The effect of cybercrime on open innovation policies in technology firms

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Abstract

Purpose – Open innovation is important for technology firms as they can use freely available resources to source creative and innovative ideas. Despite the usefulness of open innovation for technological advancements, few studies have focused on the role of cybercrime in affecting an organizations strategic direction. The purpose of this paper is to examine the effect of open innovation on cybercrime in technology firms.

Design/methodology/approach – Semi-structured in-depth interviews were conducted on technology firms to understand the role of open innovation in terms of technology scouting, horizontal collaboration and vertical collaboration on cybercrime activity.

Findings – The study found that there is a dilemma most technology firm's face in having an open innovation strategy and how to manage cybercrime. This means that a coopetition strategy is utilized that helps to not only balance the need to have open innovation but also protect intellectual property.

Research limitations/implications – The study has implications for emerging technology innovations that not only need to have cyber security but also harness the use of Big Data.

Practical implications – Managers of technology firms need to encourage open innovation as a strategy but manage the cybercrime that comes from sharing too much information in an online context.

Originality/value – This paper is one of the first to link open innovation strategy to cybercrime activity in technology firms. Thus, it contributes to the literature on open innovation and cyber theft and security.

Keywords Collaboration, Coopetition, Technology collaboration, Innovation strategy, Open innovation, Business innovation, Cybercrime, Technology scouting

Paper type Research paper

Introduction

The increased trend to share information via the internet has not only created opportunities for organizations but also increased the threat of cybercrime (Choo, 2011). Whilst organizations need to utilize innovation in order to compete in the global marketplace, they should also be cognizant of the risks associated with sharing information (Broadhead, 2018). Open innovation is a trend that has gained prominence in recent years particularly amongst technology firms due to the ability to share information with competitors (Amrollahi and Rowlands, 2017; Randhawa *et al.*, 2016; Spender *et al.*, 2017). In this paper, Chesbrough's (2003, p. xxiv) definition of open innovation is adopted, which states it is "a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as firms look to advance their technology."

Whilst there has been an increased interest in open innovation in technology firms, the negative publicity from the use of Facebook information to understand voting behavior in the US elections has brought to life the conundrum about how to share information but at the same time be respectful of privacy issues. In addition, websites like Wikipedia have become more prevalent and these are premised on the idea of open innovation but this has resulted in some incorrect and false information being posted on their websites. Thus, whilst Wikipedia encourages the posting of information, there is a secondary issue of what happens when the information is the result of cybercrime. This has occurred with restaurants like Kentucky Fried Chicken and Subway taking to court franchisees who posted illegally information about recipes. Therefore, particularly for technology firms that

pride themselves of being innovative, a question arises of how to regulate and be mindful of information that was the result of cybercrime whilst at the same time fostering an environment for open innovation (Gillespie, 2015; Robertson *et al.*, 2017).

Organizations need to balance opening up their resource repositories to new ideas in order to generate innovation with the need to safeguard their intellectual property because of cyber threats and security concerns (Klimburg, 2011). Cybercrime is one of the fastest growing types of crime that influences organizations technology policies (Joffee, 2010; Katos and Bednar, 2008).

Cyber security involves ensuring that information in an online context is safe and secure (Hunton, 2011). Technology organizations who share information via an open innovation strategy are concerned about the theft of intellectual property (Lazzarott *et al.*, 2015). This has influenced organizations strategy to include issues surrounding cybercrime such as security strategies that ensure the sharing of online information is safe (Katos and Bednar, 2008). Open innovation is important for organizations as it facilitates the sharing of knowledge, which is important for innovation. Randhawa *et al.* (2016) stated that the process of open innovation for organizations involves "opening up their boundaries to seamlessly collaborate and exchange knowledge with external stakeholders to leverage complementary assets and capabilities."

Broadhead (2018, p. 1181) utilized the Europol definition of cybercrime by referring to it as "any crime that can only be committed using computers, computer networks or other forms of information communication technology." Another definition of cybercrime by Gordon and Ford (2006, p. 4) is that includes criminal offences that occur in an online forum and include copyright infringement, content misappropriation, fraud, unauthorized access and cyberstalking. This definition is adopted in this paper as it focuses on the illegal taking of information in an online format that relates to the current trend toward open innovation in terms of making information freely available.

