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THE IMPACT OF OPEN INNOVATION PRACTICES AND MODERATING EFFECT OF INTER-ORGANIZATIONAL NETWORKS ON INNOVATION PERFORMANCE OF LARGE FIRMS IN SRI LANKA

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Abstract

Innovation plays a prominent role in the contemporary world. It brings novel products and services to the market while exploring new ways of production, distribution, marketing and impacts all other aspects of organizations including human behaviour through hard as well as soft methods. Open innovation has been introduced as a new paradigm in innovation management. This study examines the impact of open innovation on innovation performance of the listed companies in Sri Lanka with the moderating effect of inter-organizational networks. Open innovation practices have been recognized in this study in two folds – as outside-in open innovation and inside-out open innovation

Data were collected through a survey among 165 top-level managers of listed companies in Sri Lanka. The sample was selected using purposive and snowballing sampling methods. After testing the validity and the reliability of the instrument and collected data, simple regression analysis was conducted to

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test the hypotheses. The study findings indicate that both outside-in open innovation and inside-out open innovation positively and significantly impact innovation performance. Further, results show that inter-organization networks positively moderate the effect of both inside-out open innovation and outside-in open innovation on innovation performance.

Keywords: *innovation; open innovation; innovation performance; large firms; Sri Lanka*

JEL Classification: D02, D2, D9

Introduction

The term innovation is a vogue in almost all countries at present. Heretofore, the studies conducted in developed countries have stressed that there is tremendous development in the field of innovation whereas developing countries are trying to identify the mislaid main points apropos of low level of innovation. Open innovation (OI) has been introduced as a new paradigm in innovation management and it has become a widespread innovation strategy in organizational as well as national levels. This approach has created new pathways to boost innovation in both developed and developing country contexts. It has attracted wide academic attention while providing multiple benefits to business organizations. Further, open innovation has a significant impact on industrial practices and performances in developed countries. However, Wickramasinghe *et al.* (2010) have cited that presence of innovativeness in Sub-Saharan Africa, South Asia, the Caribbean and the Latin American regions is to a lesser extent. It is also stressed that there exists a disparity in technological innovation among the Asian developing countries despite the new technologies have significantly contributed to intensify innovation in those countries.

Further, limited studies conducted on innovation as well as lack of statistical bases and measurements on innovation have proved that there is a need for sheer commitment towards strengthening the innovativeness to be competitive in the global context. The dearth in innovation studies to enrich the decision making and policy formulation has been observed as a main weakness in many developing countries. The research field of open innovation also remains as an understudied research domain in developing countries.

Even though there are some recent studies on innovation in Sri Lanka, the robustness of study findings and statistical bases is a common barrier in innovation

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promotion. Pushpakumari and Watanabe (2009), De Silva *et al.*, (2012), Thrikawala (2008) and Weerasinghe *et al.* (2013) have studied different aspects of organizational innovation in Sri Lanka. However, most of these studies have paid attention on innovations in SMEs and have not sufficiently addressed the open innovation practices and the open innovation performance in established firms.

This study therefore attempts to fill the empirical gap in the domain of open innovation by examining the open innovation practices and innovation performance in large Sri Lankan firms. It also focuses on finding out the impact of inside-out open innovation practices and outside-in open innovation practices, which are two types of open innovation of the firms. In addition, this study investigates the moderating effect of inter-organizational networks on the impact of innovation practices and innovation performance of both inside-out and outside-in open innovation of large firms.

Past studies have demonstrated the need for enduring contributions to fill the knowledge gaps on the open innovation model and motivate to practice it in Sri Lankan firms. This study therefore mainly provides insights for managers engaged in industrial innovation processes, encourages them to use open innovation practices in the firms and promotes collaboration with outside firms to ensure mutual benefits. It also intends to bring awareness to this as an innovation practice and increase interest in open innovation in both industrial and academic communities.

Literature Review

Review of literature on innovation for the last three decades shows that the attention of developing countries on this crucial area of research is insignificant compared to that of developed countries. However, there are increasing attempts at present towards addressing innovation capability, sources and strategies of innovation of the firms in developing countries. The orientation of innovation studies in the early days relied on “pull factors”, which are based on scientific and technological discoveries from basic and applied research conducted in well-equipped and resource enabled laboratories of both private and public sector institutions in developed countries. In the sphere of the current resource constrained context, the “push factors” are being activated to find out cost effective and resource-less solutions for their sufferings. Most buyers are extremely poor and fall at the bottom/base of the economic pyramid where they can spend only from 2$ to 13$ per day according to the purchasing power parity prices in 2005 [Prahalad, 2010]. As such, developing countries need to pay more attention on

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open innovation practices to find innovative solutions for problems with less innovative options.

Any product with some small or large change that adds value for the customer and the firm itself is innovation. This change could be either in the product, the procedure of the product formation, or in the services that the product is offering. There is always room and a constant need for innovation in order to sustain and grow the business. There are several theories and models to better explain the innovation process. Managing a sustained innovation process can be quite complex with its own set of uncertainties. These models help overcome all the complexities and uncertainties while successfully managing the innovation process [Ford *et al.*, 2014].

The "innovation process" first came under study in 1942 led to the development of innovative models [Godin, 2015] to develop it as a new practice. It has a logical order that initially starts with basic research to explore all the possible innovations and then commercializes at the last stage. This is the first theory of technological innovation. It is termed as the linear model of innovation [Godin, 2006]. This linear model had some limitations. Another innovation model was brought forth to overcome some limitations, known as the cyclic innovation model (CIM). The CIM characterizes four cycles or four events occurring simultaneously in contrast to the chronological method of innovation process presented by the linear model of innovation. These circles or events are interconnected within a single loop [Ford *et al.*, 2014].

Apart from the cyclic innovation model, another substitute to the linear model of innovation was presented to overcome the underlying limitations, that is, the chain-linked model. There are two phases to this model. The first path of the innovation process begins with design and continues through development and production to marketing. The second path is a series of feedbacks [Mahdjoubi, 1997].

