a significant correlation between innovation, shared values, sharing knowledge and open innovation.

'H_4': There is a significant relation between trust and open innovation dimensions.

The research structure can be summarized within Figure 1:

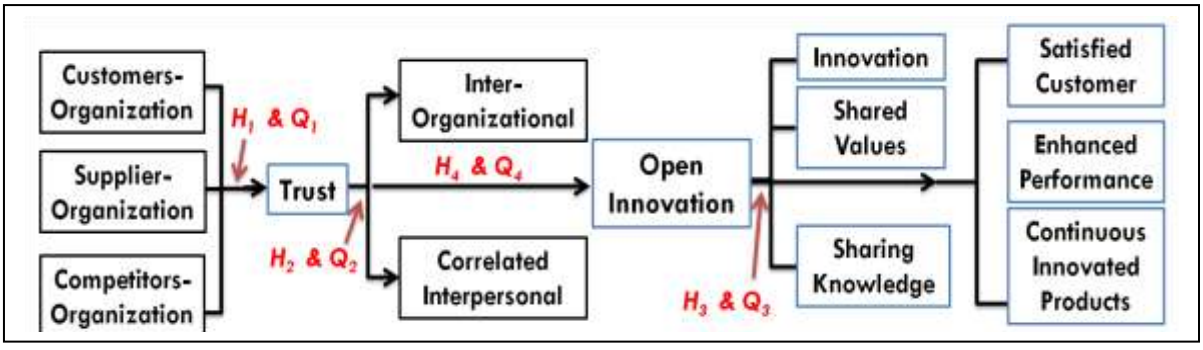

Figure 1: Research structure.

Research Methodology

The study was carried out empirically whereby the hypotheses were tested at the automobile multinational companies in Egypt. 150 questionnaires were distributed across four companies to middle line managers in all the departments; 107 valid and complete questionnaires were returned. The questionnaires were distributed via mail and through field visits to these companies over the period of one year.

Automobile multinational companies in Egypt selected for the research study are specialized in the assembly of the car components through the usage of advanced technologies and an environment of innovation potentials, as well as a culture that fosters employees' motivational performance.

To investigate the research questions and hypothesis as shown in Figure 1 and the proposed model as shown in Figure 2, structural equation modelling (SEM) is used, as it has numerous advantages in data analysis from other multivariable statistical approaches such as multiple regression, paths analysis, analysis of variances and discriminate analysis. According to Bryne (2001), SEM allows the evaluation of complex and multidimensional relationships among variables, which is the only analysis that allows a complete test of all relationships and, by extension, the casual model. Moreover, it has the ability to represent unobserved concepts in these relationships, and account for measurement errors in the estimation process (Hair et al., 2010). By allowing constructs to be represented by several measures, the researcher is provided

with a more realistic and valid means of construct operational insertion. Therefore, it allows the researcher to identify the true relationship after measurement error is accounted for.

SEM does not use a single goodness-of-fit criterion to assess model fit between the hypothesized model and the sample data; nor does it use a single goodness-of-fit criterion to assess model fit between the hypothesized model and the sample data. According to Hair et al. (2010), goodness of fit measures the correspondence of the actual or observed input (covariance or correlation) matrix with that predicted from the proposed model. They mentioned that using multiple fit measures would help the researcher to assess whether model fit was absolute fit, incremental fit, parsimonious fit, fit measures based on the non-central Chi-square distribution or the Hoelter measure.

The Role of Trust on Open Innovation Model

Based on the previous literature review, open innovation includes customer input, crowd-sourcing, open-source projects, patent acquisitions, soliciting external insights, supplier integration, venture investing and joint development projects. The myriad options for engaging external partners can be daunting, so leaders need a guide for getting started with open innovation that matches the needs of their firm (Muller, Hutchins & Cardoso Pinto, 2012).

This study argues that the core variables for identifying whether the supply chain intend to openly innovate are presented in Figure 2.

Figure 2 is based on considering trust as a central element needed in the interior and exterior of the organization to allow the flow of information and knowledge between different parties of the supply chain. If this were the case, open innovation would be applied.