Early views about the role of innovation on organizational strategy viewed it as a closed process that occurred in a sequential way. This view changed with the recognition that an open approach to innovation enables the more flexible and fluid sharing of knowledge. Spender *et al.* (2017) suggested that the adoption of an open innovation strategy is necessary for organizations due to the need to search for new ideas. This is supported by Chesbrough and Appleyard (2007) who proposed the concept of open strategy as a way of understanding how businesses can create value from having an open approach to value creation. By being inclusive and flexible with the sharing of information, it can help businesses capture more value (Bogers *et al.*, 2017). This is important as more businesses utilize collaborative models to deploy their strategies. To do this an open strategy requires a different form of governance system that facilitates the sharing of knowledge (Du *et al.*, 2016; Fisher and Fang, 2017; Lauritzen, 2017). Chesbrough (2011) has further linked the concept of open strategy to open service innovation that requires collaboration with customers and suppliers in the innovation process.

In order to advance the process of innovation more organizations are utilizing open innovation as it enables inflows and outflows of knowledge that can enable better value creation for organizations (Laursen and Salter, 2006). Chesbrough (2003) viewed open innovation as being different to previous conceptualizations of innovation due to the acknowledgment that external and internal ideas are needed for innovation. Open service innovation is important in the international marketplace that is time dependent on new innovations (Massa *et al.*, 2017). Innovation ecosystems are part of this process as they facilitate partnering with other network entities to co-create value (Eckhardt *et al.*, 2018). To do this, businesses need to transition from traditional to open business models that enable a different method to collecting and disseminating knowledge. Randhawa *et al.* (2016) suggested that the dynamic capabilities perspective can be used in open innovation to

reconfigure resources. This is important in markets with environmental turbulence that require the use of relational capabilities.

Part of the open innovation process particularly for technology firms means utilizing knowledge for entrepreneurial business ventures. Knowledge-based entrepreneurship is important for open innovation as it promotes the development of new knowledge practices. Spender *et al.* (2017, p. 20) defined knowledge-based entrepreneurship as "the ability to discern or avail of an opportunity and act to fulfill an innovative knowledge practice or product." Chaston and Scott (2012) in a study of firms in Peru found that there is more emphasis on double loop learning with firms involved in open innovation because of knowledge and entrepreneurial potential. To access the effect of open innovation, it is important to evaluate the efficiency and effectiveness of ideas.

This paper investigates the role of cybercrime in influencing an originations open innovation strategy. Open innovation is discussed in the literature review in terms of its effect on coopetition, horizontal technology collaboration, vertical technology collaboration and technology scouting. In-depth interviews of technology firms are utilized to see how their innovation strategy is focusing on open innovation and its affect on firm performance. As there is still debate about the role of open innovation in technology firms, the results of this paper help to shed light on the coopetition paradox in which firms not only need to collaborate but also compete in the global marketplace. The next section discusses the literature review for this study. This is followed by the methodology, the findings are then presented and implications for managers stated. Finally, the limitations and research suggestions are addressed.

Literature review

A firm's innovation strategy is influenced by its ability to scout for new knowledge. Wang *et al.* (2015, p. 223) defined technology scouting as "a firm's innovation resource scanning and acquisition process: it implies both searching for technology acquisition channels and supporting the process of innovation efforts." Technology scouting involves assessing appropriate capabilities and technology in other firms and industry settings. This is important in the technology industry as there are new and emerging innovations changing the business environment. When firms scout for technology, they are trying to discover new opportunities that provide a competitive advantage (Tether, 2002). Sometimes it is too costly for a firm to develop technology internally so they look for alternative sources. This helps a firm develop innovation resources that can use information and knowledge obtained from external sources (Wang *et al.*, 2015).

Firms need to be open to outside innovation due to the ability to access and utilize external knowledge (Enkel *et al.*, 2009). This is especially important in technology firms that need networks to build innovation. Firms need to collaborate and exchange knowledge in order to increase their knowledge base. There are some risks firms have with open innovation but this can be minimized with the right kinds of collaboration. Enkel *et al.* (2009) suggested that there are three core processes in open innovation: outside-in, inside-out and coupled. The outside-in process refers to the notion that knowledge can be created outside a firm but the innovation in a firm (Enkel *et al.*, 2009). This has led to firms becoming more engaged in networks and communities as a way to integrate knowledge into their firms. This helps increase the sources of knowledge that can enrich potential innovations. The inside-out process means a firm takes ideas to the market rather than relying on internal support. This enables other firms to support the ideas by transferring knowledge and providing feedback. The coupled process means partnering with another firm to help with the innovation. Increasingly, this coupled approach has been referred to as co-creation as it enables firms to work together on innovations. This provides joint capabilities that help an innovation be successful.

There has been a shift toward the use of open innovation as a way to source ideas and for collaboration (Kim and Lui, 2015). The concept of openness refers to knowledge flows that facilitate innovation practices. More openness between firms can encourage access to external knowledge, which affects innovativeness. Openness can enable the creation of new ideas and stimulate knowledge acquisition (Knudsen and Mortensen, 2011). More firms are focusing on open innovation for their success and as a way to foster collaboration. Despite the benefits associated with open innovation, there are few empirical studies examining the role of different types of technology collaboration in fostering firm performance due to the difficulties in measuring the concept (Knudsen and Mortensen, 2011).

