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# PhD Thesis Title:

The Role of Inbound Open Innovation Sources on Innovativeness and Advantage of New Products in Small and Medium Sized Enterprises

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# *Chapter 1: Research Introduction*

## *1.1. The Research in Brief*

The central and supportive idea and opinion about Open Innovation (henceforth OI) is that, nowadays, in a world of widely and broadly distributed and diffused knowledge, firms cannot depend and rely upon thoroughly on their internal research and development (R&D) capabilities and relevant departments fulfill their duties independently to innovate. Instead, firms should initiate to make partnership with other companies, customers, universities and research institutions, suppliers, even with competitors to develop new technologies and increase level of new product innovativeness.

"Open Innovation (OI); describes a distributed innovation process based on purposively managed knowledge flows across organizational boundaries" (Chesbrough & Bogers, 2014: 17). The flourishing literature on open innovation highlights the role of external knowledge and innovation sources. Scholars do agree that exploiting and sourcing of external knowledge for innovation is a substantial and remarkable process of a firm's inbound open innovation practices, "where external knowledge flows into the organizations" (Chesbrough, Vanhaverbeke, and West 2006, Dahlander and Gann 2010, Brunswicker and Vanhaverbeke, 2015).

This PhD thesis provides a quantitative empirical study based on a theoretical model, which deepens and extends previous models by analyzing the different constructs that concur to innovation performance. The theoretical model considers the relationship between different sources of outside-in (Inbound) open innovation collaborating with external partners like customers, competitors, suppliers, universities, research institutions and consultants, and their separate diverse effects on new product innovativeness and measuring new product innovativeness effect on new product advantage of small and medium sized enterprises

(SMEs) in Petroleum and Gas equipment industry. Furthermore, based on previous studies, this research contributes to the concept of internal R&D capability and firm's innovation performance, this thesis measures the effect of internal R&D expenditures as annual sales percentage on new product innovativeness, which regarded as organizational R&D strengths and intensity in SMEs of Petroleum and Gas equipment industry. In addition, building on previous literature, organizational declarative memory as one of the components of organizational memory about know-what, know-why and know-when which interacts with concepts of facts, events and propositions is considered to measure its effect on new product advantage. In addition, in order to ensure the robustness of results, several control variables were included in this research. These controls have to be considered as internal organizational component or external organizational elements. The control variables held constant in order to assess and clarify the relationship between other variable in this research such as new product advantage (NPA). The purpose of assessing these control variables is to make sure that if they may have any effect on new product advantage (NPA). Firm size, technology turbulence, market turbulence and competition intensity were added as control variables to account for the effects of extraneous factors on new product advantage (NPA).

### *2.1. The Contribution of the Study*

In current academic and professional areas, the attention and concern about open innovation has increased dramatically, as it can be observed by different conferences, review articles, and specific journal topics (Dahlander and Gann, 2010, Gassmann, Enkel, and Chesbrough, 2010, Huizingh, 2011). Different case studies (Huston and Sakkab, 2006, Remneland-Wikhamn, Ljungberg, Bergquist, and Kuschel, 2011. Rohrbeck, Hölzle, and Gemünden, 2009), and surveys (Vrande, Jong, Vanhaverbeke, and Rochemont, 2009), address the charming and absorbing issue of open innovation. These studies find that open innovation leads to leveraging firm performance due to profitability (Chiang and Hung, 2010, Lichtenthaler, 2009), R&D performance (Chiesa, Frattini, Lazzarotti, and Manzini, 2009), customer satisfaction (Chesbrough, 2011, Wagner, 2010), product innovativeness (Laursen and Salter, 2006), and new product success (Rohrbeck et al, 2009). The flourishing literature on open innovation addresses the role of external knowledge and innovation sources. Scholars point out the important role of external sources of knowledge. Researchers believe that external knowledge and innovation sourcing for innovation practices is a prominent and substantial processes of firm's outside-in (Inbound) open innovation activities, where external knowledge and innovation sources flow into the firms (Chesbrough, Vanhaverbeke, and West 2006, Dahlander and Gann 2010, Brunswicker and Vanhaverbeke, 2015). Open innovation researchers point out that sourcing of external knowledge and innovation sources cannot be used as internal and in-house R&D activities and emphasize the importance of absorptive capacity, which permits firms to recognize, assimilate, and use external knowledge (Cohen and Levinthal 1990, Dahlander and Gann 2010, Brunswicker and Vanhaverbeke, 2015). Furthermore, even though according to Parida et al, (2012), the empirical studies have emphasized that the acceptance and utilization of open innovation activities can positively affect innovation performance of SMEs, the literature contains many theoretical gaps. Small and medium sized enterprises (SMEs) have not been considered in the main discussion of open innovation (exceptions are Lee et al, 2010, Parida et al, 2012, Van de Vrande et al, 2009). However, scholars do believe that SMEs play a crucial role in innovation (Chesbrough, Vanhaverbeke, and West 2006, Brunswicker and Vanhaverbeke, 2015).

Even though most researchers would address that open innovation activities are advantageous for both SMEs and large firms (Chesbrough 2003. Chesbrough, Vanhaverbeke and West 2006, Lichtenthaler 2008a, Parida et al, 2012), the large number of previous studies have mainly focused on large or multinational firms (Bianchi et al. 2010. Christensen, Olesen, and

Kjær 2005, Lecocq and Demil 2006, Van De Vrande et al. 2009, Parida et al, 2012). SMEs are apparently different from larger firms due to their ability to utilize open innovation activities for innovation performance. Comparing with large firms, SMEs have different limitations, such as lack of resources for R&D practices, lack of structured innovation process, and less developed internal capabilities (Chesbrough and Crowther 2006, Lichtenthaler 2008a, Madrid, Guijarro, Garcia, and Van Auken 2009, Parida et al, 2012). On the other hand, SMEs generally possess less bureaucratic procedures, more intention to take risks, have more specialized knowledge, and are quicker in responding to market demands and turbulence. All of these potentials enable such firms to be better at obtaining and achieving positive results from open innovation practices comparing to large firms (Christensen, Olesen, and Kjær 2005, Stam and Elfring, 2008, Vossen 1998, Parida et al, 2012). Few prior studies have focused on the importance and effects of using external sources on innovation process of SMEs (Bianchi et al, 2010, Henkel 2006, Lee et al, 2010). Hence, there has been lack of quantitative empirical support, and there is scarce specific knowledge about the effects of different types of outside-in (Inbound) open innovation sources and activities on new product innovativeness and new product advantage of SMEs. Furthermore, there is a need to empirically test the hypotheses of this phenomenon based on quantitative method in order to test and investigate empirically the effects of different types of outside-in (Inbound) open innovation sources on new product performance of SMEs. There have been lack of empirical quantitative studies in measuring different effects of various types of outside-in (Inbound) open innovation activities on new product performance in SMEs and also scarce knowledge about exploiting and applying different outside-in (Inbound) open innovation activities for improving and increasing level of new product innovativeness in SMEs. Moreover, there has been rare information if the new product innovativeness will lead to new product advantage concurrently by using stored and accumulated organizational declarative memory, which is about customer preferences, competitors, new product area, market condition as stocked organizational knowledge embedded in organizational memory which is the product of organizational learning. Thus, these issues were found important and interesting to be studied in this PhD thesis and should be understood as the theoretical gap of innovation management in SMEs.

What have not been investigated in innovation management of SMEs yet are various effects of different components of outside-in (Inbound) open innovation sources/ or activities as external knowledge sources on new product innovativeness in SMEs. Additionally, the main important research problem that has to be considered in this research thesis is whether these different types of outside-in (Inbound) open innovation sources are affecting differently on new product innovativeness in SMEs. In addition, how internal R&D expenditures as organizational capability, strengths and intensity affect new product innovativeness. In addition, whether or not new product innovativeness after utilization outside-in (Inbound) open innovation sources will lead to new product advantage in the marketplace. This research also investigates the effect of organizational declarative memory as internal accumulated organizational knowledge source on new product advantage. The logic behind this theory is to assume that if new product advantage (NPA) could be affected by organizational declarative memory (ODM). Organizational declarative memory is internal organizational stored and accumulated knowledge of facts and events such as accumulated knowledge about customers and their preferences, product features, (e.g., product drawings and packaging) and firm’s business objectives, its market conditions, its marketing strategies and competitive positions. This is considered as the main gap of literature in innovation management theories and organizational literature.

### *3.1. The Research Aims and Scopes*

In this research, the researcher specifically tries to focus and argues the topic of outside-in (Inbound) open innovation activities in SMEs of Petroleum and Gas equipment industry in Iran. The purpose of this study is to examine empirically the causal relationship among different components of outside-in (Inbound) open innovation sources namely: *Customer Involvement, Industrial Network Partnership, External Participation, R&D and Academic Sourcing and Inward Licensing* and their effects on new product innovativeness. Likewise, to test empirically the effect of new product innovativeness on new product advantage in SMEs of Petroleum and Gas equipment industry in Iran. The objective of this research is to empirically test the causal relationship between outside-in (Inbound) open innovation sources as independent variables, new product innovativeness, and new product advantage as dependent variables of research theoretical model to predict and measure the effect of outside-in (Inbound) open innovation sources on new product innovativeness rather than confirmation of structural relationships between variables. Furthermore, this research aims to test empirically the causal relationship between organizational declarative memory as one of the components of organizational memory and new product advantage. The research aims to know and test: (1) if there is any positive or negative causal relationship between different types of outside-in (Inbound) open innovation sources and level of new product innovativeness of SMEs operating in Petroleum and Gas equipment industry? (2) To test the causal relationship between R.D expenditures as internal organizational R.D investments in SMEs operating in Petroleum and Gas equipment industry to explore if investment in R.D activities causes to higher new product innovativeness (NPI) level in such firms? (3) To test the causal relationship between new product innovativeness (NPI) and new product advantage (NPA) of SMEs operating in Petroleum and Gas equipment industry to realize if NPI after exploiting external sources of knowledge as open innovation activities affect positively or negatively on new product advantage (NPA) in such firms. (4) To test the causal relationship between organizational declarative memory and new product advantage (NPA) in SMEs operating in Petroleum and Gas equipment industry to explore if utilizing internal organizational accumulated and previous stored knowledge of facts and events as organizational memory causes to higher new product advantage (NPA) as a component of market success of these firm's products? The purpose of this research is not only based on predictive approach and forecasting, but also to contribute to developing and extending current existing theory of outside-in (Inbound) open innovation activities in SMEs. In addition, as the research method is based on partial least square structural equation modeling, (PLS-SEM), thus, it aims to predict target constructs (endogenous constructs) namely: New product innovativeness (NPI) and new product advantage (NPA). Therefore, this research contributes to developing theory of outside-in (Inbound) open innovation practices in SMEs by surveying and examining the utilization of various outside-in (Inbound) open innovation sources and measuring their effects on new product innovativeness in SMEs. The research objective is contributing to theory development and explanation of variance which is prediction of the endogenous (dependent) variables, the objective of the predictive research is not only emphasized on forecasting, but also in contributing to developing existing theory in open innovation theory in SMEs.

# *Chapter 2: Research Theoretical Review*

## *1.2. The Difference between Inbound and Outbound Open Innovation*

Since the globalization trend of world economy has been rapidly changing and shifting from industrial economy to digital and knowledge based economy. Firms are in the era of global knowledge economy, firms are more willing to try to absorb more external knowledge and ideas from innovative and technological sources and are attempting to acquire and gain more new, novel and state of the art sources of knowledge exists. Firms try to access to outside boundaries innovation sources in order to stay forward and to be in advance of their competitors in innovation activities. According to Rigby and Zook perspectives, Firms have a tendency to alter their emphasis and concentration on internal R&D endeavors with external sourcing.

Firms are changing their organizational strategies from relying solely on internal knowledge and innovative resources to external environment to acquire external knowledge ideas and gain more R&D capabilities from outside their firm's boundaries. Firm's strategic capabilities and strategic advantages can be gained and sustained by establishing and exploiting R&D collaboration with external knowledge and innovation networks. Pisano, (1990) point out that firm's strategic flexibilities can be retained by resorting and deploying R&D collaboration.

The most prevalent and usual reason of exploitation and acquisition of external technology is a reason of sustainable growth and development. The main reason is that firms are more willing to gain more sustainable advantage positions by exploiting and obtaining external knowledge and innovative sources. As Chesbrough and Crowther (2006) note, the expectation is that fundamental entrepreneurial values like growth, development and incomes will be considered as the central and major stimulator and incentives of firms to have open innovation activities.

It can be a common concept between both large and small firms. The ideas on the notion of open innovation progressively compare and balance the significance of external sources of R&D with internal developed knowledge (Chesbrough, 2003a, 2003b).

Hoffman and Schlosser, (2001) believe that concerns about market and knowledge generation are considered as key motivations for open innovation. Increasing market success and enhancing knowledge resources by firms is the main stimulator for firms to use open innovation. Enterprises might participate in collaboration with other partners to attain missing and shortage of knowledge, supplementary financial resources, to manage and remove risks, reduce costs, and to extend social networks.

**Table 1-The Influential Stance of Open Innovation Activities on Performance of Large, Small and Medium Sized Firms**

| ***High Tech and Large Firms*** | ***Small and Medium Sized Firms*** |
|---|---|
| **1.** 'Open innovation' approach has been regarded as relevant to high tech industries (Chesbrough, 2003) as well as a variety of other less high tech industries (Chesbrough and Crowther, 2006).<br>**2.** Chesbrough (2003b) states that firms are increasingly transforming the basic and pivotal strategies by which they produce and send ideas to the market and capture new ideas and thoughts from external environment to increase their internal R&D and innovation capabilities.<br>**3.** Most empirical research on open innovation has carried out mostly on large multinational firms, for example Chesbrough, 2003d and also Dahlander and Gann, (2010) point out to this fact. Case studies of pioneers and most important succeeded firms in open innovation such as Procter and Gamble, IBM or Xerox display that large firms have changed their position and professional behavior from depending only on their internal Research and Development (R&D).<br>**4.** Chandler, (1962). Chesbrough, (2003a) and Teece, (1986) point out | **1.** According to Dahlander and Gann, (2010), Spithoven et al, (2013) and Popa et al, (2017), purposive inflows and outflows of knowledge are more appropriate for sustainable competitiveness because they have more serious resource constraints and shortage of capabilities. Both internal and external flows of knowledge streams and innovative ideas are applicable and suitable for SMEs.<br>**2.** Organizations cannot only depend on their internal research departments, but must open their organizations' boundaries in order to interact and cooperate broadly with external parties (Lichtenthaler 2009). In particular, this can be applied as a principle for SMEs, which are facing with shortage and deficiencies of internal R&D department, technician team of research activities and capabilities. They can develop and increment their ability to increase the accessibility to external expertise and knowledge sources in order to be remained in the market (Rothwell 1991.Verbano et al, 2015). Firms are not able solely to rely on their internal R&D and |

| *High Tech and Large Firms* | *Small and Medium Sized Firms* |
|---|---|
| that Large firms are more relying in their own R&D resources and knowledge management departments and are more intended toward a closed innovation type of activities so that all firm innovation practices are under control and surveillance. Therefore, large and multinational firms are more dependent on their internal R&D capabilities and internal innovation practices instead of external innovative network partnerships.<br>**5.** According to Chesbrough and Crowther (2006), Open innovation approach is also applicable in other industries. The search for growth in both forms of revenue and the number of new products is a major focal stimulator for firms accepting and applying the open innovation approach.<br>**6.** Open innovation is applicable for both high and low-tech industries. Anticipation of growing in the marketplace and developing new innovative products to gain more profits by launching and supplying to the market is the main motivation of firms for using open innovation.<br>**7.** There are some comments from Chesbrough, (2003). Kirschbaum, (2005) that open innovation has been in the core of attention by scientific scholars, but up to current period, it has mostly been studied and analyzed in large, high tech multinational firms based on in depth interviews and case studies. Even though open innovation has been considered as the most remarkable and considerable topic which draw attention of many scholars in innovation management literature, many of these studies have been done in large firms which are involved in high technology multinational firms by qualitative method like in-depth interview and case study. Therefore, there is less attention to study open innovation activities, which is being done or practicing by small, and medium sized enterprises (SMEs). | innovation capabilities in or der to be sustained and need to greatly cooperate with external partners in order to benefit from external sources of innovation and R&D expertise. It is more necessary for SMEs to initiate this collaborative partnership with outside technological and innovation resources as they have insufficient internal capabilities if they aim to be remained in the marketplace.<br>**3.** During past decades, organizations used to rely on their internal resources when they were managing and administering research and development (R&D) activities, and usually only those firms that had sufficient internal resources would have been able to gain revenue and achieve growth through their own innovation practices.<br>**4.** Currently, many leading firms are facing progressively strict and aggressive competition from lately emerged firms with constrained resources to perform their own R&D. These newly emerged firms have been acting as successful firms to best commercialize other original findings and discoveries (Chesbrough, 2004).<br>**5.** It can be comprehended from Acs and Audretsch, (1987) and Vossen, (1988) that despite the existence of limitations in resources and assets, SMEs are prominent for different types of innovation, technological or non-technological ones. Recent studies and debates confirm that SMEs play an increasingly prevailing role in nowadays innovation view (Chesbrough, 2006b).<br>**6.** SMEs require profoundly relying on their network relationships to explore and find missing and lacking innovation resources, and because of their smallness, they are encountering with the small boundaries of their organizations according to their firm's size. Nowadays when there are complicated and knowledge intensive conditions throughout the globe which product life cycle has shortened, those networking behavior and attitudes has become more remarkable and crucial than before.<br>**7.** The possibility of open innovation success in SMEs depends on |

| High Tech and Large Firms | Small and Medium Sized Firms |
| --- | --- |
| | external resources, which could be important and vital to innovation process in every organization (Cohen & Levinthal, 1990). Narula, (2004) note that SMEs are often possessed less necessary knowledge or innovation resources and technologies than large firms that can be interacted and exchanged. Open innovation in SMEs is generally considered to be managed to complement and complete insufficient and inadequate resources of such firms (Lee et al, 2010). Open innovation is a method, which enables SMEs to overcome their lack of R&D and knowledge resources. By that, SMEs can improve their internal R&D capabilities to develop their product innovation activities. Furthermore, they are more likely to face to the shortage and lack of the ability and capability to transform and alter innovation activities into new products and processes (Lee et al, 2010). As a result, SMEs tend and are more willing to focus on sharing knowledge sources and technologies with other firms to focus on their resource inadequacies, insufficiencies and deficiencies. SMEs involve in diverse cooperative practices including establishing alliances and networking (Kleinknecht and Reijnen, 1992, Suh & Kim. 2012).<br>**8.** Henkel, (2006) and Van de Vrande (2009) note that few research studies have shown that open innovation is being used by small organizations. Furthermore, all of them had focused on special industries such as open source software. There have been scarce studies to focus on open innovation practices in small or medium sized firms. Most of these studies were about special industries like open source software which have not indeed concentrated on the role of exploiting open innovation practices by SMEs.<br>**9.** Although SMEs are being flexible most of the time and have interchangeable approach, which focused more on specific products, services, and technologies, they might bring advantages in accelerating innovation for them. Few of these firms have shown to |

| *High Tech and Large Firms* | *Small and Medium Sized Firms* |
|---|---|
| | own adequate capacity and capability to manage the entire innovation processes. This encourages them to collaborate with external knowledge and innovative sources such as organizations or partners (Edwards et al, 2005. Lee et al, 2010) to adopt what has emerged and decided to be named as an open approach to innovation (Grimaldi et al. 2013). |
| | **10.** As SMEs possess more approach that is flexible and less bureaucratic structure in order to focus on new product development strategies and initiate to adopt new technologies for new product innovation, it is probable that innovation practices result into advantage position for such firms. More SMEs are suffering from shortage of capacity and capability to fulfill innovation processes, so, it is crucial to collaborate with external innovation network partners. |

Chesbrough (2003, p. xxiv) introduced the concept of open innovation and defined as follows: "open innovation 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 the firms look to advance their technology" (Hossain & Kauranen, 2016). Open innovation has been proposed as a new paradigm for the management of innovation (Chesbrough, 2003, Gassmann, 2006). Open innovation is a novel and contemporary approach, which deeply challenge and compete with the traditional type of innovation management as traditional and customary approach. Recently, it has emerged and appeared as one of the most crucial topics in innovation management science. As exploitation of open innovation practices in small and medium sized firms is a contemporary prominent issue among both scholars in academia and practitioners in industry, SMEs are defined in various ways. According to the European Union, firms with less than 250 employees and annual turnover not exceeding 50 million euros are considered as SMEs (European Commission, 2003, Hossain & Kauranen, 2016).

Open innovation is a kind of supporting framework for firms to use purposively and utilizing inflows and outflows of knowledge to accelerate internal innovation, and to expand and develop markets for external use of innovation respectively (Chesbrough, 2006a, p.1).

Henry Chesbrough in 2003, coined the term ‘open innovation’ to explain a kind of shift in innovation paradigm and literature from closed or in-house and internal R&D of new products to an open innovation model which merge internal and external ideas, knowledge and technologies to make and commercialize new product and services (Wynarczyk, and et al, 2013). Open innovation focus on a new concept of shifting from internal organizational R&D practices toward applying and initiating a collaborative partnership with external knowledge and innovation resources so that internal and external knowledge and innovative ideas can boost innovative capacity and capability of firms. According to Cullen, (2000), Laursen and Salter, (2006), Marjanovic et al, (2012), Rosenfeld, (1996), Teece, (1986), von Hippel, (1986), (1988), industrial firms are trying to internalize their innovation processes and activities by acquiring external knowledge resources and capabilities through integration, collaboration, in- licensing and crowdsourcing. In addition, externalize knowledge and innovative practices by out-licensing, strategic alliances, and other user involvement in open innovation practices. There are comparative characteristics between both types of closed innovation as traditional archetype of innovation, which mostly was used in large firms and open innovation as the most current notion of innovation that is proposed by Henry Chesbrough (2003).

**Table 2- Comparison of Characteristics between Closed Innovation and Open Innovation (1)**

| *Key Locus of Closed Innovation* | *Closed Innovation Characteristics* | *Key Locus of Open Innovation* | *Open Innovation Characteristics* |
|---|---|---|---|
| **1. *Internalized Innovation Practices inside Firm's Boundaries*** | **1.1.** The expertized staffs in a particular specialized field of activity work for firms, and all the organizational innovation practices are being processed and produced inside the firm by methods and combination of activities which is done as internal research and development (R&D) endeavors.<br>**2.1.** Firms have conducted their R&D activities since long time ago as an internal process, relying often on their internal knowledge sources and innovation capabilities Chesbrough (2003c).<br>**3.1.** Firms must produce their own ideas and knowledge sources and then expand, create, marketing, distribute, and support them on their own efforts and practices. This model advises firms to be eagerly and forcefully self-dependent, absolutely advising organizing and arranging innovation activities in internal R&D departments. | **1. *Partnership With External Knowledge Sources and Innovative Network*** | **1.1.** In addition to working and partnership with specialized experts inside firms, firms require collaborate with other specialists and knowledge sources outside their firm's boundaries.<br>**2.1.** Open innovation is based on the underlying core idea that useful and beneficial knowledge is common and extensively known across community. None of the organizations has comprehensive ideas, and every organization regardless of how much effective are their internal resources, requires to be engaged profoundly and extensively with external knowledge networks and communities.<br>**3.1.** OI is ‘the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and to expand the markets for external use of innovation, respectively’ (Chesbrough et al, 2006, p. 1). |

**Table 2: Comparison of Characteristics between Closed Innovation and Open Innovation (Continued 2)**

| ***Key Locus of Closed Innovation*** | ***Closed Innovation Characteristics*** | ***Key Locus of Open Innovation*** | ***Open Innovation Characteristics*** |
|---|---|---|---|
| **1.** ***Internalized Innovation Practices inside Firm's Boundaries*** | | **1.** ***Partnership With External Knowledge Sources and Innovative Network*** | **4.1.** There is a common and frequent objective to facilitate and enable the acquisition and integration of innovations from external sources by sharing knowledge resources and innovation processes with their partners (West and Bogers, 2014.Tsinopoulos et al, 2018).<br>**5.1.** Innovation processes and skills (innovativeness) are dispersed and spread among several parties (Öberg, 2016). Access and utilizations of external knowledge sources through open innovation is progressively known as a crucial and important source of the firm's innovativeness (Duysters and Lokshin, 2011).<br>**6.1.** External sources of knowledge are increasingly becoming crucial and substantial so that those external channels are becoming as valuable and noteworthy sources (Chesbrough 2004). |

**Table 2: Comparison of Characteristics between Closed Innovation and Open Innovation (Continued 3)**

| ***Key Locus of Closed Innovation*** | ***Closed Innovation Characteristics*** | ***Key Locus of Open Innovation*** | ***Open Innovation Characteristics*** |
|---|---|---|---|
| **1. *Internalized Innovation Practices inside Firm's Boundaries*** | | **1. *Partnership With External Knowledge Sources and Innovative Network*** | **7.1.** Open innovation search and investigation strategies specify how firms arranging their exploration and search methods for external sources of knowledge outside of their organizational boundaries. For instance, R&D and knowledge sources such as universities, research labs or institutes or suppliers seem to be extremely relevant sources of knowledge and innovation (Huston and Sakkab, 2006, Brunswicker & Vanhaverbeke, 2011).<br>**8.1.** Firms would be able to reinforce and increase their absorptive capacity, innovation performance and market share if they obtain externally developed and expanded technology and exploit a large number of players, actors, agents or network partnership (e.g. customers, competitors, suppliers and research institutions) from their external environment (Chesbrough, H.W 2003a). |

**Table 2: Comparison of Characteristics between Closed Innovation and Open Innovation (Continued 4)**

| ***Key Locus of Closed Innovation*** | ***Closed Innovation Characteristics*** | ***Key Locus of Open Innovation*** | ***Open Innovation Characteristics*** |
|---|---|---|---|
| **2. *Exploration of R&D, Knowledge and Innovation Source*** | **1.2.** In order to make advantage and profit from R&D, knowledge resources and innovative activities, it is crucial to explore, develop, expand and carrying out them by firms. | **2. *Value Creation through External R&D, and Innovation Network Partnership*** | **1.2.** External R&D and innovation network partnership enable firms to make substantial values. Internal R&D and knowledge sources are required to be as complementary part of that value.<br>**2.2.** Open innovation is crucial and beneficial for accessing new efficient and effective complementary, supportive knowledge (Chesbrough, 2003, Asakawa et al, 2010).<br>**3.2.** Open innovation development objective is to facilitate and simplify the use of external sources of ideas as firms are aiming to advance and make progression their technological and knowledge capabilities (Chesbrough, 2003b).<br>**4.2.** New and useful knowledge has become extensive and general and new ideas require to be utilized with brilliance, agility and willingness, otherwise, this kind of knowledge will be lost Chesbrough (2003b). |

**Table 2: Comparison of Characteristics between Closed Innovation and Open Innovation (Continued 5)**

| ***Key Locus of Closed Innovation*** | ***Closed Innovation Characteristics*** | ***Key Locus of Open Innovation*** | ***Open Innovation Characteristics*** |
|---|---|---|---|
| **2.** ***Exploration of R&D, Knowledge and Innovation Source*** | | **2.** ***Value Creation through External R&D, and Innovation Network Partnership*** | **5.2.** Open innovation encompasses external ideas and knowledge sources relevant to internal R&D and accordingly creates new paths and solutions to create value.<br>**6.2.** Values can be created in firms by boosting new ideas and to attain significant values by using their key crucial assets, resources and positions. |
| **3.** ***Internal Traditional Innovation Practices to Sell the Innovative R&D outputs to the Market*** | **1.3.** Firms most of the time intends to exploit and get benefit from internal innovative activities and R&D outputs in order to commercialize it as the first firm mover in the market. | **3.** ***Collaborative Approach with External R&D Sources*** | **1.3.** Firms attempt to collaborate regarding R&D issues and benefit not only from internal R&D capabilities but also from external R&D and innovative network partnership. |

**Table 2: Comparison of Characteristics between Closed Innovation and Open Innovation (Continued 6)**

| ***Key Locus of Closed Innovation*** | ***Closed Innovation Characteristics*** | ***Key Locus of Open Innovation*** | ***Open Innovation Characteristics*** |
|---|---|---|---|
| **3.** ***Internal Traditional Innovation Practices to Sell the Innovative R&D outputs to the Market*** | | **3.** ***Collaborative Approach with External R&D Sources*** | **2.3.** The basic idea behind the concept of open innovation and external knowledge sourcing is that in this world where knowledge is broadly dispersed and diffused, organizations cannot only depend on their internal research departments, but must open their organizations' boundaries in order to interact and cooperate broadly with external parties (Lichtenthaler 2009).<br>**3.3.** Open innovation has been trying to explain and address this point why and how external sources share ideas, knowledge and expertise, and how these sources are synthesized with an organizations' internal knowledge to contribute to improve the quality and innovativeness of products (Chesbrough, 2003b). |

**Table 2: Comparison of Characteristics between Closed Innovation and Open Innovation (Continued 7)**

| *Key Locus of Closed Innovation* | *Closed Innovation Characteristics* | *Key Locus of Open Innovation* | *Open Innovation Characteristics* |
|---|---|---|---|
| ***4. Obtaining the First Mover Advantage Position by Introduction of Innovation to the Market*** | **1.4.** The firm that introduces an innovation outcome to market as the first mover gets an advantage. | ***4. Open and Flexible Business Model to align with Market Condition*** | **1.4.** Creating open and flexible business models according to the condition of current market is preferable than penetrating as the first company to the market.<br>**2.4.** The next borderline that will help to open up the development and execution of the open innovation approach will have to deal with creating open business models. This new openness will enable organizations to become more effective and efficient in creating and achieving value, designing the open business model will provide a large number of advantages for firms (Chesbrough (2007).<br>**3.4.** With open business models, firms will be able to gain and capture greater and more considerable values by creating and using internal and external resources more appropriate. Openness can cause a new type of competition. |

**Table 2: Comparison of Characteristics between Closed Innovation and Open Innovation (Continued 8)**

| *Key Locus of Closed Innovation* | *Closed Innovation Characteristics* | *Key Locus of Open Innovation* | *Open Innovation Characteristics* |
|---|---|---|---|
| **5.** ***Successful Firms by Best Internal Ideation and Commercialization of Innovative Ideas*** | **1.5.** Firms are successful if they make the most comprehensive and best internal innovative ideas and offer to the market and industry. | **5.** ***Successful Firms by Both Kinds of Internal and External Ideation and Commercialization of Innovative Ideas*** | **1.5.** Firms are successful if they make the most comprehensive and best combination of both internal and external innovative ideas and offer them to the market and industry.<br>**2.5.** Chesbrough (2003a, 2003b, 2003c, p. 24) introduced the open innovation concept, saying that: 'open innovation is a paradigm assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market as the firms look to advance their technology'.<br>**3.5.** Open innovation facilitates the way and allows firms to investigate and search external knowledge and utilize existing internal resources in order to achieve competitive advantage in the market (Drechsler and Natter, 2012). |

**Table 2: Comparison of Characteristics between Closed Innovation and Open Innovation (Continued 9)**

| *Key Locus of Closed Innovation* | *Closed Innovation Characteristics* | *Key Locus of Open Innovation* | *Open Innovation Characteristics* |
|---|---|---|---|
| ***5. Successful Firms by Best Internal Ideation and Commercialization of Innovative Ideas*** | | **5.** ***Successful Firms by Both Kinds of Internal and External Ideation and Commercialization of Innovative Ideas*** | **4.5.** Open innovation demonstrates that several partners and players are involved in the innovation process. These parties as components of open innovation might be internal or external to the company, and the innovation process may combine and mix internal and external partners in the process of innovation (Bessant and Moslein, 2011, West et al, 2014).<br>**5.5.** The open innovation approach defends expansion of internal system to award and compensate feasible realistic innovation activities inside the firm and also obtaining and commercializing R&D outputs, which generated outside of the firm's boundaries. |

