

Effect of networks on product innovation: Empirical evidence from Indonesian SMEs

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Abstract. Innovative companies generally establish linkages with other actors and access external knowledge in order to benefit from the dynamic effects of interactive processes. Using data from 198 furniture and software firms in Indonesia, this study shows that the quality of interaction (i.e. multiplexity) as indicated by the depth of knowledge absorbed from various external parties and intensity of interaction (i.e., tie intensity) are better predictors of product innovation than the diversity of interaction.

Keywords. informal network, multiplexity, tie intensity, tie diversity, product innovation, Indonesia, developing country.

1 Introduction

In a globalized and knowledge-based economy, firms continuously need to increase efficiency and to innovate in order to improve their competitive advantage and to survive (cf. Veryzer, 1998). Accelerated product life cycles and increased product obsolescence in combination with rapid introduction of new and improved product versions increasingly call for fast responses. Technical lead times are often so long that there is a serious risk that a market may be lost before a proper response has been made. Innovation should therefore be performed as effective and efficient as possible (Postma et al., 2012). The knowledge-based theory argues that knowledge is the key resource in such a context.

In a world of increasing competition a firm cannot rely only on its own resources, capabilities and existing knowledge base, mainly consisting of the knowledge of its employees. These so-called internal factors include, for instance, a firm's inherited capacities, such as skills, routines, and the accumulated expertise and experience of its workforce (Webster, 2004; Waalkens, 2006), as well as the technological competences and appropriability conditions (see Vega-Jurado et al., 2008). Moreover, a firm might benefit from the knowledge of external actors (Inkpen and Crossan, 1995; Lane and Lubatkin, 1998; Larsson et al., 1998). Indeed, three streams of research can be distinguished here: the first stream focuses on the use of external sources for innovation; the second concentrates on internal capabilities and processes that determine firms' innovation activity (Colombo et al., 2011); and the third combines the two streams by considering both internal and external sources (Cassiman and Veugelers, 2006). This paper can be placed in the first stream of research. From the external point of view, innovative companies establish linkages with other actors access external knowledge and learn in order to benefit from the dynamic effects of interactive processes (Pfeffer and Salancik, 1978; Caloghirou et al., 2004; Waalkens et al., 2008). In other words a main issue here is the transfer of

knowledge and the absorption of knowledge from interaction with dispersed external parties such as suppliers, competitors, buyers, online communities, and public knowledge institutions like universities (Meeus et al., 2001).

Interaction is triggered when a firm is in need of resources from the external environment in order to survive. The main reason for a firm to interact with other organizations is because it needs to access external sources to improve its capabilities and exploit opportunities (e.g. Chesbrough et al., 2006). Molina-Morales and Martinez-Fernandez (2010) argue that the use of externalities, such as public research can be used as inputs for an organization's innovation are not widespread and differ across sectors. They performed their research relating social capital to innovation in a specific industrial district research setting in Spain and established the relevance of social capital factors like social interactions for innovation. An understanding of the contribution of external networks to innovation is essential for the effective management and functioning of these networks. Morone and Taylor (2012) conceptualize the issue of knowledge integration which might affect a firm's innovation and suggest a research agenda on the subject of external knowledge integration and innovation. We concur with this and take up the challenge by exploring it and how external knowledge networks affect product innovation.

Building on this, our research is aimed at assessing the impact of social interaction in the form of an external network as represented by the social ties, between the owner-manager (hence OM) – which is in effect social capital as defined by Leenders and Gabbay (1999) – and a diverse set of network partners on a firm's performance in terms of product innovation. This study seeks to answer the following question: *do network characteristics (i.e., tie diversity, tie intensity, and multiplexity) contribute to product innovation?*

By using a survey held at 198 OMs of firms in the furniture and software sector in a certain region in Indonesia, we examine the effect of informal networks built upon interaction between the OM and their external parties. The furniture sector represents less-knowledge-intensive firms, while the software sector acts as exemplary for more-knowledge intensive firms (Alvesson, 2004).

In the next section, we discuss the relevant concepts we use in this paper and derive the hypotheses to be tested. Section 3 discusses the methodology for this study. We present the results in Section 4. Section 5 concludes the paper.