The environmental context affects the relationship between open innovation and performance in both positive and negative ways (Cruz-Gonzalez et al., 2015). This is due to external knowledge acquisition not only impacting innovation within a firm but also meaning that potential intellectual property might be misappropriated. Open innovation enables a firm to redefine the boundary between itself and the environment in order to encourage the acquisition and dissemination of knowledge (Laursen and Salter, 2006). In the more connected world, it is important for firms to gain access to knowledge from a variety of sources that influence innovation. Chesbrough (2003) discussed how the open search for knowledge enables the acquisition of new ideas. These ideas play a key role in identifying knowledge and information important for a firm's innovation activities. By being open to new ideas a firm an increase their knowledge base and identify appropriate sources of information. This helps a firm to improve its knowledge management processes and look for new opportunities in the marketplace (Huizingh, 2011).

More firms are accessing informal knowledge sources that lead to collective learning within a firm. The information gained from open sources comes from customers, competitors, industry associations, suppliers and universities (Cruz-Gonzalez et al., 2015). These many different sources of information provide a firm with complementary sources of knowledge that can be used for innovation. Openness can have negative connotations due to it being costly to source the right information in a timely manner. This is evident in Knudsen and Mortensen (2011) finding that openness can have a negative effect as it leads to slower projects. This means it is important for firms to have multiple sources of external knowledge and the appropriate management practices (Laursen and Salter, 2006).

Firms whilst scanning for appropriate partners need to be cognizant of the type of information they require. Laursen and Salter (2006) suggested that more external knowledge sources lead to a more open search strategy. This is due to the chance of acquiring the right knowledge being associated with integrating knowledge from appropriate sources. Chang et al. (2012, p. 448) defined openness capability as "a firm's ability to search for diversified sources of creative ideas from external, distant and wider orientations, rather than from internal, local and narrow ones." The implementation of open innovation needs to be integrated into a firm as there may be the "not invented here" syndrome. Therefore, for open innovation to be effective there needs to be the appropriate managerial attitudes within a firm. This is due to it being hard to integrate ideas into a firm when the source is external.

The process of open innovation involves integrating knowledge via shared communication mechanisms with competitors, which is referred to as coopetition. Coopetition is defined generally as "the simultaneous pursuit of cooperation and competition between firms" (Raza-Ullah et al., 2014, p. 189). This means that coopetition is a paradox but is increasingly common in technology firms who must compete but need to collaborate. Therefore, coopetition enables a firm to have a larger value net by decreasing opportunism whilst pursuing innovation (Bouncken and Fredrich, 2016). Coopetition acknowledges that often firms particularly those in knowledge intensive industries can leverage valuable

knowledge through collaboration with competitors. This is due to there being similar motivations for the need to access knowledge that is essential for innovation (Bouncken and Kraus, 2013).

Coopetition incorporates opposing forces of competition and collaboration but when combined can lead to potential gain for the firms involved (Fernandez *et al.*, 2014). Part of the process for coopetition involves inlearning, which refers to how a firm leverages absorbed knowledge (Bouncken and Kraus, 2013). Thus, inlearning stems from the coopetition in which use of external knowledge is internalized and combined with existing knowledge sources. Inlearning incorporates relationship building into the way firms transform implicit knowledge into explicit knowledge (Bouncken and Fredrich, 2016).

The willingness to use open innovation will positively affect firm performance as it is part of an innovation strategy. Sisodiya *et al.* (2013) found a positive impact of open innovation on firm performance. Therefore, the openness of a firm's external search for knowledge is linked to the ability to access breadth and depth of knowledge. Breadth refers to the number of external sources a firm can rely on in terms of innovation (Laursen and Salter, 2006). This means that having more search channels will enable greater access to multiple sources of information (Cruz-Gonzalez *et al.*, 2015). Depth refers to how a firm uses its knowledge in terms of finding the most appropriate ways to innovate and give meaning to the objectives of the firm's strategy (Laursen and Salter, 2006). Therefore, depth means the extent that a firm accesses information in a meaningful way from external sources. Both breadth and depth have been related to as exploratory and exploitative learning (Cruz-Gonzalez *et al.*, 2015). This means that a firm's innovation strategy in terms of its breadth and depth will affect its overall performance.