**Table 2: Comparison of Characteristics between Closed Innovation and Open Innovation (Continued 10)**

| ***Key Locus of Closed Innovation*** | ***Closed Innovation Characteristics*** | ***Key Locus of Open Innovation*** | ***Open Innovation Characteristics*** |
|---|---|---|---|
| **6. *High Conservative toward IP and License Protection*** | **1.6.** Firms must be cautious and control their intellectual property not to be copied and benefited by competitors from firm's innovative ideas. | **6. *Inward Licensing and IP Agreements Approach with External Partners*** | **1.6.** Firms are making IP agreements with external network partners and buy IP from other companies, and licensing-in inside their organizations to make progress and develop their business models.<br>**2.6.** In the current age of rapid dissemination of valuable knowledge, the closed innovation approach is no longer existed as a sustainable approach. Firms require managing their intellectual property (IP) by straightening and paralleling it with the open innovation approach. |

**Table 2: Comparison of Characteristics between Closed Innovation and Open Innovation (Continued 11)**

| *Key Locus of Closed Innovation* | *Closed Innovation Characteristics* | *Key Locus of Open Innovation* | *Open Innovation Characteristics* |
|---|---|---|---|
| | | **7.** ***Degree of Using Open Innovation based on Environmental Factors*** | **1.7.** The degree of using open innovation practices and activities is dependent on environmental components. In dynamic technological environments firms are more relying on external technology as their prevalent and frequent technological knowledge, innovative capabilities and infrastructures are quickly becoming outdated and outmoded (Jansen et al, 2006, Teece, 2007). |

**Table 2: Comparison of Characteristics between Closed Innovation and Open Innovation (Continued 12)**

| *Key Locus of Closed Innovation* | *Closed Innovation Characteristics* | *Key Locus of Open Innovation* | *Open Innovation Characteristics* |
|---|---|---|---|
| | | **7. *Degree of Using Open Innovation based on Environmental Factors*** | **2.7.** Firms in the context of market turbulence need to seek continuously for new knowledge and technologies to meet and respond to customers' new demands, requirements and priorities (Hung and Chou, 2013). This dimension is paralleled with the Contingency Theory. Due to this theory, the extent and degree of being openness of innovation strategies depend on firm particular (internal) factors and environmental (external) factors (Drechsler and Natter, 2012).<br>**3.7.** The competitiveness of firms is contingent not only because of internal adjustment of open innovation strategies and practices to organizational factors but also on the suitable and proper proportion and coordination acts between organizational strategies and business environment (Takeuchi, 2009, Greco, 2016). |

Three main open innovation models as outside-in, inside-out and coupled are described and categorized by Gassmann and Enkel, (2004) which are as following table:

**Table 3- Three Models of Open Innovation Process**

| ***Outside-In Open Innovation*** | ***Inside-Out Open Innovation*** | ***Coupled Open Innovation*** |
|---|---|---|
| **1.** Outside-In or inbound is when new ideas from external environment flow into an organization.<br>**2.** Increasing firm's knowledge base by the exploiting and integration of suppliers, customers, and external knowledge sourcing can improve and increase firm's innovativeness.<br>**3.** Firm tendency is to invest in collaboration with suppliers and customers and to integrate and incorporate the knowledge that is gained from external knowledge sources. This is achievable by customers and supplier coalition, noticing posts at innovation clusters, applying innovation among industries, purchasing and acquiring intellectual property and investing in global knowledge creation.<br>**4.** According to Vanhaverbeke, (2017), an organization that tries to have practices on open innovation will be exploiting external ideas, technologies, and knowledge sources as a common prevalent practice in its own field of business or industry, which is | **1.** Inside-Out or outbound is when internally developed technologies and knowledge ideas can be achieved and acquired by external organizations with business models that are well organized and structured in order to commercialize a specific technology or knowledge ideas (Chesbrough, 2006b).<br>**2.** Inside-Out enables firms to earn profits by diffusing ideas to market, selling IP and duplicating technology through transferring ideas to the external environment.<br>**3.** Firms concentrate on the externalizing of the firm's knowledge and innovation pools in order to introduce and take it to market quicker than they can do through internal development. To make a decision of changing the position of firms for exploiting to outside the firm's boundaries shows producing profits and benefits through gaining IP licensing and or duplicating technology by transferring ideas and knowledge to | **1.** Combining the outside-in and inside-out processes by collaboration in alliances with supportive, compatible and supplementary partners through which giving and taking is a basis of success.<br>**2.** Coupled process integrates the outside-in (Inbound) process to get external knowledge with inside-out (Outbound) process to bring and diffuse ideas and knowledge to market.<br>**3.** Firms in coupled process cooperate with other companies in the form of strategic networks or alliances. For a successful collaboration format, a kind of mutual cooperation and exchange of knowledge sources or innovative ideas are needed, thus a coupling method of the outside-in and inside-out processes is a key and crucial factor for success. |

| ***Outside-In Open Innovation*** | ***Inside-Out Open Innovation*** | ***Coupled Open Innovation*** |
|---|---|---|
| defined as outside-in or inbound open innovation.<br>**5.** The inbound aspect implies to the notion that firms explore and acquire new knowledge and technologies from external sources such as customers, suppliers, competitors, governments, consultants, universities or research organizations (Cheng and Shiu, 2015, Meissner, 2015). According to Hung and Chou, 2013, Zahra et al, 2006, Inbound open innovation involves an exploratory and investigative learning attitude which enables firms to have a glance further off its boundaries, enriching and enhancing its knowledge pool and reservoir. In this vein, firms that implement inbound open innovation activities might be able to benefit from new ideas and composition of knowledge, new market opportunities and renewed problem solving capabilities and strategies.<br>**6.** Sourcing and exploiting of external knowledge for innovation practices is a crucial and critical process of firm's inbound open innovation activities, so that external knowledge flows into the companies (Chesbrough, Vanhaverbeke, and West 2006, Dahlander and Gann 2010, | other firms.<br>**4.** Commercialization of ideas in various industries which can be defined as cross industry innovation are focusing on the inside-out process in open innovation that is able to boost and improve a firm's income deeply. Selling and commercializing IP or technologies and any sorts of knowledge to external environment and firms can be a very beneficial and market oriented open innovation activity as an outward attempt of firms.<br>**5.** There exist various approaches regarding inside-out processes such as leveraging and boosting a firm's knowledge base by opening the firm's boundaries and achieving benefits and advantages by allowing ideas flow and transfer to the external environment.<br>**6.** It permits unutilized internal ideas and technologies to be transferred to outside the firm for others to use in their relative business or industry (Inside-out or Outbound open innovation) (Vanhaverbeke, 2017).<br>**7.** By Inside-out open innovation process, firms are able to commercialize their IP | **4.** Coupled process is a joint and mutual development of knowledge and innovative ideas through relationships with special partners and parties, such as consortia of competitors (Hagedoorn, 1993. Chiesa, Manzini, 1998, Ingham, Mothe, 1998), suppliers and customers (von Hippel, 1988, Hakanson, Johanson, 1992), joint ventures and alliances (Kogut, 1988, Hamel, 1991). Also, universities and research institutions (Conway, 1995, Cockburn, Henderson, 1998. Santoro, Chakrabarti, 2001).<br>**5.** In coupled open innovation format, firms trying to collaborate in a mutual format in which they can sell their IP in the market and or Spin-out their business. It can bring external technologies and knowledge sources inside the firm by acquisitions or alliances and strategic network partnerships. |

| ***Outside-In Open Innovation*** | ***Inside-Out Open Innovation*** | ***Coupled Open Innovation*** |
|---|---|---|
| Brunswicker & Vanhaverbeke, 2015).<br>**7.** The relationship between outside-in open innovation and the financial performance of R&D projects was studied. It is found that R&D projects with open innovation partnership can bring better financial performance (Du et al. 2014, Hossain et al. 2016).<br>**8.** Making any decision on the outside-in (Inbound) process and activities as an organization's main and central open innovation approach indicates that the company tends to invest in collaboration with suppliers and customers and to incorporate and integrate the attained external knowledge. This core concept can be achieved by customer and supplier integration, listening posts in innovation clusters, applying innovation activities across industries, buying intellectual property and investing in global knowledge creation.<br>**9.** Outside-In process of open innovation creates value for firms by utilizing and deploying different external sources by which more synergies are created through the collaboration with customers, suppliers, competitors, universities and research | or any innovative ideas and knowledge source, which can be offered to the market from internal boundaries of firms to the external market. This type of open innovation focused on value and wealth creation of firms. By doing this strategy, firms are more able to get more profits and gain advantage in the marketplace. | |

| *Outside-In Open Innovation* | *Inside-Out Open Innovation* | *Coupled Open Innovation* |
| --- | --- | --- |
| institutions. External knowledge enables firms to enhance their internal capacities and capabilities in innovation and knowledge based practices.<br>**10.** Outsourcing can be exploited to bridge the knowledge sources or innovative ideas to the external environment. Outsourcing function would be done by attainment of knowledge on a market basis and structure (Grandstrand et al, 1992, Haour, 1992, Ulset, 1996. Mangematin, Nesta, 1999. Veuglers, Cassiman, 1999). Licensing of technologies and innovative knowledge sources from a second partner (Atuahene-Gima, 1992, Leonard-Barton, 1995). | | |

All of these major processes represent open innovation strategy. However, not all of them are in equal value and importance for every firm. (Figure 1).

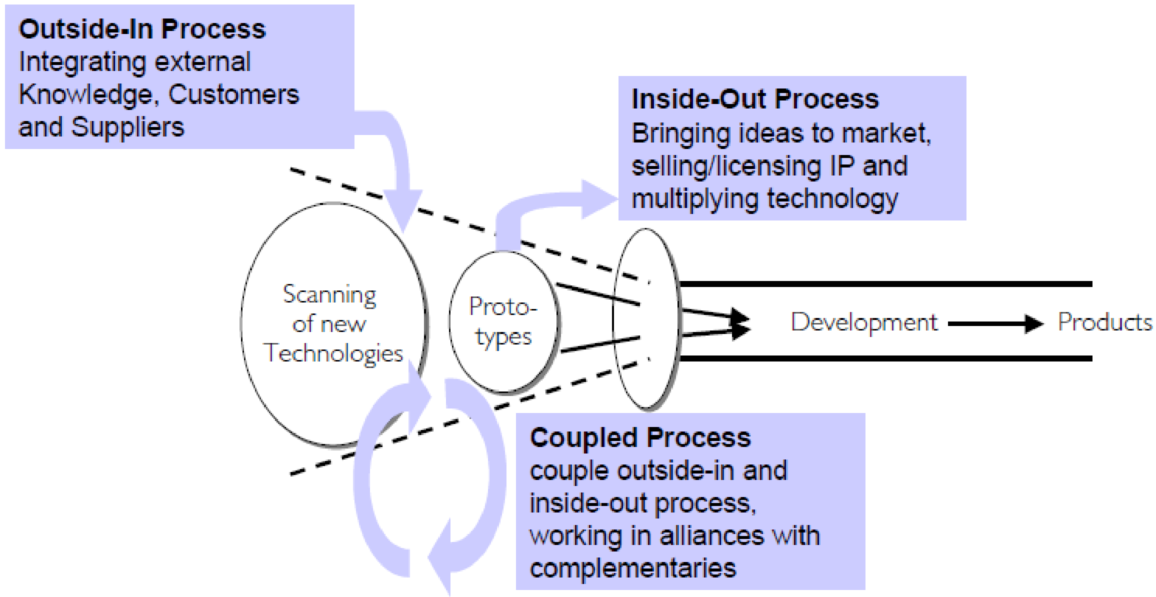


**Figure 1- Three Open Innovation Process Models (Source: Gassmann and Enkel, 2004)**

**Table 4- The Role and Stance of Collaboration of Different Outside-In (Inbound) Open Innovation Sources in Product Innovation and New Product Development Process**

| ***The Role and Stance of Suppliers*** | ***The Role and Stance of Customers*** | ***The Role and Stance of IP, Licensing and Technological Knowledge*** |
|---|---|---|
| **1.** Firms would be able to benefit if they establish outstanding and differentiated relationships with suppliers (Dyer et al, 1998. Boutellier, Wagner, 2003).<br>**2.** Suppliers can offer more opportunities to firms in particular SMEs to benefit from their strong stance in the value chain of industry. They can take advantage from the role of suppliers in mutual open innovation cooperation. | **1.** Customer integration and incorporations in product development process are extensively argued in theory, but not broadly researched (Brockhoff, 2003, p. 464). Although researchers would like to be cautious in talking about radical innovation through customer integration and incorporation, this might be noted as the definitive aim | **1.** IP licensed patents and technological knowledge are another types of valuable sources of external knowledge and innovation activities which potentially is valuable for new product innovativeness and new product development.<br>**2.** The basic advantages of utilizing external innovation and knowledge sources are in the focus of accessing to new, novel and complementary |

| ***The Role and Stance of Suppliers*** | ***The Role and Stance of Customers*** | ***The Role and Stance of IP, Licensing and Technological Knowledge*** |
|---|---|---|
| Suppliers grant firms the power to get the most updated innovative and advanced technologies and state of the art knowledge related to their field of profession. Suppliers can contribute firms to implement their new product development projects successfully.<br>**3.** If firms own the necessary competence and supply chain management capabilities and potentials, they would be able to successfully integrate and incorporate internal company resources with the prominent and crucial resources of other supply chain members such as customers or suppliers, by leveraging new product development practices across firm's boundaries (Fritsch, Lukas, 2001).<br>**4.** Suppliers can improve and increase the buyer's product success by partnering with firms to share their potentials and capabilities to innovate and develop new products. According to Wynstra et al,(2001). Ragatz et al, (1997), they have started to advance the exploration of the success factors and critical topics | and objective in order to achieve competitive advantage (Brockhoff, 2003).<br>**2.** Based on the study of Prahalad and Ramaswamy (2000), it is perceivable that how customers change their attitude from being passive recipients of product development in past decades toward demanding behavior to play a more active, lively role in the current century. "Consumers can now initiate the dialogue; they have moved out of the audience and onto the stage" (p. 80). Consumers recently can contribute to co-creation of values because they can be regarded as a source of competence and capability.<br>**3.** Innovation strategies, in which customers are involved in terms of innovation sources, enable companies to conclude and understand their requirements before customers to be conscious of them are broadly discussed.<br>**4.** Prahalad and Ramaswamy (2000) | knowledge sources and in the possibility of access to inimitable and distinctive resources. Integrating and incorporating external sources of knowledge, innovation and competence, like collaborating with suppliers, customers, research institutions and universities or integrating and acquiring external knowledge attained through listening posts trying to open up the innovation process, can be a firm's main competence (Gassmann & Enkel, 2004).<br>**3.** Using IP and making Licensing-In agreements with external partners such as suppliers, research institutions or universities can enrich firm's internal technological capabilities and competences, as they are enabled to use external technological knowledge of others by transmitting it to their internal product and process development. The new inward license or patents can generate new value for firms as could generate new wealth or increase the revenue level of companies by producing new innovative products and |

| ***The Role and Stance of Suppliers*** | ***The Role and Stance of Customers*** | ***The Role and Stance of IP, Licensing and Technological Knowledge*** |
| --- | --- | --- |
| of successful supplier activities in product development.<br>**5.** Suppliers can offer buying firms with considerable benefits which divides firms from more "operational" benefits, such as the previous recognition of technical problems, less engineering alteration orders, or the existence of prototype, to more "strategic" benefits such as better usage of internal resources, access to new or complementary product and process technologies, decreased technical and financial risks, enhanced product features, or shorter market entry for new products (Birou, Fawcett, 1994, Handfield et al, 1999, Dröge et al, 2000, Ragatz et al, 2002). | developed and improved a co-creation model according to conversation, accessibility, risk reduction, and transparency of interchangeable information between customers and company.<br>**5.** According to Leonard and Rayport (1997), it is obvious that the notion of emphatic design in which customers are being pursued in their daily behavior to understand and realize their requirements through their actions, whereas von Hippel (1986) developed the lead user model discusses that some customers are more suitable to help to co-develop new products and services than others.<br>**6.** Customers play an important role in inbound open innovation activities so that enable firms to develop and leverage degree and level of capability of new product development projects and increase the capability of firms to boost the level of innovativeness in creating | acquiring new product advantage position in the market. |

| *The Role and Stance of Suppliers* | *The Role and Stance of Customers* | *The Role and Stance of IP, Licensing and Technological Knowledge* |
|---|---|---|
| | new products inside the firm's boundaries. In addition, customers as a community are the most influential players that can help to the design and cooperating in developing products. | |

Van de Vrande et al (2009) divide open innovation dimensions into two aspects as the following table:

**Table 5- Technology Exploitation and Technology Exploration as Open Innovation Dimensions**

| *Technology Exploration as (Inbound Open Innovation)* | *Technology Exploitation as (Outbound Open Innovation)* |
|---|---|
| **1.** Purposive inflow, which implies to technology exploration, is relevant to innovation practices to gain and make profit from external sources of knowledge and innovative ideas to leverage current technological improvements and knowledge advancements.<br>**2.** Practices enable enterprises to attain new knowledge sources, innovative ideas, technologies from external environment.<br>**3.** According to Faems, Van Looy, and Debackere, (2005), Tether and Tajar, (2008), and Cheng & Huizingh, (2014), it can infer that inbound open innovation is ability of achieving and investigating knowledge from external partners. These partners are suppliers, customers, competitors, consultants, research institutions, universities, or even governments. | **1.** Purposive outflows of knowledge, or technology exploitation, suggests innovation activities to boost and increase existing technological capabilities and potentials outside the boundaries of the firm.<br>**2.** There are three practices related to technology exploitation such as venturing, outward licensing of intellectual property (IP), and the engagement of non-R&D workers or specialists in innovation inventions and activities.<br>**3.** Venturing is explained as starting up new organizations approaching to internal knowledge, for example, it classifies spin-off and spin-out processes. Receiving support and relying on parent organizations might involve financial assistance, human capital, legal advice, administrative services. |

| ***Technology Exploration as (Inbound Open Innovation)*** | ***Technology Exploitation as (Outbound Open Innovation)*** |
|---|---|
| **4.** Mazzola et al (2012) state that antecedent research propose a firm can make progress its innovation performance by cooperating with various partners, essentially involving customers, suppliers, competitors, and research organizations.<br>**5.** Inbound open innovation (Outside-in process) refers to internal use of external knowledge from partners such as customers, universities, research organizations etc, (Chesbrough, et al, 2006, Gassmann et al, 2010).<br>**6.** Inbound open innovation is the method of achievement, acquisition and transfer of external sources of knowledge and technologies into the firm through R&D collaborative agreements, university collaborations, In-licensing and IP acquisitions (Chesbrough and Crowther, 2006.Wynarczyk and et al, 2013).<br>**7.** Following to technology and knowledge exploration as inbound open innovation concept, five practices are identified such as: customer involvement, external networking, external participation, outsourcing R&D and inward licensing of IP. | **4.** Intellectual property has a prominent role in open innovation as an outcome of the inflows and outflows of knowledge (Arora, 2002, Chesbrough, 2003, 2006, Lichtenthaler, 2007).<br>**5.** Firms can start to out-license their intellectual property to receive more value and benefits from it (Gassmann, 2006). Out-licensing permits organizations to benefit from their intellectual property when other organizations with various business models find it beneficial and profitable to have an external relation to the market.<br>**6.** Outward licensing creates incomes and profits in the format of licensing payments, but existing profits might be diminished when licensees use their own technology or knowledge resources to compete in the same existing market. |

Van de Vrande et al, (2009) mention that according to Koruna (2004) study we can infer that investigating and surveying of different goals of organizations to utilize their required knowledge ideas and innovative resources from external boundaries of firms, require fulfilling industry standards, to realize learning effects, and guarantee to operate by establishing cross licensing contracts with other firms

Von Hippel, 1988 created the term of "distributed" and "open" innovation by Chesbrough, (2003), Chesbrough et al. (2006) address research cooperation practices and R&D

outsourcing as crucial types of external knowledge sources to make the internal research base completed and reinforced. Howells et al. (2003) make a relationship between external knowledge sourcing to increase competitive pressure for new product development and processes that are composed with surging complications and leveraged knowledge intensity.

According to Odagiri, (2003), we can conclude that R&D outsourcing activities imply to a large range of practices such as providing services, technology attainment, and joint research. In past decades, there has been an increasing occurrence of R&D outsourcing (Lai et al, 2009. Huang et al, 2009) and it is significantly considered as part of strategic decision-making (Chesbrough et al, 2006, Howells et al, 2008).

Mol, (2005), Gassmann, (2006) and Teirlinck and Poelmans, (2012), note R&D outsourcing practices tends to invest on external knowledge sources that is not existed internally or cannot be generated in the internal boundaries and environment of organizations in an effective and efficient costing base that it is possible to be licensed or bought from external environment. Attainment of technology from external resources that can be acquired through clients, suppliers, competitors, universities or research institutions can be regarded in several forms varying from mergers, acquisitions, and joint ventures, to those activities like non-monetary alliances, in-licensing, and R&D agreements (Van de Vrande, Lemmens, and Vanhaverbeke, 2006, Kotlar et al, 2013).

Inbound open innovation can be defined as networking or innovation collaborating with other firms or universities for product development, like engagement of customers or end users in product development practices, and licensing-in of intellectual property (IP) from other organizations (Parida et al, 2012). They emphasize to four different inbound open innovation practices respectively, and studied their effects on innovation performance in SMEs (Chesbrough, Vanhaverbeke, and West 2006. Lichtenthaler 2008a, Van De Vrande et al. 2009). As it is indicated in table number six in next page:

**Table 6- Technology Based Aspects of Inbound Open Innovation Practices in SMEs**

| ***Technology Scouting*** | ***Horizontal Technology Collaboration*** | ***Vertical Technology Collaboration*** | ***Technology Sourcing*** |
|---|---|---|---|
| **1.** Technology scouting is an internal search and scanning practices related to systematically and automatically assessing and perceiving technology trends in order to discover opportunities and potentials, and encounter threats or warnings in a proper method (Bianchi et al. 2010, Katila 2002, Laursen and Salter 2006, Lichtenthaler 2007). Focus on technological changes outside the firm (Van Wyk 1997).<br>**2.** Based on the study of Lichtenthaler, Lichtenthaler, and Frishammar (2009), it is perceivable that analyzing a firm's technological environment to collect ideas, information, and useful knowledge to protect and support its internal innovation process and practices is important.<br>**3.** Firms with advanced scouting structure are able to recognize existing opportunity gaps in the market and handle and manage remarkable decisions about which innovative product's ideas is suitable to develop. Introduction of | **1.** Cooperating with partners, which are not as part of the value chain of a peculiar SME.<br>**2.** These connections could comprise partners from the same or other industries, such as competitors or non-competitors, and large firms or other SMEs can be regarded in this process.<br>**3.** R&D collaboration with non-competitor firms is easier because of the feasibility of expanding and growing win-win collaboration as both players and partners could see the benefits of incorporating resources, competences and potentials to develop and make progression in innovative products (Pittaway et al. 2004).<br>**4.** Offers risk and income-sharing contract with other partners across industries to be beneficial for SMEs (Baum, Calabrese, and Silverman 2000).<br>**5.** Facilitate the access and explanation of uncodified knowledge causing to innovation success between SME and | **1.** According to Baum, Calabrese, and Silverman (2000), Vertical technology collaboration is a collaborative relationships with customers (Like: vertical downstream collaboration) or supplier (Like: vertical upstream collaboration). Based on open innovation literature, several studies considered vertical technology collaboration with current customers, potential customers, and end users for an enhanced internal innovation process (Chesbrough, Vanhaverbeke, and West 2006, Gassmann 2006, Henkel 2006, Von Hippel 2005).<br>**2.** SMEs often consider collaboration with large customer enterprises, as they possess strong and potent resources to transform knowledge, ideas and inventions into commercially feasible innovative products. | **1.** Open innovation activity for buying or using external technology by exploiting IP agreements. SMEs would benefit from this activity because they are facing with the challenge and risk of decreased product life cycle, prompt changes in technologies, and decrease deficiencies of capital.<br>**2.** Inward technology acquisition is almost practically crucial for firms, which are operating in an R&D intensive and high technology industry because there is generally high request for them to be innovative (Chesbrough, Vanhaverbeke, and West 2006).<br>**3.** It can enable SMEs to make progression and advance their internal |

| ***Technology Scouting*** | ***Horizontal Technology Collaboration*** | ***Vertical Technology Collaboration*** | ***Technology Sourcing*** |
|---|---|---|---|
| such innovative products prior to their competitors, the firms will be able to perceive and understand a "first mover advantage" (Cohen and Levinthal 1990).<br>**4.** Laursen and Salter (2006, p. 146), suggest, "Firms which are more open to external sources or search channels are more likely to have higher level of innovative performance.<br>**5.** Openness to external sources allows firms to draw in ideas from outside to deepen the pool of technological opportunities available to them" (Parida et al 2012). | competitor in the same industry (Liebeskind et al. 1996).<br>**6.** SMEs would be able to benefit from exploring innovative development/expansion and commercializing opportunities with other small firms as they can cooperatively enter to new markets and considerably ameliorate their opportunities versus larger firms as their competitors (Christensen, Olesen, and Kjær 2005. Lee et al. 2010).<br>**7.** Bring "spillover effect" for SMEs as they are benefiting from the experiences and skills of their partners, which would cause to learning effects for future innovative developments (Argote and Ingram 2000).<br>**8.** SMEs expand essential network relationships, which is a positive influential factor on SMEs ability and capability to access more several differentiated information and resources (Burt 2004).<br>**9.** Firms, which cooperate with competitors usually, involve themselves in a form of inter-firm collaboration mechanism might | **3.** Vertical technology collaboration can enhance the ability and capability of a firm to innovate and build values because it receives more awareness of customer's requirements and expectations Dyer and Singh (1998).<br>**4.** Customers, which are getting involved in the initial step of innovation, can remarkably decrease risks in developing and improving the likelihood and possibilities of innovation success and achievements (Ragatz, Handfield, and Petersen 2002).<br>**5.** Customer collaboration in the innovation practices and processes could have a positive effect on ideation, product concept development, prototype testing, and market launch, which can cause to innovation success (Gruner and Homburg 2000).<br>**6.** Customer and user insights can help firms to produce customized and commercially reliable and profitable | innovation process because they can integrate almost available technologies from external sources and use it to focus on existing gaps in the market (Anokhin, Wincent, and Frishammar 2011, Chesbrough, Vanhaverbeke, and West 2006).<br>**4.** Technology sourcing and similar practices lead firms to be able to "preserve an open window on science and technology and to alert to changing opportunities and threats." Teece (1989, p. 38).<br>**5.** Technology sourcing can improve and enhance innovation performance because it allows SMEs to expand complex products through integration and incorporation of tested and approved |

| *Technology Scouting* | *Horizontal Technology Collaboration* | *Vertical Technology Collaboration* | *Technology Sourcing* |
|---|---|---|---|
| | seem to cause a firm to develop and expand special features and characteristics of firms that increase and enhance its effectiveness and efficiency through acquisition of complementary technology and knowledge (Wang et al, 2015).<br>**10.** Horizontal technology collaboration has a substantial and notable potential capability, which cause to higher-level performance and competitive advantage for firms (e.g., Belderbos et al, 2004, Fey and Birkinshaw, 2005, Laursen and Salter, 2006, Parida et al, 2012, Wang et al, 2015).<br>**11.** Horizontal technology collaboration has a positive effect on firm performance. More importantly, the preliminary challenges that high technology firms faced are rapidly changing technologies, shortened product life cycles, grown R&D costs, and rapid innovation.<br>**12.** Establishing innovation collaboration with competitors might bring positive effect on the | products. Firms may also co-develop products with some specific customers and users like what is used in the case of open source software development (Henkel 2006).<br>**7.** Firms can access to valuable and remarkable resources through great deal of interactions and communications with customers in open customer communities.<br>**8.** By communicating with customer groups, external knowledge sources and innovation activities related to information resources can be efficiently and effectively gained and integrated among organizational sections to build new developed products and services (Schweisfurth and Raasch, 2015, Von Hippel, 1994, Wang et al, 2015). | technologies (Atuahene-Gima 1992, Tao and Magnotta 2006). |

| Technology Scouting | Horizontal Technology Collaboration | Vertical Technology Collaboration | Technology Sourcing |
|---|---|---|---|
| | incremental perspectives of innovation performance (Belderbos, Carree, and Lokshin 2004).<br>**13.** Competitor firms meet similar technologies, customers, and markets, collaborations with competitors allow firms to not only acquire and create new technological value but to exploit and access to other knowledge resources (Quintana-García and Benavides-Velasco, 2004, Gnyawali and Park, 2011, Wu, 2012, Wang et al, 2015).<br>**14.** Innovative firms usually compete in the form of collaborations with competitors (Jorde and Teece, 1990). Cooperation among competitors in innovation activities result into the development and expansion of integrative technologies, also formation of new markets, the detection and exploration of new business opportunities, and enhanced profits and advantages from efforts of deploying and utilizing innovation activities (Wang et al, 2015). | | |

**Table 7- Concepts and Benefits of External Search Breadth and Depth in Inbound Open Innovation**

| ***External Search Breadth*** | ***External Search Depth*** |
|---|---|
| **1.** Breadth search practices of external resources measures the degree and level of openness in terms of the number of different external parties involved in the innovation process of firms. Studies have gained a number of various partners, such as suppliers, customers, research institutions and universities, and have completed from studying a comparatively small types of external partners to many different sources (Laursen and Salter 2006, Bahemia & Squire 2010).<br>**2.** There are several external channels to gather and collect knowledge sources; it might cause to access to innovation and producing capabilities that the firm does not retain (West & Bogers, 2014, Greco et al, 2016).<br>**3.** Firm search, explore existing knowledge and innovative ideas outside its organizational boundaries, and be able to use them to enhance internal R&D activities (Dahlander & Gann, 2010). Firms that are arranged for taking advantage and receive benefit of external sources of knowledge may become more successful in introducing innovations with various kinds or levels of radicalness (Chiang & Hung, 2010).<br>**4.** This is the number of different types of external partners involved in the innovation process of firms. Previous studies, showing the value creating effect of opening up the innovation process to different types of external parties, have focused mainly and significantly on the role of traditional players (suppliers, customers, competitors, consultants, research institutions, and universities) (Bahemia & Squire 2010).<br>**5.** They can access to extra and supplementary resources that they do not possess (Grimpe & Kaiser, 2010, Weigelt, 2009). Cause to leverage their problem solving capabilities (Duysters & Lokshin, 2011). Provide new methods and ways to current market (Greco et al, 2016). | **1.** Once a channel is found, the main firm might be able to benefit from exploiting profoundly from it, causing advantage of lower transaction costs and long-term relationships. Firms will be remarkably capable to establish effective relationships with its preferred and chosen external sources (Ferreras-Mendez, et al 2015, Greco et al, 2016).<br>**2.** External search depth, which measures how intensely, deeply and comprehensively the focal firm receives knowledge sources from various channels, is thus seem to have a positive effect on innovation performance.<br>**3.** Prior research showed a positive effect of search depth on the development and extension of radical innovations (Martini et al, 2012) and incremental innovations (Chiang & Hung, 2010, Greco et al, 2016).<br>**4.** Depth search strategy refers to the significance of the external partners and has been measured due to the extent that which of special source was exploited during the innovation process (Laursen and Salter 2006, Bahemia & Squire 2010). |

Those firms which are searching extensively and deeply among different external sources of knowledge at firm level have more tendency to be more innovative. Table 8 indicates that three prior studies have identified depth as a second dimension of inbound open innovation (Laursen and Salter, 2006, Oerlemans and Knoben, 2010, Leiponen and Helfat 2010). This aspect refers to the importance of the external partners and has been measured according to the extent that which specific source was utilized during the innovation process.

| Paper | Dimension of Openness | Supplier | Customer | Competitor | University | Public Research Institute | Private Research Institute | Consultant | Generally Available Sources | Units of Analysis | Dimensions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Becker and Dietz (2004) | R&D Cooperation | ✓ | ✓ | ✓ | ✓ | | | | | Firm | Breadth |
| Miotti and Sachwald (2003) | R&D Partnership | ✓ | ✓ | ✓ | ✓ | | | | | Firm | Breadth |
| Nieto and Santamaria (2007) | Collaboration | ✓ | ✓ | ✓ | ✓ | ✓ | | | | Firm | Breadth |
| Belderbos, Carree, Lokshin (2004) | R&D Cooperation | ✓ | ✓ | ✓ | ✓ | | | | | Firm | Breadth |
| Faems, Looy and Debackere (2005) | Collaboration | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | Firm | Breadth |
| Roper, Du, Lover (2008) | Knowledge Sourcing | ✓ | ✓ | ✓ | ✓ | | | ✓ | | Firm | Breadth |
| Techer and Tajar (2008) | Sources of Information | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | Firm | Breadth |
| Techer (2002) | Joint R&D | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | Firm | Breadth |
| Rothaermel and Deeds (2006) | Alliances | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | Firm | Breadth |
| Amara and Landry (2005) | Sources of Information | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Firm | Breadth |
| Laursen and Salter (2006) | Sources of Knowledge | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Firm | Breadth and Depth |
| Leiponen and Helfat (2010) | Sources of Knowledge | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Firm | Breadth and Depth |
| Oerlemans and Knoben (2010) | Interorganizational Relationships (IORs) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Firm | Breadth and Depth |

**Table 8- "Studies about the definitions and Dimensions of Openness" (Source: Bahemia, & Squire. 2010)**

### *1.1.2. Inbound Open Innovation*

In the ‘era’ of open innovation practices (Chesbrough, H.W, 2003b) the requirements of accessing to external ‘public’ knowledge has received a lot of importance and attentions (Lichtenthaler, 2008b). In this context, firms are considered as segment of an environment, which is specified by disseminated knowledge, and the innovation process is distributed across a number of players in the innovation system (Tether, 2002, Acha and Cusmano, 2005). It refers to the potentials and capabilities to handle and coordinate external knowledge outside the boundaries of the firm, which are confronting with the condition of resource shortages, and it includes interplay in specialized networks (Tidd et al, 2005, Ritter and Gemunden, 2003). Scholars such as Coombs et al., (2003), Howells et al, (2003) mention the surging and growing ‘distributedness’ of the innovation process, accompanied with the concept of progressively distributed character and context of production process as products and services are expanded and delivered by multiple contributing organizations. Central key to open innovation is the clarity of the firm's boundaries to take into account the available and existence of knowledge sources in external environment and external boundaries of firms (Chesbrough, 2003a. Huston and Sakkab, 2006), that has already been investigated by concerning about the breadth and depth of search paths (Laursen and Salter, 2004, 2006). Up to now, little attention is paid to the concept of absorptive capacity that is required to be expanded in firms in order to successfully involve in inbound open innovation activities. In the case of inbound open innovation ideas and knowledge sources on R&D results that exist in external environment of the firms, exploiting sources from suppliers, customers, and other external players which can be occurred through technology in-licensing, acquisition or joint development can increase the innovativeness of the firm (Spithoven, and et al, 2011). From the study of Chesbrough, (2003a) and Laursen and Salter, (2006), it can interpret that inbound open innovation is an important concept, which is critical to different kinds of positive results, consisting higher in-house R&D activities, innovativeness, and performance.