2 Theoretical Framework

2.1 Innovation: stage, output, and level of newness

The business innovation literature offers various classifications of innovation (e.g. Avermaete et al., 2003; Johannessen et al., 2001; Schumpeter, 1934). Some authors (e.g. Avermaete et al., 2003; Porter, 1990; Veryzer, 1998) discuss innovation from the perspective of output (e.g. product, process, organizational), while others (e.g. Jansen et al., 2006; Veryzer, 1998) describe the concept in terms of the degree of change (i.e. radical new, really new and modified/incremental). Developing radical new products is fundamentally different from developing incremental new products. While both involve learning, this fundamental difference is reflected in two incompatible learning processes: exploration and exploitation (March, 1991). Following March (1991), exploration encloses processes such as search, variation, risk taking, experimentation, play, flexibility, discovery and innovation, whereas exploitation includes such things as refinement, choice, production, efficiency, selection, implementation and execution. Yet another perspective used in capturing the dynamic process of

innovation is that of the various stages of innovation.

As indicated, innovation can be the output of initiatives within a firm. Porter (1990) argues that a firm is a collection of activities that are performed to design, produce, market, deliver, and support its product. Innovation output can be distinguished into three types: product, process, and organizational innovation (Avermaete et al., 2003; Porter, 1990). Product innovation can be considered as any good or service that is perceived by an individual or a firm as new (Kotler, 1991). This means that it is possible that one person or organization may regard a product as an innovation while another party does not (Johannessen et al., 2001). For instance, new designs of chairs/tables or software may be perceived as a product innovation.

Furniture and software SMEs in Indonesia are usually “make-to-order” manufacturing firms, because of the nature of their products and their relationship with their buyers. This actually means that a firm is producing high variety products in relatively low volumes and products are manufactured to customer design and specification (Hendry, 1998). Furniture and software firms disclose more products-related innovation than process and organizational innovation (e.g. Van Geenhuizen et al., 2010). In Tanzania, Kristiansen et al., (2005) found dominance of product innovations over process and organizational innovation among small garment and furniture firms. Ebensberger and Herstad (2011) state that product innovations provide the better benchmark for investigating external learning interfaces. In the following we will discuss the effect of network on innovation.

2.2 Network: parties involved and characteristics

Essentially, a social interaction is any contact or relation that an actor or employee from one firm keeps with other actors or employees from other firms which can affect their access to and use of knowledge resources of the firm (Molina-Morales and Martinez-Fernandez, 2010:268). As indicated, in this paper, we take the perspective of the OM of a firm and his or her external network. A business network is a structure where in a business context a number of nodes is related to each other by specific threads, the threads can be considered the relationships between the network parties (such as producers, customers, service companies and suppliers of finance, knowledge and influence). This network is the result of complex social interactions between companies in relationships over time; each company is therefore embedded in a network of relationships (Ford et al., 2003).

Extant literature on firms' networks (e.g., Dyer and Singh, 1998; Dyer and Nobeoka, 2000; Levinson and Asahi, 1996) has widely discussed and accepted networks of firms as loci for innovation, knowledge creation and inter-organizational learning (Podolny and Page, 2000). A firms' innovation network consists of a collection of (often small) autonomous actors that pursue repeated and enduring reciprocal exchanges aimed at creating new or better products, services for final markets or creating new or improving production and/or administrative processes. According to Child et al. (2005) networks reduce uncertainty and provide flexibility capacity and speed, they also provide access to resources, information and skills not owned by the company itself. Aalbers et al. (2009) define informal communication networks as the contacts actors have with others within the organization that are not formally mandated, including friendships with co-workers, but also contacts unrelated to the day-to-day workflow, they resemble acquaintance networks (Morone and Taylor, 2012). Repeated, enduring and structured relationships are the main rationale behind the capability of networks to spread and diffuse knowledge among their members (Inkpen and Tsang, 2005), this means that the coming into existence of networks might be relevant. For a thorough discussion about network process research we refer to Hoang and Antonic (2003) and Slotte-Kock and Coviello (2009).

Parties involved. From the stakeholder perspective, the various parties involved in a (social) network are considered as those affecting or being affected by the actions of the business as a whole (Philips et al., 2003). The variety of parties which can be involved in interactive relations with a firm within a network can be relatively large: buyers, suppliers, competitors, government offices, industry associations, religious affiliations, universities, and consultants (e.g., Smeltzer et al., 1988; Fann and Smeltzer, 1989; Tidd and Trewhella, 1997). These parties are plausible sources of knowledge which we expect to enhance a firm's innovativeness. For Indonesia, Van Geenhuizen and Indarti (2005) found that the degree of interaction between SMEs and various external parties might not be sufficiently developed, while the possible advantages of these relations have to date not been properly explored. External interaction entails a broader access to relevant know-how, possibilities to perform benchmarking activities, as well as opening new markets.