Outside-in and inside-out open innovation: At the inception of the twenty-first century, the concept of innovation deviated towards open innovation. At that time, key technologies were developed within large enterprises through their own research departments. Companies assimilated to produce standard rich technologies to acquire innovation [West *et al.*, 2006]. In this traditional setting, innovations are produced and commercialized only within its boundaries. This led to the progression in industries' innovation process [Inauen, & Wicki, 2011].

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The industry started involving external and internal sources for collaboration. This open firm system opened gates of knowledge from different sources, which brought new and innovative ideas for products and services, and then they started being marketed successfully. The firms should merge internal and external sources to expand their businesses bring innovative product ideas and technology [Chesbrough, 2006].

Further, it has been recognized that open innovation has the ability to appeal to external resources to meet needs to innovate, which is essential for better product development. As a result, the firms have started integrating their R&D department with external resources to perform better. The open innovation process is the primary concern under this study to fill the knowledge gaps in both inbound open innovation and outbound open innovation practices. The inbound open innovation practice has been researched thoroughly in the present studies, while the outbound open innovation practice has more room to explore. However, the outbound or inside-out open innovation practice has now become the growing area of interest among researchers.

As Chesbrough and Bogers (2014) mentioned, the inside-out type of open innovation requires organizations to allow unused and under-utilized ideas and assets to go outside the organization for others to use in their businesses and business models. The outbound open innovation (inside-out process or external knowledge exploitation) process has been studied and measured by Lichtenthaler (2007) both at operational and strategic levels. The inside-out process is associated with outbound technology transfer capabilities. Kutvonen *et al.* (2012) identified three strategic levels of outbound open innovation: 1. Keep-or-sell decision (the company has to find out when it is beneficial to release the proprietary knowledge assets/technology outside or keep them in the company), 2. Strategic fit (if the strategic fit is high enough, profits may be realized in an optimal keep-and-sell scenario), and 3. Beyond fit (outbound open innovation can enable/drive the strategy of the firm).

Torkkeli *et al.* (2007) has identified two types of Outbound open innovation practices namely, 1. Technology transfer outbound open innovation practices (open source, out-licensing, selling of intellectual property, and donation of intellectual property), and 2. Forming new organizations (spin-outs and new ventures).

Innovation Performance: Innovation is the implementation of a new or significantly improved product (goods or services), process, a new marketing method, or a new organizational method in business practices, workplace

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organization or external relations. Innovation is a comprehensive approach to renewing and enlarging a firm's range of products, services, and markets by adopting new methods or modifying existing methods. It involves a radical change in speeding up idea generation and developing new products, services, and industrial processes [OECD, 2005]. Innovation performance is defined as "the ability to transform innovation inputs into outputs and thus the ability to transform innovation capability and effort into market implementation" [Zizlavsky, 2016].

Innovation Performance can be measured in three different indicators- product innovations, process innovations, and the percentage share of sales of newly developed products [Inauen, Wicki, 2011]. Alegre *et al.* (2006) have explained that the current competitive environment is characterised by rapid technological change, shortening of product life cycles, and more informed and demanding customers. For such an environment, firms' sustainable competitiveness depends on two innovation outcomes – one is efficiency, and another is novelty. Opening the innovation processes to different partners seems to be the right way to improve both sides of the innovation performance.

There are two major types of innovation performance, which include: 1) inventive performance – as the achievements of companies in terms of ideas, sketches, models of new devices, products, processes and systems, and it is such type of performance which is frequently measured in the context of patents, where both raw counts of patents and patent citations are taken as the actual measures, 2) technological performance, which can be defined as the accomplishment of companies about the combination of their R&D input, as an indicator of their research capabilities, and their R&D output in terms of patents.

According to Tseng and Tseng (2016) the two dimensions that define innovation performance are innovation efficacy as the degree of success an innovation enjoys and innovation efficiency as the effort put forth to accomplish the degree of success. In other words, in this approach, the authors distinguish two types of innovation performance: innovation efficiency as the state of the quality of the innovation process, and innovation efficacy as the ability to produce innovation.

According to Pateli and Lioukas (2019), firms' open innovation performance initiatives require external knowledge, integrating it with the existing knowledge in the various functional areas, and transforming it into numerous innovation outcomes. Therefore, firms' open innovation performance is based on the utilization of external and internal knowledge [McKelvie *et al.*, 2018]. Both external and internal sources are important for innovation [Rastrollo-Horrillo, &

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Rivero Díaz, 2019]. External knowledge comprises knowledge from external stakeholders and knowledge from markets. Zhang and Tang (2017) presented that encouraging internal collaboration has been documented as one of the effective management strategies to promote firms' innovation.

Open innovation practices and innovation performance: Burcharth et al. (2014) found that Open Innovation practices such as collaborating with suppliers and networking with universities have improved innovation performance. Rass *et al.* (2013) elaborated a theoretical framework. They supposed that the implementation of OI instruments strengthens an organization's social capital, which, in turn, is positively related to innovation performance. Chesbrough (2006) observed that by opening its borders to the external environment, a company could achieve and access relevant knowledge that will contribute to the innovation process. Kuittinen *et al.* (2013) explain collaboration in R&D activities has received a fair amount of attention in earlier literature, although few studies have explored the effects of R&D collaboration on innovation performance.

They investigated the effects of openness depth on two types of innovation performance (efficiency, novelty) across different stages of the innovation process with eight different partners. Their findings show that universities, intermediaries, customers, suppliers, and competitors seem to be beneficial for achieving performance, depending on different phases of an innovation process. While many companies might have gained experience with the open innovation process, managing sustainability innovations might represent a new but different challenge. Past research reports that collaboration with external partners is beneficial in terms of sustainability product and service innovations [Arnold, 2017].