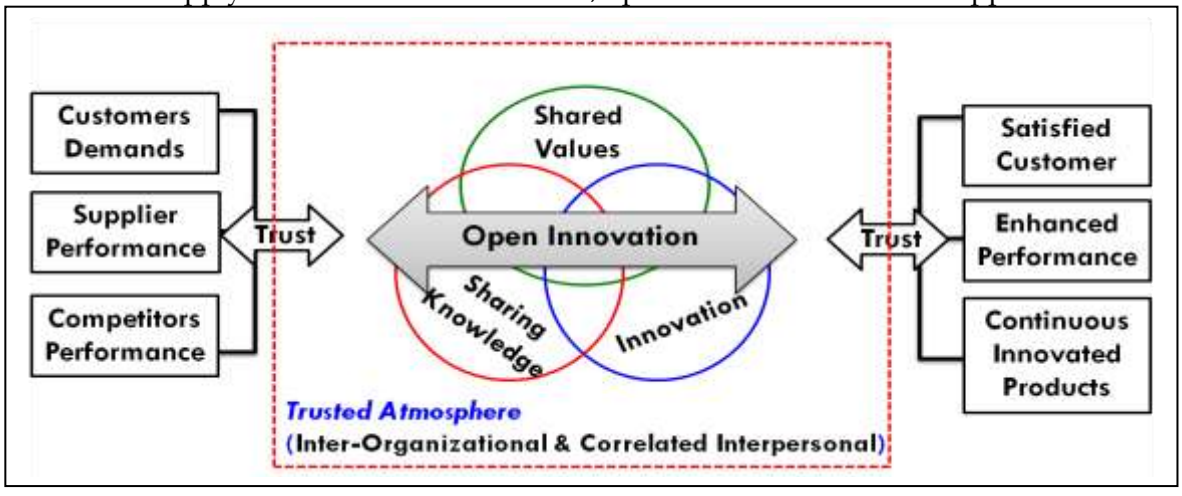

Figure 2: The role of trust in the open innovation model.

Factors for optimum apply of open innovation in supply chains

Supply chains for the optimum applying of open innovation are influential in starting to make the change from a market-share mindset to a competence-based mindset (Later et al. 2010; Chesbrough, 2003). All the knowledge necessary for creating innovations is no longer present within the firm's boundaries (Grøtnes, 2009). Besides using external ideas, knowledge and technology in the innovation process is at the centre of the open innovation model, and open innovation is almost by definition related to the establishment of ties with external parties (Hällbrant & Ingvarsson, 2012; De Jong et al., 2008) since they need to acquire knowledge from other sources (Grøtnes, 2009).

Based on a study by Shamah and Elsawaby (2014), trust is considered as a core factor when intending to apply open innovation. Feeling trust in relationships is fundamental to the effective flow of knowledge (Hällbrant & Ingvarsson, 2012; Azeredo, 2009), though Lee et al. (2009) clarify 'mutual trust in a cooperative relationship is essential to its ultimate success'. In this study, we support the idea that trust reflects the cooperation relationship between supply chain members in the research model, and refers to a firm's belief in having confidence in its partner's reliability and integrity leading to positive outcomes (Cheng, Yeh & Tu, 2008; Morgan & Hunt, 1994; Anderson & Narus, 1990).

Trust is noticed on two different levels according to Shamah and Elsawaby (2014). The first level is interior organizational trust, or internal trust (IT), and can be divided into two sublevels: inter-organizational trust (with a large extent of formalization); and correlated interpersonal trust, which is based on the individual level (i.e. how successful a company is in bringing people together into an arena) (Hällbrant & Ingvarsson, 2012). Trust theory has clearly established the important role of trust in organizational effectiveness (Nyhan, 2000; Shockley-Zalabak, Ellis & Winograd, 2000).

The second level is exterior organizational trust, or external trust (ET), and can be divided into three sublevels> The first is customer-organization trust, which refers to emphasizing customer involvement and co-creation in the development process (Maklan, Knox & Ryals, 2008) – customers are paying an increasing amount of attention to product options, design and even aesthetic, symbolic or emotional meanings of products (Dell'Era, 2010; Reinartz, Krafft & Hoyer, 2004). Secondly, supplier-organization trust is another significant element of a successful supply chain partner's relationship (Laeequddin & Sardana, 2010; Varma, Wadhwa & Deshmukh, 2006; Gounaris, 2005; Svensson, 2004; Sahay, 2003). Spekman and Davis (2004) looked at supplier-organization trust by considering trust as a mechanism enabling managers to achieve organizational openness (Laeequddin & Sardana, 2010). Trust reflects the fact that if a manufacturing firm trusts its partner, it will get its partner actively involved in the decision-making processes, and share its knowledge proactively in order to make decision-making effective, thereby reducing uncertainty. Finally, competitor-organization trust refers to competitiveness that reduces social uncertainty and vulnerability (Mollering, 2004). For all levels of analysis, active parties must be exposed to risk to some extent for trust to become operational (Doney & Cannon, 1997). In operational terms, trust implies the belief that the other partner is honest and sincere (Pimentel Claro, De Oliveira Claro & Hagelaar, 2006).