Apparently, researchers have considered inbound open innovation which most of the time regarded as a key stimulus of firms' innovation, as a reaction of the different types of knowledge sources, technologies, and ideas among external sources. Based on Ettlie, Bridges, and O'Keefe (1984), Laursen and Salter (2006), Sher and Yang (2005), and Parida et al, (2012), innovative performance may be varied and different which can be ranged from radical to incremental. Incremental and radical innovation are two types of innovation performance outcomes either of them has its own specific and peculiar contributions to firm's performance according to their specifications.

**Table 9- Comparison of Radical Innovation and Incremental Innovation and their Relatedness wit Inbound Open Innovation Practices**

| ***Radical Innovation*** | ***Incremental Innovation*** |
|---|---|
| **1.** Fundamental breaking development that needs specific resources to be provided. Even though radical innovation could enable current firms in particular small and medium sized ones to build a prevailing position in a market niche and provide opportunity for new firms to obtain a superior position in the market, it can also cause firms to encounter an increased level of risk. | **1.** Incremental innovation is development and improvement of products and services that cannot be categorized in the first group. It can be ranged from expansion of new products that are applied and used in the market to slight improvements in available products and services (Atuahene-Gima 2005, Laursen and Salter 2006). |
| **2.** According to what Miotti and Sachwald (2003) suggest, it indicates that collaboration with academic institutions improves and enhances the ability and potential of firms to carry out radical development because of access to new modern technologies. Opening the innovation process to inputs from research institutions would enable firms to manage and carry out research at the technological frontiers and expand patents for new product development projects. | **2.** The desire of incremental innovation is to exploit the intuition from customers or other sources to provide better solutions that are attractive and absorbing and would be suitable method of adding to the profits and advantages from the available products (Pavitt 1998, Xin, Yeung, and Cheng 2008).<br>**3.** According to Faems, Van Looy, and Debackere (2005), it infers that collaboration with partners from the value chain (Customers and Suppliers) prepare a powerful and potent basis for incremental development of available products and services. |

**Table 10- How Do Different Types of Inbound Open Innovation Sources Affect Different Types of Firm's Performance?**

| *Laboratories' External Collaborations and R&D Performance* | *Accessing to External Knowledge and Firm Innovativeness* | *Research Collaboration/R&D Outsourcing and Firm Overall Performance* |
|---|---|---|
| **1.** High R&D and innovative performance can be achieved by external collaboration with different knowledge sources. External collaborations are considered effective for attaining and accomplishing great R&D performance.<br><br>**2.** Any partnership agreements and cooperation between firms and universities or research institutions are crucial and vital for increasing R&D performances. It helps firms to leverage their academic competence, which can contribute them in enhancing innovativeness level of new products in such fields as designing products, adding new features, new packaging, and or branding for new developed products. Collaborative activities with universities are important issues for obtaining high level of academic performance, as they extend social capitals that permit and facilitate the way to share the core and major knowledge necessary for acquiring R&D and innovation performance (Granovetter, 1985, Nahapiet and Ghoshal, 1998, McEvily and Zaheer, 1999).<br><br>**3.** It is far reaching to acquire new, novel and the most advanced technological knowledge from key consultants, inventors, scientists or researchers | **1.** Using external knowledge as inward open innovation sources facilitates the progress of firms in boosting overall performance in particular it can provide them to access to rapid product development and innovativeness. It is feasible for them to be succeeded in their product innovation or product development projects by obtaining new knowledge sources and utilize it in their organizational processes and innovation practices.<br><br>**2.** External knowledge through open innovation is massively progressesd and realized as a critical and important source of the firm's innovativeness (Duysters & Lokshin, 2011).<br><br>**3.** Open innovation is largely assigned to explore and investigate how these strategies affect a firm's innovation performance both in economic aspect like turnover and revenue share from innovative products and industrial terms such as development of innovation. Most scholars assumed and indicated | **1.** Research collaboration or R&D and academic partnership with universities and research institutions can diminish cost in terms of innovation activities inside firms and can increase their innovation performance. In addition, R&D outsourcing improves the internal capabilities of firms to overcome innovation barriers and can decrease the risk of new product innovation and new product development. Research collaboration enables the utilization of economies of scale and scope in R&D, thereby decreasing innovation costs and allowing the possibility of sharing risks (Roller et al. 1997).<br><br>**2.** Research collaboration is expected to enhance and improve the learning efficiency in absorbing external knowledge that promotes knowledge spillovers and the effect on innovative performance of arriving spillovers (Arrow, 1962, Romer, 1990).<br><br>**3.** According to Hagedoorn (1993), it is derived that research collaborations |

| *Laboratories' External Collaborations and R&D Performance* | *Accessing to External Knowledge and Firm Innovativeness* | *Research Collaboration/R&D Outsourcing and Firm Overall Performance* |
|---|---|---|
| without any collaborative practices and partnerships between firms and academic organizations. Without the external collaboration of highly competent and qualified knowledgeable key scientists, advanced and state of the art knowledge cannot be acquired (Zucker and Darby, 1997). | that open innovation strategies have a positive effect on innovation performance. | might facilitate the possibility of access to knowledge sources that are not considered as spill over and cannot simply be made by agreements through market transactions. |
| **4.** Collaborations with local business organizations such as suppliers and venture firms can help to the laboratory's development performance in different ways. Collaborations with suppliers can facilitate the development process. Dyer and Singh (1998) found the benefit and advantages of supplier's interactions and relations for the purpose of product development. | **4.** The more a firm collaborate and communicate with other organizations, the greater will be its options to access to external knowledge sources, ideas, competences, technologies and other intangible assets so that it will lead to increase the chance to innovate successfully. Interactions and cooperation with external sources of knowledge would raise the interchange of tacit and explicit knowledge (Faems, Janssens, & van Looy, 2007. Mowery, Oxley, & Silverman, 1996) may decrease technology market incompetence (Lichtenthaler, 2013) and some risks and expenses of technological practices (Belderbos, Faems, Leten, & Van Looy, 2010). | **4.** As technology turbulence is high and product life cycles have been lessen, firms confronting increasing cost of production which hinders them for rapid responding to the requirements of the market by supplying and introducing new innovative products. Firms inevitably outsourcing R&D knowledge and research outputs from the external environment in order to reduce the cost and risks of development projects and obtain specializations that cannot find and afford them inside their organizational boundaries. |
| **5.** The advantages of suppliers involvement in external collaboration process being done by laboratories comprise obtaining competencies, capabilities, sharing risks, and launching products more quickly (Wynstra and Weggemann, 2001). | | **5.** The short time product life cycle as the result of the growth of technology complication, and growth of technology development costs, firms have progressively sourced technology and innovative knowledge from outside their organizational boundaries in order to lessen development time and costs, |

| *Laboratories' External Collaborations and R&D Performance* | *Accessing to External Knowledge and Firm Innovativeness* | *Research Collaboration/R&D Outsourcing and Firm Overall Performance* |
|---|---|---|
| | | share risks, and access to specializations and expertise that are not existed internally (e.g., Calantone and Stanko, 2007). |

### *2.1.2. The Relationship between Absorptive Capacity and Inbound Open Innovation*

Small and medium sized enterprises (SMEs) are more exposed to vulnerability to globalizations and quick technological changes because of their shortage of resources. SMEs' absorptive capacity permits them to access knowledge sources and plays a pivotal role in their capability to search and utilize opportunities in their environment. Cohen and Levinthal (1990, p. 128) argue that *'the ability to evaluate and utilize outside knowledge is largely a function of prior knowledge'*. It means that prior existing knowledge grants an ability or capability to recognize and realize the value of new information, assimilate it, and apply or exploit it to commercial outputs. Theses abilities and capabilities jointly establish what is called *absorptive capacity*. Cohen and Levinthal (1990) remark the increasing accumulative nature and context of absorptive capacity and the insight that the firm requires antecedent and prior relevant knowledge sources to use new and novel knowledge (Valentim et al, 2016). Absorptive capacity is considered as an organizational capability and ability, which reflects firms' openness and receptivity to technological change (Kedia and Bhagat 1988), and the ability of a firm to effectively and efficiently utilize external knowledge (Fabrizio 2009, Koza and Lewin 1998). Firms' decision making to involve in either exploratory or exploitative relationships will depend on both of these internal capabilities (Levinthal and March 1981) and their innovation objectives (Cyert and March 1963. March 1988). In large number of high technology industries, exploratory relationships are extensively perceived (George et al. 2001), and are considered as crucial and vital role in innovation process (Dowling and Helm 2006, Gilsing and Nooteboom 2006). One of the most broadly stimuli for this collaboration is the acquisition and attainment of new technical skills and knowledge or technological capabilities from partner firms (Hamel 1991, Powell and Brantley 1992, Shan 1990).

Exploratory relations may include connections to universities or academic and research institutions (Kitson et al. 2009, Streiffer 2006), small startups (Maurer and Ebers 2006, Whitehead 2003), or the licensing-in or buying of research services by contracting with research organizations (Miller 2004). The value of exploratory relations might be dependent on firms' potential absorptive capacity. This is considerably because of the effectiveness degree of those knowledge sources, which attained and acquired through a firms' exploratory relationship that also can be internalized and it is relying on its capability to evaluate or assess and assimilate these knowledge (Xia and Roper 2008, Zahra and George 2002, Xia & Roper. 2016).

In addition to performing main processes to allow incorporation and integration of external knowledge, to use external ideas inside innovation processes, the enterprise requires some ability and capability to apply and use the open innovation activities more remarkably and effectively. For each of the main innovation processes, various types of capability and ability are needed. The absorptive capacity should be tied with relational capability as a complementary notion. Technological knowledge creation and implementation process are increasingly becoming state of the art, broad and highly costly. Moreover, the “ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends is critical to its innovative capabilities” (Cohen, Levinthal 1990), as many organizations face with the absence of ability or capability to pay attention to their external environment and process the received signals and symptoms efficiently and progressively. The advantage and efficiency of both knowledge creation and application is based on the notion of "absorptive capacity" (Gassmann and Enkel. 2004).

The impressive and efficient incorporation of the received and acquired knowledge into corporate value adds new processes due to Cohen and Levinthal's (1990) "absorptive capacity" concept, a procedural capability that was created on an accumulated stock of previous knowledge to facilitate and strengthen the effective and potent absorption of externally attained knowledge. The existence of absorptive capacity inside the firm allows firm to use and exploit external knowledge and innovation sources as complementary factors to their internal activities regarding innovation and development inside the firm's boundaries, also enable firms to acquire more capability and capacity to leverage innovation performance and increase the effectiveness of research and development practices. When there is absorptive capacity in an organization, external research activities of knowledge sources can be a supportive and complementary function of internal research practices, gaining high level of synergies and increasing the best outcomes based on innovation approach (Arora and Gambardella, 1990, Macpherson, 1997). Such synergies ensure that internal R&D are not being declined or become outdated as the openness approach may motivate new suitability advantages for internal R&D activities (Howells, 1999, Veugelers, 1997).

The internal R&D may be considered as a crucial factor for the development of a firms' absorptive capacity, increasing the total condition of knowledge based skills and expertise within the central firm (Cohen and Levinthal, 1989. Lane et al, 2006). According to De Sanctis et al, (2002) and Tsai, (2001), the positive influence of absorptive capacity on innovation activities has been done and investigated in many empirical researches to support the importance of such theory. Based on Huang and Rice, (2009) also Hendry et al, (2007) SMEs' deficiencies in absorptive capacity is a key barrier to their innovation and growth.

Cohen and Levinthal (1989) define absorptive capacity as the ability and capability to learn from external knowledge sources through process of knowledge identification, assimilation and exploitation. According to previous studies such as Allen (1984), they believe that absorptive capacity is a by-product of organizations' R&D practices. Cohen and Levinthal (1990) had addressed to redefine the absorptive capacity as the capacity and capability of a firm to value, assimilate and apply for commercializing the end outputs, by using knowledge from external sources. There are two aspects of absorptive capacity, the first one is related to the evaluation, acquisition/attainment and assimilation of external knowledge, and the second one is related to its internal dissemination and application. Zahra and George (2002) proposed and make a link between absorptive capacity and a set of organizational routines and strategic processes that firms can acquire, assimilate, transform, and utilize knowledge with the purpose of building dynamic organizational capability. In addition, Zahra and George (2002) propose two components of absorptive capacity as the following table.

**Table 11- Two Important Components of Absorptive Capacity**

| ***Potential Absorptive Capacity*** | ***Realized Absorptive Capacity*** |
|---|---|
| **1.** Potential Absorptive Capacity includes the features of knowledge acquisitions and attainment both the capacity to value knowledge as Cohen and Levinthal (1990) introduce and the capacity to obtain knowledge and ability of assimilation.<br>**2.** Demonstrate knowledge attainment and assimilation capabilities and abilities; obtain a firm's endeavor used in valuing, acquiring and assimilating new external knowledge.<br>**3.** It includes acquisition and assimilation process of absorptive capacity.<br>**4.** Potential absorptive capacity affects competitive advantage through management flexibility and development and expansion of resources and capacities. | **1.** Realized Absorptive Capacity comprises of knowledge transformation and application.<br>**2.** It is shown in knowledge transformation and application that firm's own ability and capability to incorporate and reconfigure the current internal knowledge and existing assimilated knowledge in order to be integrated and complemented this transformed knowledge into firm's internal systems, processes, routines and operational procedures is not only based on refining existing knowledge sources and competences, but also to generate new operations, capabilities and competences (Camisón & Forés. 2010).<br>**3.** Demonstrates firms' accumulated stock of codified knowledge realized and symbolized in patents or prototype products and is based on integrating existing knowledge with recently achieved and assimilated knowledge from external partners. (Xia, T, and Roper, S. 2016). This component includes transformation and application process of absorptive capacity.<br>**4.** Realized absorptive capacity affects competitive advantage through the development of new products and processes. |

Referring to Zahra and George (2002), these two parts of absorptive capacity perform distinctively but as complementary roles. Firms cannot apply and utilize external knowledge without obtaining it. Likewise, some firms may expand and develop capabilities to obtain and assimilate external knowledge, but are not able to transform and apply the knowledge in order to turn it into competitive advantage. Therefore, both subsections of absorptive capacity fulfill an essential but as an inadequate condition to create value for the firms. Lane et al.

(2006) define the construct of absorptive capacity as a firm's capability and ability to exploit knowledge from the external environment through three consecutive processes:

(1) the perceiving and recognizing of new potential valuable external knowledge through exploratory learning, (2) the assimilation of valuable new acquired knowledge through transformative learning and (3) the exploiting of assimilated knowledge to generate new knowledge and commercial outputs through exploitative learning. As it has been studied in different researches related to absorptive capacity, this kind of absorptive capacity definition oriented to learning process, represents three core perception of Cohen and Levinthal's (1989, 1990), as classic aspects. Nonetheless, Lane et al. (2006) state the transformation capacity by considering this notion that external knowledge is assimilated through transformative knowledge, by synthesizing it with current knowledge. However, Todorova and Durisin (2007) address that knowledge assimilation and knowledge transformation capacities and dimensions are two distinctive consecutive processes. These authors argued that transformation capacity and dimensions is not the process that pursue assimilation, but relatively an alternative and substituting process, hence, define absorptive capacity as a firm's ability and capability to value, acquire, assimilate or transform, and utilize external knowledge. Based on the study of Todorova and Durisin (2007) and Xia, T, and Roper, S. (2016), when external knowledge aligns with the firm's cognitive layouts, assimilation of knowledge occurs so that results to utilizing it straightforward. In contrast, when the external knowledge sources or innovative ideas do not fit with existing internal knowledge framework, the knowledge sources or innovative ideas are being transformed.

Most research using the Cohen–Levinthal notion has assumed that higher internal absorptive capacity contributes firms to invest on external sources of knowledge and innovations. These hypotheses resulted to two classifications: firms with high level of absorptive capacity will be more likely to exploit innovations from external sources, or that firms will be more successful in using of them. Scholars like De Jong and Freel, (2010), have found that absorptive capacity creates remote collaboration more effective and efficient, and from Laursen et al, (2010) it is perceived that firms with more extensive knowledge base are more able to source "distant" technologies as external sourcing of technology. The outcomes of absorptive capacity on performance are stable. Absorptive capacity boosts the benefits and advantages of external sourcing of innovative knowledge sources on both innovativeness and financial performance (Rothaermel and Alexandre, 2009). It can accelerate the assimilation of external knowledge sourcing and commercialization of that knowledge (Fabrizio, 2009) and provides more benefits and advantages for firms looking for knowledge from customers rather than form competitors (Grimpe and Sofka, 2009, West & Bogers, 2014).

According to Leonard-Barton (1995) and Nonaka and Takeuchi (1995), the formation of knowledge is substantial, but the conversion of this knowledge into new products is the basis and fundamentals of higher performance. In this respect, both external learning capability (absorptive capacity) and internal learning capability (internal knowledge creation capacity) affect innovation capacity, which in the last phase is what causes the innovative performance. Camisón and Forés (2010) as the following table explain dimensions of absorptive capacity:

**Table 12 Dimensions of Absorptive Capacity**

| *Dimensions* | *Definitions* | *Antecedents* |
|---|---|---|
| **Acquisition** | ➢ A Capacity and firm's ability to place and posit, recognize, valuing and attain external knowledge, which is crucial and vital to its operations and processes. | Lane and Lubatkin (1998), Zahra and George (2002), Liao et al. (2003) |
| **Assimilation** | ➢ A capacity and capability, which implies to firms capacity to acquire and attract external knowledge. This capacity is the process and routines, which permits the new information and knowledge obtained from outside being examined, analyzed, processed, translated, perceived, internalized and categorized. | Szulanski (1996), Zahra and George (2002). |
| **Transformation** | ➢ A capacity of firm to develop, expand and purify the process and internal procedures, which simplify the transmissions and integration of antecedent knowledge with the current new obtained or absorbed knowledge. Transformation might be attained by excessing or removing knowledge, or by translating and completing existing knowledge in a various innovative and creative method. | Kogut and Zander (1992), Van den Bosch et al. (1999) |
| **Application** | ➢ It refers to exploitation and utilization capacity which is related to organizational capacity and capability basis according to routines and procedures, which enable firms to integrate obtained and absorbed transformed knowledge into their routine works. It not only purifies, completes, develops and boosts recent existing routines, procedures, competences and knowledge, but also tries to make new organizational practices, competences, processes, procedures, goods and services. | Lane and Lubatkin (1998), Zahra and George (2002) |

It is crucial that firm's R&D departments and special innovation laboratories to absorb external knowledge resources or ideas and try to integrate and combine them with internal knowledge and innovation practices. Case studies on open innovation practices in large firms emphasize that corporate R&D laboratories are prominent and crucial tools for absorbing external ideas and mechanisms to incorporate and combine external knowledge into internal innovation process (Chesbrough et al, 2006). Small and medium sized firms require developing and boosting their absorptive capacity in case of using external knowledge resources and innovative ideas when they intend to be involved in inbound open innovation process. In inbound open innovation, firms require developing and improving its absorptive capacity, which define a firm's ability and capability to absorb external knowledge (Caloghirou et al, 2004, Cohen and Levinthal, 1990, Lenox and King, 2004, Todorova and Durisin, 2007, Zahra and George, 2002). Furthermore, as Cohen & Levinthal (1990) already mentioned that organizational practices within the firm's boundaries are also important antecedents to the successful and effective absorption of external ideas.

**Table 13- The General Characteristics of Absorptive Capacity in SMEs**

1. Absorptive capacity plays an important role in organizational innovation and performance, regardless of firms' size and level of resources.
2. According to Lane et al. (2006), firms can only invest in developing and expanding absorptive capacity in limited areas of science and technology, due to their intuitive and resource constraints, which is aligned with the peculiarities of small and medium sized enterprises.
3. SMEs should possess dynamic learning capacity, which permits them to combine, transform and apply new knowledge in their business processes, and in this way improve their performance (Jones and Macpherson, 2006).
4. The absorptive capacity of knowledge based SMEs, which depends on relationships and structure, permits access and disseminate of relevant knowledge and plays a determining role in their capacity and capability to utilize opportunities (Meeus et al, 2001).
5. SMEs enhance their capacity and capability to exploit and transform knowledge as they attain much external knowledge (Thérin, 2007).
6. SMEs' capacity and capability increases if the capabilities of knowledge acquisition and attainment are accompanied and supported by a proactive and dynamic strategy, and in a turbulent environment, they possess capabilities of acquisitions and internal dissemination of knowledge (Liao et al, 2003).
7. According to the effects of absorptive capacity in collaboration between SMEs, R&D endeavors as determinant factors of the

firm's capability and capacity to access to new knowledge sources require to be revised and reviewed (Muscio 2007).

**8.** There are practices and activities related to innovation management literature that replace and exchange or complete R&D practices respectively, those activities related to organizational capacities and capabilities, such as network capabilities and capacities, which implies to seeking external sources of innovation and collaboration to gain and acquire external knowledge. These acquired knowledge help in sharing the costs and risks of innovation practices in organizational process (Rammer et al 2009, Valentim et al. 2016).

**9.** Traditional industries that formed by the existing activity of SMEs only demonstrate a constrained R&D intensity (European Communities, 2006) and innovation capacity (von Tunzelmann and Acha, 2004).

**10.** According to the SMEs' limited internal absorptive capacity, it may lead to this fact that firms in traditional industries or SMEs might be engaged in a criticizing situation, so that cause these firms with much greater level of absorptive capacity could manage and handle external knowledge flows more effectively and efficiently. It can lead to motivate and stimulate innovation results and gain competitive advantage (Escribano et al, 2009). Hence, it expected that these firms would try to open up their boundaries and start their innovative practices with third parties and external partners to help them establish and create absorptive capacity (Spithoven et al. 2011).

**Table 14- Resource Based View and Dynamic Capabilities Related to Inbound Open Innovation Process of SMEs**

| ***Resource Based View*** | ***Dynamic Capabilities*** |
|---|---|
| **1.** The resource-based view of firms is important because it explains how competitive advantage of firms can be attained and how this competitive advantage can be sustained during long time. The resource-based view of the firm is an effective and impactful theoretical concept for understanding how competitive advantage within firms is obtained and how that advantage may be remained as a sustainable advantage during time (Barney, 1991, Nelson, 1991, Peteraf, 1993, Prahalad and Hamel, 1990, Teece, Pisano, and Shuen, 1997, Wernerfelt, 1984, Eisenhardt and Martin. 2000).<br>**2.** Resource based view hypothesized that firms can be categorized as bunches of resources that such resources are distributed across firms as an inharmonious and varied formats, and that resource varieties are persistent over time (Amit and Schoemaker, 1993, Mahoney and Pandian, 1992, Wernerfelt, 1984, Eisenhardt & Martin. 2000).<br>**3.** When firms possess resources, which are worthy and valuable, rare, unique, and not feasible to be substituted and changed, they can obtain sustainable competitive advantage by performing novel values making strategies that cannot be simply repeated by competitor firms (Barney, 1991, Conner and Prahalad, 1996, Nelson, 1991, Peteraf, 1993, Eisenhardt & Martin. 2000).<br>**4.** If there are resources for firms that are strong, worthy, peculiar, valuable and possess an advantage that cannot be changed with any other resources or is not in such position to be imitated by competitors, it means that firms has a competitive advantage according to resource based theory.<br>**5.** Firms might benefit from outsourcing if it enables them to enrich its knowledge stock, exploit specialized resources, and fill the gaps in their technology portfolios and resources (Womack, Jones, and Roos, 1990. Powell et al, 1996, Mitchell and Singh, 1996, Steensma and | **1.** Dynamic capabilities comprise particular strategic and organizational processes like product development, alliances, or strategic decision making which make value for firms within dynamic markets by changing and controlling resources into new value generating strategies (Eisenhardt and Martin, 2000).<br>**2.** The relationship between resource based view and dynamic markets is that resource based view has not sufficiently described and addressed how and why some definite firms have competitive advantage in situations of fast and unforeseen changes (Teece et al, 1997, Eisenhardt and Martin, 2000).<br>**3.** In these markets, where the competitive stance is changing and moving, the dynamic capabilities by which firm executives and managers 'integrate, build, and reconfigure internal and external competencies to address rapidly changing environments' (Teece et al, 1997: 516) become the sources of sustained competitive advantage.<br>**4.** According to Ansen, (1999), Hargadon and Sutton, (1997), Szulanski, (1996), it can infer that dynamic capabilities can concentrate on reorganizing of resources inside the firms. Transfer processes consisting routines and procedures for repetition, duplication and organizing, which are used by managers of firms to copy, transfer and incorporate resources again, in particular knowledge based ones inside the firms (Eisenhardt & Martin, 2000). Dynamic capabilities display the ability and capability that firm should integrate, incorporate and harmonize external resources to attain and internalize new knowledge from other organizations within new processes (Wu, 2007). Dynamic capabilities show an organization's ability and capability to obtain new and innovative formats of competitive advantage (Leonard-Barton, 1992, Teece et al, 1997).<br>**5.** Getting involved in collaboration with external partners who own |

| *Resource Based View* | *Dynamic Capabilities* |
| --- | --- |
| Corley, 2000), which can enhance and boost performance by developing product variety and speed up them to market (Brown and Eisenhardt, 1997) or by reducing production costs (Poppo and Zenger, 1998). Technology outsourcing is a method, which provides firms with opportunities to strengthen and develop their capability and capacity basis and performance in the market more than those practices, which can be fulfilled through internal endeavors solely (Weigelt, 2009).<br>**6.** The attainment and acquisition of external R&D could help firms to get resources, which are not available internally (Weigelt, 2009).<br>**7.** External R&D plays an important role as a tool to acquire and attain knowledge resources that might consequently be reutilized with existing resources in a method which is much higher and preferable to competitor's utilization such external R&D resources (Barthelemy and Quelin, 2006, Desarbo, Benedetto, Song, and Sinha, 2005, Ebers and Maurer, 2014). Acquisition and attainment of external R&D and the way new products are developed (Koufteros et al, 2005. Petersen, Handfield, and Ragatz, 2003, 2005), make an argument that resource based view improves and enhances an organization's ability to innovate (Ebers and Maurer, 2014).<br>**8.** The resource based view (RBV) and its sub-item theories such as knowledge based view (KBV), argues that firms make collaboration networks with external partners in order to have access and to be benefited from their new technologies, skills, knowledge and expertise (Ahuja, 2000, Huggins and Thompson, 2015, Lavie, 2006, Meroño-Cerdan et al, 2008, Popa et al., 2016). | knowledge to share, permits organizations to find opportunities for improving and enhancing what they operate, which helps them to focus and emphasize special problems. Therefore, it becomes a difficulty and barrier for other firms to imitate and copy capability (Koufteros, Vonderembse, and Jayaram, 2005, Mishra and Shah, 2009). |

Based on previous studies by Barney, (1991) and Teece et al, (1997), contributions which arisen from the *Resource Based View* and the *Dynamic Capabilities* formats emphasize the necessity of acquiring and obtaining external information to supplement and complete current existing resources and capabilities, so that enabling the firm to increase its innovative skills.

Acquired and attained R&D from external sources helps to improve and enhance dimensions of the product and process of firms, which the focal and main organization is not able to change. Acquisition and attainment of external R&D sources could increase and boost the number of development and improvement ideas that be followed. Thus, collaboration with external partners can serve an organization access to valuable and considerable knowledge and ideas, and support its learning function. This is very important concept and much of the literature on innovation management has long discussed for the advantages of this approach, for instance, direct relationship between higher levels of collaboration and higher levels of innovation (Tsinopoulos et al, 2018).