The inbound, outbound, and coupled open innovation practices and their combinations are possible choices firms adopt to overcome their deficiency and build up competitive and sustainable advantages from the internal and external resources [Spithoven *et al.*, 2011]. The exploitation of the organization's current base of knowledge and technologies [He, & Wong, 2004], learning opportunities [March, 1991], market expansion [Koruna, 2004], multiplication of own technologies [Kutvonen, 2009], improved innovation performance [Huizing, 2011; West, & Bogers, 2014] have been highlighted in the extant literature as benefits of outbound open innovation practices. According to Yapa (2018), little evidence has been found associating outbound open innovation practices with innovation performance, although some authors have discussed the effect of outbound open innovation practices on the firm's performance. For example, Lichtenthaler (2007)

has found that outbound open innovation strategies positively affected the return on sales index.

Parida *et al.* (2012), Cheng *et al.* (2016) and Kim *et al.* (2014) have stressed the relationship between inbound open innovation practices and innovation performance of organizations. Nevertheless, inbound and outbound open innovation activities can have a positive impact on innovation performance.

Sibhato (2018) explains that the coupled open innovation combines both processes centred on strategic alliances [Spithoven *et al.*, 2011]. These processes are vital for SMEs to fill their technological, resource and competency gaps, increase the speed and quality of innovations and respond to market changes. Levinethal (2011) provided examples for a broad set of internal routines aimed to favour knowledge sharing, problem-solving and autonomy of employees in combination with external routines (OI practices such as collaborating with suppliers, networking with universities, etc.), which are proved to result in improvement of innovation performance. Burcharth *et al.* (2014) found that internal coupling activities moderate the relationship between openness and innovation performance. The employees and partners' willingness to cooperate, in a trust-based manner, encourages the exchange of knowledge, the acquisition of tacit knowledge [Nonaka, 1994], the absorptive capacity of new technologies [Cohen, & Levinthal, 1990], the joint problem solving and the coordination of complex tasks as well as the experimentation with different knowledge combinations, all these likely have a positive impact on innovation performance. Lazzarotti *et al.* (2016) focused on the scientific partners and found that both the internal relational social capital dimension (intended as employees' propensity to interact and work in groups) and the external relational social capital dimension (intended as trustful relationships with scientific partners) can mediate the relationship between the intensity of collaboration (depth) and innovation performance.

Based on the above literature first and the second hypotheses of the study were developed:

H1: There is a significant positive impact of outside-in (inbound) open innovation practices on innovation performance

H2: There is a significant positive impact of inside-out (outbound) open innovation practices on innovation performance

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Inter-organization Networks in Open Innovation Practices and Innovation Performance: Chesbrough (2006) has pointed out the need of bringing dynamic factors to research on open innovation. Networking can imply collaboration with other partners (Vanhaverbeke, 2006). Inter-organizational relations and networking is a crucial dimension of open innovation. It is indirectly present in the open innovation framework when external ideas are in-sourced to create value or when internal ideas are taken to the market through external channels [Chesbrough, 2004]. The importance of the strength of vertical ties for innovation performance is also emphasized. Internal networks play a crucial role in the way companies get organized to increase the effectiveness of acquiring external knowledge. When companies are highly dependent on other organizations in the supply of new technologies, it seems logical that open innovation has to emphasize the management of external networks to be successful [Vanhaverbeke, 2006].

Participation in business networks is an essential element in innovation performance. Companies tend to avoid innovating alone but innovate with external actors, and inter-organizational networks are seen as a significant element of the innovation. Some networks are less open to new participants than others. For example, industrial groupings such as Japan's kigyoshudanor, Korea's chaebol tend to buy within their group rather than outsiders. Hagel and Brown (2005) argue that closed networks need to become more open to develop necessary specialization and deepen the participants' innovation capability. Thus, the research could test whether closed networks have performance disadvantages where specialized or deep knowledge is required and what form of 'openness' provides value over others. If openness has economic value, then research would also be useful to identify the levers of inter-organizational change for making an existing ecosystem more open [West *et al.*, 2006].

Meanwhile, if companies are embedded in networks, we would expect to change the nature of competition between such companies: rival firms may not be competing individually but instead as part of groups of networked firms competing against other groups. In this case, the companies' performance depends no longer on firms' internal capabilities but on the overall performance of the network they belong to [Casseres, 1996]. We believe open innovation practice will be intimately linked to how firm innovation activities moderate networks, both inter-organizational and (as mentioned earlier) intra-organizational networks (West et al., 2006). Internally developed technology and resulting IP are no longer only valuable for internal use. Still, the company can also profit from the selective use

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of its IP by other companies with different business models. Open innovation thus implies an extensive use of inter-organizational ties to in-source external ideas and to market internal ideas through external market channels outside a firm's current businesses [Chesbrough, 2003].

Based on the above literature, third and fourth hypotheses of the study were developed:

H3: The relationship between outside-in (inbound) open innovation practices and innovation performance is moderated by inter-organization network

H4: The relationship between inside-out (outbound) open innovation practices and innovation performance is moderated by inter-organization network

According to the reviewed literature a conceptual framework of the study was developed as in Fig. 1 to study the impact of open innovation practices on innovation performance with the moderating effect of inter-organizational networks.