Based on a forthcoming study by Shamah and Elsawaby (2014), open innovation corresponds to three main dimensions: innovation; shared values; and sharing knowledge.

Innovation

Innovation is a complex concept since it is identified as the main driver for companies to prosper, grow and sustain a high profitability (Elmquist, Fredberg & Ollila, 2009; Christensen, 1997; Drucker, 1988). Additionally, the innovation process is the implicit side of identifying an opportunity and the creation of its accompanying business model (Muller, Hutchins & Cardoso Pinto, 2012).

Shared values

This refers to the extent to which partners have common beliefs about what behaviours, goals and policies are important/unimportant, appropriate/inappropriate and right/wrong (Morgan & Hunt, 1994). When supply chain members have the same perceptions about how to interact with one another, they can avoid possible misunderstandings in their communication, and have more opportunities to exchange their ideas freely (Cheng, Yeh & Tu, 2008; Tsai & Ghoshal, 1998).

Sharing knowledge

Knowledge is considered a main resource; most new innovations happen when boundaries of knowledge domains are crossed (Antikainen, Mäkipää & Ahonen, 2010; Carlile, 2004; Leonard-Barton, 1995). Knowledge demonstration is important for participants to be able to communicate with those who have different backgrounds and knowledge levels. In supply chains, co-providers may fill in knowledge needs rapidly with minimal effort to develop it internally, or acquire it through vertical integration (Hällbrant & Ingvarsson, 2012).

Firms should look for new sources of knowledge, markets and outlets for their existing products and intellectual property rights (IPR), and should collaborate with others (e.g. customers, rivals, academics and firms in unrelated industries) in the process (Grøtnes, 2009).

External relations affecting open innovation

Numerous studies have focused on improved innovative performance as a result of collaborations with clients, suppliers and competitors. Such relationships often link companies in 'distant' industries (Buganza & Verganti, 2009; Bonner & Walker, 2004; Olson & Bakke, 2001; Hagedoorn, 1993). Open innovation models allow the fostering of collaboration with customers, suppliers and other innovation sources, which benefits everyone (Inauen & Wicki, 2011).

Research has concentrated on networked innovation between companies (Hellström & Malmquist, 2000). The basic idea behind this is that entrepreneurial teams – which combine different personalities, knowledge, skills and backgrounds – are more likely to accomplish an innovation than homogeneous teams (Antikainen, Mäkipää & Ahonen, 2010; Vyakarnam, Jacobs & Handelberg, 1997).

Suppliers and provider perception

Companies who are successful in identifying customer needs and wants, and can subsequently develop and bring to market products and services to address these, tend to fare better than companies that cannot (Shamah, 2012; Rogers, Singhal & Dearing, 2005; Calantone, Tamer Cavusgil & Zhao, 2002; Song, Di Benedetto & Zhao, 1999; Li & Calantone, 1998; Pooltan & Barclay, 1998).

Providers' core activities include increasing the benefits and use of products through improved quality, function or imaging, and lowering costs through production, efficiency and other means – essentially, a need to consider a change in attitude and thinking (Shamah, 2012; Kasali, 2010; Sumarna, 2010; Kasali, 2002). The capability to collaborate with multiple stakeholders from an outside environment will lead to an organization's traditional expansion towards open innovation (Rosenberg, 1994).