Horizontal technology collaboration refers to collaboration with external competitors and partners in order to acquire technology-related knowledge (Wang *et al.*, 2015). This form of collaboration involves accessing knowledge from firms in usually the same industry level in order to influence innovation. These types of collaboration are important due to the short product life cycles of many technological innovations. For many technology firms, improving access to innovation through collaboration is the key source of performance. Collaboration is a major way technology firm's gain access to innovation that helps them develop new products and services (Alexiev *et al.*, 2016). A growing source of information utilized for collaboration is open innovation, but less is known about the effects on a firm's innovation strategy. Collaboration is often an innovation strategy by technology firms but there is a lack of understanding about how firms utilize technology scouting in order to facilitate performance.

Vertical technology collaboration involves collaboration with customers in order to gather feedback and help about market developments (Wang *et al.*, 2015). Utilizing customer ideas in innovation helps firms develop better products and services. The use of customers in collaboration helps a firm to innovate with novel technologies (Von Hippel, 2005). This enables firms to access information and knowledge about technology from first-hand users. This experience means customers can contribute their own ideas about how a firm should innovate. Often customers are users and innovators so with vertical collaboration firms can tap into this expertise. Customers can help firm's source new or improved products and services in a more cost efficient manner (Wang *et al.*, 2015). This helps a firm to test out ideas and see if customers will be receptive to the technology innovation.

Technology firms are more likely to cooperate with competitors because of the high level of interdependence (Gnyawali and Park, 2009). Often technology firms need to access each other's resources to develop integrative products and services. This is becoming more important as collaboration with competitors enables the acquisition and creation of new knowledge depositories. Firms utilize their competitor's technological knowledge to pursue collaborative ventures that are innovative (Wang *et al.*, 2015). The collaboration with

competitors can lead to increased performance for all firms involved through the creation of new businesses. Collaboration enables the leveraging of competitors technological capabilities and know-how that is needed for innovation. Increasingly, horizontal technology collaboration is viewed as a competitive advantage for the firms involved as it leads to increased performance (Parida *et al.*, 2012).

Communication needs to identify the knowledge and assimilate it within the firm context (Cohen and Levinthal, 1990). Moreover, the external knowledge needs to be linked to prior firm competences in order to apply it effectively. Collaboration can be both a process and an output between two or more firms (Crossan and Apaydin, 2010). Alexiev *et al.* (2016, p. 975) referred to interorganizational collaboration as "a feature of the innovation process related to the extent to which other organizations-firms or institutions-take an important part in the innovation process." Collaboration occurs at different stages of the innovation value chain depending on the type of innovation (Hansen and Birkinshaw, 2007). Collaboration is a strategic decision that involves coordinating innovation activities and managing relationships (Alexiev *et al.*, 2016). In this paper, a firm's innovation strategy will determine whether vertical collaboration is utilized. The next section will discuss the methodology utilized to analyze the role of cybercrime on an organizations open innovation strategy.

Method
Data collection
An exploratory qualitative research approach was adopted in this study. In qualitative research, there are no minimum number of participants needed as it depends on the type and nature of the study (Yin, 2013). Purposeful sampling enables an in-depth understanding about the topic under investigation (Patton, 2002). An open-ended question design structure was undertaken to enable probing of interesting information (Kalafatoglu and Mendoza, 2017). This enabled a semi-structured design process to provide rich insights.

A purposeful sampling approach to collecting the data was utilized (Lincoln and Guba, 1985). To select participants, the technology industry was chosen as it is influenced by open innovation and cybercrime. The informants were selected from the technology industry as they were deemed to be the most knowledgeable about the subject (Corley and Gioia, 2004). In addition, participants were asked if they knew others in the technology industry who might also provide useful information. The study included 16 participants and 2 cases were excluded as the managers moved to another city and could no longer be contacted. To be included in the study, the managers needed to be present in the interviews and have knowledge about their innovation business processes. The participants were all senior-level managers who had decision-making power in their organizations. However, they had differences in terms of innovation and cybercrime experiences and innovation behavior. This enabled better insights into how the nature of cybercrime is changing technology organizations innovation strategies.

Preliminary interviews were conducted with the participants to understand their thoughts about the effect cybercrime have on open innovation strategies. An interview protocol was developed then adjusted based on the preliminary interviews. The interview protocol was organized around understanding the concept and process of open innovation, innovation strategy and technology collaboration. The data collection instrument was an interview protocol based on issues addressed in the literature review. The interview protocol focused on the main issues and themes under investigation in this study. Open-ended questions were utilized in order to have some flexibility in terms of asking follow-up questions. This enabled some changes depending on responses to the questions in terms of additional areas of enquiry. The sequence of the questions mostly followed the format given in the interview protocol. A total of 16 information technology professionals in Australia

were asked about how open innovation influences cybercrime. The definition of open innovation used in the interviews was "firms using external and internal ideas to advance their technology." The questions of interest to this study included: how does a strategy of open innovation influence cybercrime at your business? What cybercrime issues are associated with the sharing of information and knowledge? What are the key suggestions you have about dealing with cybercrime coming from an open innovation environment? And finally what mechanisms would you suggest information technology businesses adopt for managing open innovation? To provide more information about the environmental context influencing open innovation, archival data were also collected such as newspaper articles, website information, books and various other documents relating to cybercrime. This enabled more information to be obtained about the process of open innovation and enabled the triangulation of the data sources (Yin, 2003).