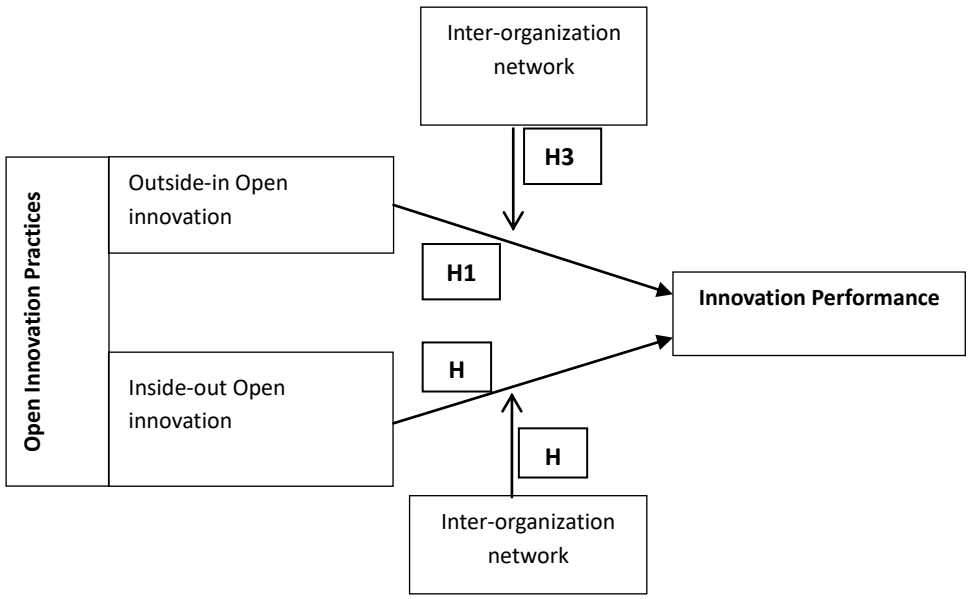

Fig. 1. Conceptual Framework of the Study

There is a common emphasis on the importance of inter-organizational networks and networking for innovation through external acquisition of knowledge

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and information in the literature. Networks can be studied under three themes: degree centrality, tie characteristics (trust, proximities and knowledge quality) and diversity of actors. By networking, firms are able to access knowledge externally from other actors and develop their own innovations. When firms interact formally (by explicit agreement) or informally (on a social basis), knowledge sharing often occurs, and the resultant knowledge is available to partners. Evidence from literature illustrates that 'those firms that do not co-operate and do not formally or informally exchange knowledge limit their knowledge base over the long term and ultimately reduce their ability to enter into exchange relationships' [Pittaway *et al.*, 2004].

Objectives of the Study

This research focuses on finding answers to the queries related to the impact of open innovation practices on innovation performance in listed companies in Sri Lanka with the moderating effect of inter-organizational networks. Following are the four specific objectives of the study.

1) to examine the impact of outside-in or inbound open innovation practices on innovation performance in large Sri Lankan firms;

2) to examine the impact of inside-out or outbound open innovation practices on innovation performance in large Sri Lankan firms;

3) to identify the moderating effect of inter-organizational network on the impact of outside-in open innovation practices and on innovation performance in large Sri Lankan firms;

4) to identify the moderating effect of inter-organizational network on the impact of inside-out open innovation practices and on innovation performance in large Sri Lankan firms.

Methodology

This is a survey type study designed to examine the strategies of large firms on developing their innovation practices and assess their innovation performance through the deductive research approach. The operational population of the study consists of large firms which are listed as Public Limited Companies in Colombo Stock Exchange in Sri Lanka. 290 listed companies as of 20th January 2020 were selected as the population of the study. According to Krejcie and Morgan (1970), 165 companies were considered as a sufficient sample for the study. Part of the sample was selected purposively based on business R&D statistics, partnership

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details, open innovation contained in 2018 annual reports, while the rest was accessed through the recommendations of the respondents aligning to the snowballing sampling technique. Data were obtained from the top-level managers of selected companies.

Primary data was collected through a self-developed questionnaire pre-tested through a pilot study. Survey instrument was developed based on indicators suggested by Chesbrough and Brunswicker (2014) and Torkkeli *et al.* (2007) to measure outside-in and inside-out innovation while those suggested by Inauen and Wicki (2011) and Sözbilir (2018) for operationalization of innovation performance in a firm. Inter-organizational networks were measured through the organization's perception based on centrality, trust, proximity, knowledge qualities, and diversity of networks as suggested by Lazaric and Lorenz (1998). Those measurements which were applied in this study are presented in Table 1.

Table 1. Operationalization of the Variables

Variables/Dimensions	Indicators
Outside-in open innovation	• Market interest in the development of innovative product/process/service/technology • Technology/ franchise/ trademark license transactions • Integrated research results of the university research initiative/ university research grants • Organization/participation in meetings or activities to obtain access to external information • Grants for foreign research programs (universities) • Contracting with suppliers of external R&D facilities (outsourcing) • Competitions for proposals • Buy new creative concepts / new goods • Strategic partnerships • Fusions and acquisitions
Inside-out Open innovation	• Activities in joint projects with external partners • Sell licenses for technology/ franchise/trademark • Selling fresh creative concepts / new goods • Corporate venture fund • Corporate sector incubation (providing office space/training) • Spinoffs

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	• New ventures • Involvement of national standardization
Innovation Performance (Product, Service and Process)	• Level of introducing product /process /service innovation • level of novelty • Use of latest technology • Speed of new product /process /service • Level of varieties • Technological competitiveness in terms of product /process /service • Level of success of product /process /service development • Level of quantity of new or significantly improved products/ services or processes • Degree of product /process /service differentiation compared to competitors • Profitability of the new products
Inter-organizational networks	
Centrality	• Firms' involvement in its network • Nature of direct relationships
Trust	• A belief that your partner is willing to share such knowledge for the benefits of each other • A belief that a partner is capable
Proximities	• Technological proximity: similarities between actors' technological knowledge • Organization proximity: similarities incorporate organizational structure, organizational culture, performance measurements systems, language
Knowledge qualities	• Usefulness of the knowledge that a firm receives • Frequent receives the knowledge
Diversity of network actors	• Interact with partners from diverse communities of practice • Multiple sources of knowledge

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Descriptive statistical analysis was applied to calculate mean values and standard deviation of the responses to understand the current open innovation practices. Correlation analysis was used to test linear relationship between independent and dependent variables while linear regression analysis was conducted to measure the impact of open innovation practices on innovation performance. Statistical analysis was performed with the IBM SPSS 25 software and process macro 3.5 applications.

