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Open innovation in SMEs—An intermediated network model

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ABSTRACT

In spite of increasing interest in open innovation, discussion about the concept and its potential application to the SME sector has been excluded from mainstream literature. However, given that the argument about the effect of firm size on the effectiveness of innovation is still ongoing, it is worth addressing the issue from an SME perspective. That is the focus of this article, which seeks, firstly, to place the concept of open innovation in the context of SMEs; secondly to suggest the input of an intermediary in facilitating innovation; and finally to report accounts of Korean SMEs' success in working with an intermediary. The research results support the potential of open innovation for SMEs, and indicate networking as one effective way to facilitate open innovation among SMEs.

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1. Introduction

Innovation is traditionally viewed as taking place mostly within a single firm. But the increasing availability and mobility of knowledge workers, the flourishing of the internet and venture capital markets, and the broadening scope of possible external suppliers in the present age have undermined the effectiveness of the traditional innovation system (Chesbrough, 2003). In the wake of these changes, the concept of open innovation has emerged, with processes that are characterised as spanning firm boundaries. Companies now want to include in their business model not only the commercialisation of their own ideas, but also of external ideas. The analysis of open innovation has subsequently been extended to various perspectives, e.g. studies on the industrial dynamics of open innovation (Christensen et al., 2005), on the open innovation processes in a particular industry sector (Cooke, 2005; Henkel, 2006), or on ways in which to boost open innovation (Lichtenthaler, 2008).

In spite of the increasing interest in open innovation research, most previous studies have been intended for managers in large technology-based companies, where the notion of open innovation first started. Discussions about the concept of open innovation in small and medium-sized enterprises (SMEs) have been excluded from the mainstream (West et al., 2006) for the following reasons. Firstly, open innovation is more easily studied in larger firms, as SMEs have less ability to access external resources and fewer technological assets that they can exchange than larger firms (Narula, 2004). However, considerations about open innovation also need differentiating between SMEs and large firms, since it is generally recognised that they are good at different types of innovation (Vossen, 1998). Secondly, SMEs use non-internal means of innovation more than large firms, as they consider alliances or network as ways to extend their technological competences (Edwards et al., 2005; Rothwell, 1991), which means that innovation in SMEs is already has an external focus, and the concept is not new to them. However, their collaborations tend to be limited to strategic alliances with larger firms (Rothwell and Dodgson, 1994) and outsourcing, mainly via other SMEs (Rothwell, 1991). Considering the fact that firms involved in multiple types of ties are more innovative than those which only utilise one type of tie (Baum et al., 2000; Powell and Owen-Smith, 1999), it is important to investigate the potential of different types of SME ties in the context of open innovation. Finally, SMEs consider external sources as a means of getting access to marketing and sales channels at the later stages of innovation (especially the commercialisation stage), while open innovation normally focuses more on the early stages of innovation, addressing external technology sourcing and networking with technology providers and innovative, upstream companies (Vanhaverbeke and Cloodt, 2006). Though open innovation at the commercialisation stage has not been considered seriously in the

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existing literature, it can be an important topic, since economic values of innovation at the commercialisation stage are to a large extent towards other downstream players.

While the argument on the effect of firm size on the effectiveness of innovation is still ongoing, it is worth addressing the particularities of open innovation from the perspective of SMEs which are nevertheless major actors in innovation (Maula et al., 2006). This article therefore focuses on open innovation strategies in SMEs, firstly seeking to place the concept of open innovation in the context of SME, and secondly to encourage innovation by suggesting a network model that emphasises the role of intermediaries in linking SMEs. Finally, it introduces some stories of open innovation success in Korean SMEs that have flowed from the intermediary activities of the Korean Integrated Contract Manufacturing Service (KICMS), which was established to facilitate innovation in Korean SMEs. The research results support the notion of open innovation in SMEs, by proposing intermediation as one way of facilitating this strategy, and by suggesting an intermediated network as an effective model to enable their collaboration and specialisation.

The rest of this paper consists of four parts. The following section briefly reviews the characteristics of innovation in SMEs, while Section 3 discusses how those characteristics can be reflected and facilitated by proposing an open innovation model for SMEs. To verify this discussion, open innovation efforts among Korean SMEs are introduced in Section 4. For this purpose, we analysed the report, Korea's Technology Innovation completed in 2005 and published by the Survey Science and Technology Policy Institute (STEPI) to understand the nature of innovation activities in Korean SMEs, and conducted a case study of KICMS activities. The final section presents some conclusions and notes on limitations.

2. Open innovation in SMEs

2.1. Nature of innovation in SMEs

There is considerable literature about innovation, and various models have been suggested to describe its nature, such as product innovation and process innovation; radical innovation and incremental innovation; systemic innovation and component innovation; technology-push and market-pull; and more recently closed innovation and open innovation. Models can also be divided according to their innovation processes (linear models, chain-linked models, etc.), or according to the fitness for developed or developing countries, etc.