Recent research shows (e.g., Von Hippel et al., 1999; Freel, 2000; Faems et al., 2005) that collaboration or interaction with *buyers* has a positive impact on product innovation performance. Likewise, many authors (e.g., Eisenhardt and Tabrizi, 1995; Nieto and Santamaria, 2007; Wilhelm and Kohlbacher, 2011) argue that interaction between a firm and its *suppliers* significantly stimulates the accumulation and sharing of knowledge, which can be used in the innovation of the firm's products.

Horizontal interaction or collaboration with *competitors* is positively related to a firm's innovativeness (Linn, 1994; Inkpen and Pien, 2006). Linn (1994) argues that cooperation with competitors enables firms to gain an insight into their technological know-how. *Consultants* also play crucial roles in the advancement of firms' innovation policies (Kelly, 1999; Tether and Tajar, 2008). *Government institutions* play an important role in the support and stimulation of firms' activities in the field of innovation by providing facilities, financial support and implementing supportive policies and a sound legal context (Hughes, 2001; Segelod and Jordan, 2002). *Industry associations* generally serve as a knowledge pool containing information on various domains, from knowledge about new technology to information regarding market opportunities (Hauschildt, 1992). Another aspect of the informal network in the Indonesian context, concerns *religious affiliations*, which may also form an important source of knowledge for product innovation. In this country, religious activities do not only take place in mosques and churches, but are also embedded in the societal context (e.g., Candland, 2000). *Research institutions/universities* are considered as scientific systems which function as sources of external knowledge for product innovation (Hauschildt, 1992). Tidd and Trewhella (1997) found that in the context of large firms, universities are the most important sources of external technology to produce product innovation.

Based on the previous discussion and by building on the value chain of Porter (1990) to unveil the various network parties for the Indonesian context, which are involved in innovation networks, we derive two categories of parties, namely individual and institutional parties. Individual parties include buyers, suppliers, competitors, and consultants, while institutional parties for instance consist of government institutions, industry associations, religious affiliations, and research institutions/universities (Van Geenhuizen and Indarti, 2008; Tidd and Trewhella, 1997). Fig. 1 shows the parties that are involved in the interactions between the focal firms and their network as a source of external knowledge for stimulating a firm's innovativeness.

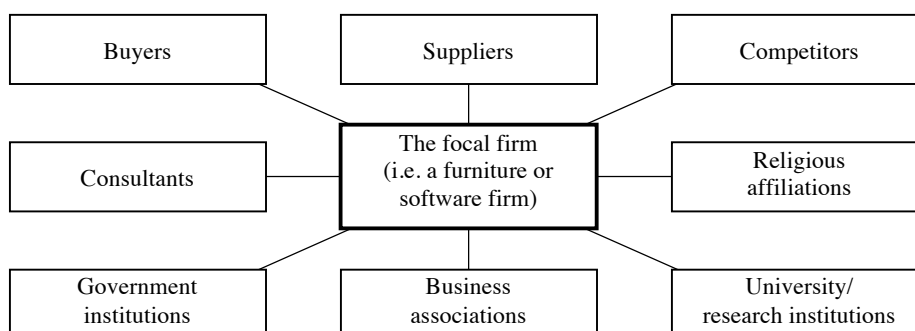


Fig. 1. Parties involved in a network.

This study addresses informal networks contributing to a firm's innovation in the context of Indonesian SMEs. Van Aken and Weggeman (2000) call a network an emergent network, when it is not created by deliberate actions, but emerges organically from frequent and satisfying business transactions between organizations and by personal interaction between organizational representatives. Dyer (1996) argues that spatial and cultural proximity plays an important role in the formation of an informal network. In a developing country like Indonesia where a collectivist culture (Hofstede, 1991) prevails, relationships with other parties usually come into existence in an informal way. An informal network develops through frequent interaction, which enables a firm to absorb relevant external knowledge, e.g. by using informal communication networks.

Based on our reading of the SME network literature, we found the following relevant network characteristics for our study, which are: (a) tie diversity (the number of different parties); (b) tie intensity (frequency of contacts); and (c) multiplexity (the number of knowledge domains).

Tie diversity. Previous studies (e.g. Becker and Dietz, 2004; Nieto and Santamaria, 2007) point out that interaction with diverse partners may provide various advantages. Diverse sources of knowledge allow the firm to create new combination of technologies and knowledge, which in turn it provides opportunities for the firm to select among various possible paths (Metcalfe, 1994). Partners may also contribute different resources and capabilities instrumental to improve the firm's innovation capabilities (Becker and Dietz, 2004).