As stated in Table I, the interviewees were all in the information technology sector and had different lengths of experience. Thus, they have specific knowledge about cybercrime. The respondents in the sample had varied academic qualifications with most having studied information technology at university or via a post graduate diploma. The interviews were conducted in English via phone, e-mail and in-person. Most interviews went for at least 20 min and were transcribed.

Analysis
The transcripts were analyzed for main themes using a thematic analysis approach. This enabled an analysis of the outputs and topics emerging from the interviews. The themes were analyzed in terms of patterns and convergence in responses. Areas of divergence were also analyzed to help understand different points of view. The study utilized an interactive approach to take into account data from not only interviews but also continuous dialogue. Notes were taken during the interview to highlight key points and interesting findings. The data were analyzed manually by categorizing then recategorising quotes based on emerging themes. This enabled relevant patterns to emerge that enabled an understanding about the role of open innovation for cybercrime.

To preserve anonymity of the participants we utilized codes. The data were coded with the aim of identifying relationships and links to the existing literature (Strauss and Corbin, 1998). This involved the data being examined in stages to see emerging themes that were becoming evident until a point of data saturation was reached. The data were read and

Case	Line of business	Position	Years worked in industry
1	Services	Managing director	1
2	Retail	Employee	20
3	Services	Employee	2
4	Government	Director	20
5	Services	Managing director	3
6	Services	Director	2
7	Retail	Director	4
8	Government	Employee	3
9	Services	Owner	10
10	Services	Director	2
11	Services	Director	3
12	Government	Employee	3
13	Retail	Owner	5
14	Retail	Managing director	2
15	Services	Employee	10
16	Services	Employee	2

Table I.
Sample profile

re-read to understand its meaning (Gioia *et al.*, 2013). The data were coded based on themes that helped to identify the main connections. The data analysis involved comparing information with the previous interviews in an ongoing process. The analysis involved going back to the interviewees to clarify and amend the responses (Guba and Lincoln, 1994). This enabled a process of amplification so that novel insights were highlighted then clarified for meaning amongst the participants. In addition, it enabled the data collected to be corroborated to ascertain the main themes.

Following the approach used by Werthes *et al.* (2018), each of the participants was compared to see the changes in response and attitude. This enables an examination of the patterns among the participants of the study to be analyzed (Eisenhardt and Graebner, 2007). In addition, the study followed Yin's (2009) quality measures for qualitative research that include internal validity, external validity and reliability. Thus, two other researchers examined the data to see if they derived the same themes. These external researchers came to the same conclusion about the themes and corroborated the findings.

Research findings
Subsequently, the study analyses the effect of cybercrime on open innovation policies in technology firms. A process logic approach is followed to understand the role of innovation strategy and technology scouting for open innovation policies. In addition, the effect of horizontal and vertical forms of technology collaboration on open innovation strategy is discussed. Throughout the analysis, illustrative quotes from the managers of the technology firms are provided. The data indicate that all participants are interested in the way open innovation is used as a business strategy. Over time each of the managers from the technology firms has adopted a way to cope with the threat of cybercrime. The findings reveal that all participants are changing their innovation strategy based on the environmental context. The analysis suggests that technology collaboration is a way of reducing risk of cybercrime as increased usage of partnerships can deter the risk of inappropriate stealing of data and information.

There was a range in the background profile of the respondents, which is illustrative of the different amounts of time people spend in the information technology industry. The years worked in the industry ranged from 1 to 20 years, which is also linked to the age of the respondents. Some of the interviewees might also have seen the years worked in the industry as related to the current position as Managing Director rather than the overall number of years spent in the Information and Communications Technology industry. This is reflected in these quotes: "I have worked specifically in the IT industry for 2 years as a Service Manager for a large technology company. But I have (had) a range of other roles that are linked in some way to my current position but would not necessarily classified as information technology" (Interviewee 6) and "I am an employee of this firm so one of the top employees in terms of sales. Here I have worked in the industry for 2 years. Before that I was in technology but in a different industry" (Interviewee 16). This broad range of experiences is helpful to understand the different points of view that individuals have about the effect of cybercrime and innovation on the industry. In addition, the diversity is good as it takes into account the views of individuals with both a short- and long-term experience of change in the information and communication industry.