However, strangely, there have been very few studies regarding an innovation model specialised for SMEs. The majority of literature limits its focus to the study of entrepreneurial traits or structural characteristics (Hoffman et al., 1998), but there is little examination of the embeddedness of innovation in SMEs (Shaw, 1998; Paniccia, 1998). According to Laursen and Salter (2004), it is not statistically evident that larger firms are better than SMEs in new-to-the-world-type innovation, meaning that SMEs may well have capacity for innovation, especially radical innovation. It is agreed that, while SMEs' flexibility and specificity can be advantages in accelerating innovation, few of them have sufficient capacity to manage the whole innovation process by themselves, and this encourages them to collaborate with other firms (Edwards et al., 2005). They can lack the resources and capabilities in manufacturing, distribution, marketing and extended R&D funding, which are essential for transforming inventions into products or processes. As a result, while many studies have shown that SMEs tend to have a higher R&D productivity than larger firms (although there is considerable variation by industry, see Audretsch and Vivarelli, 1996), there is still much debate on assessing the innovativeness of SMEs because of their material or resource factor disadvantages.

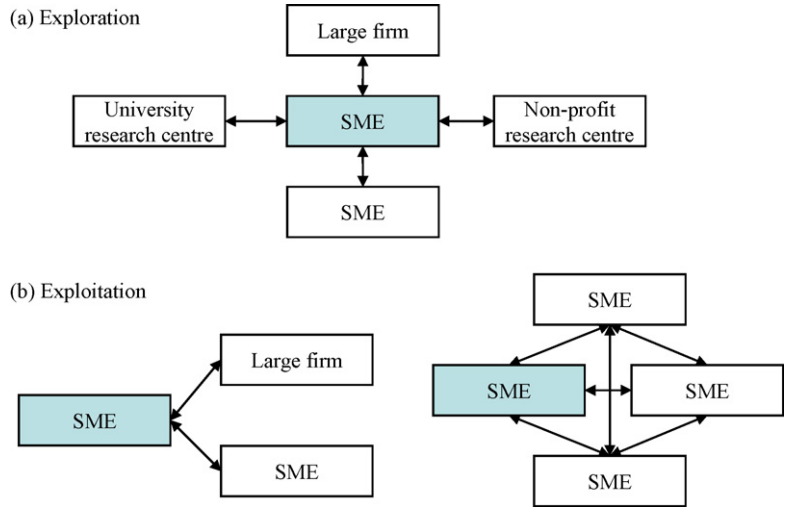

Fig. 2. Possible models for open innovation with SMEs.

While alliances with large firms have often benefited SMEs, they can also oblige SMEs to share their technological competence with the large firms, leading to increased flexibility for the large firms, thus negating a major comparative advantage of the SMEs. As a result, as SMEs gain opportunities to collaborate with large firms, they lose opportunities to compete against them (Narula, 2002). SMEs may also be required to produce a cheap product to meet the large firms' lowest specifications, thus delaying further innovation on the part of the SMEs.

An alternate model is a network, which has been described as a specific type of relationship linking a set of persons, objects or events (Knoke and Kuklinski, 1983). Well-constructed and managed networks can offer clear benefits to SMEs (Inkpen and Tsang, 2005), helping them decode and appropriate flows of information such as technological change, sources of technical assistance, market requirements and strategic choices by other firms, thus strengthening their competitive advantage (Bougrain and Haudeville, 2002). In addition to efficient co-development of products and services for innovation (Gulati, 1998), network members are affected by each others' experience, yielding learning effects for future innovation (Argote and Ingram, 2000). SMEs usually specialise in a specific area, and involvement in a network may be an effective way to successfully enter wider markets and acquire complementary resources, and of increasing core competencies to improve their chances of competing against their large competitors. Particularly for start-ups, the networking model of investing jointly to share risks and profits can help SMEs develop further business opportunities.

3.2. Intermediation of collaboration

How can a network best be constructed to obtain a desired outcome? Resource-based theory suggests the decision as to selection is predicated the partners' potential to provide additional resources to their mutual benefit (Kogut et al., 1992). But searching for and deciding on who to collaborate with to create an effective network can be difficult for SMEs, who may have limited information sources, and lack the financial resources to gather vital information (Julien, 2002) compared to larger firms, who can often afford professional intelligence processes for scanning and monitoring their technological environments (Lichtenthaler, 2003) to search for competitors, potential collaborators and customers in the markets for their technology (Makadok and Barney, 2001). Due to these difficulties, SMEs are likely to build only deep and lasting ties once they organise a network (Simard and West, 2006). To solve the problem of finding a suitable partner, we suggest a collaboration model that emphasises the role of an intermediary in supporting SMEs' ability to make a collaboration network and eventually work together more effectively. An intermediary can help SMEs maximise their chances of innovation and increase their likelihood of