Moreover, varied network partners, may attract more heterogeneous knowledge, experimentation, search, variation, and risk-taking, which contributes to explorative innovation (March, 1991; Nieto and Santamaria, 2007) and to sustain innovation (Laursen and Salter, 2006). More specifically, collaboration with varied partners improves the chance of achieving product innovation (Becker and Dietz, 2004; Nieto and Santamaria, 2007). Against this backdrop, therefore we propose

P1: The higher the tie diversity, the higher the innovation results will be.

Tie intensity. As indicated, repeated, enduring and structured relationships are the main rationale behind the capability of networks to spread and diffuse knowledge among their members (Inkpen and Tsang, 2005). Social interactions are reflected in the intensity in terms of number of times actors share time in any kind of event, so, more interactions between actors could mean more access to knowledge of others, possibly resulting in more sharing of this knowledge (see e.g. Molina-Morales and Martinez-Fernandez, 2010; Tsai and Ghoshal, 1998; Yue-Ming, 2005).

The firm's current innovation capability is determined by its history and experience

(Dosi, 1988), while the firm's current knowledge is dependent on its previous related knowledge (Cohen and Levinthal, 1990). When ties become more intense, the quality of the knowledge exchange is likely to increase, especially so-called strong ties (see Granovetter, 1973), allow for more knowledge exchange and more exploration (learning), and therefore we propose

P2: The more intense the ties, the higher the innovation results will be.

Multiplexity. Arguably, tie diversity and tie intensity do not suffice to capture the quality on interaction with diverse partners. Tie diversity indicates the number of partners in the network, while tie intensity denotes the frequency of interactions. To complement them, we introduce the notion of multiplexity to indicate the amount and the variety—i.e. the depth—of knowledge transferred during the interactions. Multiplex means that a single line or channel can carry various messages simultaneously; it refers to the complexity of the relationships, the variety of the exchanges embedded in the relationship or the number of diverse types of ties (see also, Tuli et al., 2010).

We argue that this issue concerns the number of various knowledge domains to which an interactive relationship refers ranging from design to production to markets. More multiplex relationships between firms in a network concern richer knowledge domains (Hoang and Antonic, 2003). Collaboration with different partners affects the amount and variety of knowledge to be shared which enhance the firm's innovation (Becker and Dietz, 2004).

We contend that the more diverse the knowledge that is exchanged in the relationships, the more probable will be that this knowledge positively affects a firm's innovation, thus we propose the following

P3: The higher the multiplexity, the higher the innovation results will be.

2.3 Control variables

Larger firms have higher financial capacity to fund innovation and may have access to a wider range of knowledge and other resources than small firms, allowing higher rates of innovation (Daghfous, 2004; Rogers, 2004). In their study of high-tech firms, Lee and Sung (2005) indicate that size as measured by the number of employees, is significantly related to R&D activities, which are often used as an indicator to measure a firm's innovation. Sørensen and Stuart (2000), who studied high-tech firms, state that a firm's age as measured by a firm's number of patents is positively correlated with innovation. Further, a study on innovation in Belgian small food firms by Avermaete et al. (2003) shows that older firms are more likely to introduce new products than younger ones. These findings support the claim that as a firm grows older, its organizational operations and competencies have gradually improved, which promotes a climate for innovation (Sørensen and Stuart, 2000).

Hence, we expect that a firm's size and age positively relate to product innovation; older and larger firms probably have more elaborate networks, which might positively affect the possibility to exchange knowledge and to innovate. Also, we expect that there might be sector-specific differences, because of the nature of the production processes and network relationships. In the more mature furniture sector we expect more established relationships between firms and external parties than in the generally younger software industry. Based on this, our conceptual model is presented in Fig. 2.

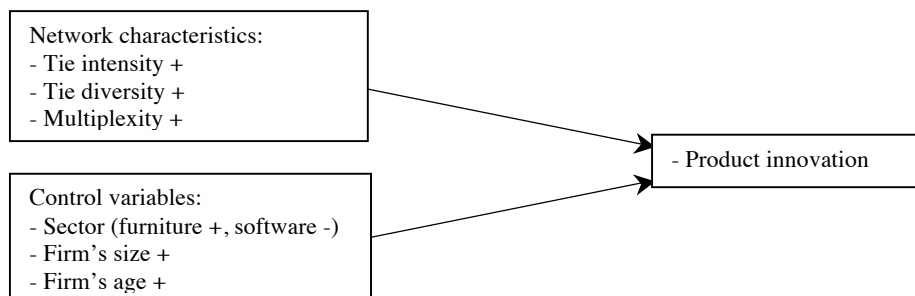


Fig. 2. Conceptual research model (including the propositions).

3 Methodology

3.1 Research instruments

This research is of a quantitative nature and data collection is performed by means of a questionnaire, which is held through a personal interview with owner-managers of small- and medium-sized firms in the software and the furniture sector in Indonesia.