However, the downstream side of innovation has a strong impact on open innovation. Suppliers' early integration can comprehensively increase innovation performance in most industries (Gassmann, Enkel & Chesbrough, 2010; Hagedoorn, 2002; Hagedoorn 1993). Consequently, establishing partners is an important step in improving a company's competitive advantage and positioning in the marketplace. This would help them create new earnings logic for their service activities, and generate new and more effective ways of finding growth and revenue-generation opportunities (Grönroos & Helle, 2010). Additionally, this approach will enable the firm to change its business mission in a customer-centric direction (Grönroos, 2007). Participants bring with them their knowledge, research and development (R&D) capabilities and IPR, generating specifications for unique products, technology, procedures, systems or architectures. Accordingly, IPR must flow for open innovation to take place, as it is needed for firms to acquire new technology (outside-in) and a way for firms to let others exploit their innovations (inside-out). Without some form of protection and a way to sell their technology,

firms would not have a way of appropriating value from their inventions, and there would be no case for open innovation (Grøtnes, 2009; West, Vanhaverbeke & Chesbrough, 2006).

User perception

A compelling need for open innovation, as well as many businesses' focus on customer experience, suggests a need for innovative methods, techniques and R&D practices (Bitner, Ostrom & Morgan, 2008).

Users are integrated into the innovation process in its early phases in order to understand potential customers' latent requirements and hidden application knowledge (Hippel & Urban, 1988). This research field on innovation's downstream side started with lead users' involvement in the innovation process (Hippel, 1988), the availability of toolkits (Hippel & Katz, 2002) and the idea of mass customization (Franke & Piller, 2003), while involving the quasi-political concept of democratizing the innovation process (Hippel, 2005). As a consequence, user innovation is one of open innovation's best researched fields (Grøtnes, 2009).

Previously, market research has focused on forecasting customer acceptance of innovation and predicting the resulting changes in a company's marketing mix. Nowadays, increasingly participative approaches are emphasizing customer involvement and co-creation in the development processes (Maklan, Knox & Ryals, 2008). As such, customer relationship management has become of significant importance because price has focused attention on product options, design and even aesthetic, symbolic or emotional meanings of products (Inauen & Wicki, 2011; Dell'Era, 2010; Reinartz, Krafft & Hoyer, 2004).

Moreover, the relation perspective involves a customer experience built over an extended period of time, starting before and ending after the actual sales experience or transaction (Voss & Zomerdijk, 2007). Customers usually rely on knowledge of the total life-cycle of costs and benefits when purchasing; therefore, the service provider should consider creating the most value assess whether prospective customers are aware of this value, and then focus on capturing part of that value as profit (Shamah, 2012; O'Malley, 1998).

Competitor and provider perception

Besides resources and competences, companies and their R&D departments additionally need to be able to explore and exploit external sources of technological knowledge (Inauen & Wicki, 2011). Innovation marketplaces have arisen alongside the open innovation phenomenon. These marketplaces, or innovation intermediaries, act as mediators between different actors (companies, customers, suppliers, competitors, etc.) (Antikainen, Mäkipää & Ahonen, 2010).

Collaboration is a way to increase creativity and efficiency of innovativeness, and this is highlighted in earlier studies that have shown that collective cognition in organizations has a significant effect on individual cognitive processes (Thompson et al., 1994; Hutchins, 1991). The concept of the collective mind may explain the reasons why collective working increases efficiency, especially in high-reliability organizations (Weick & Roberts, 1993). The most basic assumption underlying collective cognition is that human thought plays an important role in human behaviour; a second assumption is that a group is an entity with psychological significance (Antikainen, Mäkipää & Ahonen, 2010; Gibson, 2001).

In this study, we are switching from a competitor view to a collaboration view. Cooperation with competitors is another common way to acquire knowledge. The scope of competitive collaboration is broad and includes strategic alliances, joint ventures, outsourcing agreements, product licensing and cooperative research (Inauen & Wicki, 2011; Hamel, 1991; Hamel, Doz & Prahalad, 1989).

An intellectual property policy for a network is a challenging arrangement. Multiple parties have different interests that must come into balance. Defining IPR enables the exchange of ideas and technologies between the many parties who possess useful knowledge (Chesbrough, Vanhaverbeke & West, 2006). In the open innovation paradigm, changes in the general role of intellectual property have been observed, particularly in patenting practices. This may be attributed to technological changes, in which IPR cease to be the only source of value capturing to firms (Perkmann & Walsh, 2007; Simcoe, 2006). Laursen and Salter (2006) conclude that openness is associated with a moderate level of appropriability through IPR; consequently, depending on the industrial sector, patents and university research may play a larger or smaller role in innovation (De Freitas Dewes et al., 2010).