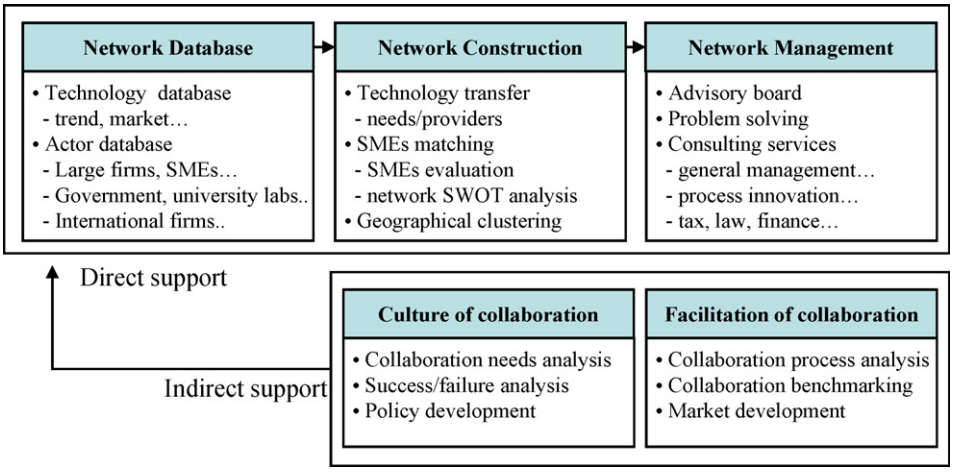

Fig. 3. Conceptual framework of intermediary role.

success in developing new products and services. Recognising the potential value of such a role, several policies and programmes have been developed to support SMEs' innovation, with public authorities adopting the role of intermediary (Davenport et al., 1999; Bougrain and Haudeville, 2002). Based on the literature review and policies, the role of intermediary is summarised in Fig. 3.

The role of an intermediary consists of three direct activities. First, the purpose of the *network database* is to identify appropriate collaborative partners. By collecting information on technologies, markets and competitors (Bougrain and Haudeville, 2002), and on potential partners (Fontana et al., 2006), an intermediary can create and maintain a relevant database, and share the information to support SMEs' search processes. Secondly, much support may be needed at the *network construction* stage, where an intermediary can help network construction by supporting technology transfer to improve strategic technology management (Rosenfeld, 1996), by evaluating each firm to assist in the construction of a network of matching SMEs (Kogut et al., 1992), by proposing an effective network structure, and by encouraging geographical clustering (Simard and West, 2006). SMEs may reluctant to disclose detailed R&D information to potential competitors, while, at the same time, potential partners may hesitate to cooperate if they lack sufficient information to evaluate their potential partners' capabilities (Lee and Burrill, 1994). An intermediary can hold important information to evaluate each SME objectively and provide other SMEs with the results of their analysis, rather than original technological information. Finally, network management is another important role for an intermediary in supporting the actual process of collaboration (Davenport et al., 1999; Luukkonen, 2005). In addition to these three direct activities, two indirect activities, one designed *to develop the culture of collaboration* and the other *to facilitate collaboration*, can help SMEs' networking efforts (Rosenfeld, 1996). With the help of an intermediary, the conventional collaboration model, based normally on reliance on larger firms or outsourcing to other SMEs, can be developed towards a more open structure.

4. An intermediated network model: KICMS case

4.1. SMEs in Korea

Many Korean SMEs possess competitive technology and are involved in innovation activities. To explore the characteristics of innovation in them, this study examines the 2005 Technology Innovation Survey published by STEPI, an organisation established to support Korean government policy-making in the science and technology sectors. STEPI conducted a survey of Korean firms' innovation activities from 2002 to 2004 aiming to boost technology innovation in Korea and increase its global competency. Of 2743 firms responding to the survey, 329 were large firms and the remaining 2414 were SMEs. This research analyses Korean SME innovation activities in the context of open innovation in order to understand the situations of Korean SMEs and subsequently to help improve their innovation capabilities by identifying their needs on collaborations, which will justify the necessity of intermediated network model.

4.1.1. Innovation activities in SMEs

First, we analysed the differences in innovation processes between large firms and SMEs. Innovation activities were divided into eight types, and the percentage of large and SME firms involved in each activity analysed (see Table 2). The results indicate that SMEs were less active than large firms in most innovation activities, and above all, as suggested by previous studies, were much less interested in following up and marketing innovation ideas that originated from external sources and training for innovation than large firms. Among them, the low value in marketing innovation can be attributed to the following two reasons: (1) little necessity and (2) difficulties in investing in spite of its necessity. Firstly, innovative activities in SMEs are more frequently than in large firms directed towards customising products for individual customers (mostly large firms) without following the sequence of invent-develop-commercialise, and this type of business model may require less marketing. However, sticking this process will reduce the ability of marketing in SMEs. In that case, even when they get to have a potentially innovative technology, it is rarely commercialised without any support from the individual customers. Networking with other specialised SMEs can be one option to commercialise their idea successfully, which will increase the innovation potential in SMEs. Secondly, some SMEs, especially ventures, will find ways to bring their ideas to the market instead of producing customised products for individual customers. They might be a small subgroup of SMEs but their contribution to the innovation could be huge. SMEs of course can have both of the business models, partially meeting the needs of individual customers and partially commercialising their own innovative technologies. For them, supporting in marketing activities will be needed but has not been addressed as much as it should be.

Table 2
Innovation activities.