The questionnaire consists of three parts. The first part consists of questions on demographical characteristics of the owners and the firms. The second part consists of items to measure product innovation. The last part consists of questions related to network characteristics including the frequency, mode of interactions and the content and nature of absorbed knowledge during the interactions.

3.2 Operationalization of the variables

Product innovation is measured by using six items and a 5-point Likert scale ranging from 1 (very seldom) to 5 (very often), which is adopted from Jansen et al. (2006). The items are: (1) our firm accepts demand which goes beyond existing products/services; (2) we frequently refine the provision or conditions of our current products/services; (3) we invent new products and services; (4) we regularly implement small adaptations to our current products/services; (5) we regularly improve our current products/services; (6) we commercialize products/services that are completely new to our unit (see Appendix).

Tie intensity indicates the intensity of interaction between the focal firm and the external parties. A firm that interacts more frequently with various external parties has stronger tie intensity. The respondents were asked to rate how often their firm interacts with each of the external parties (see Fig. 1), using a 6-point Likert scale (0=never; 5=very often). Tie diversity represents the number of various external parties involved in the interaction with the focal firm (see Fig. 2). A firm that has interaction with more various external parties has higher tie diversity. The respondents were asked to mention which external parties they interact with.

Multiplexity represents the depth of knowledge domains absorbed by the focal firms from various external parties (e.g. Simon 1976; Van der Spek and Spijkervet, 1997). The deeper and more various knowledge domains absorbed from the external partners, the higher the degree of multiplexity. The respondents were asked to indicate the specific knowledge content (for instance in terms of design/products,

process, and organizational) obtained from what external sources (see Figure 1) and also indicate the depth of the knowledge per domain using a Likert scale ranging from 1 (little) to 5 (very much). For example, a respondent may consider that knowledge on design/product were obtained from buyers was very much (score = 5) and that from government institutions was little (score = 1), while the knowledge on process scored differently. Arguably, innovation in one aspect (e.g., product innovation) may have affect or be affected by innovation on other aspects (e.g., process) (Avermaete et al., 2003). The higher the score, the deeper the knowledge obtained.

Subjective measurement is selected to address difficulties in the data collection process. Collecting objective data (such as number of patents and R&D expenses) among the Indonesian SMEs is impractical, mainly because most of them do not adopt modern management practice and have no proper documentation systems. In this study, we focus on informal networks that is neither well documented.

The *age of the firm* is measured by the number of years passed since a firm's establishment (Kimberly, 1976). The *size of the firm* is measured by the number of employees (Da Rocha et al., 1990; Flatten et al., 2011; Heunks, 1998). *Industry sector* is operationalized as a dummy variable (software firms = 1; furniture firms = 0).

3.3 Internal validity of the instrument

As discussed above, the questions of the research instrument were developed on the basis of various studies. After testing the questionnaire with some OM's in a real life situation, we slightly adapted the phrasing of some questions in the instrument in order to improve the understanding of the questions. In this study, we used Cronbach's alpha value to examine the internal consistency of the instrument. For all network and innovation variables the values of Cronbach's alpha were higher than 0.60 (see Table 1). Based on this, we conclude that the items to measure the tie-intensity, tie-diversity, multiplexity, and product innovation are acceptable, which means that they provide consistent results.

Table 1. Instrument reliability.

<i>Variable</i>	<i>Items</i>	<i>Alpha</i>
Multiplexity	24	0.91
Tie intensity	8	0.62
Product innovation	6	0.63

Notes: Reliability test is not relevant for the variables operationalized by only one item (i.e., tie diversity, firm's age, firm's size, and sector)

3.4 Data collection and analysis

This study concerns fieldwork in the furniture and software industry in four big cities in Indonesia. With respect to the furniture sector, the province of Yogyakarta, with its high density of furniture SMEs, was selected as our research site. A spatial analysis performed by Kuncoro (2000) indicates that Yogyakarta is one of the cities on the island of Java where relatively many SMEs are clustered. In addition, Yogyakarta is considered as one of the main visiting places for handicraft and furniture buyers in Indonesia (Raharjo, 2009).

The Indonesian software sector is still in its early years. The vast majority of SME software development firms in Indonesia are concentrated in large cities (Donny and Mudiardjo, 2006). In this study, we selected Bandung, Yogyakarta, Surabaya, and Malang, where many software firms are located, as the main research sites. These

four cities are known in Indonesia as main locations of institutions of higher education, such as universities, where the number of potential start-ups is relatively high (Rahardjo, 2002). The higher education institutions train thousands of software engineers every year.