The interviewees all were aware of the growing risk of cybercrime and had a variety of opinions about its relevance to open innovation. Most of the interviewees expressed the view that innovation was needed but open forms of innovation created additional risks in terms of potential data theft. This is evident in the following quote:

In the tech industry we need constant innovation to stay ahead of competitors. But some of the innovation requires collaboration. That is what you refer to as open innovation. But it comes at a price.

> Open is not always open because people choose what they want to share. Some of the information can be stolen. There is a lot of cybertheft but the information as intentionally shared then it is not stealing but part of the sharing process. (Interviewee 5)

The greatest cyber security concern of most of the interviewees related to data breaches in terms of confidential and private information. This was evident in the discussion in the interviewees that focused on how to balance the sharing of information in the view of open innovation but also protecting important information. As the concept of open innovation seemed to be more an idea rather than practiced by the interviewees it produced some interesting quotes. For example:

> Open innovation sounds a wonderful idea. In the online format it makes sense if people are not concerned with money. But our company needs to make a profit. How to do that with open innovation is an issue I think about. (Interviewee 12)

> Open innovation is a good idea but we work hard and our ideas are money. So we share some information but not all. Some information has the potential to accidentally share intellectual property that was not deliberately intended. So security wise we need to share but be careful with the content. (Interviewee 2)

The issue of innovation strategy and its impact on cybercrime was discussed in the interviews. This seemed to be an important area of concern for the interviewees who needed to search for knowledge that had specific relevance to their businesses. Interviewees expressed the view that technology firms needed new knowledge for competitive reasons and this was part of the nature of their industry. However, obtaining the right knowledge was hard as evidenced by their collaboration strategy using open innovation. This is expressed in the following quotes:

> Our strategy is to have access to more information in the hope that some will be relevant for our business. Being open about what we need and have helps with our innovations. (Interviewee 5)

> I try to get others to read widely as a way to see new trends in the marketplace. Business partners are helpful and the strategy of sharing knowledge is useful in the technology industry. (Interviewee 9)

Interviewees discussed the role of technology scouting as a way to support the open innovation process. This means assessing other businesses in terms of information being shared to determine if it was useful for their business. Cybercrime was one of the issues that interviewees thought was a risk and there was efforts to ensure more private ways of sharing information between businesses. This is evident in this quote:

> We look to see for change and this is part of our open innovation strategy but we need to ensure some information is only shared through the appropriate channels. Some gets lost. Some gets stolen. It depends on the website, the technology and the information. (Interviewee 10)

The impact of open innovation for business strategy was an issue that influenced the building of cyber security systems. This was important as even though the thought of open innovation means it is accessible to all in reality the technology firms were hesitant to share all types of knowledge. This meant that the firms took different forms of strategy in order to cope with open innovation.

Horizontal and vertical forms of technology collaboration were used by the businesses in pursuit of their open innovation strategy. Horizontal collaboration tended to be the preferred form as it was easier for the firms to connect with each other. The interviewees expressed the view that they understood the business strategy of other firms in the same industry level, which made it easier to collaborate. This enabled the interviewees to discuss how their firm was dealing with cybercrime. For many of the interviewees, horizontal collaboration

enabled sharing of strategies that focused on deterring cybercrime. This is stated in the following quote:

> To talk to others in the same industry is part of business. Is industry practice. These talks refer to a range of topics with cybercrime always coming up in conversations. (Interviewee 8)

Vertical technology collaboration occurred in different contexts amongst the interviewees. This tended to reflect the need for open innovation to help customers, suppliers and business partners communicate about new developments in their field. The communication from the interviewees suggested that knowledge was important to improving processes and business systems. This means that part of the open innovation process involved the technology firms sharing information about how cybercrime might harm their business strategy. This is reflected in the following quotes:

> Sharing information with them helps improve our processes but we need to keep careful attention on information that slips through. In the past some of our information was lost and had malware viruses attached to them that meant it was insecure. This is part of the cybercrime that happens on an everyday basis in tech firms. (Interviewee 14)

The next section will further discuss the results of the interviews in terms of cybercrime issues influencing technology firms.