**Table 15- Innovation Capability Driven Strengths and Challenges of SMEs**

| ***Strengths of SMEs*** | ***Challenges of SMEs*** |
|---|---|
| **1.** Small and medium sized enterprises (SMEs) that show a strong effect on the economies of many countries all over the world through their ability and capability to innovate new products and processes, have been considered as the engine of economic growth and technological progress (Bruque and Moyano, 2007). Based on the study of O'Regan et al, (2006) and Zeng et al. (2010), The continuing process of globalization highlights and remarks the significance of innovation in all SMEs<br>**2.** SMEs deals with and make partnership with increasing number of players and parties in innovation ecosystems with their market maturity and development (Laursen and Salter, 2006, Hossain, 2013).<br>**3.** It is accepted that SMEs' flexibility and characteristics can be beneficial and advantageous in accelerating innovation process (Edwards et al, 2005. Lee et al, 2010).<br>**4.** SMEs activities are less bureaucratic; they are more flexible in decision-making, they intend to take greater risks, and usually own specialized and expertise knowledge only in a particular niche | **1.** SMEs also varied in their activities and most SMEs do not own capacity and capability for systematic R&D activities (Hossain, 2013).<br>**2.** SMEs face the absence and insufficiencies of resources, capability and IP protection. They need to collaborate closely with other large and small firms (Hossain, 2013).<br>**3.** SMEs confront much complicated challenges for innovation and commercialization of their technology (Hossain, 2013).<br>**4.** Innovation activities for SMEs are becoming more complicated (Diez, 2000, Zeng et al. 2010).<br>**5.** Most of the SMEs' weaknesses in innovation emerge from their size (Freel, 2000, Narula, 2004, Teece, 1986, Ahn et al. 2015).<br>**6.** SMEs with less level of intensive R&D capacity and capability may not be able to use external knowledge sources efficiently and effectively (Rosenberg and Steinmueller, 1988, Zeng et al. 2010).<br>**7.** Few SMEs have adequate and sufficient capacity and capability to manage the whole innovation process independently, and this can motivate and persuade them to collaborate with other firms (Edwards et |

| Strengths of SMEs | Challenges of SMEs |
|---|---|
| (Christensen et al, 2005). | al, 2005. Lee et al. 2010).<br>**8.** SMEs lack and face the shortage of resources and capabilities in manufacturing, distribution, marketing and extended R&D funding, which are essential and considerable for transforming inventions into products or processes (Lee et al. 2010).<br>**9.** Regarding to obstacles and impediments existed, it is not a simple action for SMEs to accomplish economies of size and scope, they might not transfer their technologies among product lines to design and produce new products (Teece, 1980, 1982, Ahn et al. 2015). |

**Table 16-The Stance of Open Innovation and its Adoption in New Product Development by SMEs**

| The Stance of Open Innovation in SMEs | Adoption of Open Innovation in New Product Development by SMEs |
|---|---|
| **1.** SMEs will play a more remarkable role in the era and age of ‘‘open innovation’’. Some studies from developing countries stressed, innovation cooperation or interaction has become much more important for SMEs in emerging economies and developing countries to improve and enhance their innovation capabilities and abilities (Liefner et al, 2006, Biggs and Shah, 2006, Kaminski et al, 2008, Zeng et al, 2010). Open innovation in SMEs deals with the innovating capabilities and capacities of these firms resulted from interaction and collaborations with other firms (Chesbrough, 2003, Greco. 2016).<br>**2.** Open innovation literature in SMEs has been considered in limited attempts and therefore appropriate studies on open innovation in SMEs are not very much in academia (Vanhaverbeke, 2012). Studies on open innovation specifically concentrate on large and technology oriented firms (Chesbrough, 2003a, Hossain, 2013).<br>**3.** There are many issues remained unexplored and little studies focused on them. Although, large firms possess the larger part of R&D expenditure of | **1.** As SMEs cannot capitalize and invest large financial resources in internal R&D, then they try to establish an innovation system portfolio and use it to receive the most benefits and advantages (Alstrups, 2000). According to this careful, strong and centralized innovation involvement for SMEs, open innovation activities can help increasingly to new product development in SMEs than in large firms (Spithoven et al., 2013, Ahn et al. 2015).<br>**2.** New product development (NPD) performance cannot be exclusively and merely determined by internal R&D practices, but also relies on the contributions of a widespread range of external partners, from individual customers to large research institutions (Bahemia & Squire 2010).<br>**3.** The majority of studies on open innovation in the academic area have shown the value effects, which are creating by integration and combination of a wide and large span of external partners, |

| *The Stance of Open Innovation in SMEs* | *Adoption of Open Innovation in New Product Development by SMEs* |
| --- | --- |
| a country, the share of SMEs in R&D expenditure is increasing rapidly. The main concern is how to exploit the internal R&D capabilities of SMEs to maximize through open innovation (West and Gallagher, 2006). Therefore, further studies considering several significant aspects of open innovation in SMEs that are crucial (Hossain, 2013).<br>**4.** Despite the relevant lack of studies covering open innovation in SMEs (Ahn et al, 2013, Brunswicker and van de Vrande, 2014, Lee et al, 2010, Parida et al, 2012, Spithoven et al, 2013, Van de Vrande et al, 2009), a few remarkable of these studies found different motives and stimulators for an impediments to open innovation in SMEs (Ahn et al. 2015).<br>**5.** Small and medium firms can accept open innovation in order to respond actively to market changes, to meet customer demands and or develop and expand new sale channels (Lee et al, 2010, Van de Vrande et al, 2009). To solve the problem of inadequate and insufficient R&D expertise, SMEs can try to explore and investigate a broad range of external knowledge and information sources (Lee et al, 2010) or to utilize companies' specialization by formulating alliances to access complementary assets (Ahern, 1993, Nooteboom, 1994, Teece et al, 1997, Van Dijk et al, 1997, Ahn et al, 2015).<br>**6.** Although, large firms are more broadly included in various open innovation activities, SMEs are involved in a few open innovation practices (Ahn et al. 2015). | including suppliers, customers, competitors, consultants, research institutions, and universities, in the innovation process (Faems et al, 2005, Love and Roper, 1999, Tether and Tajar, 2008, Bahemia & Squire 2010).<br>**4.** The central root of inter firm R&D collaborations can be observed in studies examining and investigating the incorporation and mixture of different external partners, including suppliers (Hakansson and Eriksson, 1993, Petersen et al, 2003, Ragatz et al, 2002, Handfield and Lawson, 2007), customers (Hippel, 1978, Cooper and Kleinschmidt, 1987, Atuahene-Gima, 1995), competitors (Hamel, 1991), and universities (Gerwin et al, 1992, Santoro, 2000) into the innovation process (Bahemia & Squire 2010). |

According to Dahlander and Gann, (2010), Inbound open innovation is divided and categorized into sourcing and acquiring types. The specifications of these two types of inbound open innovation are as following:

**Table 17- Comparison of two Types of Inbound Open Innovation Specifications**

| | Inbound Open Innovation Sourcing | Inbound Open Innovation Acquiring |
|---|---|---|
| **Logic of Interchange** | ➢ Non-Monetary—indirect benefits | ➢ Monetary- Money included in transactions |
| **Central Concentration** | ➢ Exploiting external innovative ideas and knowledge sources from suppliers, customers, competitors, consultants, universities and research institutions (Lakhani et al, 2006, Laursen and Salter, 2006a).<br>➢ Using external knowledge and innovative ideas from different knowledge and technological sources.<br>➢ Obtaining and bringing new knowledge into the firm from outside without any financial and monetary transaction. Ideation which is making new ideas including other sources, conference participations, crowdsourcing, competitors, university and research institutions, which would be organized and specified as resources of interchanges and proceedings (Cranefield & Yoong, 2007, Ebner, Leimeister, & Krcmar, 2009, Piller & Walcher, 2006, Stieger, Matzler, Chatterjee, & Ladstaetter-Fussenegger, 2012, Öberg. 2016). | ➢ Attaining inventions and inputs to the innovative and creative processes through informal and formal relationships (e.g. Chesbrough and Crowther, 2006, Christensen et al, 2005).<br>➢ Buying and acquiring intellectual property, knowledge, innovative ideas and skills such as licensing-in practices, and acquisition of whole firms (Cranefield & Yoong, 2007, Ebner, Leimeister, & Krcmar, 2009, Piller & Walcher, 2006, Stieger, Matzler, Chatterjee, & Ladstaetter-Fussenegger, 2012, Öberg, 2016). |
| **Advantages Causing Openness** | ➢ Approaching and availability of an extensive knowledge and innovative resources (Laursen and Salter, 2006a).<br>➢ Exploring radical and state of the art novel solutions to solving issues and problems (Lakhani et al, 2006). | ➢ Possibility of obtaining access to resources and knowledge of external partners (Powell et al, 1996).<br>➢ Enhancing being supplement with partners (Dyer and Singh, 1998). |
| **Disadvantages Causing Closeness** | ➢ Large numbers of resources build a complicated problem of choosing from too many alternatives and integrating them to solve the problems (Laursen and Salter, 2006a, Sapienza et al., 2004). | ➢ Existence of barriers to sustain so many relationships with various partners (Ahuja, 2000).<br>➢ Existence the risk of outsourcing for firm's business. |

### *3.1.2. The Effect of Inbound Open Innovation on Innovation Performance in SMEs*

Open innovation literature addresses the importance of utilizing external knowledge for successful innovation, which has been already noted by many researchers (Leonard-barton, 1995, Keil, 2002). Research has concentrated on the scope of exploiting external knowledge sources to clarify firm's technology innovation performance (Levinthal and March, 1993, Katila and Ahuja, 2002, Laursen and Salter, 2006) or the relationship between specific knowledge sourcing strategy and technology innovation performance (Brockhoff, 1992, Goerzen, 2007). There are different strategies of external knowledge sourcing such as information transfer from informal and unofficial network partnership (Laursen and Salter, 2006), R&D collaborations (Pisano, 1990, Brockhoff, 1992, Shan et al, 1994). In addition, technology acquisition (Granstrand, 1982, Granstrand and Sjölander, 1990) and large number of firms sourcing external knowledge by concurrent exploitation of various external knowledge and innovative idea methods from different sources. Nonetheless, prior studies investigated the effect of external knowledge sources on technology innovation performance without considering various effects of different external knowledge sourcing ways and strategies.

The influence of external knowledge on technology innovation performance can be different according to the external knowledge sourcing methods. Thus, it is strongly required to study and investigate different effects of several methods for utilizing external knowledge on technology innovation performance. Prior studies suggested that the degree and limit of using external knowledge is specified by various external knowledge sources exploited by core and main firms and the power and strength of relationship between core and main firms and external knowledge sources (Levinthal and March, 1993: 103, Katila and Ahuja, 2002, Laursen and Salter, 2006). The effect of utilizing external knowledge on technology innovation performance differs and depends on not only the extent and scope of using external knowledge but also on the type of external knowledge sourcing method and strategy (Kang and Kang 2009). In 2009, Van de Vrande's focus on Dutch SMEs to understand and perceive how open innovation activities are exploited in the Netherlands.

They found that SMEs are engaging in many open innovation practices and there are not great differences between manufacturing and service firms in terms of open innovation practices. Nevertheless, medium sized enterprises are approximately more profoundly in the process of open innovation activities than small sized firms. Based on the study of Laursen and Salter (2006), Garriga et al, (2013) found that external knowledge sourcing and internalizing external innovation sources increase open innovation performance (Hossain et al 2016). External networking with knowledge resources or innovation partners can increase firm's innovative activities and affect their innovation performance. According to Cohen and Levinthal, (1990), Laursen and Salter, (2006), Powell et al, (1996), external knowledge sourcing is prominent and vital to firm innovation practices.

A focal item of the innovation process considers what causes inbound openness of innovation. To specify how firms can access external knowledge sources and technology, one part of research emphasizes the role of inbound open innovation (Chesbrough, 2003a. Parida et al, 2012, Sisodiya et al, 2013), by which external collaborative partners can complete and make additional value to internal R&D practices and, in turn, enhance firm performance (Cohen and Levinthal, 1990, Ahuja, 2000, Stuart, 2000, Powell et al, 1996). In addition, many studies have demonstrated that inbound open innovation is an important and essential factor to a diversity of positive consequences, including larger internal R&D activities, innovativeness, and performance (Chesbrough, 2003a, Laursen and Salter, 2006).

Apparently, scholars have considered inbound open innovation, which is frequently regarded a key stimulator of firm's innovative practices, as an outcome of the different types of knowledge sources, technologies, and innovative ideas among external partners. Therefore, inbound open innovation can be described as an outside-in process by which it is feasible to access knowledge sources and technology that usually settled further away a firm's boundaries to make the firm's internal innovation activities and basis more completed. Prior researches have noted the fact that acquisition and attainment of external technology and knowledge sources has formed into a key stimulus of firm's innovation performance (Chesbrough et al, 2006, Laursen et al, 2015, Moreira, 2014, Stuart, 2000, Van De Vrande et al, 2009, Wang et al, 2015).

Innovation performance implies to the degree and level of success obtained by firms in achieving goals relevant to new product or services innovation (Henard and Szymanski, 2001, Montoya-Weiss and Calantone, 1994). It should be noted that past studies used large number of innovation performance measures, such as new products or service innovativeness, the degree and level to which new products or services succeed, customer services, and sales percentage (e.g., Atuahene-Gima and Wei, 2011, Baker and Sinkula, 2007, Blazevic and Lievens, 2004, Im and Workman, 2004, Salomo, Talke, and Strecker, 2008). There is such evidence shows the support of general positive relation between open innovation and innovation performance (Cheng Huizingh. 2014).

When employing inbound open innovation strategy, a firm attempts to explore and search external environment and outside of its boundaries for the skills, expertise, knowledge, competence or technologies that it does not exist inside firms and that could take too much cost, effort and time to be done or developed internally. A large number of external factors and players such as universities, research institutions, suppliers, customers, consultants and competitors may provide required knowledge and innovative ideas, which firms need (Faems, Van Looy, & Debackere, 2005, Tether & Tajar, 2008, Greco et al, 2016).

Based on Acs and Audretsch, (1987). Laursen and Salter, (2004), it can be concluded that SMEs are a relevant and applicable source of innovation. SMEs do own the capacity and capability for radical, new to the world of innovation practices, not just large firms. However, their innovation models and practices vary from large firms. Whereas they are generally more flexible, less stand in formalized procedures, and are fast decision makers, also their financial resources for internal R&D are constrained (Acs and Audretsch, 1987, Bessant, 1999, Lee et al, 2010, van de Vrande et al, 2009). Likewise, SMEs cannot encompass all innovation activities needed to recognize successfully an innovation (Lee et al, 2010). Therefore, external innovation and operational assets and properties are considerably relevant and attractive to SMEs (Baum et al., 2000). SMEs are more willing to involve frequently in inbound open innovation. Inbound open innovation search strategy, which is non-monetary in essence, might be extremely attractive to SMEs in order to improve and strengthen their innovation performance (van de Vrande et al, 2009, Harryson, 2008). Non- monetary model of open innovation search is considered as a less resource dependent than attaining and acquiring innovation inputs thorough the market. External acquisitions require expertise and specialists to control and investigate a number of factors in a firm's innovation network which SMEs typically lack (Dahlander and Gann, 2010, Brunswicker & Vanhaverbeke, 2011).

In non- monetary model of open innovation in SMEs, there is not any instant and urgent financial reward system dealing with knowledge flow across organizational boundaries while in the monetary model there is an immediate and prompt monetary and financial compensation or repayment related to knowledge flow (Dahlander and Gann 2010). A firm's external knowledge sourcing shows a prominent non-monetary model of inbound open innovation. It implies to how firms can utilize external sources of knowledge in a non-monetary framework. Empirical studies on external knowledge sourcing often explain openness of firms toward external knowledge sources and innovative ideas as the number of external sources of knowledge that each firm tends to use in its innovation activities (Laursen and Salter 2004, 2006, Brunswicker & Vanhaverbeke. 2015). Sourcing inbound open innovation as a non-monetary of openness in SMEs applies to how organizations can use external sources of innovation for internal innovation process and practices. Chesbrough et al. (2006) declare that firms can scan and explore the external environment before starting R&D work. If current ideas and technologies exist, the firms can use them. With consideration of corporate R&D laboratories, we can infer that these laboratories are suitable for absorbing and acquiring external ideas and mechanisms to evaluate internalizing and make them appropriate with internal processes (Freeman, 1974). On the other hand, acquiring and attaining monetary inbound open innovation is a type of openness, which addresses to obtaining input to the innovation process through the market as external environment. Openness can be perceived as how firms in-licensing and acquire knowledge sources and expertise from outside (Dahlander & Gann. 2010).

According to many prior studies regarding the exploitation of open innovation and measuring their effect on innovation performance, and despite the relevance of existing scientific work on open innovation, there are wide and great gaps which still exists in the literature of open innovation management. First, open innovation notion has rarely been studied in small and medium sized enterprises (SMEs); however, there are just few exceptions such as Lee et.al, (2010), Van de Vrande et al, (2009). SMEs suffering from insufficient knowledge and innovative capabilities to facilitate their new product innovation and new product development processes inside the firm, and there have been rare interests in studying and surveying open innovation activities in SMEs. There is a reality that SMEs possess fewer technological capacity and innovative capabilities for innovation practices and innovation management, and therefore, scholars usually have paid little attention to innovation management in SMEs (Acs and Audretsch, 1987, Brunswicker & Vanhaverbeke. 2011). Moreover, there is much literature which is still unexplored about the different elements and components of open innovation practices that motivate the success of innovation activities in small and medium sized enterprises (SMEs), but in fact various studies frequently confirm the prominence and importance of open innovation practices for SMEs (Hemert et al, 2013, Wynarczyk et al, 2013). A limited number of studies have explored and investigated the acceptance of open innovation activities in SMEs (Parida et al, 2012, Hossain & Kauranen, 2016).

Despite increasing importance of SMEs in national economies, sufficient intuition about SMEs from an open innovation perspective is scarcely existed in the literature and there is missing of adequate and profound perception of using open innovation activities in SMEs.

Studies about open innovation are mostly focused on large firms, particularly in high tech industries (Lichtenthaler, 2008, Xiaobao et al, 2013). Even though previous researches about open innovation in SMEs have increased, some of empirical studies have already investigated different aspects, such as industrial dynamics (Christensen et al, 2005), external sourcing (Laursen and Salter, 2006), open source strategies (Henkel, 2006, Lecocq and Demil, 2006), trends and challenges (van de Vrande et al, 2009), strategies for technology transaction (Lichtenthaler, 2008), and the effects of different open innovation activities (Parida et al, 2012). It is still believed that open innovation in SMEs has received very little attention from the perspective of researchers and also practitioners (van de Vrande et al, 2009, Hossain, 2013). Taking into account the high relevance of open innovation in SMEs, the shortage of comprehensive and extensive reviews of the studies on open innovation in SMEs is unexpected and amazing (Hossain & 2016). The more survey and investigation regarding the role of exploiting open innovation in SMEs is essential to be considered more in academia. Many small and medium-sized enterprises (SMEs) can depend and rely on their own capacity and ability to be innovative for achieving and sustaining competitive advantage in the market. However, the average rate and level of successful innovative efforts seem to be much lower than what is expected, that is mainly due to the existence of high level of risk, complexity, and uncertainty, which is considered as natural phenomenon in innovation process (Cooper, Edgett, and Kleinschmidt 2003, Griffiths-Hemans and Grover 2006, Koufteros, Vonderembse, and Jayaram 2005). Furthermore, innovative development and expansion practices is ordinarily challenging and difficult for SMEs, because they are encountering the "liability of smallness," which means, SMEs often have shortage and deficiencies of multidisciplinary competence base (Bianchi et al. 2010), and tend to utilize less structured approaches to innovation (De Toni and Nassimbeni 2003, Vossen 1998). Moreover, compared with large firms, SMEs have several inherited limitations, such as lack of resources for R&D, unstructured innovation processes, and underdeveloped internal capabilities (Chesbrough and Crowther 2006, Lichtenthaler 2008a, Madrid-Guijarro, Garcia, and Van Auken 2009).

Regarding all of these factors, SMEs may be restricted by their ability to innovate and achieve competitiveness. To this background, recent researches in the innovation and technology management domain have proposed several potential benefits of opening up the innovation process. In the literature, it described as a shift from the traditional or "closed" innovation model, with a focus on internal research and development (R&D), toward an "open innovation" approach (Chesbrough 2003, Gassmann 2006, Lichtenthaler 2011). According to Van de vrande et al (2009), it is perceived that SMEs need to deploy and extend the exploitation of open innovation activities, which can provide access to knowledge resources, reduce the costs of development, provide feasibilities for risk sharing, and improve and progress the product development process in such firms. For example, as Henkel (2006) note, with an open source development approach, SMEs can gain from the competence of enthusiastic and skilled programmers from around the globe, and compensate for the lack of limited in-house resources. Based on the previous researches of Lichtenthaler (2008a) and Van De Vrande et al. (2009), the effects of open innovation have not been sufficiently investigated in the context of SMEs. To the best content of knowledge, Van De Vrande et al. (2009), Lichtenthaler (2008a), and Laursen and Salter (2006) have studied the three important researches which surrounding a wider set of open innovation activities in SMEs by doing and performing it on a larger quantitative data sets. However, one study has ignored small firms (Lichtenthaler 2008a) and another has excluded micro firms which mean SMEs having less than 10 employees from the analysis (Van De Vrande et al. 2009), so that making the results valid solely for larger SMEs. As a result, although previous studies have provided important contributions to the literature and managerial implications as well, by focusing open innovation activities in the SME context, there is obviously a requirement for more quantitative studies, which can make progress and advance the more understanding and perceiving about the effects of different sources of inbound open innovation activities in SMEs. Studies so far have made significant contributions to understanding the literature of open innovation in SMEs, but they lack generalizable empirical examinations about how different open innovation practices are related to innovation performance. In addition, the effects and influences of various open innovation practices are still limited (Parida, 2012). Even though prior research showed that open innovation activities have a great and remarkable impact on different measures of performance, the relationship between open innovation and firm performance of SMEs has been done in a very limited scope and scarcely has been investigated. At the same time, great parts of the studies on open innovation are descriptive and most based on case studies and in depth interviews (Chesbrough, 2003, Dodgson et al, 2006, Huston and Sakkab, 2006b, Popa et al. 2017).

According to Laursen and Salter (2006), empirical evidence show that openness, measured as the number of external sources, positively affects a firm's financial innovation performance. Their measure of openness referred to search breadth on open innovation (Chen, Chen, and Vanhaverbeke 2011, Parida, Westerberg, and Frishammar 2012). Nevertheless, as a research gap, which needs to be more focused on and being more clarified, this fact is ignored that not all potential external sources of open innovation are of equal value for all innovating firms and there are differences in the strength of capability and capacity of interactions. Therefore, as Dahlander and Gann (2010), Gassmann, (2006) explain, it is crucial to concentrate on the specific context and the different distinguished combination of interactions with external innovation partners in a firm's external sourcing strategy to enhance and improve our understanding of openness in SMEs. It is proposed by previous studies that purposive external knowledge sourcing as nonmonetary inbound open innovation is an important strategic aspect of openness in SMEs. As not all sources are of equal values to innovating in SMEs, it is assumed that there are various external sourcing strategies among SMEs, which permit them to enhance and increase innovation performance and are related and connected to organizational and managerial capacities and capabilities for innovation (Brunswicker & Vanhaverbeke. 2015). The main gap about the literature of open innovation management in SMEs is that little is done to know about how SMEs involve in open innovation practices to recognize and source external knowledge. Naturally, Edwards et al, (2005) believe that SMEs are more relying on inter organizational relationships and external connections to keep competitive position. According to Baum et al, (2000), Lee et al, (2010), comprehension of external relations for innovation activities in SMEs is mostly surrounded to collaborative ties and alliances. It would be important to better perceiving on how SMEs purposively search and explore external ideas and knowledge, and in particular how they can incorporate different types of external technological and knowledge sources in order to leverage and increase their product innovativeness. As a research missing point which should be concerned as a research gap of innovation management literature, there is little comprehension of how “openness” in SMEs is built in firm's internal innovation capabilities or potentials and organizational facilitator factors for innovation in such firms. Comparing to large firms, SMEs are scarcely intending to do formal R&D activities (Vossen, 1988, Brunswicker & Vanhaverbeke, 2011).

The sources of inter firm R&D collaboration as open innovation strategy can be viewed in many studies investigating the coalition of different types of external sources and parties which include suppliers (Hakansson and Eriksson, 1993, Petersen et al, 2003, Ragatz et al, 2002), customers (Hippel, 1978, Cooper and Kleinschmidt, 1987, Atuahene-Gima, 1995), competitors (Hamel, 1991), and universities (Gerwin et al, 1992, Santoro, 2000) into the innovation process. However, the focus of studies were limited to the role of a single type of external source and party as suitable particular flows of research, for instance in supply chain management (suppliers), marketing (customers, competitors), and research policy (universities, private and public research institutions). As a result, according to Bahemia & Squire, (2010), the interactive effect of opening innovation processes to a different collection of external partners and factors has not been well recognized by scholars. Obviously not all of the potential and capable sources are of the same value for the process of innovation in firms (Laursen and Salter, 2004).

This research is focusing and trying to fill the aforementioned gaps of how different external knowledge and technology sources as inbound open innovation activities are being applied by SMEs from external environment's sources and outside of their organization's boundaries. In addition, how different external open innovation sources, which are not in equal values and usefulness of utilizing for small and medium sized firms, can affect new product innovativeness of these firms. It is known that not all of inbound open innovation sources have the identical and similar valuable effect on innovation performance of SMEs, Therefore, the main research gap is that how each of these external technology and knowledge sources which are considered as varied external partners of SMEs demonstrating their different effect on product innovativeness of firms. In addition, little concern has been existed to the effect of different types of inbound open innovation and their application inside the SMEs' boundaries. In addition, the rare and scarce academic research and study about the relationship between external knowledge and technology sourcing and SMEs' overall performance in which product innovativeness is one of the main core aspects of these firms has been considered and emphasized.

According to all above aforementioned literature, findings and studies from different scholars, which emphasize to the importance of exploiting open innovation activities in small and medium sized firms. There has been lack of empirical study to explore and investigate the effect of different sources or channels of inbound open innovation on innovation performance. In particular, there has been scarce research to study this effect on new product innovativeness of SMEs. In addition, since not all of the external sources of inbound open innovation practices have equal values to exploit inside SMEs and do not possess identical effects on new product innovativeness. Therefore, this research addresses this issue and question that how different types of inbound open innovation sources such as customers, suppliers, competitors, universities and research institutions as a mix of sourcing and acquiring of both monetary and non-monetary resources which is based on external search breadth strategy can affect new product innovativeness in SMEs. Moreover, to understand further the effect of open innovation, in this research outside-in (Inbound) open innovation activity has been used to develop theoretical explanations for the effect of different types of inbound open innovation sources on new product innovativeness of small and medium sized enterprises. Therefore, due to the classification and explanation of different relevant studies in open innovation literature which address on applying various types of inbound open innovation sources and their effect on SMEs performance. Moreover, as most antecedent studies focused on analyzing the effect of outside-in open innovation on performance of large, high tech multinational firms, specifically industries such as open source software. In order to fill up the existing gap of how different types of inbound open innovation activities can affect new product innovativeness of SMEs, the first question of this research is as following:

***Research Question 1:*** How different types of inbound open innovation sources affect new product innovativeness in SMEs?

### *2.2. The Theoretical Role and Stance of R.D Expenditure as R.D Strength of Firms and its Relationship with New Product Innovativeness in SME's*

According to Cohen and Levinthal, (1990), Rosenberg, (1994) and Ahn et al, (2015), it is concluded that internal R&D not only creates new technologies but also enhances absorptive capacity. This capacity development mostly is conditional on the level of accumulated prior knowledge. The supplement role of organizational internal R&D activities and its expenditures also its relationship with external technology acquisition and sourcing practices has been considered as the main and important issue since Cohen and Levinthal's first study about absorptive capacity (1980, 1990). Either this complement role of R&D expenditure and R&D practices internally or sourcing externally is perceived that the performance of one practice can improve and enhance the marginal revenue on other practice and activity (Arora and Gambardella, 1990, Cassiman and Veugelers, 2006). There are two folds of organizational internal R&D practices: First, it shows a straight impact and simultaneously it increases the effectiveness of external technology and knowledge sourcing by supplying and preparing the essential tools to perceive and exploit externally attained information (Cohen and Levinthal, 1989, Griffith et al, 2003. 2004). Specific internal R&D practices and expenditures, and external knowledge and technology sources cause leveraging innovation performance. However, according to the lack of sufficient concern of firms and their managers about innovative practices, there are constrained investment and capitalizing in internal and external innovative practices. There are different types of innovation strategies in order to implement the ultimate and best quality innovative performance. There are limited numbers of research studies about the assessment of the different kinds of external knowledge or technology sourcing strategies to the innovative performance of firms. The combination of internal R&D and external technology and knowledge sourcing is assumed to influence the productivity of innovative practices. Many scholars have shown that many elements are crucial to affect the success of innovation. Schewe (1994) address the success of innovation is importantly relevant to internal capacities and capabilities including R&D, manufacturing, and commercialization. Many innovative firms do not perceive and understand the required and expected financial returns of research and development projects even though they do have potential and intense research and development capabilities, they actually possess the inadequate capacity and capabilities to successfully launch and supply new innovative products in the market. Innovative firms should not only show their willingness and tendency toward R&D capabilities, but also in manufacturing and commercializing new innovative products.

Rosenberg (1990) suggest that if firms aim to collaborate with other sources regarding key knowledge basis and technological innovation practices in order to follow and reach innovative values, they have to maintain and own a vast and widespread R&D capacities and capabilities as prerequisites. The twofold stance of R&D activities implies that internal R&D intensity is not only making progress of the firm's innovative capabilities but also increases the firm's absorptive capacity (Cohen & Levinthal, 1989, Zahra & George, 2002, Todorova and Durisin, 2007). Internal R&D capabilities specify how an innovative firm can identify, assimilate and exploit external innovation in an appropriate way. Internal R&D capabilities therefore define the collection and gathering of its prospective technological and innovative capabilities. According to the study of Rosenberg, (1990), Cassiman, Perez-Castrillo and

Veugelers, (2002), it can be inferred that effective and successful outside know-how and external innovative sources can only be acquired and exploited when firms capitalize and invest sufficient and adequate expenditures in internal R&D activities. Based on Teresko, (2004), Chesbrough, (2006), Chen and Vanhaverbeke, (2011) suggestions, it should be derived that internal R&D capabilities and capacities are the key and main factors for open innovation. Open innovation is not a strategy of outsourcing R&D, and either not a shutdown trend of internal R&D. This is a strategy of exploring, finding and inbounding new external knowledge and innovative ideas that are complementary to the current R&D projects.

Mowery (1983) emphasizes that how internal R&D was given a special attention to making costs of organizing inside the firm at a lower level comparing to acquiring and attaining of external innovative ideas and knowledge from the market. Although it is important and significant action to invest in R&D and strong internal resource funding, it is prominent for firms to search and seek new resources outside their organizational boundaries. It is perceived that firms are sticking to investing in internal R&D activities despite their exploitation from external sources and partners. According to Cohen and Levinthal's (1989), Cohen and Levinthal, (1990) and Dahlander and Gann, (2010), it is perceived that firms must develop new internal R&D practices and to create the absorptive capacity in order to assess the condition of development outside the firm boundaries. They address that firms with great investments in R&D seem to be more capable to benefit and take advantage of spillovers.

Great attention and dedication to internal R&D development has to cause to wider internal expanding and developing of new findings and outcomes also leading to increase the stream and movement of new scientific information inside the firm. Some prior studies have focused on the relationship between R&D spending, productivity results and outcomes, and firm performance (Comanor, 1965, Grabowski and Vernon, 1990, Graves and Langowitz, 1993, Hill and Snell, 1989, Vernon and Gusen, 1974), and they have found some different and contradictory results. Nevertheless, some other studies have examined and investigated the role of technology base on R&D expenditures and found that in a complicated technological context, such as biotechnology, positive and important returns are gained from R&D investments (McEvily and Chakravarthy, 1999).

The main problem of allocating budget and investing in R&D activities in small and medium sized enterprises is that high technology small firms have limited resources, constrained financial capacity, and require investments in many areas such as R&D, organizational development and market development. The method of how to allocate their limited resources is the crucial decision, which small business owners must make. The managers and CEOs of new small venture firms must attempt to specify the level of investing in each of these scopes, which leverage the amount of profit or wealth generated by small venture firms. In knowledge intensive industry, a prominent strategic responsiveness to R&D seems to be vital to the firm's ability to develop the competencies for the requirement of success. Studies and research have shown that R&D intensity and strength is not being used as a measurement of internal learning, but also as a necessity of external learning as firms requires expanding a determined degree of internal knowledge in order to apply for external knowledge (Bierly and Chakrabarti, 1996, Cohen and Levinthal, 1990). Some studies support the positive relationship between R&D intensity and market value creation (Jose et al, 1986, Lustgarten and Thomadakis, 1987). Other studies have found that R&D expenditures in some industries have been concerned as the expense of shareholders, which is a means of enhancing diversification (Dial and Murphy, 1995, Hill and Snell, 1989).