The respondents are OMs of the firms. In the case of SMEs, the OMs are the main actors in charge of and responsible for the firms' growth and innovation, while practically all information goes to these people (c.f. Stanworth and Curran, 1976; Tidd et al., 2005). Therefore, information is obtained on the organization as a whole. To ensure that the respondents would match the objective of our study, we used a judgment sampling technique (Cooper and Schindler, 2008) and based on that established a number of criteria. Selected firms should be (1) furniture or software manufacturing firms which had existed for more than 2 years; and (2) firms which employed less than 100 people.

We have to add that many SMEs in Indonesia operate without a legal basis. According to data from The Indonesian Statistics Bureau (www.bps.go.id), this is typical for Indonesian SMEs which can be classified as home industries or family businesses. When selecting the firms in our sample we used the databases from the Business Directory of the Indonesian Department of Industry and Trade, the Indonesian Furniture Industry and Handicraft Association, the Association of Indonesian Software Developers, and the Internet (www.indonetwork.net). Since not all furniture and software firms are listed in the databases, we gathered additional information by following a 'snowballing' procedure: here, participating respondents suggest other relevant companies. Snowballing, which sometimes also referred to convenience sampling, is a common methodology used in the following cases: (1) when no comprehensive data are available (Cooper and Schindler, 2008); (2) when the participating respondents have access to extensive personal and informal networks; and (3) when a recommendation from a former respondent makes it easier to approach a potential new participant (Souitaris, 2001).

The data were collected in the period from October 2007 until March 2008 by means of personal face-to-face interviews with the firms' OMs, which took 45-60 minutes on average. All (100%) of the returned questionnaires were completed by the respondents and subsequently included in the data analysis.

Out of the 265 software firms we contacted, 132 (49.81%) were either closed down or less than two years in operation. The rest (133) was considered to be eligible for participating in the research. Of this group, 33 firms were not willing to participate in the research. So, 100 questionnaires were included, which accounted for a 75.2% response rate. As regards the furniture firms, out of 322 on the list, 168 were not eligible to participate as respondents because they had been operating for less than two years and were now engaged in the handicraft business. Of the rest of the firms (154), 100 were willing to partake in the study, resulting in a response rate of 64.9%. The total number of returned questionnaires was 200. No clear patterns were identified in the non-response. Mostly the non-responders were not willing to participate due to various reasons, such as a lack of time or other engagements at the time of the data collection. All in all, 198 sample firms were considered as suitable for analysis.

To deal with the possible violation of traditional statistical assumptions, we chose to use partial least square (PLS) to test the research model. PLS is soft modeling that combines a mathematically rigorous procedure that leads to efficient predictions, but it is well suited for research constrained by conditions of low information (small sample size), nascent or emerging theory and subjective observations of phenomena (Sosik et al., 2009).

4 Results

4.1 Demographics of the firms

As regards status, 96% of the firms are independent, most furniture (98.0%) and slightly less software (94.0%) companies in the sample are independent (see Table 2), which is a typical characteristic of small firms (Government of Indonesia, 2008).

In SME settings, particularly in developing countries such as Indonesia, the firm's owner is usually the initiator of new business ventures, which also applies to the owners of the firms we studied. They were the most important actors with respect to initiating new activities (80.8%). As regards the establishment of businesses, most (82.7%) furniture firms appear to have been initiated by their owners (see Table 2). In general, firms are located in an urban/town context, even 90.0 % of all software firms are located in such a context, but most of the furniture firms are located in suburban or village context, because they need a lot of space. A large proportion (79.0%) of the software firms is also initiated by the owner, followed by friends (35.0%). After their establishment, the firms' growth rate may vary. In general, we find that 66.3% of the firms in the two sectors started to expand within two years of their existence.

Table 2. Demographic aspects of firms.

Variable	Furniture firms		Software firms		Both Sectors	
	N	%	N	%	N	%
Status						
- Independent	96	98.0	94	94.0	190	96.0
- Subsidiary	2	2.0	6	6.0	8	4.0
Location						
- Urban/town	26	26.5	90	90.0	116	58.6
- Suburban	36	36.7	9	9.0	45	22.7
- Village	36	36.7	1	1.0	37	18.7
Firm's growth after its establishment						
- Within 2 years	61	62.2	70	70.0	131	66.3
- After 2 years	37	37.8	30	30.0	67	33.8
Initiator*						
- Your self (the owner)	81	82.7	79	79.0	161	80.8
- Parents	13	13.3	2	2.0	15	7.6
- Relatives	16	16.3	1	1.0	18	8.6
- Friends	5	5.1	35	35.0	40	20.2
Monthly revenue (IDR million)						
- < = 100 (EUR 7,702a)	85	86.8	89	89.0	174	87.9
- > 100	13	13.2	11	11.0	24	12.2

Note: *Multiple answers are allowed; www.xe.com, accessed on 30 January 2010.