Types of innovation activities	Large firms	SMEs
Training for innovation	84%	63%
Marketing for innovation	61%	47%
Introduction of external knowledge	67%	53%
External R&D for innovation	59%	46%
Organisational innovation	78%	67%
Supports of product/process innovation	75%	68%
Internal R&D for innovation	92%	85%
Introduction of capital goods (facilities, machines, tools, etc.)	78%	73%

4.1.2. Information usages in SMEs

Looking at the details of external information sources for innovation, while SMEs stressed the importance of information acquired from collaboration with other firms, they seem to have relied more on internal and public information. In Table 3, sharpening its focus on SMEs, the first and second columns list the types of information source and the third and fourth columns show the ratio of SMEs that have ever used the information source and their evaluation of its importance. The table shows that SMEs recognise the importance of information acquired from affiliates, competitors in the industry, and customer and suppliers, but that few of them use the information in their innovation process (see text in bold).

Then, going into some more details of the external information sources, this paper analysed the correlation between types of innovation and the SMEs' external information usages. Referencing the work by Laursen and Salter (2006), which identified the relationship between the degree of novelty in innovation and the firms' external search strategies, several variables were designed for the analysis. Firstly, regarding the innovation performance, we focused on the four types of innovation – major product innovation, minor product innovation, service innovation and process innovation – and used the numbers of innovation that the firm has made for the last three years in each type of innovation. The number was then normalised by firm size measured by the number of employers. Secondly, regarding the SMEs' external information usages, two variables termed as *breadth* and *depth* were designed (Laursen and Salter, 2006). The breadth of information is defined as the number of information sources that firms use. For the 17 external sources in Table 3, except the ones from within a firm, each of them was coded as a binary variable, 1 being used and 0 otherwise. Then,

Table 3
Information sources for technology innovation in SMEs.

	Information sources	Share of firms using the information source	Importance of the information source[a]
Within the firm	Development	77%	3.51
	Manufacturing	74%	3.28
	Research	69%	3.68
	Marketing and sales	68%	3.26
	Purchase	64%	2.88
From other firms and market	**Customer and user**	**59%**	**3.59**
	Competitors in the industry	**56%**	**3.22**
	Suppliers (raw materials/SW)	49%	3.06
	Suppliers (machine/facilities)	48%	2.98
	Non-competitors in industry	43%	2.88
	Business service provider	40%	2.73
	Affiliates	**31%**	**3.31**
From university and research centre	University	43%	3.02
	Government agencies	33%	3.01
	Non-profit organisation	31%	2.61
	Private research centre	26%	2.54
From public information	Exhibition	72%	3.23
	Internet	71%	3.23
	Magazine	66%	2.98
	Conference and meeting	61%	2.92
	Mass media (newspaper/TV)	59%	2.62
	Patents	56%	2.99

[a] The maximum value is 5.

by adding up the values of 17 variables, we could get a value for breadth. On the other hand, the depth of information is defined as the extent to which firms use the information intensively from different sources. In the similar way, the 17 external sources were coded as a binary variable, 1 being used to a high level and 0 to a low or medium level. Again by summing up the values of 17 variables, we could get a value for depth. Here, it is assumed that firms using more sources more intensively are more open. Finally, using the variables, the correlation between the number of innovation and the external information usages in SMEs was calculated (see Table 4).

The table shows that three types of innovation, major product innovation, minor product innovation and service innovation, are related to the depth and breadth of external information usages at the significance level of 0.01. Process innovation is related only to the breadth at the significant level of 0.05. In general, therefore, effective and broad use of external information is significantly associated with the number of innovation. In particular, the breadth is more closely linked to the product innovation than the depth, though the coefficient of depth and breadth is high corresponding to 0.697. Little differences in the correlation with external information usages are found between major product innovation and minor product innovation. Intensive use of external information seems to be slightly more related to major product innovation than minor product innovation while searching information from various external channels is more linked to minor product innovation than major product innovation, which means that major product innovation may require not only getting information from external channels but also applying it actively to their innovation process. Another interesting finding is that service innovation is more closely related to the depth than breadth. It seems that customer needs of target markets, as external information sources, should be considered carefully and so having a deep relationship with a few external sources are critical for service innovation. Unlike other types of innovation, process innovation is not significantly linked to external information usages. To summarise, the analysis results indicate that both the depth and breadth of external information is linked to innovation in SMEs, which might be based on the fact that a firm that is more interested in innovation is more likely to be involved in active information usages, but the role of external channels might be different by innovation types.

Table 4
Correlation analysis between innovation and external information usages in SMEs.

Innovation performance	External information usages			
	Depth		Breadth	
	Coefficient value	*p*-value	Coefficient value	*p*-value
Major product innovation	0.065**	0.001	0.091**	0.000
Minor product innovation	0.063**	0.002	0.106**	0.000
Service innovation	0.099**	0.000	0.074**	0.000
Process innovation	0.029	0.160	0.047*	0.021

* *p*-value less than 0.05.
** *p*-value less than 0.01.

4.1.3. Collaboration patterns in SMEs

The patterns of collaboration between SMEs and other organisations belonging to the 'other firms and markets' and 'university and research centre' categories were analysed to identify the influence of other actors on SMEs' innovation. The levels of collaborations for technology purchasing, and of strategic alliances (other than outsourcing), were measured, and the contribution of each organisation in the collaboration to innovation evaluated (see Table 5).