There still exist a big question that whether an intense focus on expenditures of R&D activities would establish shareholders of small venture firms profit and wealth? In addition, it is still an ambiguous and questionable topic in R&D management and innovation practices literature in SMEs that if great, significant and considerable amount of investments on R&D

practices of small firms from annual sales revenue of firms would bring any advantage or cause to make any type of innovativeness in such firms? Nonetheless, according to the demand and conditions of high technology environment and the requirements of the small firms to develop its internal capacities and capabilities, it is questionable that R&D expenditures can cause to the creation of profit for those firms by innovating new product or services? (Deeds, 2001). Nevertheless, the main missing point as the research gap in R&D expenditures and intensity inside firms is that there are limited capabilities in small firms in financial and other internal organizational capacities to invest more on their R&D expenditures as a stimulator and motivator of new innovative practices inside the boundaries of these firms. Thus, it can constrain their overall performance to launch and supply new innovative products to the market. Due to lack of sufficient concern of these firms to innovative activities; there is weakness and limited capability and ability of investment in internal R&D activities of small firms that lead to the question of this research that how R&D expenditures can increase the effectiveness and innovativeness of new products in small and medium sized firms. Moreover, there exist inadequate and insufficient internal sources, capacities and capabilities in small and medium sized enterprises. Therefore, according to the classification and explanation of different relevant studies about R&D expenditure or intensity, focus on the role of internal R&D capabilities in small firms and its effect on firm innovative performance and the relationship between R&D expenditures and new product innovativeness with focus on small and medium sized enterprises, in order to fill up the research gap of how R&D expenditure can lead to new product innovativeness, the second question of this research is as following:

***Research Question 2:*** How R.D expenditures as internal organizational investment as the percentage of sales in research and development capabilities and activities affect new product innovativeness in SMEs?

### *3.2. The New Product Innovativeness and New Product Advantage in SMEs*

Product innovativeness is comprehended as the novelty, newness, and originality type of new products, which is recognized through new product's attributes, characteristics, traits and features. Experts of new product development regularly and mostly try to make the best efforts to enhance and boost the innovativeness of new products offerings to absorb and draw the attention of customers and solve their problems and issues related to consuming of products. In addition, this approach attempts to obtain and maintain customer loyalty. It is also assumed that development and growth in product innovativeness will cause to increasing and surging product sales and profits. According to Millson (2013), product innovativeness can be explained as the degree and level of product uniqueness recognized and realized by customers processing prominent knowledge according to the development and expansion of new products alike to products of close and relative competitors. 'Innovativeness' is most frequently used and defined as a measure of the degree and level of 'newness' of an innovation. 'Highly innovative' products are considered as having a high degree and level of newness and 'low innovative' products posits at the opposite point of the continuum. Based on macro perspective, 'innovativeness' is regarded as the capability of a new innovation to make and establish a new concept in the science and technology and in the market structures in industrial area. On the other hand, from a micro perspective, 'innovativeness' is the capability of a new and novel innovation to affect the firm's current existing marketing resources, technological resources, skills, knowledge, capabilities, or strategy (Garcia & Calantone, 2002). Product innovativeness is regarded to technical and marketing discontinuities (Danneels and Kleinschmidt, 2001, Garcia and Calantone, 2002), while product advantage implies to a product's superiority, advantage and excellence relevant to other products in the marketplace on different aspects such as quality, benefits, and functions (Gatignon and Xuereb, 1997, Montoya-Weiss and Calantone, 1994). Classification and categorization of Garcia and Calantone for product innovativeness and its structure focuses on industry technological level or degree and market discontinuity, also on firm level technical and marketing know-how newness and novelty as a macro level (Industry) and micro level (Firm) measures and index of overall product innovativeness, that ultimately affect customer newness. Moreover, Danneels and Kleinschmidt believe in firm and customer perspectives. They emphasize firm dimension has two sub items: (1) acquaintance and awareness of technical and marketing environments, (2) compatibility with technical and marketing resources. The customer dimension comprises product attributes and characteristics, risk adoption, and requirements for behavioral alteration (Calantone et al, 2006). The term of "Innovativeness" is explained as the concept of openness toward new and novel ideas as a dimension of firm's culture (Hurley and Hult 1998, p. 44). This openness to new and most advanced knowledge and innovative ideas can be considered from external environment. In small firms, innovativeness refers to a willingness and tendency of the owner or CEO of the firm to learn and accept the innovative method, both as input and output of markets. High degree of innovativeness of small firm does not imply to this insight that the owner of the firm is innovative in all areas. Kirton (1976) found that each person or individual has a preferable method of creativity and decision making that can be different to be accepted to innovative.

Adopters have a tendency to implement things more appropriate inside the commonly adopted theories, strategies, and opinions. Innovators and initiators are more likely to consider truly things that exist and accepted thoughts and ideas to reconsider the problems and to solve the new problems. Buttner and Gryskiewicz (1993) found that founders and owners of a company with an acceptable and adjustable model of decision-making are frequently pursuing the business during passing the time as founders are focusing on a more innovative method of decision-making. Limited resources, capacities and capabilities restrict small firms in many industries from implementing internal or in-house research and development practices. Many innovations, which are done by small firms as, based on previous existing and available technologies, notions, and or resources proposed by suppliers. Consequently, new inputs are highly important source of innovations for small firms. Networks of small firms can create and form collective research and development (R&D) programs as a base of new product innovation of network members. Small firms, which manufacture distinctive products, also would innovate solely by accepting products according to the requirements of the customer's target group (Verhees & Meulenberg, 2004).

According to Danneels & Kleinschmidt, (2001), the dimensions of new product innovativeness included two aspects: (1) New product innovativeness from the customer's perspective. (2) New product innovativeness from the firm's perspective.

**Table 18-Two Perspectives of Product Innovativeness**

| ***Product Innovativeness from the Customer's Perspective*** | ***Product Innovativeness from the Firm's Perspective*** |
|---|---|
| **1.** According to Booz, Allen, and Hamilton methodology, the most frequent used method of new products is a kind of differentiating between customers and firm dimensions on product newness (Booz et al, 1982).<br>**2.** New products are being classified according to two dimensions of newness: newness to the developing firm and newness to the market.<br>**3.** The newness to the market aspect according to the Booz, Allen, and Hamilton philosophy can be explained as evaluating and assessing the innovativeness of the product to its potential customers.<br>**4.** Relative advantage, compatibility, complexity, trialability, and observability are five innovation attributes or characteristics relevant to perceive whether an innovation activity is accepted and adopted or not? (Rogers, 1995).<br>**5.** Relative advantage as the first attribute and characteristics from new product innovation scholars' point of views has received important | **1.** Product newness to the firm is how innovative the product is to the firm that develops and expands it (Booz et al. 1982).<br>**2.** In order to perceive what kind of methods and ways can be considered for new products from the perspective of firms and according to the view of enterprises, it is feasible to focus on two parts of literature: 1- literature, which examines and investigates organization and environment relations (Normann, 1971, Starbuck, 1976, Thompson, 1967), and 2- The resource-based theory of the firm (Mahoney and Pandian, 1992, Penrose, 1959, Wernerfelt, 1984).<br>**3.** The newness as familiarity conception implies to organizational theory concerning to the relationship between the organization and its surrounding external environment (Starbuck, 1976). Thompson (1967) discuss that all firms or organizations establish and create a "domain," which "identifies the points at which the organization is |

| *Product Innovativeness from the Customer's Perspective* | *Product Innovativeness from the Firm's Perspective* |
|---|---|
| attention. | dependent on inputs from the environment." |
| **6.** In new product innovation literature, the concept of product newness to the customers purchasing and using the products has mostly been described as product uniqueness or superiority and preferable product advantage. | **4.** Normann (1971) found that new products may expand the domain of firms, and to that extent that they continue, it enables the organization confronts an unknown domain which can be included as the part of environment, the technological environment, and the market environment. |
| **7.** "Really new" products defined according to their ability or capability to offer greater and higher functionality, distinguished and different from incremental products, by rapid movement as an advancement process in performance they can offer (Colarelli-O'Connor 1998). | **5.** Normann (1971) also argue that employees of firms understand, recognize and transfer the meaning and concept of events and signals from the domain and territory of external organizational boundaries more simply. Motives from famous and reputable sections of external environment is the domain, benefit and advantages from formed and created channels of communication and make it appropriate into recent existing intuitive and cognitive structures. |

**Table 19- The Concept and Characteristics of New Product Advantage**

| |
|---|
| **1.** Products which are offering significant advantage comparing to competitor's products also have willingness and tendency to be unique or distinctive (McNally et al, 2010). |
| **2.** New products with radical innovativeness are more varied from competitor's products and have a significant and greater product advantage (Gatignon and Xuereb, 1997), customers are showing more doubt and skepticism toward these types of innovations (Hoeffler, 2003, McNally et al, 2010). |
| **3.** Exploiting new products with advantage might need learning by the customers (Carpenter and Nakamoto, 1989), and customers mostly should change their consuming behaviors toward obtaining the proposed and offered benefits (Dahl and Hoeffler, 2004, McNally et al, 2010). |
| **4.** Product advantage related to allowing to customers to implement new tasks, satisfying and meeting customer requirements, and supplying unique and exclusive features or characteristics for the customers (Bastic 2004, Healy et al, 2014). |
| **5.** "Product advantage as certain product's predominance providing customers' superior than competitor's benefits. These benefits are quality, features, technical performance and the capability to satisfy consumer needs" (Hsieh et al. 2008), p. 2, Healy et al. 2014). |
| **6.** Product advantage is a combination of varied product attributes and characteristics (Henard and Szymanski 2001, Healy et al, 2014). |

Some other scholars such as Tatikonda and Montoya-Weiss, (2001), Cooper, (1992), Griffin and Hauser, (1992) suggest that new product attributes and features such as new product quality, reliability, newness, uniqueness and distinctiveness prepare and supply more comprehensive and realistic overview and outlook of a firm's ability and capability to provide and meet customer's requirements. There are “differences between alternatives on the important attributes provide direct evidence of advantage” (Day and Wensley, 1988, p. 14). According to Hsieh et al. (2008, p. 2) it is derived that many high technology firms follow and chase an “innovative and product advantage” strategy when launching and supplying their new products. These kinds of firms and enterprises have targeted and purposed to introduce and launch highly innovative products and start to compete with competitors and opponent firms by producing high quality products. In addition, this aligns with Gatignon and Xuereb’s (1997) beliefs that more and higher radical the product, the smaller and limited the product likeness and resemblance with competitors, and ultimately leads to greater product advantage. This notion indicates that firms to be innovative and have radical approach have constantly been connected and related to increased and enhanced product advantage. Healy et al. (2014) point out that, Rijsdijk et al. (2008) have established measures based on Atuahene-Gima (1995) and Cooper and Kleinschmidt (1987) previous study on product advantage and integrate product advantage into two parts as follow:

(1) ***Product meaningfulness***: Considers the benefits that users gain from buying and using a new product.

(2) ***Product superiority***: Considers the extent and degree to which a new product demonstrates a higher quality of functions, and outperforms competing products.

Theoretically, it has been approved by studies that the relationship between product innovativeness and product financial performance has shown a significant statistical relationship. According to Kleinschmidt and Cooper, (1991), And Song and Parry, (1996) agreed, Logically, it is anticipated that there should be a positive relationship between newness and uniqueness of innovative products and a sustainable advantage against competitors which means to achieve greater opportunities for differentiation and might patentable products. However, highly innovative products are less compatible with firm's culture, and customers, therefore, causing greater risk, possibility of wrong actions, less likelihood of customer acceptance of innovative products, and finally a bigger possibility of financial and profitable risks. Furthermore, In addition to Calantone et al. (2006) beliefs, it should be noted that product innovativeness has not any direct effect on product advantage and profitability. In addition, Kleinschmidt and Cooper (1991) show a nonlinear relationship between innovativeness and performance, proposed a moderated relationship. They conclude that high and low innovative products are more frequently to be succeeded than those that have moderate and common innovativeness because of differences in product advantage, synergies, and poor performing of predevelopment practices. According to the definition of highly innovative products, Gatignon et al. (2002) found that technological discontinue innovation activities are dealing with commercial success and good achievements. Therefore, as a missing point which is considered as a gap in new product innovativeness and product advantage literature, the existing and available research suggests that the role and effect of product innovativeness on product financial performance is not obvious and straightforward. Decomposition of product innovativeness into varying aspects will contribute to disclose its complicated relations with product financial performance (McNally et al, 2010).

Some studies demonstrate that innovativeness negatively affect performance according to customer's fearfulness related to accepting unapproved and unobvious technology. These prior studies focus on the negative effects that increased and enhanced product innovativeness might show the uncertainty or skepticism which customers are experienced.

For instance, according to high switching costs, high risks, and increased investments of time to learn new behaviors with highly innovative products (Higgins and Shanklin, 1992), some customers associate with the anxiety or concerns about uncertainties and the new learning experiences requirements of the new innovative products. It is needed to obviously avoiding or hesitating in buying the new improved and developed versions (Dhebar, 1996). As a result, it could be an unexplored topic to analyze if new product innovativeness at firm level of small and medium sized would cause and lead to increasing new product advantage as a component of new product success and new product financial performance as a whole. As there may be uncertainty and fearfulness from customer's perspectives to respond positively to new innovative products and buy new products in the market without anxiety and unreliability, it is needed to study more profoundly and find out about the relationship between new product innovativeness and new product advantage in SMEs. There is a literature gap of ambiguity about the successfulness of new innovated products, which innovated inside SMEs to have a competitive advantage in the market. Therefore, it is crucial and critical to have more research to examine this relationship to make sure and find out if innovativeness of new products in SMEs would lead to new product advantage in the market.

Based on Goldenberg et al. (2001), innovativeness does not consider guaranteeing successfulness of product market performance. A successful way of innovativeness should be new and novel, and to be easy to be perceived and comprehended simultaneously. Without a good introduction and launching strategy, product's innovativeness may be conceived uncertain and risky by customers, though it may even supply and show superior benefits. This negative comprehension of product innovativeness as a conceptual and theoretical gap may result to acceptance and adoption resistance or any kind of opposition behavior. For example, Philips company launched and introduced the digital compact cassette technology and tried to replace and change the recent existing recordable tape technology (cassette tapes). The company has not been successful to encourage and ensure consumers to change their purchasing behavior from existing analog cassette tapes to digital compact disc system. Philips' mistake may related to its poor and weak product launch advertising strategy, which ignored to address or focus the issue of previous adaptability and has not make any effort to eliminate customers' uncertainties about the benefits of digital recording technology (Hill, 1997).

Beliefs of Lee and Colarelli O'Connor, (2003) address this point that making any relationship or communicating with customers to handle and manage their understanding and perceptions of new product innovativeness is considerably crucial and important, specifically when launching and introducing a highly level innovative product which customers might not willing to adopt because of lack of product knowledge. Therefore, this may lead to lack of superior new product performance and limiting the chance of getting advantage position in the market as a new introduced and innovative product. Thus, according to the classification and explanation of different relevant studies in new product innovativeness and new product advantage which address on the notion of new product innovativeness and its dimensions. In addition, new product advantage concept, its various characteristic, and the relationship between new product innovativeness and new product advantage with focusing on small and medium sized enterprises. In order to fill up the research gap of how new product innovativeness can lead to the creation of new product advantage as a component of new product success which is considered under the overall category of new product performance of small and medium sized enterprises in the marketplace , the third question of this research is as following:

***Research Question 3:*** How new product innovativeness affect new product advantage in SMEs?

### *4.2. The Organizational Memory*

Memory "refers to the amount of stored information or experience an organization has about a particular phenomenon" (Moorman and Miner, 1997: 103, Tippins & Sohi, 2003).

According to Slater and Narver, (1995), and Tippins and Sohi, (2003), it is interpreted that memory is considered to play two prominent roles in the organizational learning process.

First, it is perceived that it can offer a basis for alteration through productive learning processes, and second, it shows an important effect on the learning process by the effort, which affects the types of information that was searched and the method by which the information is analyzed.

**Table 20- The Concept and Essence of Organizational Memory**

| | |
|---|---|
| **1.** | Organizational memory is "collective beliefs, behavioral routines, or physical artifacts that vary in their content, level, dispersion, and accessibility" Moorman and Miner, (1997: P. 93). |
| **2.** | Collective knowledge achieved through experience is stored and stocked in distinguished and distinctive forms in the firm. |
| **3.** | Organizational memory refers to stored and accumulated information and knowledge from organization's history that is possible to be brought for current organizational decision-making (Walsh & Ungson, 1991: 62). |
| **4.** | Organizational memory relies and depends on the mindset of employees and can be set and incorporated in work processes or lessons acquired from past experiences (Walsh & Ungson, 1991). |
| **5.** | According to Camisón, Boronat, and Villar, (2010), it is concluded that organizational memory makes it easier to access to organization's previous and antecedent knowledge, such as information and knowledge about the competitive market, the present market condition and existing customers or other market factors. This type of knowledge is specifically difficult to be transferred or imitated and thus is a worthy and valuable asset for an organization (Ebbers and Wijnberg, 2009). |
| **6.** | According to Moorman and Miner's (1997), organizational memory is defined as the amount and level of a firm's stored and stocked knowledge and the existence of information and knowledge about a peculiar event or phenomenon. Organizational memory is a resource that firms can locate and extend it to improve and enhance their financial performance by two basic roles of memory: interpretation and action guidance. |
| **7.** | The interpretive role of memory refining the way that information and experience are classified and categorized, whereas the action guidance role indicates individual and organizational behavior. |
| **8.** | According to Walsh and Ungson, (1991) and Moorman and Miner, (1997), organizational memory consists organizational knowledge, skills, rules, procedures, shared assumptions and beliefs. |

9. Organizational memory (OM) is a perspective of an organization's history and past experiences in which firm's knowledge are obtained and stored in a format that they will be accessible in the future for the organizational decision making. This is the available techniques by which knowledge and information from the past experience, and events, occurrence and phenomenon can affect current organizational activities. Organizational memory is one of the main elements of organizational learning theory, decision-making and organizational cognition and behavior (Walsh and Ungson 1991).
10. Moorman and Miner (1997) note that the content of organizational memory implies to the meaning of collectively and jointly stored information, and aligned with prior statements, which was classified as declarative and procedural memories (Kyriakopoulos and Ruyter, 2004, Akgün et al. 2012).
11. Moorman and Miner (1997) found that organizational memory can be regarded as possessing different aspects such as level (the amount of stored and accumulated information), dispersion (the degree that information or knowledge is shared across the organization), and accessibility (the extent to which information can be recaptured and regained or availability for using and lessons that are stored).

Organizational memory is classified into two subgroups as declarative and procedural (Moorman and Miner, 1998b). They are explained in the following table:

**Table 21- The Differences between Organizational Declarative Memory and Organizational Procedural Memory**

| ***What is Declarative Memory?*** | ***What is Procedural Memory?*** |
|---|---|
| **1.** Declarative memory includes facts and events. In business to business, if a firm trying to learn more about its customers, declarative memory can represents knowledge and information about customers, firm's business objectives, market position and conditions, marketing strategic plans and competitive positions. | **1.** Procedural memory encompasses the notion and knowledge about routines, processes and procedures. These procedures might include the process of purchasing orders, procedures to recognize customer requirements, and procedures to consider and regard customer complaints. |
| **2.** Declarative memory possesses the most relevant relation with general knowledge, which can be applied and exploited to a broader range of different status (Tippins and Sohi. 2003). | **2.** Organizational procedural memory is a memory "for how things are done" (Cohen and Bacdayan, 1994: 404) or memory for "things you can do" (Berliner, 1994: 102). Procedural memory contains skills or routines. The nature of these kinds of skills is relied and depend more on the specific scope in which individual or organization are practicing and performing. |
| **3.** Declarative memory is "memory for facts, events, or propositions" (Anderson, 1983. Cohen, 1991: 137). Thus, unlike procedural memory, which encompasses routines or skills as memory, declarative memory is more general. The main specification of declarative memory is the different utilizing of it that can be set and put in | |

| What is Declarative Memory? | What is Procedural Memory? |
|---|---|
| different orders (Moorman & Miner. 1998). Declarative memory implies to knowledge of facts and events (factual knowledge), such as stocked and accumulated knowledge about customers and their preferences (Lynn and Akgün, 2000), product features such as product drawings and packaging (Moorman and Miner, 1998) and firm's business goals and objectives, firm's market conditions, firm's marketing strategies and competitive positions (Tippins and Sohi, 2003). | |

### *1.4.2. The Organizational Memory as Component of Organizational Learning*

Organizational learning is the process that firms with that can develop and promote their knowledge capabilities and insights from the experiences gained by the employees of the firms, and it can affect behaviors and increase the firm's capacities and capabilities (Fiol and Lyles, 1985, Huber, 1991, Senge, 1990, Slater and Narver, 1995). According to the Huber (1991), the process of organizational learning includes four subcomponents and individual items (Baker and Sinkula, 1999, Sinkula, 1994, Slater and Narver, 1995, Weerd-Nederhof et al, 2002). The first step is knowledge acquisition; this is the process of obtaining new information and knowledge. The second is knowledge distribution, the process that employees share information inside the firm. The third is knowledge interpretation that occurs in a way which each employee enriches the meaningful aspect of knowledge and information and transforms information into new common and regular knowledge. The last is organizational memory, which is the process of storing and stocking the information and knowledge for future plans of organizations. In addition, organizational learning process which organizational memory is the last part of it, can create sustainable competitive advantage for firms and enable internal variables to increase and enhance the organizational performance (Brockmand and Morgan, 2003, Dodgson, 1993, Fiol and Lyles, 1985, Garvin, 1993, Gnyawali et al, 1997, Nevis et al, 1995, Stata, 1989). Therefore, firms that have the capacity of learning for storing knowledge as their organizational memory have a better opportunity to feel the different situations, trends and procedures in the market (Day, 1994, Sinkula, 1994, Tippins and Sohi, 2003). Consequently, learning organizations are frequently more inclined to show rapid reaction to competitors' activities in the marketplace (Day, 1994. Slater and Narver, 1995), which provide the appropriate context for firms to maintain their competitive advantage position (Dickson, 1996, Jiménez & Sanz Valle, 2011). According to the Huber (1991) classification of organizational learning processes, researchers have mainly focused on the first phases, and organizational memory as the last stage, which is the storing, and stocking practice of organizational knowledge, information and outcomes derived from learning has received very little attention by scholars. The availability of organizational memory assumed that firms must be considered as mental mechanism, which possesses capability of thinking and storing knowledge from prior knowledge and experience (Sandelands and Stablein, 1987, Weick, 1979). The general and common practices of organizations that processing, utilizing and storing information and knowledge can be regarded as to be different and distinguishable from individual actions (Daft and Weick, 1984, Huber, 1991) and the achieved stored information and knowledge creates organizational memory (Duncan and Weiss, 1979, Moorman and Miner, 1997, Chang and Cho. 2008).

### *2.4.2. The Effect of the Organizational Memory on the New Product Performance*

New product development is one of the main motivating factors for obtaining competitive advantage and sustainable growth of organization. According to this notion, many researchers and practitioners discuss to find the factors, which result to new product development success. Despite the necessity and significance of new product development, it is supposed that there are not any applicable guidance and instructions for successful product development. There might be an answer for this logic, as the new product development process involves a complicated interplay with organizational factor, which it causes a great uncertainty (Kanter, 1988, Van de Ven, 1986). Some researchers believe that a learning capacity in which organizational memory is one part of that can exceed beyond other competitors as the only source of a firm's competitive advantage (De Geus, 1988, Dickson, 1992, Slater and Narver, 1995). Regarding this issue, it is remarkable to state that it can result to the diagnosis which organizational learning and information-processing capabilities in which organizational memory is included are the main key significant sources of new product development success (Leonard-Barton, 1992, Lynn et al, 2000, Madhavan and Grover, 1998). Some scholars' results show that there are positive influences of organizational memory on firm's new product performance. They believe that organizational memory should increase and boost new product performance of firms, because a firm's long time experience and knowledge can enhance efficiency of organizations (Cyert and March, 1963, Duncan andWeiss, 1979, Chang and Cho. 2008).

Organizational memory and its crucial impacts on new product development success have been considered from scholar's point of views. In this respect, organizational declarative memory is related to facts and events, and procedural memory is related to operational procedures and processes. However, the results from previous studies in this regard can be split into positive effect of organizational memory on new product development performance (Cohen and Levinthal, 1990, Walsh and Ungson, 1991) and negative effect (Berghman et al, 2013, Kyriakopoulos and De Ruyter, 2004). Whereas accepting the academic notion and perception of the advantages and benefits of organizational memory and the effects of its two kinds are still unknown and vague. It is believed and emphasized by different scholars that new product development should be considered as learning process (Leonard-Barton, 1992, Madhavan and Grover, 1998), which the improvement and advancement of current knowledge as well as the progression of new knowledge is addressed by them (Andriopoulos and Lewis, 2010, Choi and Phan, 2014). These scholars mentioned that organizational memory is a source of affecting firm performance leveraging only in a situation that it can assist and aid firm competencies, and organizational adaptation capabilities (Moorman and Miner, 1998) and learning capacities and capabilities (Camisón and Villar-López, 2011).

Firms are presumably possess knowledge about facts and events as well as process and procedural routines in their organizational memory (Moorman and Miner, 1997), if the firm's memories direct and conduct their learning efforts in the wrong and incorrect direction, they might not obtain new product development performance benefits or advantages.

Organizational memory displays what firms have aggregately learned and has an assisting and conducting role for them in order to decide when and how to improve learning (Walsh and Ungson, 1991). In particular, firms that are owning the accumulated and stored amount of knowledge and information about new product development, the routines and procedures focus on how to integrate the stocks of knowledge more efficiently and effectively (Madhavan and Grover, 1998), organizational memory can help these firms. Organizational memory contributes to these firms better understanding and perceiving new information, and extend future new product development pathways (Cohen and Levinthal, 1990, Walsh and Ungson, 1991, Lee et al. 2017). The firm's capability of storing knowledge and experiences from the past and the possibility, ability and method of applying such internalized and accumulated organizational knowledge as the last part of organizational learning process and its effect on new product advantage as a component of new product success and performance is scarcely received any scholar's attention to study.

**Table 22- Resource Based View, Knowledge Based View and Capabilities Based View as the Basis of Competitive Advantage**

| ***Resource Based View*** | ***Knowledge Based View*** | ***Capabilities Based View*** |
|---|---|---|
| **1.** According to Barney,(1991), The resource based view assumes that firms' competitiveness can be formed due to unique, distinctive and inimitable groups and packages of tangible and intangible assets which are considered as the valuable, scarce, hardly imitative, and sustainable. Some resources firms possess can be called such as management skills, organizational processes, procedures, routines, and the information or knowledge, which is under control of the organization.<br>**2.** Daft, (1995) mention that firm resources consist all kinds of assets, capabilities, organizational processes, firm characteristics, information and knowledge, which can be controlled by firm. These resources as internal organizational capabilities and capacities are those ones that can provide competitive advantage for the firm. | **1.** The knowledge-based view of the firms is the core part of the resource-based view (Conner and Prahalad, 1996). The knowledge-based view of the firm presumes that the firm's capability and capacity to make and exploit knowledge is the most critical and crucial source of a firm's sustainable competitive advantage (Grant, 1996, Kogut and Zander, 1992, Nonaka, 1991, Prahalad and Hamel, 1990, Nonaka 1991. P.96). It is believed that the most reliable and confident long lasting source of competitive advantage is knowledge (Zheng et al 2010). | **1.** Capabilities based view shows the relationship between capabilities, innovation and sustainable competitive advantage (Mol and Birkinshaw, 2009). Capabilities based view is a theory that supports this notion which sustainable competitive advantage is applicable for companies when they own heterogeneous or varied resources and capabilities (Amit and Schoemaker, 1993, Barney, 1986, 1991, Wernerfelt, 1984).<br>**2.** Capabilities are implied to both employees who possess dispersed knowledge or those capabilities, which firms own as the survivor of the organization and its members (Amit and Schoemaker, 1993). Organizational memory and learning capability are concerned as knowledge based capabilities. |

According to Nelson and winter, (1982), it should be noted that capability based view, organizational memory and learning capability is core and main knowledge based capabilities. Both organizational memory and organizational learning capabilities are results and output of organization specific and tacit knowledge (Polanyi, 1962) which enable innovative activities in the organizations (Kamasak and Bulutlar, 2010, Storey and Kelly, 2002). Concurrently, innovation is mostly admitted as the basic source of sustainable competitive advantage (Day and Wensley, 1988, Hurley and Hult, 1998).

Organizational memory includes stored and stocked organizational knowledge and experience, which might have favorable and unfavorable concepts and applications for new product development performance in technological turbulent market. There is a drawback for using organizational declarative and procedural memory inside firms, which it might develop, and increase static and stable approach for dealing with competitors. Therefore, the missing point is that this approach and strategy can be transformed rapidly into an obsolete and outdated one, which can be pursued and imitated by other competitors in the marketplace (Hamel and Prahalad 1989). This negative point and drawback is considered as there is not an apparent and transparent effect of organizational memory on new product success in general and new product advantage in particular. Furthermore, another negative point is that strong organizational memory can decrease firms' potential capability and ability to further improvement and diminish chances to respond properly to changing condition of markets (Miner, Bassoff, and Moorman 2001, Moorman and Miner 1998a, Hanvanich et al, 2006). This can confront firms to be transformed from a dynamic and agile position to a very rigid, unchanging and static one in order to respond to the market and customer requirements properly. Likewise, other researchers emphasized to organizational memory's disadvantageous and detrimental impacts, it is believed that changing from antecedent patterns and strategies to new developing and competitive strategies becomes more tough and hard when memory in a special area and scope developed (Dougherty, 1992, Leonard-Barton, 1992). The main missing point in the literature is that the influence of organizational memory is not plain and obvious, but has a more complicated and conditional role in new product development phases. Other researchers also argued that in a method in which memory is characterized and shared in organizations is more prominent and critical than its exact level and degree (Brockman and Morgan, 2003, Moorman and Miner, 1997, Chang and Cho. 2008).

Some previous research pointed out to the negative perspective of memory's inflexibility. Particularly, they would have addressed that if organizational memory is implanted and placed in the format of routines and procedures, or stocked and stored knowledge basis, flexibility and agility of firms are hindered and obstructed. This effect has been applied to as a "firm trap" (Levitt and March, 1988), “core rigidity” (Leonard-Barton, 1992), and “routine rigidity” (Dickson, 1992). In the new product development literature, some qualitative studies approved that higher and greater levels of memory have a negative effect on innovative performance and competitive advantage position, because it prevents and hinders any activity outside previous existing practical patterns (Dougherty, 1992, Ghemawat, 1991, McDonough, 1993), particularly in developing innovative products. Innovation activity and reaching to competitive position should change the current existing models and templates of actions in organizations. If firms directly and clearly follow and pursue prior routines and procedures or fixed behavioral patterns inside the organization, they may find it difficult to create and produce innovative ideas or knowledge. Many researchers who had studied before about organizational memory's negative effects on firm's innovative practices and advantageous positions emphasized on this point as the gap of uncertainty about the effectiveness of utilizing organizational memory in order to boost innovative level and competitive advantage in the market place. Dougherty (1992) define a firm's routines and procedures as to be an obstacle and hindrance to innovation and Leonard-Barton (1992) and Levitt and March (1988) argue that an organization's routines and procedures has negative effect on new product development performance because it causes rigidity in firms (Chang and Cho. 2008).