Discussion of findings

This study contributes to the literature on open innovation by investigating the role of innovation strategy in preventing cybercrime. Previous research by Alexiev *et al.* (2016) suggests that an organization's innovativeness is influenced by how it responds to security threats in its environment. This paper helps to build an understanding about how horizontal and vertical technology collaboration influences the way technology firm's scout for information that might impact their performance. Amrollahi and Rowlands (2017) suggested that a more open approach to collaboration can result in better performance outcomes. Open innovation was evaluated using three different measures: innovation strategy, horizontal technology collaboration and vertical technology collaboration. This study provides some direction to technology entrepreneurs to develop their open innovation strategy but recognize the potential pitfalls in sharing information. This complements research by Gillespie (2015) who highlights that cybercrime is a disadvantage of increased collaboration but can be combatted through better organizational strategies.

It is important for technology entrepreneurs to demonstrate the benefits of open innovation as a way to enable a co-creation process and as an effective tool to find new opportunities. This confirms research by Elg *et al.* (2012) who found that co-creation can help firm's develop better market innovations. Thus, in line with the literature review it was found that the data collected from the technology firms influenced open innovation practices. This supports research by Brown and Mason (2014) who found that the knowledge exploitation is a crucial part of an entrepreneurial ecosystem.

An innovation strategy helps to influence the type of information and knowledge that is scouted for in the environment. The potential for innovativeness increases when firms collaborate and share knowledge about potential future market trends (Tajeddini and Trueman, 2008). Thus, it helps to explain how a firm's internal and external environment impacts its decision to utilize different types of technology to collaborate. This supports research by Rubin *et al.* (2015) who suggested that there are different types of knowledge produced by firms that is depend on the nature of the knowledge flow. As open innovation is premised on the idea that customers, competitors and stakeholders have valuable insights this links with the notion of coopetition impacting cybercrime in technology firms.

As more technology firms seek to find ways to exploit their knowledge sources, it is helpful to understand the ways they can influence their innovation strategies in order to

increase their overall firm performance (Lazzarott *et al.*, 2015). The findings of cybercrime being influenced by both horizontal and vertical collaboration corroborate research by Tajeddini (2015) who found that to increase effectiveness and efficiency in firms they need to collaborate and share knowledge in order to enhance their competitiveness. Therefore, the findings of this paper can be useful to managers of small- and medium-sized organizations that are thinking about ways to utilize open innovation but protect themselves from cybercrime. This means that in the competitive marketplace some sharing of information is required in order to contribute to the innovation process but the level and amount of this information shared needs to be carefully considered. Thus, policies need to be in place that deal with potential cybercrime to ensure that confidential and sensitive information is not used in a malicious way. The findings of this research show that there can be open innovation but it needs to be managed in a careful way with other entities that the organization trusts. Therefore, a vetting process needs to be in place to ensure the right type of entities is being included in innovation discussions that have the potential to collaborate or help organizations in the future.

However, as Bader and Enkel (2014) found that a greater level of openness requires more organizational complexity there needs to be some management support on knowledge flows. Organizations can pursue innovative strategies but use the results of this paper to decide how to combat cybercrime when adopting an open innovation strategy. This supports research by Schott and Sedaghat (2014) who found that entrepreneurial social capital helps new entrepreneurs to innovate.

The study shows that the open innovation process of the interviewees was important in moving the direction of discussion to matters about cybercrime. With the exception of two interviewees, most in the study had a formal organizational strategy of participating in open innovation. This strategic direction influenced the willingness of interviewees to share valuable information that might have intellectual property rights associated with its usage. This involved coopetition in the open innovation process as the interviewees indicated that most knowledge shared was intelligence that had the potential to benefit their competitors. Therefore, the study provides a valuable basis based on the theoretical framework of open innovation for further research about the impact of cybercrime. Clausen and Rasmussen (2015) found that there are more social than private benefits of open innovation. The findings from this study are helpful to innovation and technology interest groups involved in cyber security. Governments not only need to provide training on how to deal with cyber security but also encourage technology firms to pursue open innovation. Policy makers should provide support to technology firms involved in open innovation to improve our understanding about how to deal with cybercrime.

Research contributions

The strongest finding from this research relates to the importance of collaboration for innovation whilst being mindful of cybercrime threats. For many technology firms, cybercrime has meant they are reluctant to share information but with changes in the market environment occurring at a rapid pace it is becoming important for them to have partners. As reflected in the discussion section, both horizontal and vertical forms of collaboration help increase innovation repositories in technology firms. However, there is seemingly an acknowledgment amongst managers of these technology firms that open innovation is part of their business strategy. Thus, technology scouting in terms of finding new solutions and different sources of information is a tool for innovation. Many of the technology firm managers seemed to regard cybercrime as an inevitable occurrence in their business.