To list a few distinguished features, technology purchasing appears to be more prevalent than strategic alliances among SMEs. In addition, while SMEs prefer collaborating with other firms for technology purchasing (where there is no danger of technology exposure), they prefer universities and research centres to other firms for strategic alliances relatively, though the number of alliances is fairly low. The reason seems to be that SMEs usually adopt acquisition strategies when they need quick access to the technology involved (Radnor et al., 1970) and/or where the technology developed by other firms offers the best option and they do not have enough R&D capabilities or experiences for the technology considering their limited resources (Hamel et al., 1989). On the other hand, where SMEs plan longer-term technology development in strategic alliance situations, collaborations with university and research centres focusing on more fundamental research are more likely to be indicated. Another finding is that many SMEs

Table 5
Collaboration patterns in SMEs.

Collaboration partner	Technology purchasing		Strategic alliance	
	Contribution to innovation[a]	Share of firms	Contribution to innovation[a]	Share of firms
Other firms and market				
Firms in its group	3.29	32%	3.10	27%
Competitors in the industry	3.27	56%	3.06	29%
Non-competitors in industry	**2.95**	**49%**	**3.10**	**38%**
Customer and user firms	3.45	54%	3.41	41%
Business service providers	**2.86**	**40%**	**3.03**	**32%**
Suppliers	3.27	57%	3.13	38%
University and research centre				
Private research centre	2.70	31%	2.90	22%
University	3.00	40%	3.28	45%
Government agencies	2.95	37%	3.32	29%
Non-profit organisation	2.62	33%	2.89	24%

[a] The maximum value for 'Contribution to innovation' is 5.

have experienced technology purchasing from collaborations with 'industry non-competitors' and 'business service providers' (49% and 40% respectively), and while their evaluation of contribution to innovation reported are relatively low in each case (2.95 and 2.86 respectively), the degree of satisfaction increases to 3.10 and 3.03 respectively where the collaboration type was the more active 'strategic alliance' form (see texts in bold). It seems that when SMEs collaborate with others who are not in their field, greater efforts are required if the collaboration is to yield the desired benefits.

4.1.4. Innovation barriers in SMEs

Finally, the 817 SMEs that participated in innovation through the more active 'strategic alliance' type of collaboration were analysed to identify what barriers to innovation they faced, to help identify what an intermediary can do for SMEs (see Table 6). The mean value scores represent the SMEs evaluations as to the degree of difficulties they faced. For this question specifically we conducted a comparison analysis of three groups – all SMEs (Group A); SMEs that had at least one innovation between 2002 and 2004 (Group B); and SMEs that had adopted at least one strategic alliance for innovation purposes during those years (Group C). Contrary to our expectations, we found that Group C reported the greatest difficulties and Group A the fewest. We concluded that those SMEs taking more active interest in technology innovation (and who therefore were those involved in strategic alliances) were also those who were most conscious of the difficulties involved. The 10 barriers reported most often by SMEs together with by large firms are listed in Table 6.

The table shows that the difficulties in SMEs are quite different from those in large firms. SMEs suffer from 'labour shortages', 'lack of information', 'lack of infrastructure' and 'lack of financial resources', while large firms indicates such difficulties as 'oligopolists', 'needlessness of innovation', 'R&D department without power". The difficulties in labour shortage, lack of information, and financial resources can be relived by collaboration, and those with lack of information and lack of infrastructure could be alleviated to some extent by the action of an intermediary to help them complete innovation activities more effectively.

4.2. An intermediated network model in Korea

4.2.1. KICMS for SMEs in Korea

This section considers the case of the KICMS, an association established to facilitate collaboration between Korean SMEs. An ICMS is a collaborative business model based on a horizontal structure of specialised SMEs, and represents the open innovation process for SMEs suggested in this study. Rather than trying to execute the whole innovation process by itself, a firm adopting the model focuses only on the particular functions where it has competitive advantages, and enters into a contract of mutual trust to leave other functions to different specialised firms. Thus technology venture firms and SMEs are temporarily linked in collaborative structures, known as CF^2s (Cross-Functional Consortium Families), enabling open innovation among SMEs, and helping maximise the possibility of achieving business synergies to compete against large firms. KICMS was established in 2004, advocating a collaborative

Table 6
Barriers to innovation in SMEs compared to large firms.

Innovation barriers	SMEs		Large firms	
	Ranking[b]	Score[a]	Ranking[b]	Score[a]
Difficulties in finding suitable manpower in a labour market	**1**	**3.12**	**3**	**3.00**
Short of suitable manpower within the firm	**2**	**3.10**	11	2.71
Market uncertainty in innovative products	**3**	**3.00**	18	2.20
Imitation possibilities of technology innovation	**4**	**2.95**	16	2.39
Short of ability in R&D planning and management	**5**	**2.91**	23	1.75
Lack of technological information	**6**	**2.87**	**9**	**2.79**
Funding difficulties due to high risk from technological uncertainty	**7**	**2.85**	26	1.55
Funding difficulties due to high innovation and commercialisation costs	**8**	**2.79**	**2**	**3.06**
Lack of market information	**9**	**2.78**	**7**	**2.84**
Frequent turnover human resources (usually for R&D)	**10**	**2.66**	**5**	**2.94**
Difficulties in using external services (technology and business services)	14	2.49	**10**	**2.79**
R&D department without power	16	2.37	**8**	**2.82**
Monopolistic or oligopolistic market structure	18	2.33	**1**	**3.14**
Funding difficulties due to delayed payment by customers	23	2.02	**6**	**2.84**
Needlessness of additional innovation	25	1.97	**4**	**2.96**

[a] The maximum value for 'Score' is 5.
[b] The range of ranking is 1–26. Texts in bold indicate the top 10 innovation barriers.