Technological changes is strengthening and increasing, and product life cycle is shortening, firms confront developing and growing pressure and forcing to develop executing and managerial activities for increasing new product development (Leonard-Barton, 1992).

Following this concept they feel uncertain and unsure about the usefulness and applicability of their stored knowledge and experience. Furthermore, some studies described and specified that organizational memory as organizational stored knowledge and routines can lead organizations to organizational inflexibility (Moorman and Miner, 1997, Newey and Zahra, 2009). It could cause to hide the transparency of environmental changes for firms, resulting to deteriorate performance (Berghman et al, 2013, Kyriakopoulos and De Ruyter, 2004). Even though organizational memory can develop and increase the rigidity inside the firms and hinders to show the current market changes or technological conditions (Newey and Zahra, 2009, Berghman et al, 2013. Kyriakopoulos and De Ruyter, 2004), declarative memory is a particular component of organizational memory which regarded as the main concentration and variable of this research. Organizational declarative memory and its effect on new product advantage is a double edged sword which causes the question of how it can increase and boost new product development performance that remained unanswered and unexplored (Lee and Joshi. 2017). In this research, organizational declarative memory is being applied as it contains components, which are more relevant to product features and market conditions of firm's new product advantage and success.

Therefore, according to the classification and explanation of different relevant studies about organizational memory focus on the role of organizational declarative memory as the memory for facts, events (factual knowledge) or propositions including know-what, know-why, or know-when. In addition, as using this kind of organizational memory is more tied with notions and concepts of stored and accumulated knowledge about customer's preferences and product features, which is more relevant to product success and performance in the market by using this memory. Thus, according to the relationship between organizational declarative memory and new product advantage as a component of product success and performance, and despite the fact that some previous studies focused on the negative impact of organizational memory on firm innovation performance and firm new product performance. This research is surveying the effect of organizational declarative memory on new product advantage in small and medium sized firms in order to fill up the research gap of how organizational declarative memory can lead to new product advantage and successfulness in the marketplace. However, it is believed that organizational memory as stored information, knowledge or experience can hinder and make obstacles to high performance of new product in the market, as the product life cycle is shortening and technological changes is increasing rapidly. Accordingly, the fourth question of this research is as following:

***Research Question 4:*** How organizational declarative memory as a previous stored and stocked knowledge about facts, events and propositions affects new product advantage in SMEs?

# Chapter 3: Theoretical Model and Hypotheses

### *1.3. The Relationship between Inbound Open Innovation and New Product Innovativeness in SMEs*

The literature in open innovation varies in studies that have enthusiastically determined to search to examine the simultaneous effect of external knowledge and innovative sources from various types of external sources. Firms that own a heterogeneous and inharmonious network of various types of external sources, such as suppliers, customers, consultants, competitors, universities, public and private research institutions, have been considered to possess and experience a better innovation performance. Networked approach of innovation practices by collaborating with different partners demonstrates more synergies and effectiveness for firms (Becker and Dietz, 2004, Miotti and Sachwald, 2003, Nieto and Santamaria, 2007, Belderbos et al, 2004). By increasing the number of different kinds of external partners, it is anticipated that the innovation performance of new products will be leveraged (Faems et al, 2005, Roper et al, 2008, Tether and Tajar, 2008). The study of Amara and Landry (2005) address and suggest that when firms depend and rely more on a large number of external sources of information and knowledge sources, they are most probably able to develop new innovative products (Bahemia & Squire. 2010).

Based on study of Van de Vrandea et al (2009) about open innovation dimensions in SMEs, open innovation activities is split into two practices in their study: Technology Exploitation (Outbound open innovation) and Technology Exploration (Inbound open innovation) that each of them consists various aspects of open innovation activities. Some studies found that open innovation causes to improve and increase firm performance according to profitability (Chiang and Hung, 2010, Lichtenthaler, 2009), R&D performance (Chiesa, Frattini, Lazzarotti, and Manzini, 2009), customer satisfaction (Chesbrough, 2011, Wagner, 2010), product innovativeness (Laursen and Salter, 2006), and new product success (Rohrbeck et al, 2009). Furthermore, other researches have emphasized on the relationship between some determined and specified perspectives of open innovation and performance, such as collaboration with other innovative parties and knowledge resources (Chesbrough and Prencipe, 2008), external technology commercialization (Lichtenthaler, Ernst, and Hoegl, 2010) and co-creation with customers (Fang, Palmatier, and Evans, 2008, Popa et al. 2017).

Hadjimanolis (2000), Lee et al, (2010), Romijn and Albaladejo, (2002), Van de Vrande et al, (2009) have analyzed the effect of open innovation practices in smaller organizations, to examine if the innovation performance of SMEs would be leveraged by using strategic external relationships with other knowledge and information sources. For instance, Lee et al (2010) address to the notion of open innovation in the context of SMEs. They emphasize to the potential and applicability of open innovation in SMEs and suggest that different networking methods can simplify open innovation among small Korean firms. Recently some evidence show that the introduction of various distinctive types of innovation sources is really and apparently dealing with the exploitation of different kinds of knowledge and information sources and collaborative partnerships (De Jong and Vermeulen 2006, Todtling, Lehner and Kaufmann 2009, Varis and Littunen 2010, Lasagni. 2012).

There is a common understanding that SMEs are flexible and have powerful relationships with customers, it enables them to have a quick response to technical and market changing conditions. According to the study of Rothwell (1994), it is imaginable that small firms generally have synergistic, internal effective and quick internal communications, which can creates less bureaucratic condition inside the firm, and establish a dynamic management style. The study of Freeman and Soete (1997) address that, flexibility is a big advantage for SMEs according to innovative practices. The capacity and capability of small firms for innovation practices is deeply depend on to a great span of internal motivation and stimulus, which might or might not persuade firms to get involve in innovation activities (Acs and Audretsch 1988, Kleinknecht et al. 1989, Rothwell and Dodgson 1994, Lasagni. 2012).

According to the study of Van de Vrande (2009), the construct of inbound open innovation was unpacked and considered as five dimensions of inbound sources of open innovation, which are definitely paralleled to the study of Van de Vrandea et al (2009). It is supposed that in this research, different sources of inbound open innovation have different effects on new product innovativeness of SMEs that is empirically assessed. In other words, it is assumed that: (1) Sources of inbound open innovation can be different. (2) Different sources of inbound open innovation can have different effects on new product innovativeness in SMEs. Van de Vrande et al. (2009), Lichtenthaler (2008a), and Laursen and Salter (2006) have published three prominent studies encompassing a broad set of open innovation activities in SMEs by focusing on larger quantitative data sets. Recently, scholars have started to empirically analyze and examine, through large-scale quantitative studies, the effects of inbound open innovation activities on firm's innovation performance. One notable study in this vein is the research of Inauen and Schenker-Wicki (2011) on the relationship between the openness of the outside-in process in R&D management and the companies' innovation performance.

The research of Inauen and Schenker-Wicki (2011) focuses on the influence of an open outside-in (Inbound) innovation management strategy on companies' innovation performance measured in terms of product innovation, process innovations and sales' share of new products on the total sales. Then a multi-dimensional construct of innovation performance is adopted and accepted. Moreover, Parida et al (2012) investigate the effects of four inbound open innovation activities on innovation performance of SMEs. Research of Parida et al (2012) focus on four different inbound open innovation activities namely *technology scouting*, *horizontal technology collaboration*, *vertical technology collaboration*, and *technology sourcing*, and investigate and examine their effects on innovation performance of SMEs (Chesbrough, Vanhaverbeke, and West 2006, Lichtenthaler 2008a, Van De Vrande et al. 2009).

More recently, Cheng and Huizingh, (2014), focus on the relationship between open innovation and innovation performance. They find and address to this issue that adopting independently and or simultaneously both types of open innovation (For instance; inbound and outbound open innovation) are related positively and significantly to four main dimensions of innovation performance: new product/service innovativeness, new product/service success, customer performance, and financial performance. In addition to study of Inauen and Schenker-Wicki (2011), however, Cheng and Huizingh, (2014) measure the direct relationship between open innovation and innovation performance defined as a whole, totally and entirely multidimensional construct. Likewise, recent discussions emphasize that SMEs play an increasingly predominant and prevailing role in today's innovation landscape (Chesbrough, 2006a, Brunswicker and Vanhaverbeke. 2011).

SMEs are very different and varied from large business firms as most of them lack and confront insufficient formal process for developing new products and services (Nieto and Santamaria 2010). This is remarkably due to possessing limited and scarce resources to dedicate and devote to that process, which can make a defective and imperfect circle of condition that hinders most small businesses from growing significantly. Therefore, literature suggests that SMEs should practice in innovative context in a different format from large companies, and concentrate more on building networks with other companies, research institutions, customers and suppliers (Kleinknecht &Reijnen 1992, Bullinger et al, 2004).

This type of open innovation activity generally focuses on early phases of innovation practices, expressing and addressing external sourcing of technology, knowledge, innovative ideas and intellectual property, therefore, SMEs make networking with technology and innovative knowledge idea providers (Chesbrough and Crowther 2006, Vanhaverbeke and Cloodt 2006, Vrgovic et al, 2012). Inbound open innovation activities and sources refer to the ability to attain, explore and survey knowledge, technological and innovative sources from external partners. These partners and external sources of knowledge and innovation can be named as suppliers, customers, competitors, consultants, research institutions, universities, or even governments (Faems, Van Looy, and Debackere, 2005,Tether and Tajar, 2008).

Research and studies regarding inbound open innovation activities have focused and encompassed the integration and comprehensiveness of external partners (Dittrich and Duysters, 2007, Enkel, 2010) and new sources of innovative ideas (Piller and Fredberg, 2009, Cheng & Huizingh, 2014). Besides, Henard and Szymanski, (2001), Montoya-Weiss and Calantone, (1994), believe that innovation performance implies to the degree and level of success attained by firms in achieving goals and targets related to new products or services. According to Atuahene-Gima and Wei, (2011), Baker and Sinkula, (2007), Blazevic and Lievens, (2004), Im and Workman, (2004), Salomo, Talke, and Strecker,(2008), Cheng and Huizingh, (2014), a widespread scope of innovation performance measures such as new products, service innovativeness, the degree to which new products or services succeeded, customer services, and the percentage of sales have been carried out. It is considering and focusing on antecedent studies about the relationship between inbound open innovation and innovation performance. Bahemia and Squire, (2010) also investigate the effects of three dimensions of inbound open innovation (Breadth, Depth and Ambidexterity) on new product performance. Based on previous literature, this PhD research first investigates the causal relation between five different types of inbound open innovation sources and their effects on new product innovativeness.

Building on these studies, in this PhD thesis the innovation performance and its components is factored and decomposed that are individually considered and modelled. In this regard, only one construct is considered: new product innovativeness. In particular, consistently with innovation performance literature like Cheng and Huizingh, (2014) which measure the impact of outside-in (Inbound) open innovation on innovation performance that one of its components was new product/service innovativeness. Thus, in this research, new product innovativeness is considered as an outcome of inbound open innovation activities at firm level of small and medium sized enterprises (SMEs). Based on the study of Van De Vrandea et al (2009), that segment open innovation activities into two parts: technology exploitation and technology exploration as outbound and inbound open innovation respectively. Thus, in this PhD study, inbound open innovation activities, which hereinafter will be called inbound open innovation sources is unpacked and considered as five independent variables and various types of inbound open innovation resources. Laursen and Salter (2006) provide empirical evidence that openness, measure as the number of external sources, positively affects a firm's financial innovation performance. Their measure of openness referred to as search breadth inspired further studies on open innovation (Chen, Chen, and Vanhaverbeke 2011, Parida, Westerberg, and Frishammar 2012).

SMEs innovation models and strategies differ from large firms. Even though SMEs are usually more flexible, less formalized and fast decision makers, their financial resources for internal R&D are limited and they lack sufficient financial resources (Acs and Audretsch, 1987, Bessant, 1999, Lee et al, 2010, Van de Vrande et al, 2009). In addition, they do not have this capability to apply all innovation activities required to recognize successfully an innovation (Lee et al, 2010); therefore, external innovation resources and operational assets are greatly relevant and noteworthy to SMEs (Baum et al., 2000). As a common result and outcome of innovation practices, SMEs may have more tendencies to exploit much more from inbound open innovation sources. Inbound open innovation search strategies that are non-monetary in essence may be highly attractive and interesting to SMEs in order to improve their own innovation performance (Van de Vrande et al., 2009, Harryson, 2008, Brunswicker and Vanhaverbeke, 2011).

One of the comprehensive literature reviews regarding the notion of product innovativeness is suggested by Garcia and Calantone (2002), which it is crucial and significant to concern the concept of product innovativeness from both technological and marketing aspects. Product innovativeness can be defined as the degree that a firm's new product needs unknown technological and marketing resources and capabilities based on resource based view and organizational learning theory (Molina-Castillo and Munuera-Aleman, 2009, Song and Parry, 1997). The level of product innovativeness will be high when new product of firm needs a large number of unknown and unexplored technological and marketing resources and capabilities (Feng et al, 2016). Product innovativeness (Ziger, 1997) has been considered as a main and critical concern (Masaaki and Scott, 1995, Schmidt and Calantone, 1998) that it is regarded as a vital and essential antecedent factor and function to product success (Zirger, 1997, Sethi et al, 2001), which is greatly and extensively dealing with sustainable business success indeed (Henard and Szymanski, 2001). Innovative products provide substantial opportunities for businesses according to the context of growth and expansion into new areas and scopes. Substantial and considerable product innovations permit firms to create and build superior position in the competitive market, and enable new entrants to the markets to benefit from opportunities and obtain a position in the marketplace (Danneels and Kleinschmidt, 2001). Product innovativeness is conceptualized as frequently implies to "perceived newness, novelty, originality, or uniqueness of products" (Henard and Szymanski, 2001). The concept of perceived newness covers two dimensions: from the consumers' aspect and the firm's aspect (Atuahene-Gima, 1995, Cooper and de Brentani, 1991, Danneels and Kleinschmidt, 2001). In 1996, Andrews and Smith address and define the notion of appropriateness, the extent to that a new product is observed as helpful and beneficial to some customers, as a crucial and critical feature of product innovativeness. Danneels and Kleinschmidt (2001) configure and integrate two aspects of product innovativeness: (1) From the customer's perspectives, specifications such as innovation peculiarities and features, accepting and adoption of risks, and levels of alteration which have made previous behavioral patterns and methods to be considered as types of product newness. (2) From the firm's perspective, acquaintance with the environment and marketplace and project-organization compatibility, and technological and marketing characteristics are regarded as aspects and features of product innovativeness. Also according to Wang and Ahmed (2004), product innovativeness is defined as the "novelty and meaningfulness of new products introduced to the market at a suitable and timely fashion". In this research, new product innovativeness is addressed and considered from firm's perspective operating in Petroleum and Gas equipment industry when outsourcing their product innovativeness requirements by inward technological and innovative sources as inbound open innovation practices from outside their firm's boundaries to boost and improve their product innovativeness function.

As small and medium sized firms usually confront with scarce resources to develop and commercialize new products inside their firm's boundaries and, consequently, these firm are more often intended or forced to collaborate with other organizations and external resources. Hence, the term of technology exploration implies to those activities and practices, which enable enterprises to acquire and utilize new knowledge and technologies from the outside. Based on the survey and relevant open innovation literature in SMEs, five practices were distinguished related to technology exploration: *customer involvement*, *external networking*, *external participation*, *outsourcing R&D* and *inward licensing of IP* (Van de vrande et al, 2009).

In this regard, it is supposed that there are different types of relations between different sources of inbound open innovation and new product innovativeness in SMEs based on firm's perspective. As a result, in this research it is anticipated that different types of inbound open innovation activities or sources affect new product innovativeness of small and medium sized firms operating in Petroleum and Gas equipment industry. Therefore, it is predicted that:

**H1:** *Different types of inbound open innovation sources positively and significantly affect new product innovativeness in SMEs.*

#### *1.1.3. The Effect of Customer Involvement on the New Product Innovativeness in SMEs*

According to Van de Vrande et al, 2009, the first practice of technology exploration as an open innovation activity for SMEs is customer involvement. Customer involvement is directly and specifically involving customers in your innovation processes inside your firm, for example by proactive market research activities to check and investigate customer's needs and their new consuming requirements, or by innovating and developing new products based on customers' specifications, modifications or adjustments of products similar like yours. Open innovation theorists realize that customer involvement is an important and critical alternative needs to be concerned in internal innovation processes (Gassmann, 2006).

Firms might be able to benefit and take advantage from their customers' ideas and behavioral model and innovations by active and dynamic market research. They are preparing and supplying tools to examine, investigate and develop products alike and equivalent to the ones that are recently offered, or by producing products based on the designs and ideas of customers and evaluating what may be learned from general product development (Van de vrande et al, 2009). Furthermore, sourcing external knowledge, technology and innovative ideas among the traditional value chain might be a valuable approach for SMEs. Small and medium sized firms might search and explore downstream to access "sticky information" on customer needs and requirements, customer community, customer insights and customer experience. This type of information is tacit and difficult and rigid to be stated and articulated (von Hippel and von Krogh 2006, Reichwald and Piller 2006). The involvement of indirect customers and or users might provide and grant us new insights and intuitions into new business and market opportunities beyond existing current products and markets (Enkel, Kausch, and Gassmann 2005, Brunswicker and Vanhaverbeke, 2015).

Exploiting external knowledge resources and take advantage of using this kind of external innovative assets is growing as an important factor for developing successful new products (Chao-Ton et al, 2006, Feng and Wang, 2013, Peng et al, 2014). Customers have been considered as a very prominent and critical source of external knowledge from scholars and practitioner's points of views. It is emphasized to the importance of customer involvement into new product development process (Feng et al, 2010, Menguc et al, 2014, Mishra and Shah, 2009).

Customer involvement is the level and degree of involving and engaging customers in an organization's new product development project and non-stop, persistent and ongoing improvement programs (Feng et al, 2014). Customer involvement is varying from offering and preparing slight design ideas and suggestions from consumers to have a responsiveness duty toward the entire development and innovativeness of a new product (Chen and Paulraj, 2004). According to Feng et al, (2014), it is inferred that customer involvement has been in the core consideration of new product innovation literature. Because this is mostly contribute to develop and improve new product performance and also customers can be engaged and involved not only in existing market opportunity analysis, but also in product design, commercialization of new product and uninterrupted constant improvements in new product development projects. Previous studies like Carbonell et al, (2009), Feng and Wang, (2013), Gruner and Homburg, (2000), Johnson and Luo, (2008), Lau, (2011) regarding customer involvement showed that this concept increases new product performance by realizing and perceiving customer requirements much better, finding new innovative ideas, improving product quality, and decreasing development time. Based on study of Olson et al, (1995), Prajogo, (2016), it is perceived that according to strategic alignment, customer involvement as the strategic option of a firm has to be fit with the essentials and needs of new product development process to increase and boost new product performance. Due to resource based view (Barney, 1991), it is important to address and explore how it can be feasible to leverage and increase resources possessed by internal tasks and performance and external resources or strategic partners which affect firm's success (Lau et al, 2010).

Wernerfelt, (1984) address this issue that based on the structure of resource-based view, a company is supposed to be as a bunch of resources. Long-term competitive advantage would be possible to be obtained if a "firm owns valuable, rare, inimitable, and non-substitutable resource" (Barney, 1991). The resource-based view discusses that firm resources involve tangible, transparent and apparent resources (such as products, equipment and employees). In addition, intangible and abstract resources (such as corporate culture, brand reputation, and relationship with customers) (Barney, 1991), as well as internal organizational resources (such as employee skills and expertise and raw materials) and external resources (such as market response and customer relationship management) (Wade and Hulland, 2004, Lau et al, 2010). Lau et al, (2010) suggest that external comprehensive and integrative capability is one type of external resources. Therefore, customer involvement can help firms to obtain valuable and inimitable resources needed for innovating and developing new products. Several current researches have regarded customer involvement as important and necessary external source and capability for a company to improve and develop new product performance (Feng and Wang, 2013, Lau, 2011).

Feng and Wang, (2013), Mishra and Shah, (2009) believe that referring to resource based view; it is noticeable that firms require involving and including participation of customers into their new product development process in order to exploit customers' resources and capabilities such as ideas, or knowledge and insights toward products to increase and leverage product development performance and success. Therefore, customer involvement is a source of competitive advantage through preparing resources, knowledge and information needed by new product development (Feng et al, 2010, Feng et al, 2014). Referring to Lau et al, (2010) and Wang et al, (2016) studies, it is inferable that involvement of customers into the product development process permits customer priorities and requirements to be received and gained by the firm and simplifies the building of effective and synergistic customer centric products which might boost and increase new product performance. A better comprehension and perception of customer needs and preferences offer chances to company to attain distinguishing and specific resources and information that can direct and lead to higher level and dominant performance. In contrast, lack of adequate concern and worry about customer priorities and requirements in the product development process mostly causes to sudden malfunctions and new product fails (Menguc et al, 2014). Likewise, customer involvement contributes to diagnose design difficulties and defects on a proper time, choosing ideas and insights effectively and efficiently, decrease design changes, which may occur in next phases of the new product development process and prepare innovative ideas and knowledge (Lau, 2011). This can improve and enhance new product development speed (Feng and Wang, 2013), manufacturing agility and activity (Feng et al, 2010) and customer satisfaction (Tan and Tracey, 2007). Thus, it is concluded that greater and higher degree of customer involvement will lead to more proper, timely and relevant customer resources and information beneficial to firm. Firms would be able to utilize the resources and information to make innovation and marketing differentiation that can result to leveraged new product performance (Lau, 2011, Feng et al, 2016).

During past decades, market research just concentrated on prediction of customer adoption and acceptance of innovation and tried to foresee and forecast the prospective results that will gain from a firm's marketing mix. Currently, high demanding philosophies and approaches of customer participation express to customer involvement and their role of co-creation in the improvement and development process (Maklan et al, 2008). According to Reinartz et al, (2004); Dell'Era, (2010), it can be suggested that customer relationship management has been in the core and main attention of importance and prominence, because customers are more cautious and aware about product options, design or beautiful and attractive perspectives, symbolic and also emotional dimensions of products. There is the concept of lead user innovation which is proposed by von Hippel (1986), narrates that large number of commercialized significant products are primarily ideated, imagined and also prototyped by lead users instead of producers or manufacturers of products (Inauen and Schenker-Wicki. 2011).

Rothwell and Gardiner (1985) argue that there is remarkable and substantial gain power by involving customers and user in the product design and development stages in firms (Freel. 2000a). Moreover, open innovation scholars recognize that customer involvement understand and realize as one prominent and crucial alternative to be introduce and presented to internal firm's innovation processes (Gassmann, 2006). In accordance to the study of Von Hippel (2005), customers and users of products are extensively considered not just passively accepting innovations, but they might much more extend and develop their own innovative ideas and knowledge, which producers and manufacturers can copy or imitate. Firms may take advantage and benefit from their customers' ideas and innovative knowledge by dynamic and active market research. They prepare required tools to examine and develop new products similar to those existing products that are currently launched and produced, or by producing products, which is inspired by the designs of customers, and assessing what might be perceived and learnt from general product development (Van de Vrande. 2009).

As customer involvement may help small and medium sized firms to increase their capacity and capability of performance, In addition, the engagement and involvement of customers may enable firms to enhance and improve the effectiveness and innovativeness of their new products. It might help firms in product design, changing features, and receiving new innovative ideas for new product development projects. As a result, in this research it is anticipated that customer involvement as one of the aspects of inbound open innovation activities or sources affect new product innovativeness of small and medium sized firms operating in Petroleum and Gas equipment industry. Therefore, it is predicted that:

***H1a:*** *Customer involvement as one of the inbound open innovation sources positively and significantly affects new product innovativeness in SMEs.*

### *2.1.3. The Effect of the Industrial Network Partnership on the New Product Innovativeness in SMEs*

Establishing relationships with network partners are generally considered as a long time centric practice and its purpose is to attain and obtain joint and common value creation rather than effective interactions and efficient transactions. This relationship is built according to trust and confidence, and are determined by reciprocal comprehension and understanding among network partners. Simultaneously, network partners provide SMEs access to supplementary innovation assets and supplementary operational resources such as "manufacturing, marketing and access channels" (Teece, 1986, Christensen et al, 2005), these kinds of resources usually require many years to be obtained by firms (Baum et al, 2000).

According to the effectiveness and synergistic essence and nature of interplays and interchanges among firms in the format of network partnership, network relationships provide the condition easier to recognize access and attract external ideas and sources of knowledge. Referring to Van de Vrande et al, (2009), it can perceive that for SMEs, network relationship and partnerships in an industrial collaborative format are greatly and highly important sources of new ideas and knowledge (Brunswicker & Vanhaverbeke, 2011).

External networking as an industrial partnership is another notable and significant perspective of external knowledge sourcing which is systematically correlated with open innovation (Chesbrough et al, 2006). It comprises all practices and activities to attain and sustain relations and ties with external sources of social capital such as individuals and organizations. In essence, it includes both formal collaborative projects and more general and informal networking cooperation and activities. Networks permit firms to meet quickly particular knowledge requirements without any need to spend a long period of time and expenditure to develop and increase internal knowledge as sources of organizational knowledge or information inside their firms or attain and absorb this knowledge through vertical integration in value chain. Likewise, networks might be developed and advanced into formal collaborative endeavors such as R&D alliances. These alliances among those firms, which are not competing with each other, have become a particular tool for obtaining and attaining technological capabilities and capacities (Gomes-Casseres, 1997, Van de Vrande, 2009).

Small and medium sized enterprises (SMEs) also have this target to search and explore for “upstream” to benefit and take advantage from the specialized and professional expertise of suppliers particularly in technological area if they want to involve them in the process of new product development. According to Tsai, (2009), it is believed that suppliers as a part of network partnership can help to provide new ideas and innovative knowledge for improved and enhanced technological solutions or innovation process. SMEs might consider suppliers as a substantial and important external source as they are usually focus and emphasize on solutions and commercial value and advantage in the short time (Chesbrough and Prencipe, 2008, Dyer et al, 1998, Brunswicker & Vanhaverbeke, 2011).

Networks for SMEs lead to improve and advance interaction and collaboration between various players that indicate a complementary reply and reaction to lack of trust and confidence occurring because of development and exploitation of new technologies. Hence, it is crucial for SMEs to connect and link different firms, research institutions, suppliers and also customer networks as an intensive network partnering that enable them to share common knowledge and profit from complementary capabilities and competencies (Bullinger et al, 2004). Networking can be considered as a supplementary item when collaboration and networking collaborating are needed to gain and achieve economies of scale, or to combine and synthesize different skills, technologies, capabilities and competencies (Mancinelli and Mazzanti, 2008). Kaminski et al, (2008) believe that SMEs hold and retain few external relationships in their innovation process. Based on the study of Hewitt- Dundas (2006), the external resources, capacities and capabilities that SMEs would be able access thorough external innovation and network partnership might prepare the situation for them to use the stimulus and capacity to innovate, whereas, the lack of innovative network partnership cause a negative effect on innovation performance. Cumbers et al. (2003) state that benefits and advantages that SMEs can gain from local and centralized networks are specifically important for SMEs to contribute such firms to decrease and deviate the firm size related advantages and benefits which large firms possess. Likewise, Fukugawa (2006) show this insight that according to research and study in Japan; networking was an ability and capacity to leverage and accelerate innovation process inside firms and prepare the condition of accessing to specialized skills and resources. Furthermore, it should be mentioned that the progress and success of innovation often needs owning and access to assets that are supplementary to innovative resources (Teece, 1986). As SMEs confront limited and scarce resources, it would be difficult for them to control and overcome internal and external limitations and restrictions for the expansion and development of innovation activities. Thus, there is a strong requirement for completing and integrating resources, such as resources relevant to R&D continuing and practices, production, marketing and management capabilities and capacities (Lofsten and Lindelof, 2005).

Suppliers as one of the main network partners and members, prepare crucial and substantial external source of knowledge, technological and innovative idea transfer. It should be emphasized that the long time relationships between firms and their suppliers in order to advance and upgrade supply chain practices and central business processes is in the main and core important attention (Lambert and Cooper, 2000; Kim, 2000; Walton et al, 2006). The intention of suppliers to collaborate in innovation practices are firmly relies on the supplier's dependence and reliance on the firm. Based on the study of Kamath and Liker (1990), affiliated and interdependent suppliers are being considered more intended to collaborate and invest in innovation activities to sustain and maintain their customers and the company. Furthermore, collaboration with competitors inside the network is another usual type of attaining and obtaining knowledge. Based on Hamel et al, (1989) and Hamel, (1991) research, the continuum and domain of collaboration with competitors is very extensive and involves strategic alliances, joint venture, outsourcing agreements, product licensing, and cooperative research. Industrial network collaboration can reduce the turbulence and uncertainties exist in the market and technology development activities (Garud and Karnoe, 2000, Inauen and Schenker-Wicki, 2011).

Current literature on the relationship between network collaboration based on innovation interactions and cooperation and innovation performance of firms has been studied and investigated. Some scholars emphasized that network collaboration or exploiting a large number of external players and parties as external knowledge and innovation sources had a positive impact on innovation performance of firms (Brioschi et al, 2002, Nieto and Santamaria, 2007). Referring to Cainelli et al, (2007), networking is considered as the concept of social capital and demonstrated that R&D activities and networking as the social capital belief are implying to supplementary and completing operating and motivating forces of innovation outputs and results. Brioschi et al, (2002) state that social activities and interactions found on trust and collaboration has a prominent role in coordination or harmonizing of the practices and activities among different SMEs. In addition, there are case studies based on developing countries that express the relationship between network or external partners and knowledge sources and the innovativeness of SMEs (Hadjimanolis, 1999, Biggs and Shah, 2006, Liefner et al, 2006, Kaminski et al, 2008). Biggs and shah (2006) research reveal that networked SMEs in Africa had benefited more innovative practices. According to an investigation and survey on Zhong Guan Cun SMEs in China, Liefner et al. (2006) found the collaboration model between firms and identified that cooperation and practices with foreign firms could help them to receive and exploit new innovative ideas and to enter the market with new innovative products (Zeng et al. 2010).

External networking which in this PhD research according to in-depth interview with CEOs and managers of SMEs operating in Petroleum and Gas equipment industry and the essence of their collaboration with their counterparts and partners in the network collaborating which is called in this research as industrial network partnership is another important dimension of technology exploration. This is consistently associated with open innovation sources (Chesbrough et al, 2006). It is defined as causing to collaborating with external network partners to support and strengthen innovation processes, for example to acquire external innovative knowledge or human capital.

Based on Narula (2004) research, it can infer that networking partnership is considered as a suitable method of collaboration for SMEs, more frequently as a possible technique and strategy to innovate greater and in a better way as large firms do. According to this notion, there is evidence and studies that the success and advancement of SMEs in comparison to large companies is based on SMEs' ability and capability to exploit external networks more efficiently and effectively (Rothwell and Dodgson 1994). SMEs can apparently benefit and take advantage from external collaborating with networks that are well organized, developed and managed (Inkpen and Tsang 2005), leading them to strengthen and reinforce their competitive advantage (Bougrain and Haudeville 2002), to provide much more innovation capabilities for these firms (Lee et al, 2010). These industrial collaborative networks can help SMEs to jointly innovate and co-develop products and services (Gulati 1998), and help all the firm members inside the network to share experience, enhancing and enriching learning effects for future innovation practices (Lundvall 1993, Argote and Ingram 2000).