After applying this model, the main results would be: getting customers satisfied; enhancing the entire supply chain performance; and providing continuous innovated products. Innovated products provides the most obvious means for generating revenues; process innovation, on the other hand, provides the means for safeguarding and improving quality, and also for saving costs. Improved and radically-changed products are regarded as particularly important for long-term business growth (Johne, 1999; Hart, 1996). The power of product innovation in helping companies retain and grow their competitive position is indisputable; products have to be updated and completely renewed for retaining strong market presence (Johne, 1999).

Scales and measurement tools used in this study

To measure open innovation, this study used the instrument developed and validated by Shamah and Elsawaby (2014). They proffered three dimensions for elaborating the existence of open innovation: innovation; shared values; and shared knowledge. They modified the instrument of measuring trust that was developed by the International Association of Business Communicators Research Foundation (IABC) (2000) to consider trust as an overall factor. For applying open innovation within supply chains, the IABC classified trust into two main divisions: exterior trust and interior trust. They also measured the validity and the reliability of the suggested measurement dimensions.

A reliability of 0.7 or higher is sufficient for our cause. The Cronbach's Alpha results from the analysis show that the output of the survey is reliable and consistent (see Table 1).

Table 1: Total reliability statistics.

Dimensions	Cronbach's Alpha	N of Items
Part 1: Open Innovation (OI)	**0.961**	**31**
1.1 Sharing Knowledge (SK)	0.947	13
1.2 Shard Value (SV)	0.936	4
1.3 Innovation (I)	0.951	14
Part 2: Trust	**0.957**	**30**
2.1 External Trust (ET)	0.947	17
2.2 Interrelated Trust (IT)	0.936	13
All items	**0.978**	**61**

Statistical results and analysis

Structural equation modelling (SEM) is gaining wide acceptance among researchers in social sciences, and is used in this study to test the presented model and the study hypotheses. SEM is a statistical methodology that allows a set of hypothesized relationships between one or more variables to be examined. It is not a single statistical technique but rather a collection of techniques, including multiple regression, path analysis and confirmatory factor analysis. This

indicates that SEM is theory driven, and can be used as a technique with reference to prior understanding of the potential relationship among variables.

In the SEM process, the researcher presumes a statistical model, which is based on theory, empirical research or a mix of both. The model which indicates a relationship between variables is expressed diagrammatically to clarify the researcher's ideas about the relationship.

The main goal of SEM is to statistically test the hypothesis' model in order to determine the extent to which it is consistent with the data obtained from the sample. If the model fits the data, then the model may be of valid use for the presumed relationships among the variables. But if the model does not fit the data, then the hypothesized relationships are rejected. Actually, most of the initial results from most applications of SEM do not support the model, so most of the researchers prefer to modify and retest their initial (casual) model rather than abandon the entire model (Lee, 2007).

The researchers highlight three popular types of goodness-of-fit measures (Hair et al., 2010): absolute fit measures; incremental fit measures; and parsimonious fit measures. According to Hair et al. (2010), the researcher is encouraged to employ one or more measures from each type. The application of multiple fit measures would help provide consensus across different types of measures regarding the acceptability of the proposed model. Therefore, this study suggested various measures within each class of goodness-of-fit measures. The cut-off values for the selected indexes are consolidated in Table 2.

Table 2: The three selected model fit measures and the cut-offs values for the models acceptance.

Fit measures	Minimum acceptable value for model fitness
1. Absolute fit measures	
Likelihood-Ratio Chi-Square statistic (CMIN, $\chi 2$)	p-value > 0.050
Normed chi-square (CMIN/df, $\chi 2$ /df)	Acceptable ratio <2-5, not over 5
Goodness-of-fit index (GFI)	No absolute threshold, recommended 0.90 or above
Adjusted Goodness-of-Fit Index (AGFI)	No absolute threshold, recommended 0.90 or above
Root Mean Square Error of Approximation (RMSEA)	Acceptable < or = 0.03 to 0.08; not over 0.1.
2. Incremental fit measures	
Tucker Lewis Index (TLI)	No absolute threshold, recommended 0.90 or above
Comparative Fit Index (CFI)	No absolute threshold, recommended 0.90 or above
Incremental Fit Index (IFI)	No absolute threshold, recommended 0.90 or above
3. Parsimonious fit measures	
The Parsimony Goodness-of-fit Index (PGFI)	No absolute threshold, recommended 0.60 or above
The Parsimony Comparative Fit Index (PCFI).	No absolute threshold, recommended 0.60 or above

SEM serves for testing and estimating causal relationships using statistical data, as well as qualitative causal assumptions. It is suited for theory testing rather than the development of a theory, which is rarely used in exploratory research. It tests the qualitative causal assumptions embedded in the model against the quantitative data in order to confirm the model.