The results from this study demonstrate that open innovation causes a change in an organizations strategy toward cybercrime. This supports previous findings by

Lazzarott *et al.* (2015) who suggested that open innovation requires firms to absorb knowledge. The interviewees in the study were all from the technology industry and had knowledge about innovation processes in their organization. The interviewees suggest that cybercrime is an important issue in technology firms that influences the level of open innovation. As stated by Minshall *et al.* (2010), open innovation strategies benefit from asymmetric partnerships between firms due to differences in knowledge. To understand how open innovation and cybercrime are related it is important to situate it within the tech industry. As suggested by Spender *et al.* (2017), more longitudinal studies of open innovation are required due to their complex and evolving nature.

During the open innovation process, there should be more knowledge and information circulated between firms (Verbano *et al.*, 2015). The findings of this study suggest that technology firms have to weight up the advantages of being in an open innovation ecosystem and the potential cybercrime risks that might result. Therefore, this research supports Tajeddini *et al.* (2015) who found that the performance of firms is increased through collaboration. Past research has found that inter-firm market orientation is an important way to increase overall firm performance (e.g. Elg, 2007, 2008; Tajeddini and Ratten, 2017). This process can be difficult but this study suggests that it is better for organizations to utilize open innovation to share information about preventing cybercrime. As Chesbrough (2006) stated that there are different strategies for firms adopting open innovation. The findings indicate that there are different ways cybercrime is perceived by managers. Therefore, further research should focus on understanding how cybercrime is embedded in the innovation ecosystem environment for technology firms. This should involve focusing on emerging and novel types of open innovation such as cross-sector collaboration partnerships to see the way they deal with cybercrime.

Theoretical implications
From a theoretical perspective, this study relies on open innovation theory and its wider contextualization within innovation strategy to explain the effect of cybercrime. In line with open innovation theory, managers of technology firms can serve as coordinators and instigators of an innovation policy that takes into account risks concerning cybercrime. The application of open innovation theory to cybercrime offers a way to encourage collaboration between technology firms to understand the negative effects of cybercrime. As there is more emphasis on technology firms having an open innovation policy, innovation theory has rarely been applied in the context of cybercrime. Other theories such as innovation strategy have been more prevalent in the literature but open innovation offers a better contemporary direction for the innovation activities of technology firms. The direct consequences of cybercrime have negative effects for technology firms so it is important that managers of these firms foster collaboration but are also aware of the downside effects.

Practical implications and future research suggestions
The findings from this study help managers to focus on the positive benefits of open innovation, which are increasingly needed in the technology industry in order to compete in the global marketplace. Existing practices can be improved by taking safeguards to protect intellectual property when collaborating with other organizations. This can be conducted by having clear policies in place that not only encourage innovation but also highlight the potential cyber security threats. Workshops that disseminate information about new ideas and technology but at the same time have limitations on the amount of data shared would be a way to manage cyber security risks.

Managers should frame their innovation strategies so that they incorporate both horizontal and vertical forms of technology collaboration. This ensures that firms listen to and gain information from a variety of different sources including their

competitors and customers. In the past, most knowledge about potential new innovations came from competitors but now with increased emphasis on user innovation customers can be good sources of knowledge and information. Therefore, managers should provide mechanisms for customers to share their ideas in an online and open forum in order to encourage innovation. In addition, as managers scout their environment for potential trends it would be useful if they discussed these approaches with customers and competitors in the form of co-opetitive strategy.

Future studies could advance the findings of this research by addressing some of the limitations due to time and resource scarcity. As this study focused on technology firms in one geographic setting, it would be useful to analyze internationally if there are any cultural differences in the way collaboration and innovation affect cybercrime. In addition, due to the cross-sectional nature of this study, it would be interesting to evaluate changing perceptions toward open innovation over a longer time period. Therefore, longitudinal and process-orientated studies could be conducted to see how technology firm managers are changing the way they deal with open innovation. Understanding the decision making about open innovation could also further help understand how it can be incorporated into a firm's strategy (Aloini *et al.*, 2015). In addition, this study focused on vertical and horizontal technology collaboration but there may be various other more hybrid forms of collaboration. For example, do firms specifically focus on partners for horizontal or vertical forms of technology collaboration? What type of technology collaboration to prevent cybercrime is preferred? And what is the best form of technology collaboration for open innovation? This would be helpful for managers to understand in more depth the complex and dynamic nature of open innovation.

Conclusion
In conclusion, open innovation is an important way for technology firms to increase their performance as long as they understand the different types of collaboration and have an appropriate innovation strategy to manage cybercrime. Managers of technology firms need to decide when to use horizontal or vertical collaboration as an innovation strategy. Simultaneously, technology firms need to be scouting their environment for trends and changes. Therefore, open innovation and environmental contexts may offer important insights in how to improve firm performance in the competitive marketplace. Future research can further focus on the role of collaboration in technology firm's innovation strategy and its effect on firm performance.

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