According to Diez, (2000) and Vrgovic et al, (2012) studies, it should be mentioned that since SMEs usually confront advanced uncertainties and unpredictable barriers to innovation, network partnership is believed to represent a complementary response to lack of security and confidence occurring from development and utilizing of new technologies so that diminishing and decreasing uncertainties in innovation. Networking is frequently used by SMEs, which have carried out and performed R&D activities with innovative willingness and intentions to search and explore cooperative opportunities (Bergman, 2008). The significant aspect of networking indicates various actual situations which is known worldwide, so that inter firm collaborations is the main preliminary and pioneering factor to better and successful performance of both the individual and single firms and the entire and total network (Mancinelli and Mazzanti, 2008). Firms chase and follow inter firm collaborations in order to achieve and obtain sources of knowledge, which is accessible and available outside of the firm's environment. It provides quick access to new and modern technologies or new markets, which provide economies of scale in joint R&D and production strategies. Moreover, it contributes to decreasing risks by sharing it through practices that are out of reach and are rarely being used according to the weaknesses of capacities and capabilities of single firms (Fischer and Varga, 2002, Zeng et al 2010).

As network partnership contributes to small and medium sized firms to increase their internal capacity and capability to innovate in a wide range and improve their performance based on innovative practices. Network partnership provide complementary innovation resources for small and medium sized firms leading to increasing effectiveness and innovative performance of such firms, and regarding this notion, the interactions among small and medium sized firms makes it easier for them to access and extract external innovative ideas and knowledge. For SMEs, industrial network partnership and relationship in industrial collaborative formats are important sources of knowledge. External networking as industrial partnership is another prominent aspect of external knowledge sourcing related to inbound open innovation, causes firms to jointly innovate and develop new products. As a result, in this research it is anticipated that industrial network partnership as one of the aspects of inbound open innovation activities or sources affect new product innovativeness of small and medium sized firms operating in Petroleum and Gas equipment industry. Therefore, it is predicted that:

***H1b:*** *Industrial network partnership as one of the inbound open innovation sources positively and significantly affects new product innovativeness in SMEs.*

### *3.1.3. The Effect of the External Participation on the New Product Innovativeness in SMEs*

According to Van de Vrande et al, (2009), external participations enable the firm to upgrade or update innovation capabilities that were neglected or overlooked at the first phases of activities or were not in the core consideration of the firm. External participation is defined as "Equity investments in new or established enterprises in order to gain access to their knowledge or to obtain other synergies" (Van de Vrande, 2009). Firms might have a strategy to invest in startups and other businesses in the market to become aware of potential and capable opportunities (Chesbrough, 2006, Keil, 2002). Based on Van de Vrande et al, (2006), it is perceived that the strategy of equity investments as an inbound open innovation activity offer new opportunities for incremental and advanced increase of external collaboration with firms that their technologies were proved to be significant and valuable.

Equity investments as external participation practice in newly established corporate and enterprises in order to achieve and obtain more special and peculiar technological knowledge or services, new innovative ideas or even innovative products and services is considered as a new external searching strategy which is called "Corporate Venturing". In this research according to Van de Vrande (2009, and 2006), external participation is a kind of new term of corporate venturing that is the practice of firms directly investing corporate funds into external startup companies to achieve more synergistic outcome and output for their firms.

Firms are progressively exploiting corporate venturing to learn or acquire innovative ideas from knowledge sources beyond their firm's boundaries. Different types of external corporate venturing (Keil, 2002, Miles and Covin, 2002, Sharma and Chrisman, 1999) such as, "corporate venture capital investments, alliances, joint ventures alliances and acquisitions of entrepreneurial ventures, enable firms to learn". In addition, it helps firms to acquire more innovative knowledge flows from external environment. External venturing might allow firms to control and investigate the development of markets and technologies (Keil, 2002, McNally, 1997, Winters, 1988), to acquire and absorb antecedent technologies, which were used by their alliance partners and collaborative sources (Mowery, Oxley, and Silverman, 1996, Stuart and Podolny, 1996). It aims to enter, expand and develop new emerging market structures and segments (Barkema and Vermeulen, 1998, Mitchell and Singh, 1992), and more usually to be transformed into a more innovative firm so that to leverage their growth rapidly (Powell, Koput, and Smith-Doerr, 1996, Stuart, 2000). There have been several studies, which empirically examine the learning, and innovative implications concentrating on various types of external corporate ventures. For example, previous studies have indicated a positive relationship from corporate venture capital investments to parent and major firm's innovativeness (Dushnitsky and Lenox, 2002, Schildt et al, 2005).

As the technological changes are happening quickly, technology based new business development cannot be expanded and obtained through internal corporate venturing (McGrath and MacMillan, 2000). Thus, external corporate venturing is considered as a more important part of enterprise's long-term growth and development strategy (Keil, 2002, Chesbrough, 2003, Van de Vrande et al, 2006). According to Keil, (2002), Miles and Covin, (2002), Sharma and Chrisman, (1999), it is revealed that external corporate venturing implies to the building and creation of new businesses by firms in which a firm leverages and increase external partners in an equity or non-equity inter organizational relationship. Firms are entering into inter organizational relationships either to establish and make new ventures or to develop and expand current existing internal business activities. There are different modes of corporate venturing such as corporate venture capital investments, non-equity alliances to develop and expand new business ventures, joint ventures, and acquisitions of the entrepreneurial ventures (Schildt et al, 2005).

Old method of external technology acquisition and growth have been attained and gained through the utilization of strategic alliances, joint ventures, licensing agreements, mergers and acquisitions. At current time, firms are more conscious and alert of other solutions such as corporate venture capital investments (Dushnitsky and Lenox, 2005a,b). Corporate venturing which is a kind of business development implies to the corporate entrepreneurial efforts by which new business organizations are made within the corporate organization (Sharma and Chrisman, 1999). There are differences between internal and external corporate venturing. External one is that firms exploit external partners and resources to build new ventures. Keil, (2002) and Veugelers (1997), define how internal R&D play role as a fundamental factor for recognizing external technological opportunities and capacities and utilizing of external obtained technologies. This can be called as absorptive capacity, which is "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal, 1990). They explain that a firm's absorptive capacity is a crucial and prominent factor to its innovative capacities and capabilities and that absorptive capacity is a function and output of the firm's degree and level of previous knowledge. In addition, internal technology development increases and boosts the firm's technological and innovative competence and leverages its ability to identify and adjust external acquired and attained technologies and innovative knowledge. Moreover, corporate venture capital investments as an external participation practice by firms can be regarded as "equity investments by established corporations in entrepreneurial ventures" (Dushnitsky and Lenox, 2006).

Corporate venture capital investments can be regarded as stimuli and motives for corporate venture capital funds as either financial (generating financial returns) or strategy to examine new capacities and capabilities. It expands and develops a supportive backup technology and innovative knowledge, to search and find strategic opportunities or to control and look at market developments (Siegel et al, 1988, Chesbrough, 2002, Keil, 2002).

Strategic technology alliances is a kind of "cooperative effort in which two or more separate organizations while maintaining their own corporate identities, join forces to share reciprocal inputs' (Vanhaverbeke et al, 2002). Strategic alliances can be in various formats of organizational forms, such as joint ventures, distribution and supply arrangements, and technology exchange (Inkpen, 1998). Even though they are being utilized for other aims and objectives such as sharing development and expansion risks and costs, attaining and achieving from supplementary knowledge sources and decreasing time to market

(Hagedoorn, 1993. Duysters, 1996), they are extensively being used to associate with turbulent competitive market conditions and environments. Strategic alliances as an external participation practice can be regarded as either equity based or non-equity. Equity based alliance, such as joint ventures include a method of financial investments either in the new firm, or in the partner firm. Therefore, these types of alliances offer a great and high exit costs (Gulati, 1995) and thus are not easy to be terminated comparing to non-equity method.

The greatest and biggest part of the alliances that are exploited and made these days are non-equity alliances and do not include and offer any type of financial investments. Non-equity alliances as another aspect of external participation are more inclined to be flexible than equity alliances. Also both equity and non-equity alliances include and represent a higher degree and level of commitment from the firm which investing than corporate venture capital investments. Mergers and acquisitions are other kinds of equity collaboration and alliances. For instance, acquisition activity is referred to those practices that one firm buys another company with this intention to obtaining and gaining access to the firm's knowledge, innovative resources and technologies (Schilling and Steensma, 2002). Different methods of technology sourcing enable firms to absorb and incorporate technology in a smooth way and at various occasions for the purpose of new business development process (Van de Vrande et al, 2006).

External participation in general could contribute small and medium sized firms to increase their knowledge capabilities and leverage the power of product innovativeness by investing in external partner's resources. Equity investments as an external participation strategy in new created startups are one way of increasing internal knowledge resources and technological capabilities as well as advancing synergies inside SMEs. In addition, this type of external participation in order to achieve to specialized knowledge, innovative technologies from new built corporates and enterprises is being called corporate venturing, by which firms can increase their external participation power and help the surging and upgrading internal innovative capabilities. According to environment turbulence, firms cannot further rely on their internal corporate venturing as internal knowledge capabilities, thus, they tend more to use external corporate venturing as external participation, which is a part of inbound open innovation practice in order to boost their innovation performance and develop their growth strategy. External participation is the third prominent component of external knowledge sourcing related to open innovation, causes firms to jointly innovate and develop new products. As a result, in this research it is anticipated that external participation as one of the dimensions of inbound open innovation activities or sources affect new product innovativeness of small and medium sized firms operating in Petroleum and Gas equipment industry. Therefore, it is predicted that:

***H1c:*** *External participation as one of the inbound open innovation sources positively and significantly affects new product innovativeness in SMEs.*

#### *4.1.3. The Effect of the R&D and Academic Outsourcing on the New Product Innovativeness in SMEs*

R&D outsourcing and academic collaborations with universities, academic and research institutions are in the core consideration and attention of SMEs as such external knowledge and innovation sources playing an important stance to leverage innovation performance of such firms. These collaborations with academic area are strongly supposed to be an originative, ingenious, and inventive for creating industrial knowledge as prerequisites for scientific approach as it might remarkably change the search method of inventions practices (Tsai, 2009, Fabrizio, 2006, Shinn and Lamy, 2006, Fleming and Sorenson, 2004). Relations and linkages with universities and research institutions represent rather a great extent of welltimed and proper trends and procedures for firms (Fabrizio, 2009, Brunswicker, Sabine, Vanhaverbeke. 2011).

According to the study of Loof and Broston (2008), and Inauen and Schenker-Wicki, (2011), it is inferred that collaboration practices between universities and firms have a positive effect on the level and degree of new product innovativeness profits and increase the possibility of firm to search and acquire for a patent. Relationships and linkages with innovation centers and knowledge networks are considered as advantages and benefits, which can be obtained to organizations by professional consultants, university researchers and scholars, and technology centers like science and technology parks (Le Blanc et al., 1997, Hoffman et al., 1998 Oerlemans et al, 1998, Keizer, J. A., Dijkstra, L., and Halman, J. I. 2002).

Small and medium sized firms might outsource R&D and innovative activities from external environment to obtain and gain external knowledge and innovative ideas. This can be done through the channel of universities or research institutions in R&D and academic collaboration format, which offer scientific and research outputs as external sources of knowledge for firms as a component of inward open innovation paradigm. Firms might make effort to outsource R&D practices and utilize external innovative knowledge and R&D sources for internal exploiting to get high innovation performance. Gassmann, (2006) and Van de Vrande, (2009) point out that according to the core part of open innovation paradigm, it is presumed that firms do not have this capacity and capability to perform and fulfill all R&D and innovative practices by themselves. But instead of the solely depending on internal R&D and innovation activities, they need to invest on external knowledge resources which is feasible to be licensed or bought from research organizations.

Buying R&D and academic research projects and services from universities, public research institutions, consultants, commercial engineers or even suppliers are R&D and academic outsourcing practices for SMEs which are considered as inbound open innovation activities which can contribute to leverage and boost the innovativeness of new products in SMEs (Van de Vrande, 2009). It has been emphasized and addressed to this issue by some researchers that collaborations with universities and research institutions have a positive effect on product innovation performance (Tsai, 2009, Hung and Chiang, 2010, Un et al, 2010). Apparently, universities and research institutions possess this mechanism and potential system that can make the process much feasible and provide the possibility of achievement to new and complicated knowledge (Mazzola et al, 2012).

Technical service firms such as engineering firms and high tech institutions, which provide special services for enterprises, have been considered as important players in the innovation process. Partnership with universities and research institutions as collaborative R&D activities seems to be beneficial and functional approach by which strategic and organizational flexibilities can be developed and new knowledge and innovative ideas can be achieved (Pisano, 1990,Quinn, 2000, Fritsch and Lukas, 2001). Since R&D outsourcing as an organizational functional fulfilment has been caused to organizational cost savings in most enterprises, majority of managers and CEOs are exploring and searching the value of R&D and academic collaboration for achieving higher innovation performance rates (Gassmann, 2006).

Various research studies show and examine the significant role and stance of universities and research institutions on firm's innovation performance (Belderbos et al., 2004; Liefner et al., 2006). Generally, these academic and research collaborations as a network cooperation is supposed to diminish and reduce the existing risks of the cooperating partners which cause to foster productivity and effectiveness (Pekkarinen and Harmaakorpi, 2006).

According to Belderbos et al. (2004), the collaboration with research organizations and universities as the most productive and efficient methods to obtain and gain innovations, desired to find new markets and segments by the firms. According to the study of Liefner et al., (2006), collaborations with public research institutions and academic higher education organizations are usually considered a crucial and substantial source of new knowledge for SMEs in developing economies. Universities are greatly regarded as the strong causing factor of innovation and development in science and technology. Several scholars have addressed the significance of universities in innovation in developing countries. Liefner et al. (2006) show that in developing countries, which possess powerful higher education organizations, and research institutions, universities would be able to affect directly on SME innovation performance. In addition, research institutions are considered to become as important partners to support the innovation practices in business activities of SMEs (Diez, 2000). Fritsch and Franke (2004) demonstrate that a relationship with public research institutions was led to R&D practices, enable firms to attain an adequate and comprehensive innovation level to be qualified and be prepaid for patenting. Nieto and Santamaria (2007) identify that firm's collaborations with research institutions would reinforce and boost their innovation performance (Zeng et al, 2010).

As small and medium sized firms are not capable enough to invest in all internal R&D and academic research projects to fill the gap of innovating new product or developing new products in their projects and increase their performance. They have to establish new relationships and make linkages with external R&D and academic sources such as universities or research institutions, which exclusively and purely focus on R&D projects and academic research and studies relevant to the firm's requirements. In this regard, this kind of collaboration with external R&D resources such as universities and academic and research institutions can affect properly and positively on innovation performance of firms. As a result, in this research it is anticipated that R&D and academic outsourcing as one of the dimensions of inbound open innovation activities or sources affect new product innovativeness of small and medium sized firms operating in Petroleum and Gas equipment industry. Therefore, it is predicted that:

***H1d:*** *R.D and Academic outsourcing as one of the inbound open innovation sources positively and significantly affects new product innovativeness in SMEs.*

### *5.1.3. The Effect of the Inward Licensing on the New Product Innovativeness in SMEs*

Studies report that the topic of intellectual property and licensing of patents have been attaining and drawing a great attention as an important phenomenon in inter firm R&D collaborations (Hagedoorn, van Kranenburg and Osborn 2003) also the amount and ratio of jointly owned patents has been growing continuously and consistently during the past decades (OECD 2002). Inward licensing and buying patents from other companies is considered as a type of cooperation with competitors. For instance, one type of collaborative relationship with competitors is product-licensing (Hamel et al., 1989a; Hamel, 1991). Licensing from other firms is regarded as one of the most generally and frequently implied and exploited method in order to use external technology and knowledge sources. Based on the study of Tidd and Bessant, (2009) and Inauen and Schenker-Wicki, (2011), it is inferable that licensing is explained as the utilization of intellectual property of other firms during a specific and peculiar time.

Different studies have shown that there exists a positive relation between the success and progress of the firms and increasing capabilities and capacities of its patent holdings and portfolios. An intellectual property strategy therefore has to target and make an objective of developing and expanding patent holdings and portfolios with advanced and great type of quality. Ernst and Omland (2003) emphasize that new startups and newborn firms with intensive technology in particular in biotechnology firms, would be able to enhance and increase their profit, advantages and growth by using patents in order to protect their products. Patents and licensing of intellectual properties are known as potent and strong tools for innovation activities and technology management issues inside firms to remove barriers regarding discontinuities, however, they require to be adopted and being mixed with other tools and methods (Harmann 2003). Intellectual property strategies like inward licensing usually has this purpose to enhance and improve the economic outcomes and results such as revenues deriving from investments done on innovation practices and should thus express on different and distinctive decisions. These decisions can be make or buy, innovation strategy or adaptation of new knowledge and technology, the safeguarding or utilization of knowledge, public or private research financing, protecting or sharing of intellectual property and dominant advantages or disadvantages (Borg 2001, Harhoff and Reitzig, 2001). According to Brouwer and Kleinknecht (1999), and Gassmann and Bader, (2006), firms have more intentions to patent as a prominent and great influential factor among R&D collaborators.

Small new venture firms can be considered as the main sources of innovation, knowledge and technological advancement and fostering (Bhide, 2000). Nonetheless, they might confront with shortage and inadequacy of organizational capabilities such as financial, production and marketing resources essential for innovating, expanding and commercializing their new innovative products (Allen, 2003). Thus, this can lead these firms to license the technologies and knowledge from other firms into their organization's boundaries, so that it can decrease their total costs concurrently when they are relying and depending solely on their rare and insufficient resources which can accelerating the commercialization of their exploration and search. Inward licensing can also enable small new venture firms not being forced to invest in unknown and unclear technologies, and try to focus on such practices that can transform their products into unique and distinctive ones from other competitors in the marketplace. Inward licensing is the only and exclusive method for small venture firms to access to other firms' intellectual property, in particular when these firms are not intending to sell their whole technologies. Inward licensing is a crucial and significant action because most new small venture firms are possessing powerful technological capacities and capabilities in one or few specific scopes (McGrath et al, 1992) but frequently own insufficient and inadequate complementary knowledge and technologies need to commercialize their innovation projects (Zahra, 1996, Zahra et al, 2005).

There is a quick trend of technological changes and complication of products are increasing dramatically which induce new small ventures to establish relationships with external sources of knowledge and utilize them in their organizational procedures (Kessler, 2003). This is a common trend among new small ventures, which generally own scarce and limited internal knowledge and skills. As these firms are considered as small sized firms and experiencing constrained proportion of knowledge resources and capabilities, they show more tendencies to inward licensing from other firm's technologies. Small size and newness of small new ventures offer limitations to new venture managers' capacity and capability to expand and foster all the skills and knowledge required to commercialize rapidly their technologies and products. In this vein, inward licensing links small new ventures to ‘knowledge and innovation networks’ (Powell, Koput and Smith-Doerr, 1996), and provide them new innovative knowledge and ideas to boost and increase their innovativeness (Henderson and Cockburn, 1994). Inward licensing provide the simplicity and accessibility of small new venture firms to other firm's capabilities and competences, instead of exactly investing in unobvious and unclear R&D activities which might not prepare these capabilities. This is a substantial and prominent aspect according to the vast and enormous technological and market uncertainties, which determine small new venture firms' markets.

The requirements for being flexible, time makes limitations based on inability of economic activities in capability building (Dierickx and Cool, 1989). The unpredictability and unreliability, which exist for internal R&D capabilities and practices, propose that small new venture firms must explore and investigate inward licensing and other external sources to increase and reinforce their internal capabilities and capacities. Inward licensing has this capability to contribute to small new venture firms to boost and foster the innovativeness of their products (Kotabe et al., 1996). Inward licensing can prevail and remove weaknesses and challenges in small new ventures product designing, manufacturing and marketing strategies and skills (Killing, 1977); and create the required skills and expertise for expediting commercializing new innovative products (Teece, 1986; Ogbuehi and Bellas, 1992; Allen, 2003). Rapid product innovation and product development and consecutive product development projects and upgrading its features and technical characteristics, persuade small new venture firms to utilize and complement different and various types of knowledge sources that most of which is not existed and cannot be found internally. Small new venture firms usually have limited knowledge sources and are not competent enough to develop and advance this source of knowledge inside their firms.

This source of knowledge requires investing on technological alterations, gaining benefit from them is generally specialized, and few organizations own it. Even if some small new venture firms possess this specialized and expertized knowledge, the essence and dynamism of their environment can rapidly change the current skills and expertise needed for product advantage and success. In this way, inward licensing guarantees the flow of new knowledge into small new venture firms' development and innovation process. It is feasible to facilitate and accelerate their product development and commercialization process. It is substantial to note that inward licensing is an important and expanded strategy in industries that are involving in rapid technological changes (Mowery et al, 1996). Moreover, based on the knowledge-based view, small new venture firms can exploit inward licensing to achieve and gain rapidly competence, which enables them to become competitive in the areas that are not in their core experience or expertise (Wilkinson, 1985). Few firms have the knowledge and innovation sources to compete in dynamic industries. This is on the opposite side of stable industries which knowledge is extensively spread and diffused. Therefore, Grant, (1996a, b) and Zahra et al, (2005) reveal that alterations in an industry's technological base and customers' requirements push small new venture firms to explore and investigate external knowledge sources through inward licensing. Chiaroni et al., (2009), and Wu et al, (2016), address this issue that CEOs and mangers of firms in the process of inward licensing should recognize and insource knowledge, IPs and technologies, which are aligned with the company's markets, also aims to commercialize by the means of firm's resources and networks. To access technological knowledge, SMEs may rely on intermediate service providers. Experts on intellectual property rights can provide crucial information services that help to bridge the gap between a technological opportunity and its successful commercialization (Bessant and Rush, 1995). Buying or using intellectual property, such as patents, copyrights or trademarks, of other organizations to benefit from external knowledge are considered as inward licensing and interactions with experts of intellectual property rights to access technological knowledge. Firms are able to obtain externally intellectual property, including the licensing of patents, copyrights or trademarks, to gain benefit and take advantage from external knowledge sources and innovation opportunities (Chesbrough, 2006). This phenomenon might be considered as a requirement to enrich and stimulate firm's business model, expedite, encourage and promote internal research capabilities (Van de Vrande et al, 2009).

Small and medium sized firms are suffering of inadequate and insufficient organizational capabilities such as internal R&D sources, technological sources, and innovative knowledge ideas. They need to fill the gap of innovating new products or developing new products in their commercializing projects and increase their innovation performance. Therefore, they need to connect to other firms in order to use their patents and intellectual property by inward licensing to decrease the risk of high production costs and overcome their constraints regarding new innovative products' manufacturing and developing new products. Since patenting and inward licensing of intellectual property is regarded as a crucial and significant external knowledge sources for improving and developing firms' innovative activities. As a result, in this research it is anticipated that inward licensing as one of the dimensions of inbound open innovation activities or sources affect new product innovativeness of small and medium sized firms operating in Petroleum and Gas equipment industry. Therefore, it is predicted that:

***H1e:*** *Inward licensing as one of the inbound open innovation sources positively and significantly affects new product innovativeness in SMEs.*

### *2.3. The Effect of the R&D Expenditures on the New Product Innovativeness in SMEs*

It is believed that new product results such as new product innovativeness and new product development and product advantage are relied on the level and degree of financing and investing in R&D activities. Likewise, according to Chidamber and Kon (1994); Freeman (1994), the theory of "Technology Push" as an assumption which is obtained from the traditional paradigm, defines and considers R&D strengths as the main motivators of new product innovativeness and new product advantage. Day (1994) considers R&D strength as a core internal capability and capacity and suggests that strong and competent R&D activities prepare and offer technological and knowledge basis, which is rather crucial and necessary to new product development, projects in firms. Research and development strength implies to firm's resources and capability for the development and expansion of new technology and innovative practices. Traditional economic school of thoughts and current modern research on new product development and product innovation presume that R&D strength offers a positive effect on new product results and outcomes. The economic approach explains the production driven approach. In product innovation management literature (Hill and Snell 1989, Szymanski, Bharadwaj, and Varadarajan 1993), R&D strength is anticipated to have a positive relationship with product innovation and product advantage, because firms with a higher technology development resources and capabilities have more chances to create and make new innovative products with more innovative features and specifications. Cooper (1983, p. 248) express that R&D strength possess a prominent and important effect on firm's ability and capability to manufacture high level innovative and high technology products, particularly those that are complicated according to mechanical engineering aspects and technical dimensions. These kinds of high level innovative products, which are considered as complex ones affect forcefully, and strongly customer behaviors, and make various specifications and characteristics as distinctive advantages. Holak, Parry, and Song (1991) demonstrate several frameworks and emphasize on different and varying effects of R&D on measurement of performance. Normally, they address that R&D applies a positive effect on performance. The previous research indicates that it is more valuable and useful to emphasize to this concept. New product outcomes and performance are presumed being dependent and related on the level and amount of investments in R&D activities (Li and Calantone, 1998).

Eisenhardt and Martin, (2000), Wilden and Gudergan, (2015), Gupta et al, (1986) and Sharma et al, (2016) mention that research and development (R&D) activities and strengths inside firms are regarded as the prominent and crucial dynamic capability factor and a stimulus of product innovation practices. It is believed in different ways that why R&D can be focused only as an internal issue. Firms with considerable and substantial investments in internal R&D can expand various organizational structures to advance the innovative process. Regarding this strategy, firms will be able to gain and take advantage of economies of scales and scope for their R&D practices (Henderson and Cockburn, 1996). Furthermore, the determined and appropriate amount of expenditures on research and development activities has so far been applied as an index of a firm's innovative practices in industrial firms (Scherer, 1980). According to prior studies which express the important role of R&D strengths and expenditures being spent for new product development and producing new innovative products, and its positive effect on new product innovativeness in firms. As a result, in this research it is anticipated that R.D expenditure as percentage of sales is being used to measure the effect of internal research and development capabilities and organizational investments of small and medium size firms operating in Petroleum and Gas equipment industry. Therefore, it is predicted that:

**H2:** *R.D expenditure, positively and significantly affects new product innovativeness in SMEs.*

### *3.3. The Relationship between the New Product Innovativeness and the New Product Advantage in SMEs*

The term of innovativeness has been used and applied at product level (Szymanski et al, 2007) and firm level (Akgün, Keskin, and Byrne, 2012, Wang and Ahmed, 2004). Garcia and Calantone (2002, p. 113) explain product level innovativeness as “a measure of the potential discontinuity a product (process or service) can generate in the marketing or technological process.” the firm level product innovativeness as “the propensity for a firm to innovate or develop new products” (Story et al, 2015).

Innovation is the first step and is the most studied aspect of entrepreneurship orientation. In the area of business, innovation implies to the intentional and determined exploration for value and income creating opportunities and making these opportunities into operational plans (Drucker, 1985, 1998). Synergistic and effective strategy implementation depends upon precise perceiving and understanding of what consumers need and what does a firm possess.

The condition of innovativeness is the prior cultural aspect of innovation (Salavou, 2004; Wang and Ahmed, 2004). Innovativeness implies to the intention of a firm to utilize new or various ideas for the formation and establishment of a new or substantially developed and improved products, process or service. In the context of new product development (NPD) research, innovativeness of a firm is being assessed that how these firms are taking the responsibility of enhancing and developing innovative behaviors and activities. How much are they strong and well prepared to capitalize in promoting and expanding of radical new innovative products (Covin and Slevin, 1989)? In addition, how many new innovative products they have developed in a specific period? Considering innovativeness, a cycle can be created which might finally cause to product success (Kam, 2012). The concept of product innovativeness is conceptualized as the newness, novelty, and originality of new inventive products that is recognized and comprehended through new product's characteristics, features, quality, aspects and elements. Developers of new products often endeavor to boost and enhance the innovativeness of new products presenting to consumers to solve and remove their problems in addition to attaining and maintaining customer loyalty. It is also presumed that leveraging and fostering product innovativeness will result into increasing in new product sales and gaining income and profits (Millson, 2013).

New product innovativeness is a significant and crucial prior procedure to product advantage and product success (Zirger, 1997, Sethi et al, 2001, Wang and Ahmed, 2004) that can extensively deal with sustainable business success (Henard and Szymanski, 2001, Wang and Ahmed, 2004). Innovative products offer considerable and substantial opportunities for businesses according to growth and development into new scopes and areas (Wang and Ahmed, 2004). Substantial and considerable innovations permit firms to build a prevailing position in the competitive marketplace, and can achieve to new segments of market as a new entrant and be successful to attain a competitive advantage position in the market (Danneels and Kleinschmidt, 2001, Wang and Ahmed, 2004). Product innovativeness is usually implied to as "perceived newness, novelty, originality, or uniqueness of products" (Henard and Szymanski, 2001, Wang and Ahmed, 2004). This perceived newness embraces and includes two dimensions: (1) From the consumers' perspective and (2) From the firm's perspectives (Atuahene-Gima, 1995, Cooper and de Brentani, 199, Danneels and Kleinschmidt, 2001, Wang and Ahmed, 2004). Andrews and Smith (1996) address the appropriateness, the level and degree by which a new innovative product is considered as advantageous and helpful to some customers, in terms of considering the significant feature and characteristics of new product innovativeness (Wang and Ahmed, 2004). There is a tendency in the literature to integrate distinctive dimensions of innovativeness in product innovativeness. For instance, Danneels and Kleinschmidt (2001) introduce two viewpoints of product innovativeness: (1) From the customers' viewpoints, characteristics such as innovation attributes, acceptance of risks, and degree of change in previous built behavioral types and methods are considered as types of product newness. (2) From the firm's viewpoints, environmental acquaintance and being fit with firm's projects and technological and marketing perspectives are regarded as aspects of product innovativeness. Product innovativeness is defined as the "novelty and meaningfulness of new products introduced to the market at a timely fashion", (Wang and Ahmed, 2004).

According to the work of Garcia and Calantone (2002) regarding to product innovativeness, they classified a framework based on two views: (1) "Industry level technological and market discontinuities" and (2) "Firm level technical and marketing know-how newness" as two classifications at macro (industry) and micro (firm) indices of whole product innovativeness which lastly affect customer novelty. Product innovativeness is considered with "technical and marketing discontinuities" (Danneels and Kleinschmidt, 2001; Garcia and Calantone, 2002), while product advantage implies to a "product's superiority relevant to other products exist in the marketplace based on perspectives such as quality, benefit, and functions" (Gatignon and Xuereb, 1997, Montoya-Weiss and Calantone, 1994, Calantone et al, 2006).

Substantial innovations permit firms to reestablish and reconstruct their position in current markets. They can enter and penetrate into new markets, and consider and concern about new market opportunities and openings (Danneels and Kleinschmidt, 2001; Kyrgidou and Spyropoulou, 2013) because new and novel (as radical) new products can lead firms to build and make a distinctive advantage against competitors (Tellis et al., 2009, Story et al, 2015).

Some studies discuss that new product innovativeness positively affect new product performance, because causing to leverage firm's competitive advantage. New product advantage is considered as one component of new product success in the marketplace (Brown, 1992, Goldenberg et al, 2001), which in addition makes more substantial and additional incentives and motives for firms to capitalize and finance in innovations and enhance product innovativeness in order to afford competing in high tech markets. They argue that high degree innovative products have to build more opportunities for differentiations and competitive advantage and eventually influence positively on performance (Lee and Colarelli O'Connor, 2003). Furthermore, referring to Slotegraaf and Atuahene-Gima (2011) research, it can infer that presumably there exist a positive relationship between new product innovativeness and new product advantage in SMEs by exploring and utilizing inbound open innovation sources. Regarding this, new product advantage (NPA) is conceptualized as the superiority of the quality, features, and benefits of the firm’s new products, comparing and relative to those ones that competitors offer. Moreover, in this research, NPA used Slotegraaf and Atuahene-Gima’s (2011) and Griffith and Lee (2016) four item. Assessing whether (1) the firm’s products are owning higher quality than competing products available to customers, (2) the firm’s products solve and remove problems which customers have with competitors’ products, (3) the firm’s products offer unique and distinctive benefits to customers, and (4) the firm’s products meet established and expected performance standards better than those of competitors. There are large numbers of studies, which focus on the direct effect of product innovativeness on new product performance. Lau (2011) found that new product innovativeness positively affect new product performance because a new product with various level and degree of innovativeness will be focusing on different needs and requirements of consumers (Feng et al, 2016). Theories about product advantage evaluates the level by which a product representation and exposure is being superior to those of competitors' products. Based on the presumptions that product innovation is taking place with the purpose of creating a competitive product, the advantage enclosed to the new innovated product might be rooted from the innovativeness of product. This assumption is stabilized on past research studies that have addressed to new product innovativeness to be positively related to new product advantage (Gatignon and Xuereb, 1997; Henard and Szymanski, 2001; Holak and Lehmann, 1990, Calantone et al, 2006).