Table 7
KICMS' collaboration facilitating activities.

Research	Structuring	Consulting	Marketing
• Needs analysis	• DB maintenance	• Advisory board	• Market research group dispatch
• Policy analysis	• Expansion of basis	• Matching	• Promotion
• Supporting systems	• International network	• SWOT analysis	• E-marking
• Success/failure cases	• Geographical clustering	• General management, law, and finance	• Niche market
• Policy development	• Training staffs	• Production and process innovation	• Overseas market analysis
• Process development	• Session for policy	• Funding and tax	• International and domestic exhibition
• Benchmarking	• Presentation	• Control and role	• Overseas buyers
		• Conflict and resolution	

networking mode where network members share funding and risks to help realise rapid and flexible production and open new markets. By 2007, 4415 firms and other organisations, ranging from non-profit organisations to very large firms, had become KICMS members.

KICMS's intermediary activities can be classified into four categories. The first is *collaboration research* to discover effective ways to facilitate collaboration; the second is to support construction of *collaboration structures* by collecting data about members, training staff, designing geographical clusters, making connections with international collaboration partners, etc.; the third is to provide *consulting services* during collaboration, regarding the match between SMEs, SWOT analysis, process innovation, conflict resolution, advice on law/tax/accountancy, etc.; and the fourth is *open markets* for SMEs, which has been the area that causes SMEs most difficulty in their attempts to successfully commercialise and diffuse their innovative technologies. These innovation-encouraging activities are summarised in Table 7.

Through KICMS's intermediation, a number of CF^2s have been organised and led on to successful business collaborations. Theoretically, various networking models can be designed but we find the following four presented in 51 consortia are the dominant collaborative structures: (1) R&D-focused CF^2s; (2) manufacturing-focused CF^2s; (3) marketing-focused CF^2s; and (4) new business-focused CF^2s. 15 consortia were *R&D-focused CF^2s*, where the R&D-specific firm took the main role in the network with their core technology and pursued opportunities for radical innovation by forming a network with others who are specialised in manufacturing and marketing. The largest number of cases (30) involved *manufacturing-focused CF^2s*, most of which focused on incremental innovation. In these consortia, the manufacturing firm organised networks with an R&D and marketing firms for new product development, product improvement or new market development. An alternative type of network was composed of several manufacturing firms, aiming to co-develop, co-manufacture and co-sell multi-technology products. Neither *marketing-focused CF^2s* nor *new business-focused CF^2s* were so common, with only three cases of each type. In the former, a marketing firm which has received an order may play the leading role in a network with an R&D firm and a manufacturing firm (usually for incremental innovation), or a manufacturing firm takes full responsibility for manufacturing, while other, marketing, firms concentrate their efforts on sales through their business connections or open a new market. By contrast, in the latter, all firms were involved in the whole process of identifying new products and services, manufacturing and marketing them to realise radical innovations. A graphical description of each model is presented in Fig. 4.

4.2.2. A successful collaboration case

As KICMS has only been established for three years, it is not easy to evaluate final success or failure of CF^2s, but many of the CF^2s have been doing satisfactory business. From amongst them, this paper presents the case of network M, and R&D-focused CF^2, consisting of five firms that have collaborated to commercialise a Flat Satellite Dish (FSD) embodying Wave Guide Horn (WGH)[1] antenna technology to verify the feasibility of suggested model. WGH antenna technology is regarded as an incomplete technology, only previously used for military purposes in a few advanced countries. However, one Korean SME possessed the technology sufficiently for civil application, and developed the world's first antenna embodying WGH technology. Despite the considerable potential of its innovation, however, firm M had cost and quality problems in seeking to commercialise the WGH antenna by itself. To solve these difficulties, firm M decided to collaborate with other specialised firms, contacted KICMS for help, and finally organised a collaboration network. It hoped that would allow it to construct a stable and price-competitive production system: the other collaborators expected that participation in the commercialisation of such a promising innovation would lead to increases in their sales.

Table 8
Summary of SMEs in network M.

Firm	Role	Previous main business type	Size[a]
M	R&D (marketing)	Satellite dish (manufacturing)	27
H	Marketing, distribution	Transportation service (export/import agency)	145
C	Components	Telecommunications components (wholesale-retail trade)	15
K1	Manufacturing	Electronics (manufacturing)	10
K2	Manufacturing	Moulding (manufacturing)	10

[a]Size is measured by the number of employers.