Validity and Reliability

Data collection instrument and collected data were tested with several measurements to ensure that the study is conducted through valid inputs and collected through reliable instruments. Self-developed questionnaire which was constructed through a rigorous literature review was used to collect primary data. To ensure face validity of the questionnaire, the researcher developed 45 questions, and the questionnaire was tested with three academics in this field and refined based on expertise ideas.

A pilot survey was carried out among 50 respondents. The respondents were selected using the purposive sampling technique chosen based on the descriptions of open innovation activities presented in the annual reports. According to the pilot study, the questionnaire was further refined. Preliminary statistical tests were also conducted to test reliability and validity of the data collected through pilot study and confirmed standards required to continue primary data collection. The questionnaire was developed with adequate coverage by comprising a sufficient number of items (or questions) that represent the variables of interest, ensuring the content validity of the instrument.

The statistical test confirmed that The Kaiser-Meyer-Olkin values were acceptable being >.5 and Bartlett's test was highly significant ($p < 0.05$) thereby confirming the validity and suitability of the responses. To measure the construct validity researcher used Average Variance Extracted (AVE) analysis. AVE was calculated as the mean-variance extracted for the items loading on a construct and is a summary indicator of convergence. AVE of 0.5 or higher is a good rule of thumb, suggesting adequate convergence [Hair *et al.*, 2006]. According to Hair *et al. (*2006), the rule of thumb for Composite Reliability value of 0.7 or higher suggests good reliability and the calculated values for all the variables were greater than 0.7.

One of the tests to mark discriminant validity is to compare the AVE values for any two constructs with the square of the correlation estimate between these two

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constructs. If the AVE is greater than the squared correlations, discriminant validity can be established [Hair *et al.*, 2006]. To confirm the discriminant validity, AVE values of the variables were compared with the square of the correlation estimate between these variables, as shown below. The AVE values for each variable were higher than the square of the correlation between that variable. Thus, all the variables in the study represent different concepts and there were no problems with discriminant validity.

Cornbrash's alpha reliability test was conducted to check the internal reliability of the questionnaire. The reliability analysis calculates several commonly used scale reliability measures and provides information about the relationships between individual items in the scale. Cronbach's Alpha values for all the variables were higher than 0.7 indicating that the internal reliability of the questionnaire is acceptable.

Data Analysis

The sample which included 165 responses can be categorized into sectors or industries as it was a representation of 29% of diversified holdings, 18% of banks and finance, 25% of food and beverage, 15% of manufacturing, 5% of telecommunications and 8% of other corporations. The majority of the companies in the sample have over 20 years of experience, ensuring that these are mostly long established companies. In terms of the experience in open innovation, 11% of the companies have 1-5 years of experience, 20% have 6-10, 25% have 11-15, 26% have 16-20, and 18% have more than 20 years of experience in at least one practice of open innovation such as collaboration or partnership with their customers, suppliers and other external parties.

Human capital strength of the innovation process is a key capability for innovation in the firms. According to the data collected, there were 12% of companies with less than five employees for research and development, 26% of companies with 6-10 employees, 18% employed 11-15 , 22% with 16-20, and 22% had more than 20 employees for research and development. Within the sample, a significant number of employees were in the research and development department.

Number of New Product/Process/ Service Innovation, introduced in 39% of the companies were found to be 1-4. Out of 165 listed companies 39% of companies reported 5-10 while 22% of companies reported more than ten new product/ process/ service innovations during last three years. This study found R&D investment in 2018 as a percentage of sales of each company. 15% of the

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companies spent less than 5% on R&D as a percentage of sales. 23% invested 6%-10%, 18% spent 11%- 15%, 28% invested 16%-20. 16% of the companies invested above 20% of their sales on R&D investment. From the sample of 165 companies, 73% of the companies have their own R&D department, 13% have several R&D departments, and 14% outsource R&D. In terms of frequency of engaging in innovation activities, 58% of the companies often engage with R&D activates, 28% are very often doing R&D activities, 12% sometimes, 2% are rarely engaged with R&D activities, and no company was available in the sample who does not engage with R&D activities.

The majority of the companies (69%) often engage with the customers when doing a R&D Project, 35% sometimes engage with suppliers, 27% often engage with suppliers, and 25% very often engage with suppliers. A significant number of the organizations (45%) rarely cooperate with competitors, 51% of companies very often, and 40% of companies often cooperate with cross-industry firms in the R&D projects. 67% of the companies are engaged with consultant firms very often. When considering engagement with universities in R&D Projects, 32% very often, 17% often, 32% sometimes, and 16% rarely. The majority (72%) of companies cooperate with other service providers in R&D Projects (see Fig. 2).

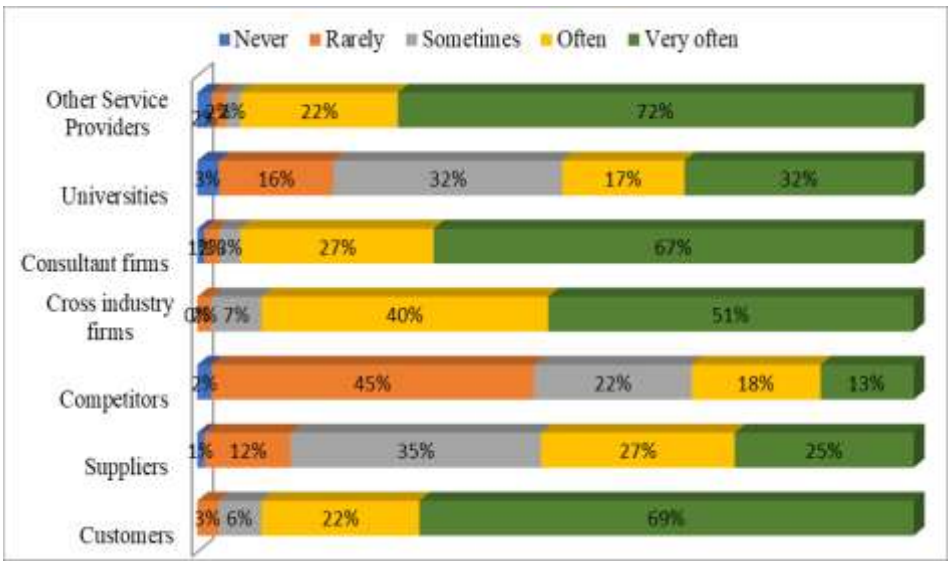

Fig. 2. Cooperation Intensity with the Partners in R & D Project

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The sample has a very significant cooperate intensity with the partners in R&D activities. All the companies in the sample are actively engaged with every partner. It displays that the companies initiate collaborating with their partners in developing innovations, and these samples appropriately indicate the firms' openness to the external.