SEM grows out of, and serves, purposes similar to multiple 1, but in a more powerful way. It takes into account the modelling of interactions, non-linearities, correlated independents, measurement error, correlated error terms, multiple latent independents – each of which are measured by multiple indicators, and one or more latent dependents (Lee, 2007).

SEM is a collection of statistical techniques that are used to examine and test the causal relationships between observed variables and unmeasured, latent variables related to the observed variables. In order to test the final model, the researcher deleted all paths of

significance to the research model in order to modify the model. All paths estimates of the observed endogenous variables were found to be significant at 10%. The new aggregate developed model is shown in Figure 3. Moreover, Table 3 shows paths estimates of endogenous variables (unstandardized–standardized), standard error, critical ratio and p-value at 1% significance. The researcher used AMOS (21.0) to estimate the research model and test all the research hypotheses.

SEM is useful for modelling the complex causal relationship between variables. In this study, SEM was used to examine the effect model. These outcomes will be used to test the study hypotheses.

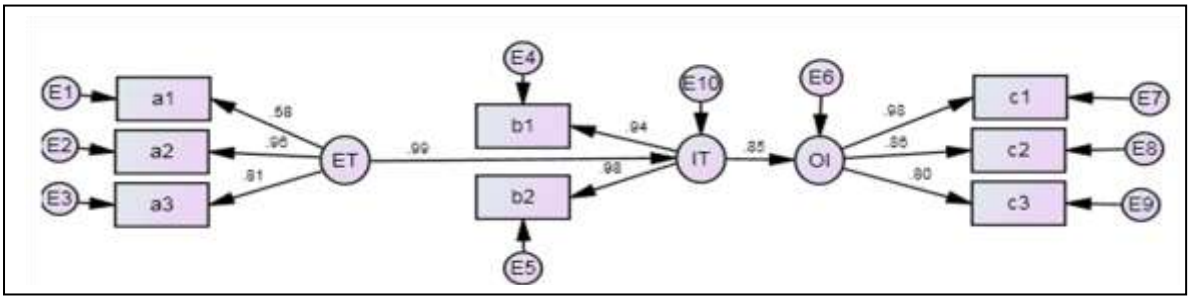

Figure (3): Path of the Full Model Using SEM

Table 3 presents paths estimates of endogenous variables (unstandardized–standardized), standard error, critical ratio and p-value (at 1% level of significance). This shows that all paths estimates of endogenous observed variables are at a significance of 1%.

Goodness-of-fit tests

It is important to first assess the model fitness, since 'significant' path coefficients in poor fit models are not meaningful. Goodness of fit should be less than or equal to 1; hence, a value of 1 indicates a perfect fit. The research model shows a relatively good fit: Chi-Square ($\chi 2$) = 31.253; Normed Chi-Square ($\chi 2$ /df) = 3.125; p-value = 0.001; Goodness-of-fit index (GFI) = 93.4%; Comparative-of-fit Index (CFI) = 98.2%. Also, the Root Mean Square Error of Approximation (RMSEA) was 0.082 (values close to zero indicate a better fit). Based on these values (H_4) is accepted.

Table 3: Paths estimates of endogenous variables.

Paths			B	Beta	S.E.	C.R.	P-Value
ET	**<---**	**IT**	1.433	.991	.210	6.829	0.000
IT	**<---**	**OI**	.992	.846	.076	13.100	0.000
ET	**<---**	**a1**	1.000	.576			
ET	**<---**	**a2**	1.771	.962	.254	6.979	0.030
ET	**<---**	**a3**	1.264	.815	.129	9.764	0.000
IT	**<---**	**b1**	1.000	.937			
IT	**<---**	**b2**	1.235	.977	.054	23.015	0.000
OI	**<---**	**c1**	1.000	.977			
OI	**<---**	**c2**	.840	.865	.056	15.129	0.000
OI	**<---**	**c3**	.826	.802	.066	12.466	0.000

[$\chi 2$ = 31.253; DF = 10; P = 0.001; GFI = 0.934; CFI = 0.982; RMSEA = 0.082].