Examining briefly the role of each actor in the network (see also Table 8): KICMS helped to construct the network and provided the consulting service during collaboration; Leading firm M mainly focused on R&D, determining specifications for the antenna and the system, developing a computer program, and designing production procedures, and managing the overall collaboration process. Firm K1 was in charge of managing the FSD products production process and of manufacturing electric circuits and gears, a function that had previously been outsourced, leading to frequent problems. Firm K2 took charge of the casing, injection moulding and plating of the antenna. The firm suggested various ideas for customising the antennae for customers and also contributed to reducing costs by suggesting a cheaper and better way injection moulding method. Firm C supplied all except core components at lower wholesale prices, leading to savings on previous purchasing costs of over 15%. Firm H played a central role in distribution, especially for the customs procedures and delivery of overseas orders, contributing to

[1] A Wave Guide Horn is a pipe made by an electric conductor like copper which acts as a transmitter to transfer electronic energy or high frequency (more than Microwave i.e. above 1 GHz) signals.

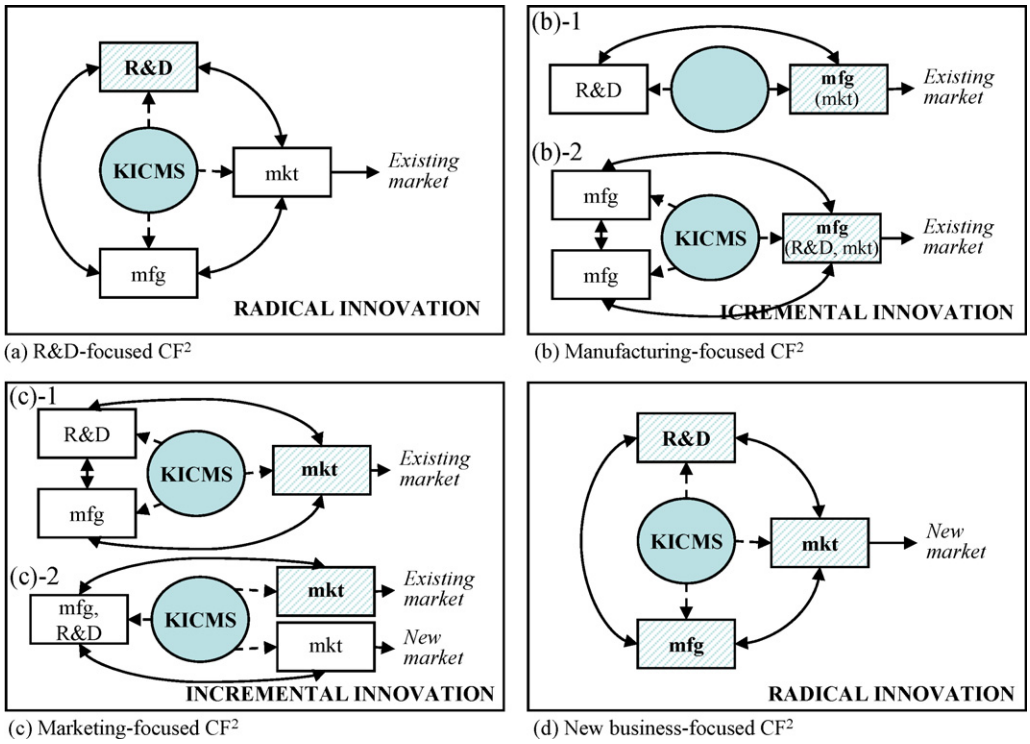

Fig. 4. Four major types of CF²s.

increased expertise and cost reductions in distribution. Particularly in this case, the firm M also needed to participate in marketing, since an entirely new technology was involved in the product, and potential customers needed to understand the technology and the product fully explained to them. Therefore, the network model is a slightly modified version of an R&D-focused CF².

4.3. Advantages

The intermediated networking model causes transaction cost but gives more benefits if well organised and operated properly. Firstly, networking cuts the time to market for its idea. In the case of M, the CF² was organised in February 2004, product planning started in April, prototyping was completed in September, and final sales contracts were achieved in December of the same year. It took only eight months from product planning to building the production systems: this swift construction of such an effective production system based on the joint efforts of specialised SMEs to overcome their limitations in commercialising a competitive technology shows the clear benefits of the collaboration. Secondly, SMEs can access complementary assets without the participation of any large firms. In the case of M, the network model provided a basis for moving from invention to innovation based on its own competitive advantages. The results of this collaboration for the leading SME M, in terms of its total sales, sales of the collaboration product, cost reductions and working ratio of facilities, are summarised in Table 9.

Thirdly, beside those short-term results, the model enables SMEs to reinforce their strength. In the case of M, the firm was able to concentrate their capacity just on its R&D and marking efforts, which strengthened the market acceptance and diffusion of its products. Finally, the network helps to create a number of innovative ideas by benefiting from the active technological discussion and knowledge exchange with collaborative firms, which should provide it with several possibilities for future business diversity. Rapidly increasing sales are expected with the introduction of further new models, which was also reported by the case.

4.4. Managerial implications

Several points arise from the analysis of the activities of KICMS. It is almost impossible for SMEs to have a complete set of expertise in technology (ideas), funding (products), and marketing (distribution channels) and so their ability to commercialise their innovation is too often limited. However, the case in this research indicates that SMEs can also commercialise competitively if they work together in a flexible and more open structure that can build on their individual competitive advantages. Nevertheless, SMEs should be cautious about networking: it is only one of the options they can take, and depending on the nature of the technology, of the market and of many other factors, keeping the technology inside the firm or commercialising in partnership with a large firm may be better options.