Central tendency and dispersion of the data collected for the main variables were calculated for understanding the behaviour of responses. Table 2 shows the mean values and standard deviation of each mean value for the main three variables in the present study. The mean value of Outside-in open innovation (OIOI) practices is 3.6652 and the mean value of Inside-out open innovation (IOOI) is 3.3076. Innovation performance (IP) has recorded the mean value of 3.6519 while responses for inter-organizational network (ION), the moderating variable represents the mean value of 3.2683. Furthermore, Table 2 shows that the values of standard deviation for OIOI, IOOI, IP and ION are 0.73070, 0.77530, 0.80183 and .75160 respectively. Therefore, it implies that there are no higher deviations from the mean values, which lies on the middle of the five point Likert scale.

Table 2. Descriptive Statistics of Variables

	N	Mean	Std. Deviation
	Statistic	Statistic	Statistic
OIOI	165	3.6652	.73070
IOOI	165	3.3076	.77530
IP	165	3.6519	.80183
ION	165	3.2683	.75160

The correlation coefficient analysis was conducted to understand relationship and the nature of that relationship between independent and dependent variables of the study. It was found both positive moderate correlations between OIOI and Innovation Performance (r = 0.599) and IOOI and Innovation Performance (r = 0.463) which were significant at 5% level of significance (p = 0.000). Correlation coefficients for the relationships between OIOI and IO was 0.313 (p = 0.006) while the IOOI and ION was calculated as 0.310 (p = 0.000). ION has been correlated with the Innovation Performance positively (r = 0.481) and all three coefficients were significant with at 5% level of significance.

Conforming to these significant correlation coefficients, the suitability for running a regression analysis was tested through mainly four assumptions – normality,

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autocorrelation, heteroscedasticity and multicollinearity or the collinearity between independent and dependent variables. After fulfilling the above four basic requirements, the researchers have conducted simple and multiple-liner regressions to test first two hypotheses.

The simple linear regression analysis was conducted to examine the impact of outside-in open innovation practices on the innovation performance in listed firms in Sri Lanka. The coefficient of determination (R^2) value was 0.358. Therefore, it can be concluded that 35.8% of the total variation of innovation performance is explained by the outside in open innovation. The total sum of square is 143.646, and besides, 51.471 percentage of variance was explained by the regression, and 92.175 percentage was explained by residual. Further, it can be identified that the calculated F value is 91.020, and the p-value of the F test is 0.000, which is less than 0.05. Hence, it confirms the overall significance of the model. Regression model to explain the impact of OIOI on Innovation Performance is shown in Table 3.

Table 3 Coefficients of the Regression Model for OIOI and Innovation Performance

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.305	0.257		5.072	0.000
	OIOI	0.723	0.076	0.599	9.540	0.000
a. Dependent Variable: IP						

Following the regression equation, the constant value is +1.305 meanwhile the coefficient of outside-in open innovation is +0.723. The p-value of the t-test is 0.000, and it is less than 0.05. Hence, there is a significant positive impact of outside-in (inbound) open innovation practices on innovation performance which means H_1 is supported at the significance level of 0.05. Consequently, the simple linear regression equation can be expressed as follows:

$$\mathbf{IP = 1.305 + 0.723\ (OIOI) + \varepsilon}$$

OIO = Outside-in open innovation, **IP** = Innovation performance, **ε** = Standard Error

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Simple linear regression analysis was conducted to identify the impact of inside-out (outbound) open innovation practices on innovation performance in listed firms in Sri Lanka. Accordingly, R^2 value was calculated as 0.214. It can be concluded that 21.4% of the total variation of innovation performance is explained by the inside-out open innovation. The total sum of square is 143.646, and besides, 30.757 percentage variance was explained by the regression, and 112.888 percentage was explained by residual. Further, the calculated F value was 44.411, and the p-value of the F test was 0.000, which is less than 0.05. Hence, it confirms the overall significance of the model. Outcome of the regression analysis to explain the impact of IOOI on Innovation performance is shown in Table 4.

Table 4. Coefficients of the Regression Analysis for Impact of IOOI on Innovation Performance

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.523	0.332		4.582	0.000
	IOOI	0.593	0.089	0.463	6.664	0.000
a. Dependent Variable: IP						

The constant value of the regression equation is +1.523. The coefficient of inside-out open innovation is +0.593. It is the average change in innovation performance due to one unit change in inside-out open innovation. It suggests that when inside-out open innovation is increased by one unit, innovation performance increases by 0.593, approximately 0.6 times. The p-value of the t-test was 0.000, and it is less than 0.05. It could be concluded that there is a significant positive impact of inside-out (outbound) open innovation practices on innovation performance. Hence, H_2 is supported at a significance level of 0.05. Consequently, the simple linear regression equation can be expressed as follows:

$$\mathbf{IP= 1.523+ 0.593\ (IOOI) + \varepsilon}$$

IOOI = Inside-out open innovation, IP = Innovation performance, ε = Standard Error

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The moderating effect is analyzed by the multiple regression analysis through process macro 3.5 applications in SPSS developed by Hayes (2015). Objective three and four aim at finding the moderating effect of inter-organization networks by testing hypotheses 3 and 4. When considering the model summary, the R^2 value was 0.3846. Hence, it can be concluded that 38.46% of the total variation of innovation performance is explained by the outside-in open innovation with the moderating effect of inter-organization networks, and the model is significant as p = 0.000 as it was less than 0.05. Outcome of the multiple regression analysis is presented in Table 5.