After verifying the fit of the model, we tested the hypothesized relationships between the latent variables of the model. Three hypotheses were accepted (H_1, H_2, and H_3), as their p-values were <0.010 (Table 4).

Table 4: Summary of AMOS output for measuring the model.

Path	Estimate*	Standardized	S.E.	C.R.	P-Value
FA <--- a1	1.000	.501			
FA <--- a2	2.123	.992	.356	5.965	.000
FA <--- a3	1.328	.753	.154	8.622	.000
FB <--- b1	1.000	.963			
FB <--- b2	1.177	.948	.050	23.578	.000
FC <--- c1	1.000	.934			
FC <--- c2	.916	.899	.058	15.904	.000
FC <--- c3	.720	.706	.061	11.714	.000
Over Fit Measures: Absolute fit measures: CMIN = 47.856 DF =12, P =0.000, CMIN/DF =1.439 GFI =0.842, RMR =0.016, RMSEA =0.057 Incremental fit measures: IFI =0.932, TLI =0.838, CFI =0.931					

* Initial value to start the solution

Managerial implications

Managerial implications can be drawn from the findings of this research, which could contribute to the better practices of organizations. As open innovation is a forthcoming topic in the field of management, there is a growing trend towards this area.

First, this research highlights the importance of trust as a core element needed to be implemented to allow the flow of information and knowledge between different parties in a supply chain. Second, it introduces a model for applying open innovation, which closes an identified gap and therefore adds significant value to the management body of knowledge. As a result, this research has an impact on the literature of open innovation and supply chain management.

Third, a key word regarding the management of open innovation in supply chains is 'trust', as it enhances the chances to achieve mutual understanding and is essential for the proper functioning of the systematic efforts for different parties. Trust can be noticed on two different levels. Firstly, the level of interior organizational trust can be devoted to two sublevels: inter-organizational trust and correlated interpersonal trust. The second level is exterior organizational trust and can be divided to three sublevels; customer-organization trust; supplier-organization trust and competitor-organization trust.

Fourth, knowledge integration was mentioned as a central concern in open innovation to understand knowledge inputs from diverse sources and being able to develop ideas.

Finally, every organization should look at decisions and opportunities through the lens of shared value. This will lead to new approaches that will generate greater innovation and growth for companies.

Recommendations

For enterprises in the process of applying or considering to apply open innovation (almost every company can implement open innovation, but to a limited extent), it is a matter of the degree of openness. As such, we would like to recommend the following guidelines:

- As trust is a fundamental critical factor that is present in all aspects of open innovation, a company has to adopt potential strategies to improve trust that are likely to promote collaboration through creating a platform of respect, ensuring increase partner cooperation, and developing understanding between stakeholders.
- Companies should transform their customers into a trusted enterprise network that shares experiences, knowledge and requirements openly with the company, so that the company can satisfy their customers' needs.
- Integrating a certain number of ideas and technologies from external sources through acceptance of external ideas and top-down targets.
- The commitment of top levels of management is one of the most important key factors for implementing open innovation. This can be done through sustainable support.
- Creating awareness among all employees of potential benefits through a top-down strategy that opens up the innovative process.
- Create shared values through virtual alliances leaders that have a vision, inspire possibilities in partners, and increase innovation.

Conclusion

Open innovation is a concept that has recently attracted a lot of attention, both in practice and in academia. One of the main reasons is that the concept fits very well alongside many trends in the broader management arena. Many studies published in the past decade provide lots of useful insights, and many more studies are currently available as working papers. Therefore the purpose of 'Trust as a Nucleus Key for Open Innovation' is to gain a better understanding of how we could apply open innovation through the existence of trust to facilitate the flow of information between different parties. Open innovation can improve enterprises' performance; however, we continue to be frustrated by the large and persistent gap between potential and results. To be sustained, open innovation requires a specific set of institutional mechanisms.

However, the suggested model has been analysed to improve the dimensions of open innovation. We assumed that the implementation of such models is influenced by external and internal trust perspectives. Existing models expose the experiments that enterprises are facing in their decision processes concerning the implementation of open innovation models.

To conclude, open innovation in supply chains is a process that helps organizations find, select, organize, disseminate and control its resources in order to gain business advantage through environmental phenomena.

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