4.2 Correlation and regression analysis

Table 3 shows the result of the correlation analysis between the main variables in this study and some descriptive results. The size of the firm across the two sectors is about 15 employees, with a considerable standard deviation. The mean age of the firms in this data set is about nine years, also with a considerable standard deviation. Product

innovation is significantly and positively correlated with multiplexity and tie intensity, which is in line with our propositions; while it has negative significant correlation with tie diversity. The resulting variance inflation factors (VIF) for these variables are between 1.18 and 2.79, which are less than 10. According to general rules of thumb (e.g., Kutner et al., 2004), value above 10 alludes to a potentially severe problem of multicollinearity. Thus, we could conclude that there is no multicollinearity problem here.

Table 3. Correlation between variables and some descriptive results of the main variables.

Variable	Mean	SD	Tie intensity	Tie diversity	Firm's size	Firm's age	Product innovation	VIF
Multiplexity	1.48	0.48	0.56**	-0.56**	0.01	-0.09	0.23**	1.67
Tie intensity	1.49	0.71	1	-0.77**	0.22*	0.03	0.20**	2.67
Tie diversity	3.85	1.89		1	-0.28**	-0.07	-0.16*	2.79
Firm's size	14.71				1	0.13	0.13	1.18
Firm's age						1	-0.11	1.23

Notes: * p<0.05; ** p<0.01

We tested two models. The first model included only multiplexity, tie intensity, and tie diversity as the independent variables, while the second model brought in sector (as the control variable), firm's age, and firm's size (as the moderating variable). Results of the analysis of the first and the second models are depicted in Fig. 3 and Fig. 4 respectively.

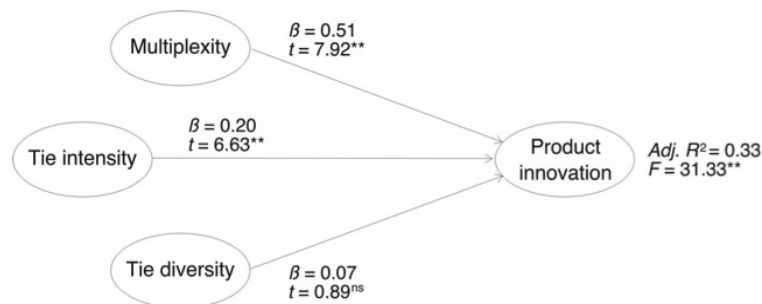


Fig. 3. Results of the analysis of the first model.

As can be seen in Fig. 3, we find that multiplexity and tie intensity significantly effect product innovation, while tie diversity does not. The two significant variables explain 33% of the total variance.

When the control variables are included in the analysis (see Fig. 4), the explanatory power of the model increases from 33% to 38%. Multiplexity and tie intensity are still significant predictors of product innovation, while tie diversity is not significant. We also find that firm's age has a negative significant impact on product innovation, while firm's has a positive impact. Note that, sector has no significant impact on product innovation.

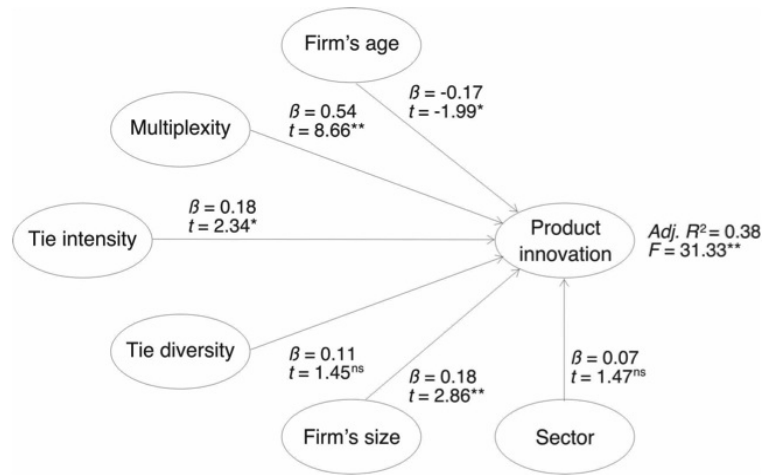


Fig. 4. Results of the analysis of the second model.

5 Discussion and Conclusion

In this paper, we have outlined the relevant network partners for Indonesian SME's in two sectors, i.e. the furniture and the software sector, in a central area of that country and discussed their possible contribution to product innovation.