The CF²-M case studied here indicates how a collaboration network benefited SMEs in transforming an invention into an innovation. The SMEs in the network were all specialists in their areas, but, more importantly, they made considerable efforts in terms of trust creation, information networking, procedural learning and know-how transfer, which contributed greatly to the network's success. Mutual trust in a cooperative relationship is essential to its ultimate success, and, while an intermediary can provide a basis

Table 9
Results of collaboration case as reported by M.

	Before (2003)	After (2004)	Change
Sales (total)	1 443 000[a]	7 752 000[a]	437% increase
Sales (collaboration item)	865 000[a]	4 652 000[a]	438% increase
Cost			
Vehicles use	300[a]	255[a]	13% decrease
Domestic use	23[a]	19.55[a]	15% decrease
Working ratio			
Antenna test chamber	60%	70%	10% increase
Near field system	65%	80%	15% increase
Network analyser	65%	85%	20% increase

[a] All figures in thousands of Korean Won.

for this trust, each member must make continued efforts to develop it.

How best to construct a network is also a significant issue. For a successful collaboration, network firms must understand each other and each others' needs. KICMS does not have an advanced system for recommending suitable members based on partner selection criteria, and while it supports a consulting service to evaluate suitability, as more SMEs join the association, a more systematic evaluation process will be needed, involving not just lists of SMEs, but also data on various aspects of their operations – including their strengths and weaknesses, and their capacity, vision and characteristics – to be used as criteria for organising the best networks. Another issue is an appropriate number of collaboration partners. External search breadth and depth are related to innovative performance, taking an inverted U-shape (Laursen and Salter, 2006). If firms use too many sources of external knowledge for their innovative activities, negative returns might set in. These phenomena can be applied to networking and thus careful consideration is needed when networks are organised.

Finally, we did observe cases of CF^2 failures even where a collaboration network had been successfully organised. One critical problem was lack of financial resources: in spite of the joint investment of members firms, CF^2s can still lack sufficient funds in production, operational or R&D areas, which can halt the progress of the collaboration. Recognising this problem, KICMS is attempting, as one solution, to incorporate more SMEs with substantial funds into the networks they help to set up – another solution could be institutional support at the government level. Korea prioritises collaborative SMEs as beneficiaries of government funding, but the evaluation criteria currently depend mainly on the individual firms' past business results, whereas it might be better to base the evaluation process and estimates of likely future success on the business validity, growth potential and expected sales of the collaboration.

5. Conclusion

At the stage that a movement from a relatively closed business model to a very open one has posed challenges for SMEs, it is important to address their innovatory capabilities in the context of open innovation. This paper attempts to identify the potential of open innovation for SMEs, and to develop collaboration models to enhance this potential. These models are classified into several modes, according to the actors in the models, and each actor's role is defined. On the premise that commercialisation after invention is essential for innovation, and that SMEs are good at inventions but lack adequate resources for commercialisation, we suggest that one possibility to boost open innovation in SMEs lies in collaboration with other firms at the commercialisation stage. Of various collaboration modes, an intermediated network model is investigated, which reflects the open innovation concept, and the role of an intermediary in organising the network is examined, which takes account of SMEs' limited ability in searching for partners and contributes to building trust between network members.

We also analysed technology innovation survey data to understand the current condition of innovation activities among Korean SMEs. From this analysis, we explored the role of external actors in their innovation process, and also identified the barriers to innovation, based on which a network model is suggested and the necessity of an intermediary is highlighted. To verify the feasibility of the model, we introduce the case of KICMS, which was established to support the virtual organisation of Korean SMEs and has encouraged them to establish cross-functional collaborative networks. With the help of KICMS a number of consortiums (called CF^2s) have been organised to compete against large firms. KICMS has introduced the collaboration models actively to the SMEs and provided the information that they need together with the basis of trust, helping to organise their collaboration networks effectively. This research supports the concept of open innovation in SMEs by indicating effective networking as one possible way to facilitate their innovation capabilities.

Nevertheless, future research is still needed to improve our current understanding of open innovation in SMEs as a whole. Firstly, we have indicated several possibilities of facilitating innovation in SMEs, and then restricted our focus to the collaboration network model. However, other possibilities could be fruitfully examined through a framework encompassing the concept of open innovation and using quantitative data. Secondly, the several terms used to describe this collaboration mode, such as strategic alliance, collaboration, co-operation, networking, etc. – which are used together to point the same or different patterns and thus are quite confusing – need to be clearly defined. Finally, based on the literature review and the KICMS case, this paper tries to define the role of intermediary and more research using survey or interview methods will statistically support the findings of this paper. For example, future research can focus on analysing more CF^2 cases in terms of their ratios of success and failure and the factors behind these outcomes, and investigating how to improve the role of intermediary in terms of the matching algorithms and policy support. Also, the future research is needed to find the characteristics of SMEs that are more likely to benefit from collaboration and collaboration via an intermediary in particular.

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