Table 5. Regression Model for the Impact of OIOI on IP with Moderating Effect

	Coefficient	t	p
Constant	0.2998	6.4282	0.0000
OIOI	1.1343	5.6433	0.0000
ION	0.5003	2.4101	0.0171
Int_1 (OIOI*ION)	0.1304	2.1482	0.0332

Based on the regression equation, the constant value is +0.2998. It implies that the value of innovation performance when the outside-in open innovation equals zero with the moderating effect of inter-organization networks. Furthermore, the coefficient of OIOI, ION and interaction (OIOI*ION) respectively are +1.1343, + 0.5003 and 0.1304. The model is therefore statistically significant as all p-values of t-tests is less than 0.05. Accordingly, multiple regression model is derived as follows:

$$\mathbf{IP= 0.2998+1.1343(OIOI) + 0.5003(ION) + 0.1304}$$

OIOI = Outside-in open innovation, IP = Innovation performance, ION = inter-organization networks

R^2 Changes in 0.0176 and p=0.0332<0.05 indicate significant moderation of inter-organization networks on the relationship between outside-in open innovation and innovation performance. Conditional effects of the focal predictor at values of the moderator(s) are presented in Table 6.

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Table 6. Effect of ION on Relationship of OIOI and IP

ION	Effect	t	p
1.9504	**0.5214**	**4.2023**	**0.000**
3.3253	**0.7007**	**9.1527**	**0.000**
4.7001	**0.8800**	**8.6875**	**0.000**

The results indicate the effect of inter-organization networks on the relationship between outside-in open innovation and innovation performance. It explants when ION changes in a particular amount, impact of OIOI on IP. When ION is changed by 1.9504, 3.3253, and 4.7001, it affects the relationship between IP and OIOI respectively by 0.5214, 0.7007, and 0.8008. It illustrates that when ION increases, the relationship between IP and OIOI also gradually increases. Since, the p-value = 0.000<0.05 each effect of ION is significant. Thus, it could be concluded that the inter-organization network moderates the relationship between outside-in innovation practices and innovation performance (H_3) is supported at significance level of 0.05.

The fourth objective and H_4 have been set for identifying the moderating effect of ION on the impact of IOOI on IP. Statistical analysis revealed that R^2 value for this model was 0.2710. It can be concluded that 27.10% of the total variation of innovation performance is explained by the inside-out open innovation with the moderating effect of inter-organization networks. The model was significant as p = 0.000 which is less than 0.05. Table 7 shows the summary of the regression model for the moderating effect of ION on the impact of IOON on IP.

Table 7 Regression model for IOOI and IP with moderating effect of ION

	Coefficient	t	p
Constant	1.2666	5.4855	0.0000
IOOI	1.3570	5.8110	0.0000
ION	0.8271	3.5300	0.0005
Int_1 (OIOI*ION)	0.2263	3.5245	0.0006

According to the regression equation, the constant value is +1.2666. Furthermore, the coefficient of inside-out open innovation, inter-organizational networks, and interaction (IOOI*ION) respectively were +1.3570, + 0.0.8270 and

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0.2263. The p-value of the t-tests was less than 0.05 and it confirmed the model is statistically significant. The following regression model was derived accordingly.

IP= 1.2666+1.3570(IOOI) + 0.8271(ION) + 0.2263(IOOI*ION)

IOOI = Inside-out open innovation, IP = Innovation performance, ION=inter-organization

R^2 Changes in 0.0562 and p=0.0006<0.05 indicate potentially significant moderation between inter-organization network and inside-out open innovation on innovation performance. Conditional effects of the focal predictor at values of the moderator(s) are shown in Table 8.

Table 8. Effect of ION on the Relationship of IOOI and IP

ION	Effect	t	p
1.9504	**0.2933**	**2.4261**	**0.0164**
3.3253	**0.6045**	**7.0064**	**0.0000**
4.7001	**0.9156**	**7.2711**	**0.0000**

Since there is a potential significant moderation effect, the study has examined the effect of inter-organization networks. It explains that when ION change in a particular amount, the impact or effect it has on IP and IOOI. When ION change by 1.9504, 3.3253 and 4.7001, it effects the relationship of IP and IOOI respectively by 0.2933, 0.6045 and 0.9156. It displays that ION increases the impact on the relationship between IP and IOOI also gradually increase. Since, the p-value = <0.05 each effect of ION is significant. Hence, it could be concluded that inter-organization networks moderate the relationship between inside-out innovation practices and innovation performance (H_4) is supported at a significance level of 0.05.

Discussion

The descriptive analysis presented above confirms that the listed companies in Sri Lanka have a fair perception on conducting open innovation activities within their firms, such as market and client co-creation, university research grants, publicly funded R&D consortiums, contracting with foreign R&D service providers, start-up contests, Intellectual properties in-licensing, crowd sourcing strategic partnerships and joint projects.

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This study reveals that there is a clear positive association between outside-in open innovation and innovation performance. Based on the simple regression analysis, outside-in open innovation has a positive and significant impact on the innovation performance in listed companies in Sri Lanka. This finding is consistent with Burcharth *et al.* (2014) as they found that open innovation activities such as supplier partnership and university networking have improved innovation performance. Based on the analysis conducted by Inauen and Wicki (2011), it is shown that there are statistically relevant connections with innovation performance between rivals, cross-industry businesses, consultancy firms, and universities. Furthermore, several scholars stressed the positive link between organizations inbound OI practices and innovation performance [Parida *et al.*, 2012; Cheng Yang. & Sheu, 2016; Kim *et al.*, 2014].