Multiplexity and tie intensity are the variable of the set of network characteristics that has a significant impact on product innovation. This finding indicates that the depth of knowledge content absorbed from the external parties (i.e., multiplexity) and the intensity of interaction (i.e., tie intensity) are important for product innovation. This can be explained because through higher multiplexity and tie intensity, external economies of cognitive scope can be obtained (Nooteboom, 1999), which enhances a firms' innovation potential and is also in line with Waalkens (2006). Contrary to our expectations, the number of various external parties involved in the interaction (i.e. tie diversity) has no significant direct impact on product innovation. The findings indicate that the quality and intensity (sometimes referred to as strong ties) of interaction with certain external parties will be significantly more important than spreading energy to more various parties with less intensity of interaction. The varying degree of relevance of one external party to another (e.g., lead customers can be very important in order to detect certain trends, while input from other parties such as religious affiliations might be less relevant) may explain this finding.

The role of a firm's age and a firm's size as control variables are confirmed by the study but in different direction. The former affects product innovation a negative direction, while the latter does positively. These findings can be interpreted that the effect of the network variables on product innovation is stronger among the younger and the larger firms. The results also demonstrate that the industry sector has no effect on the relationship between tie intensity, tie diversity and multiplexity on product innovation.

A main contribution of this paper is that it provides the insight that in the context of an emerging economy, the quality of interaction as indicated by the depth of knowledge absorbed from various external parties (i.e., multiplexity) and the intensity

of interaction (i.e., tie intensity) is more important than the diversity of external parties (i.e., tie diversity) involved in the interaction in determining product innovation. As a consequence, in order to obtain a significant impact on product innovation, intensity of interaction should be set-up to get more knowledge on various domains.

Taken altogether, in this study, only P2 and P3 gain support, while P1 is not proven. Given, the correlation results, further research on the network variables is needed, maybe by finding another or a more comprehensive construct measuring the network effect; note that our research does not confirm the research by Molina-Morales and Martinez-Fernandez (2010). Age and size probably better can be treated as moderating variables (cf. Flatten et al., 2011). Also, the usual limitation of a cross section analysis applies here; probably a longer research time frame provides additional insights on the proposed relationships, especially when we consider absorptive capacity of a firm in the light of dynamic capabilities and strategic learning processes.

Another limitation of this study is the use of subjective measurement to operationalize the variables (i.e., tie intensity, multiplexity, and innovation), although this approach at the same time may be also considered as a strategy to cope with the uniqueness of the context. For the similar reason, we do not take the number of each type of partner into consideration when measuring tie diversity. Future studies may address these limitations both to validate the results and to provide better measurement strategies.

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Appendix

This appendix consists of items in the questionnaire used to operationalize the variables.

Tie intensity

Based on your experience within the past two years, how do you rate the frequency of interactions between your firm and the following parties?

No.	Party	Never					Often	
1	Buyers/customers	0	1	2	3	4	5	
2	Suppliers	0	1	2	3	4	5	
3	Consultants	0	1	2	3	4	5	
4	Government offices	0	1	2	3	4	5	
5	Competitors	0	1	2	3	4	5	
6	Industry associations	0	1	2	3	4	5	
7	Religious associations	0	1	2	3	4	5	
8	Research institutions/universities	0	1	2	3	4	5	

Tie diversity

The score for tie diversity is measured by summing the number of external parties from the above table with non-zero answers.

Multiplexity

Based on your experience within the past two years, please indicate what specific

knowledge content your firm gets from external parties. If an external party is not relevant, put a cross (x) in 0. Please indicate also the depth of knowledge on the domain (1=little, 5=very much).

No.	Party	Knowledge domain/content		
		Product	Process	Organizational
1	Buyers/customers	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
2	Suppliers	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
3	Competitors	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
4	Consultants	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
5	Government offices	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
6	Industry association	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
7	Religious affiliations	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
8	Research institution/ university	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5

Product innovation

The following are several innovation activities that may be conducted in your firm within the past two years. Please rate each of innovation activities. Note: 1= seldom and 5= very often.

No	Activity	Very seldom					Very often
		1	2	3	4	5	
1	Our firm accepts demand that go beyond existing products and services	1	2	3	4	5	
2	We frequently refine the provision of existing products and services	1	2	3	4	5	
3	We invent new products and services	1	2	3	4	5	
4	We regularly implement small adaptations to existing products and services	1	2	3	4	5	
5	We regularly improve our current products/services	1	2	3	4	5	
6	We commercialize products and services that are completely new to our unit	1	2	3	4	5	