The second simple regression analysis indicates that inside-out open innovation has a significant positive impact on innovation performance. The utilization of surplus information and technology in the company [He, & Wong, 2004], learning resources [March, 1991], business growth [Koruna, 2004], multiplication of own innovations [Kutvonen, 2009], improving the innovation performance [Huizing, 2011; West, & Bogers, 2014] have been highlighted in current literature as advantages of outbound innovation practices. As opposed to outside-in open innovation practices, inside-out open innovation is moderately conducted in the listed companies in Sri Lanka. These businesses follow some of the inside-out open innovation tactics such as venturing, engaging in standardization events, corporate market incubation, joint venture activities with external partners. It is recognized that there is a deficiency in practicing spinoffs, IP out-licensing, and selling patients, donating patents and inventions. Firms appear to have less awareness of the importance of these practices. This might be the reason for the traditional attitudes and culture of the organization. Rass *et al.* (2013) clarified that the introduction of inside-out OI tools enhances the social capital of an enterprise, which, in turn, is strongly linked to innovation performance. Chesbrough (2006) noted that an organization could access appropriate information by opening its boundaries to the external world and contributing significantly to the innovation process.

It reveals that less than 50% (35.8% and 21.4%) of the overall variance of innovation performance is explained by the outside-in open innovation and inside-out open innovation practices respectively in listed companies in Sri Lanka. That suggests the other resources such as innovation strategies, organizational structure, innovation culture, technological capability, and customer and supplier

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relationships [Sanchez *et al.*, 2011 and Terziovski, 2010] might have an impact on innovation performance.

The findings in previous studies have also confirmed the results obtained in the present study. Belderbos *et al.* (2004) and Loof and Brostro'm (2008) found that openness in R&D processes positively effect both product and process developments. Parida *et al.* (2012) and Cheng *et al.* (2016) have found that inbound and outbound OI operations will positively impact on innovation performance. Levinthal (2011) describes the mixture of external rituals (OI activities such as supplier cooperation, university networking) that have been shown to increase innovation performance. The ability to collaborate, the development of expertise [Nonaka, 1994], the absorptive potential of emerging innovations [Cohen, & Levinthal, 1990] are all likely to positively affect the innovation performance. In contrast to the findings of the present study, Berchicci (2013) has revealed that open innovation decreases the performance of the innovation, and these two terms do not have a clear association. Furthermore, too much openness would lead to negative innovation performance as businesses lose focus and leverage over their core competencies [Laursen, & Salter, 2006].

Even though some contradictions exist, many studies have confirmed that inside-out and outside-in open innovation positively impact innovation performance. The Study inferred that open innovation, both outside-in and inside-out, have a strong association with innovation performance and both inside-out and outside-in substantially affect innovation performance in Sri Lanka's listed firms. These findings lead to fill both empirical gap and the knowledge gap associated with open innovation literature.

Conclusion

Innovation has been recognized as an essential part for companies to grow and sustain competitiveness and achieve high profitability. To this end, companies need to continuously enhance their innovation efforts and explore new opportunities for commercialization. Further, innovation plays a significant role in ensuring high productivity of the organizational processes. It becomes an ongoing process as it evolves. However, there are many complexities and uncertainties when managing innovation. This has led to various models systematizing the innovation process to drive successful and sustained innovation.

With the inception of the twenty-first century, innovation model has shifted towards "Open Innovation" with increasing interest since the term was introduced

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by Chesbrough (2003). Further, it has identified that open innovation has significantly impacted on industrial practices in developed countries.

This research identified that open innovation is an emerging and modern theory with research gaps to be further explored. There were contradictions in the findings related to the open innovation on the innovation performance in the literature. Less emphasis has been given on the inside-out (outbound) open innovation, which is one of the most critical open innovation practices with gaps in the theory. Therefore, this study was conducted to examine the impact of open innovation practices on innovation performance in Sri Lanka corporates. Further research expanded to investigate whether inter-organization networks moderate the relationship between inside-out open innovation and innovation performance and outside-in open innovation and innovation performance.

Analysis of the descriptive statistics indicates that most of the firms have agreed to the statements in the questionnaire that imply perception of the respondents regarding the importance of outside-in open innovation practices for enhancement of innovation performance. The study found a significant positive impact of outside-in open innovation on innovation performance and a significant positive impact of inside-out open innovation on innovation performance. Hence, both hypotheses were supported by the statistical analysis at the 5% level of significance.

The study revealed many obstacles and hurdles faced by the organization when implementing innovation performance. Resistance of the company culture when obtaining ideas and knowledge from outside the company, risk associated with collaborative efforts, risk of the security of the intellectual property, lack of resources and lack of confidence for being open to external, lack of adequate understanding of the value of marketing, unused intellectual properties or technologies, suspicion of the misappropriation of their IP by other enterprises, risk of collaborating with companies that do not have a strategic fit are some of the obstacles revealed in this study. Hence, this study suggests developing strategies for minimizing such obstacles to ensure better innovative performance through open innovation practices.

This study was also aimed at testing the moderating effect of inter-organizational networks on the relationship between open innovation practices and innovation performance. This study analysed inter-organization networks as vigorous variables on open innovation, following the inter-organization networks taken as the moderator. In contrast, the importance of inter-organization networks in terms of innovation performance has not been much discussed.

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The study explores how inter-organization networks favourably moderate the relationship between inside-out open innovation and innovation performance and outside-in open innovation and innovation performance in listed companies in Sri Lanka. Besides, it reveals that strong inter-organization networks have a strong relationship between outside-in and inside-out open innovation and innovation performance. The poor inter-organization networks result in a poor relationship between outside-in or inside-out open innovation and innovation performance in listed companies in Sri Lanka. Therefore, considering the findings of the study and the findings mentioned in the literature, it is verified that inter-organization networks positively moderate the relationship between inside-out open innovation and innovation performance as well as outside-in open innovation and innovation performance in listed companies in Sri Lanka.

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