Hsieh et al. (2008, p. 2) found and emphasized that many high tech firms follow an “innovative and product advantage” strategy when they are launching and introducing their new products to the market. These kinds of firms are purposing to offer and introduce highly innovative products and attempt to compete with competitors in the market by producing products above the medium level. This idea agrees with Gatignon and Xuereb's (1997) thoughts, as they believe that the more radical products will lead to the smaller similarity and likeness of product with competitors, and also the higher and greater the product advantage. This idea recognizes that to be innovative and radical have always been connected to leveraged and enhanced product advantage (Healy et al, 2014). It is supposing that despite the challenges SMEs are facing for product development in a competitive and rapidly changing environment, exploiting external sources of knowledge as inbound open innovation can leverage new product superiority that can obtain a high acceptance level in the marketplace and enhance new product performance. It can strengthen the level of product innovativeness so that new product innovativeness can positively affect new product advantage as one of the components of new product market performance of SMEs. As a result, in this research it is anticipated that new product innovativeness affect new product advantage of small and medium sized firms operating in Petroleum and Gas equipment industry. Therefore, it is predicted that:

**H3:** *New product innovativeness, positively and significantly affects new product advantage in SMEs.*

### *4.3. The Relationship between the Organizational Declarative Memory and the New Product Advantage in SMEs*

The notion of organizational memory (OM) has received a wide range of attention in different literature, such as organizational theory and behavior (Olivera, 2000, Paoli and Prencipe, 2003), marketing (Park and Bunn, 2003, Berthon et al, 2001), information technology (Stein and Zwass, 1995, Wijnhoven, 1999), technology and innovation management (Moorman and Miner, 1997, Kyriakopoulos and Ruyter, 2004). In addition, the literature of management in general addresses the key and main role and character of both notion of innovation (Baker and Sinkula, 2002, Balkin et al, 2000, Darroch and McNaugton, 2002, Lyon and Ferrier, 2002, Utterback, 1994, Vrakking, 1990, Wolfe, 1994), and organizational learning. According to the studies of Brockmand and Morgan, (2003), Dodgson, (1993), Fiol and Lyles, (1985), Garvin, (1993), Gnyawali et al, (1997), Nevis et al, (1995), Stata, (1989), Jiménez and Sanz Valle, (2011), organizational memory is considered as the last component and function of organizational learning, which is playing substantial role in order to advance, and increase firm's competitive advantage. Since the study of Walsh and Ungson (1991), the notion of organizational memory (OM) achieved extensive attention in the technology and innovation management literature (Cacciatori, 2008, Chang and Cho, 2008, Moorman and Miner, 1997, Kyriakopoulos and Ruyter, 2004, Akgün et al 2012).

Generally, organizational memory as a common and widespread meaning should be considered as the amount and degree of a firm's stored and stocked knowledge and acquaintance or information about a specific phenomenon and experience. Moreover, organizational memory includes organizational knowledge, skills, expertise, rules, regulations, procedures, shared beliefs and hypotheses (Walsh and Ungson, 1991, Moorman and Miner 1997, Akgün et al 2012). According to prior literature, it is presumed that organizational memory is a resource that firms can posit, expand and exploit it to enhance and ameliorate their financial performance thorough memory's interpretation and action guidance roles (Moorman and Miner 1997, Hanvanich et al, 2006). Regarding to the prior studies of Hargadon and Fanelli (2002) and Hanvanich et al, (2006), organizational knowledge is considered as latent and hidden knowledge and memory in the organizations comprises of offering special and peculiar situation and events, which are made and shaped from antecedent experiences.

Organizational memory is regarded as a reservoir and storage of information and knowledge of organizational history, which can be regarded and applied in current situations and decision-making actions (Walsh and Ungson, 1991). Organizational memory is the outcome and product of organizational learning. According to the organizations' growth and development, organizational memory is expanded into various levels (Sinkula, 1994, Tsai, 2008). Primarily, organizations learn from experience, and create formal and informal routines, processes, procedures, documents and scripts. Afterward, these behaviors associated with routines, processes and procedures encoded into organizational memory. Then organizational memory might be discovered in organizational beliefs, knowledge, reference, models, values, norms, principles, rules and regulations. Lastly, physical outcomes and products, such as documents, facilities, plans and projects, are statements and declarations of organizational memory. Organizational memory fulfills and accomplishes as filtering structure to sort, classify, and store relevant data and information. Furthermore, organizational memory is action guidance by commanding individual and group action (Moorman and Minor, 1997, Tsai, 2008). Consequently, organizational memory affects the absorptive capacity of the firm (Cohen and Levinthal, 1990, Tsai, 2008). In addition, antecedent research prepare empirical verification and support that what has already been learnt, achieved and stored as stocked information in organizational memory lead to innovation phenomenon (Hanvanich et al, 2006, Tsai, 2008). Likewise, Moorman and Miner (1997) address that organizational memory implies to the notion of plural and collected stored and deposited information, which constantly stabilized with the prior writings, categorized it as comprising declarative and procedural memories (Kyriakopoulos and Ruyter, 2004, Moorman and Miner, 1997, Akgün et al 2012).

Declarative memory comprises knowledge of facts and events such as factual knowledge as accumulated and dense gathered knowledge about customers and their priorities and preferences (Lynn and Akgün, 2000); product features such as product drawings and packaging (Moorman and Miner, 1998); and firm's business objectives and aims, firm's market conditions and positions, firms' marketing strategies, and firm's competitive positions (Tippins and Sohi, 2003, Akgün et al, 2012). In order to leverage previous studies, organizational declarative memory as a component of organizational memory included in the theoretical model which is theoretically relevant to product innovation (Tsai and Ming, 2008), firm innovativeness (Akgün et al, 2012), organizational performance (Hanvanich et al, 2006), new product financial performance and creativity (Moorman and Miner, 1997), new product success (Chang and Cho, 2008) and sustained competitive advantage (Camisón and

López, 2011). In this regard, organizational declarative memory is considered as an independent variable relevant to new product performance notion, which its causal effect as an organizational memory about factual events and knowledge of firms on new product advantage is measured. In this research, organizational declarative memory like memory for facts, events, or propositions including know-what, know-why, or know-when has used as an organizational memory independent variable in order to test the causal relationship with new product advantage.

Moorman and Miner (1997) indicate that organizational memory affects core and key new product development processes by affecting the (1) translation and explanation of inward transferred information and (2) the performance of new innovative and developed action and its routines. They discover that higher and greater organizational memory degrees increase the short time financial performance of new innovative or new developed products; while higher and greater the memory diffusion can boost and foster the performance, creativity and innovativeness of new products. The results of their research demonstrate that if organizations are not competent sufficiently and able to perceive and understand the exact and accurate methods by which various features and specifications of organizational memory affect product development, they might confront with failures to collecting the full value and advantage of organizational memory.

Akgün et al (2012) find the influence of organizational emotional memory through organizational declarative memory on firm innovativeness. They discovered that (1) emotional experience storage affects organizational declarative memory. (2) Emotional experience level and degree affects the organizational declarative memory to that amount that emotional experience clarity and distinctness enhances. They also address that emotional experience diffusion has a direct effect on firm innovativeness. They demonstrate that organizational declarative memory partially and to a limited extent mediates the relationship between organizational emotional memory and firm innovativeness, this emotional experience storage and depository affects innovativeness inside the firm through organizational declarative memory. However, in this research, organizational declarative memory is being considered as independent exogenous variable and its causal relationship with new product advantage is measured. Exploitation of declarative memory that permits authors or scholars to analyze new problems, creates new translations of recent information, and utilize that information in a various types of applications is the main obvious reason that why and how this type of memory contents and concepts are crucial and significant for innovativeness in the firms (Akgün et al, 2012). Accordingly, in this research, it is more specifically relevant and prominent to explore whether or not SMEs can acquire new product advantage as one of the aspects of new product success in the market more properly by exploiting organizational declarative memory. This kind of organizational memory is a prior internal accumulated and stored knowledge and experiences about customer's preferences or product features for new product development which are embedded in organizational memory.

Generally, according to the concept of organizational memory, it is found that this type of organizational memory can be regarded as an interesting organizational component to empirically test the causal relationship between organizational declarative memory and new product advantage because of the following reasons:

- Organizational declarative memory and its potential can strengthen new product advantage as the success of the new products in the market. Small and medium sized firms with prior stored and repository information, and factual market knowledge from customer's insights and their preferences, customer participation as information source, customers as development source, or previous experiences or knowledge about product features, market condition and competitive positions in the market can contribute to make and turn the possibility and potential of new products of SMEs to be succeeded in the market and gain competitive advantage. In other words, the higher using organizational declarative memory as stored and accumulated previous knowledge about customer's preferences, product features, competitive position in the market, competitor's strategies and market condition, the more possibility of acquiring and gaining new product competitive advantage in the market.

Dynamic capability theory defines that why firms in a high turbulent environment should regard to express and address to learning orientation or organizational memory. Based on Nelson and winters, (1982) point of view about an organization as a collection group of interdependent operational and administrative rules and routines. Teece, Pisano, and Shuen (1997) explain dynamic capabilities as a firm's capability and ability to complement, construct, and to reconfigure internal and external capabilities and competences to underline and stress on quickly changing environments (Zollo and Winter 2002, Hanvanich et al, 2006). Dynamic capability also empowers and enables firms to build and form new products and processes to reply and interact to changing market conditions (Helfat 1997). Contrary to the resource based view of firms, dynamic capability theory assumes that firm's competitive advantage does not require being gained or attained from scarce, uncommon, inimitable or unique, and non-substitutable resources, instead, competitive advantage can be achieved and attained from resources that are similar and equivalent across firms (Eisenhardt and Martin 2000). According to this view, firms can obtain a competitive advantage by effectively and efficiently reorganizing or utilizing homogenous resources under different environmental conditions (Hanvanich et al, 2006).

With considering notion of new product advantage, this research aims to test empirically the effect of organizational declarative memory as an internal organizational independent variable in order to know how SMEs in Petroleum and Gas equipment industry exploit and benefit from their internal stocked and stored previous knowledge regarding the important roles of customers, competitors and suppliers. Moreover, how they are able to use and implement these stocked sources of knowledge as their organizational strategy to achieve to new product advantage in the market. As a result, in this research it is anticipated that organizational declarative memory affects new product advantage of small and medium sized firms operating in Petroleum and Gas equipment industry. Therefore, it is predicted that:

**H4:** *Organizational declarative memory positively and significantly affects new product advantage in SMEs.*

According to dynamic capability theory, utilizing organizational declarative memory as another independent variable of theoretical model of this PhD research seems to be as an appropriate factor in a technological and market turbulent environment of Petroleum and Gas equipment industry in Iran. Measuring organizational declarative memory direct effect on new product advantage at firm level has not been studied before in literature of innovation and technology management. However, organizational declarative memory was used as mediator in study of Akgün et al, (2012) which played the mediating role between organizational emotional memory and firm innovativeness. In this regard, using declarative memory and empirically measuring its effect on new product advantage as a product and market success aspect of small and medium sized firms is considered as one of the contributions of this research in innovation and technology management literature. In addition, unpacking and decomposing of inbound open innovation activities or sources based on study of Van de Vrande (2009) are another contribution of this research. As prior studies, just measured inbound open innovation as a whole and general variable, and it was not split into sub-components of inbound open innovation sources so that to enable the researcher to measure the effect of either of them on new product innovativeness at firm level distinctly. Thus, in order to leverage previous studies and to overcome the limitation of empirically assessing the impact of different sources of outside-in or inbound open innovation activities on new product innovativeness as well. This research has split this kind of open innovation into five sources and based on measurable questions, all five inbound open innovation sources and their effects on new product innovativeness are measured. In addition, the effect of new product innovativeness on new product advantage, the effect of R&D expenditures on new product innovativeness, and the effect of organizational declarative memory on new product advantage is being measured empirically in the theoretical model of this PhD research. Moreover, there are four control variables, which are more significant and relevant to the literature of this research, and in particular, it is critical and crucial to measure their effects on new product advantage of small and medium sized firms operating in Petroleum and Gas equipment industry. Accordingly, a comprehensive theoretical model is developed which extends and complements previous models that have never used inbound open innovation components as quantitative measurable variables distinctly. (Figure 2)

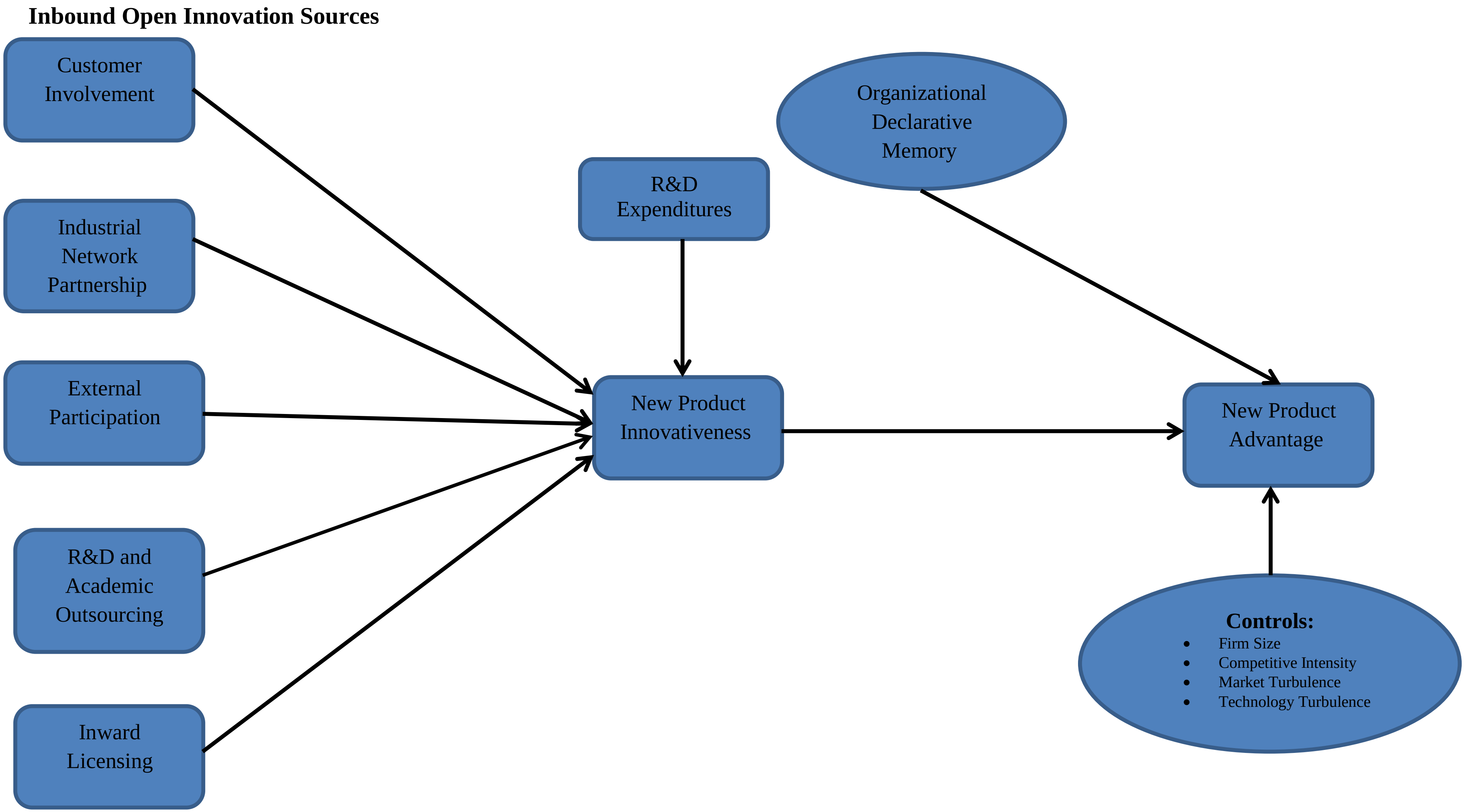


**Figure 2- Theoretical Model**

### *5.3. The Operational Definitions of the Dependent, Independent and Control Variables of the Theoretical Model*

#### *1.5.3. Independent Variables*

- ***Inbound Open Innovation:*** "Open innovation is a paradigm assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology", Chesbrough (2003). Open innovation is using of purposive and intentional inflows (Outside in or inbound) and outflows (Inside out or Outbound) of knowledge resources to expedite the process of internal innovation, and to develop markets for external use of innovation, respectively (Chesbrough 2006a, p. 1). Open innovation is considered as a conceptual framework for a firm's strategy to profit and take advantage from innovation activities (Chesbrough et al 2006, Brunswicker and Vanhaverbeke, 2015). "Inbound open innovation (outside-in process) refers to internal use of external knowledge, from partners, customers, universities, research organizations and etc", (Chesbrough, et al, 2006, Gassmann et al, 2010, Huizingh, 2011, Mazzola et al, 2012, Greco et al, 2015). And inbound open innovation is the attainment, acquisition and transfer of external technologies, ideas and knowledge resources into the firm through R&D agreements, university and research institution's collaborations, In-licensing agreements of patents and intellectual property for acquisition and utilization of them inside firms' boundaries, (Chesbrough and Crowther,2006, Wynarczyk et al, 2013). In this research, in accordance with Van de Vrande et al (2009), inbound open innovation is considered as purposive and intentional inflows of knowledge resources, innovative ideas and external technologies which refer to as technology exploration. It relates to innovation activities to obtain and benefit from external sources of knowledge or innovative technologies and ideas to increase and raise current technological and innovative developments. It involves five components of inbound open innovation, which in their study is categorized as technology exploration. Technology exploration refers to those activities, which enable enterprises to acquire new knowledge and technologies from the outside of the firm's boundaries. In the survey, five practices were distinguished related to technology exploration: *customer involvement, external networking, external participation, outsourcing R&D and inward licensing of IP*. (Van de Vrande et al 2009).

- ***Customer Involvement as Inbound Open Innovation Source:*** Customer involvement is a type of inbound open innovation resource and activity which customers are directly involving in firm's innovation processes and activities. It can be implemented and carried out by proactive market research projects to check customer's requirements. It can be fulfilled as well by innovating or developing new products based on customers' characteristics, modifications and moderation of products resembling yours.
- ***Industrial Network Partnership as Inbound Open Innovation Source:*** Focusing on collaborating with external network partners utilizing their knowledge, technological and innovative capabilities to support and enrich innovation processes. External knowledge resources such as expertized specialists or human capital are included in networking partnership.
- ***External Participation as Inbound Open Innovation Source:*** Equity investments in new or established enterprises or even small new ventures in order to access to their knowledge and innovative or technical resources or to obtain synergies to increase higher performance. New venture capital investment is a way of external participation of SMEs in new venture startups. External participation is a firm's strategy as "corporate venturing"

that is action of firms which specifically and directly investing their firm's funds into external startup companies in order to buy new technological and innovative knowledge to gain more effective and productive output from new ventured startups for their firms.

- ***R&D and Academic Outsourcing as Inbound Open Innovation Source:*** Buying R&D and academic research services and outputs from other organizations, such as universities, public research organizations, engineers, specialized practitioners and consultants or suppliers.
- ***Inward Licensing as Inbound Open Innovation Source:*** Buying or using intellectual property, such as patents, copyrights or trademarks, of other organizations to benefit from external knowledge or technologies in the format of inward licensing practices and agreements.

Accordingly, in this PhD research, researcher uses these five elements of inbound open innovation as independent variables of theoretical model of the research based on two theoretical dimensions: (1) based on the study of Van de Vrande et al (2009). (2) In order to explore the insight of managers and experts of Petroleum and Gas equipment industry and to know if there is any more concept, source or activity of inbound open innovation from their point of views, a structured in-depth interview was carried out by researcher. Each question of these inbound open innovation sources are designed based on structured in-depth interviews with CEOs, managers and experts of Petroleum and Gas equipment industry in order to identify and recognize their opinions and insights toward open innovation concept in SMEs to better defining and formulating items of inbound sources of open innovation as independent variables and also for better unpacking elements of this type of variable in the research model.

- ***R&D expenditure:*** Research and development strength refers to a company's resources, capacity and capability for new technology and knowledge development. Traditional economic theories and current research on new product development and new product innovativeness presume that R&D strength has a positive effect on new product outcomes such as invented innovativeness and new product developed results (Li et al, 1998). R&D expenditure increases radical innovation in industrial manufacturing firms (Spanjol et al, 2012). R&D spending and expenses have been broadly and extensively approved as one of the biggest contributing factors and elements to new product commercialization (Day, 1994, Kleinschmidt et al, 2007). R.D expenditure is measured according to the work of Cooper, 1984, Li and Calantone, (1998) and Spanjol et al, (2012) while annual R&D expenditure is measured as percentage of annual sales.
- ***Organizational Declarative Memory:*** Organizational memory is the amount and degree of a firm’s stored and stocked knowledge and information and awareness of it or data and artifacts about a particular event or phenomenon. Organizational memory includes organizational knowledge, skills, rules, routines, technical know-hows, procedures, shared assumptions, and beliefs (Walsh and Ungson, 1991, Moorman and Miner 1997, Akgün et al 2012). Organizational declarative memory comprises knowledge of facts and events (factual knowledge), such as accumulated and stored knowledge and information about customers and their priorities and preferences (Lynn and Akgün, 2000), product features (product drawings and packaging) (Moorman and Miner, 1998), firm’s business objectives and goals, firm's market circumstances and positions, firm's marketing strategies and competitive positions (Tippins and Sohi, 2003, Akgün,et al, 2012).

In this PhD research, organizational declarative memory is being considered as an independent variable in order to assess the potential capability of internal firm's knowledge as stored and accumulated prior memory, knowledge and experience of factual events inside the organizations and measure its effect on new product advantage of firms in Petroleum and Gas equipment industry. This research intends to survey that organizational declarative memory as an internal organizational knowledge source positively affect new product advantage or not? Furthermore, it is more specifically relevant and prominent to explore and investigate whether or not SMEs can better increase the chance of competitive advantage of new products in the market by using prior internal accumulated and stored knowledge and experiences about customer's preferences and product features for new product advantage, which are embedded in organizational memory. Organizational declarative memory construct is measured based on the studies of Moorman and Miner (1997), Tippins and Sohi (2003) and Akgün et al, (2012).

### *2.5.3. Dependent Variables*

- ***New product innovativeness:*** Product innovativeness is frequently implied to as perceived and conceived newness, novelty, originality, uniqueness and exclusiveness of products (Henard and Szymanski, 2001). The perception and conception of newness and novelty new product innovativeness includes and embraces two dimensions: First, from the customer's perspective. Second, from the firm's perspective (Atuahene-Gima, 1995, Cooper and de Brentani, 1991, Danneels and Kleinschmidt, 2001), Andrews and Smith (1996) define rightness and properness of new product innovativeness as the degree or extent by which a new innovative product is considered as helpful, beneficial and advantageous to some customers. This is considered by them as prominent feature and attribute of new product innovativeness. Danneels and Kleinschmidt (2001) integrate two dimensions of new product innovativeness: (1) From the customer's perspective: traits and specifications such as innovation peculiarities and features, acceptance of risks, and degrees and amounts of change in a stabilized and fixed previous determined behavioral models are considered as types of product newness and novelty. (2) From the firm's perspective: awareness and being acquaintance with external environment and being fit with firm's project and technological and marketing aspects are regarded as dimensions of product innovativeness. Product innovativeness is addressed as the originality, novelty and meaningfulness of new products offered and launched to the market at a suitable and appropriate time (Wang and Ahmed, 2004). This construct and dependent variable is based on previous and antecedent studies, and its tendency and propensity is most focused on new product innovativeness from the firm's perspective. This construct is measured according to the works of Avlonitis et al, (1994), Sivadas and Dwyer, (2000), Gebert et al, (2003), Wang and Ahmed, (2004), Knowles et al, (2008), Akgün et al, (2012), Nybakk (2012),Yuan and Chen, (2015).

- ***New product Advantage:*** New product advantage (NPA) is considered and conceptualized as the superiority and prominence of the quality, specifications, features, benefits and advantages of the firm's new products, relevant to similar products of competitors (Slotegraaf and Atuahene-Gima 2011). This research is utilized and captured new product advantage (NPA) concept done by Slotegraaf and Atuahene-Gima’s (2011) four-item, seven-point Likert scale which is assessing whether (1) The firm's products are possessing higher quality compared with competitor's products in the market that are available to customers. (2) The firm's products solve and eliminate problems customers are facing comparing to competitor's products. (3) The firm's products represent and offer distinctive and exclusive benefits and advantages to customers. (4) The firm's products can offer and represent created, prior appointed, and determined performance standards much better than peer competitors (Griffith et al, 2016).

### *3.5.3. Control Variables*

- ***Firm size:*** Firm size is an important factor, which affects the firm's strategic behavior and decision making remarkably and substantially. It depends and relies to the firm's ability and capability to exploit and utilize existing current competencies and capabilities, build and create new ones, boost and promote innovations (Chandy and Tellis, 2000, Mu et al., 2009, Di Benedetto and Mu, 2011). Firm size is measured in terms of the number of full time employees.
- ***Competition Intensity:*** According to Houston (1986) and Kohli and Jaworski (1990) studies, without existence of competition, an organization might have a better performance, even if this organization is not being a very market driven and customer oriented, because customers are more intending to consume and be loyal to the current organization's products and services. In opposition, under circumstances of high competition, customers have many new alternatives of choices to meet and satisfy their needs and requirements. Hence, the higher and greater competition intensity condition in the market needs the more necessity for increasing the product innovativeness and product advantage in the market. Therefore, it is assumed that there is an extensive competition to be in the market of Petroleum and Gas equipment industry that can affect new product advantage in the market. Competition intensity implies to the level and amount by which competitors are involved in competitive practices in the market. These activities involves changing marketing mix strategies, to attain and achieve competitive advantages (Song and Perry, 2009; Zhou and Li, 2010). In the existence of competitive advantage, firms are intended to limit their

concentrations on the current created markets and to be more alerted and cautious to the requirements of customers in the market (Christensen, 1997). However, the market condition and industrial environments are changing consecutively and persistently (Hamel and Prahalad, 1994). Consequently, firms frequently are not potent to reply productively to the created and emerged new technologies (Tripsas and Gavetti, 2000). In turn, they might strictly follow their prevalent organizational routines and procedures, which enhance and improve the dependence and confidence on current resources but prevent expansion and enhancements of new competences and capabilities (Gilbert, 2005). Industrial competition offers a prevalent type of environmental threats such as business and industrial warnings to the maintenance and survival of firms and business performance. Consequently, firms in intensive competition conditions are unwilling to challenge with new technologies, instead concentrate on boosting and increasing current existing technologies to achieve competitive advantage (Christensen, 1997; Gilbert, 2005, Bao et al, 2012). A high degree of competition intensity might comparatively persuade a firm to accept differentiation strategies (Lusch and Laczniak, 1989). Therefore, firms' activities in a high competitive environment might design and make innovative products that significantly are different from those ones already existed on the market to decrease competitive push (Danneels and Kleinschmidt, 2001; Souder and Moenaert, 1992) and improves and enhances the possibility of new product success (Huang and Tsai, 2014). This construct is measured as control that is taken from Jaworski and Kohli (1993), Yannopoulos et al, (2012).

- ***Technological turbulence:*** Technological turbulence, defined as a rapid rate of technological change, is considered an important and crucial environmental factor that affects new product performance (Jaworski and Kohli 1993, Narver and Slater 1990, Song and Montoya-Weiss 2001, Im, and Workman, 2004). Firms, which work and operate with ongoing developing and growing technologies that are in the condition of quick-change modes, might be able to gain and achieve a competitive advantage through technological innovation practices (Jaworski and Kohli 1993).

The level and degree of technological advances and progressions in an industry implies to the meaning of technological turbulence (Zhou et al, 2005). Previous research indicate that technological turbulence makes and forms opportunities for radical innovation and pushes firms to expedite the degree of innovations in order to be kept away from being fallen behind other competitors in the marketplace (Jaworski and Kohli, 1993; Zhou et al., 2005). The external technical knowledge and technological base is progressively changing (Lichtenthaler, 2010). Technological varieties have been indicated to increase and advance firm capacity and capability and reconfiguring current existing knowledge and technology with new elements of knowledge and boost the feasibility of radical innovation (Quintana-Garcia and Benavides-Velasco, 2008, Bao et al, 2012). Rapid technological progression and advancements would make the product life cycles shorter, so that would expedite the transitional process from traditional monopolized industries to competitive industries and also would decrease the impediments of industry entry (Li et al., 2005; Song et al., 2005, Li et al, 2008). Therefore, it is assumed that there is a great deal of turbulence in technological markets of Petroleum and Gas equipment industry in new technology and technological methods, production processes and turbulence in new technological innovativeness. This construct is measured and is taken from Jaworski and Kohli (1993), Grewal and Tansuhaj (2001), Song et al. (2005), Citrin, Lee, and McCullough, (2007), Yannopoulos et al, (2012).

- ***Market turbulence:*** Market turbulence is considered as the degree and level of alterations and changes in the combinations of customers and their priorities and preferences. In markets with high and great degree and rate of turbulence, firms have tendency to have new customers whose product requirements and preferences are different from those of current existing customers. Furthermore, in the markets with high level of market turbulence, firms' current existing customers frequently change their product needs and preferences or more willing to explore and try to seek new products continuously and persistently. Firms in order to be remained and protected their positions in this kind of market environment, they must respond to the changing priorities and preferences of recent customers and the preferences of new customers as well (Hanvanich et al, 2006). Firms which operate in more active and turbulent markets are most probably enforced to change and moderate their products and services consecutively in order to properly and suitably supply and offer their products according to the customers' changing preferences and priorities. In the opposition side, a firm's products and services are most probably need little attention for modifications and changes in stable and non-competitive markets where the customers do not intend to change their preferences and priorities very often (Jaworski and Kohli, 1993). This construct is measured and is taken from Han, Kim, and Srivastava, (1998), Hanvanich et al, (2006).

# *Chapter 4: Research Methodology*

### *1.4. The Research Design*

This research is designed to empirically test and analyze the hypotheses and measure the applicability and effects of (1) Different sources of inbound open innovation on new product innovativeness. (2) The effect of R&D expenditure as percentage of sales and as research and development intensity on new product innovativeness. (3) The effect of new product innovativeness on new product advantage as a part of product success. (4) Lastly the effect of organizational declarative memory as factual knowledge about stored knowledge and previous events related to customer's preferences or product features is being measured on new product advantage of small and medium sized firms (SMEs) operating in Petroleum and Gas equipment industry in Iran. This research is considered and designed to use quantitative and survey method. The first step was designed to use in-depth interview in order to deepening the understanding of the concepts of first independent variables group in this research, (Inbound open innovation sources) as the first part of the theoretical model. In-depth interview started with CEOs, top managers, R&D and product development experts of SMEs in Petroleum and Gas equipment industry in Iran in order to deeply identify and recognize their opinions and insights toward open innovation notion and its applications in small and medium sized manufacturing firms. Also to develop a richer theoretical understanding of inbound open innovation practices and activities in order to better defining and formulating items of inbound open innovation sources as independent variable and also for better unpacking and decomposing elements of this type of variable in research model in such firms. The in-depth interview which included open questions was carried out with key senior managers which helped to better understanding their views and insights regarding the application and practices of inbound open innovation sources in SMEs for designing the questions of inbound open innovation sources in the questionnaire for measuring the effects of these constructs on new product innovativeness, then it was followed by quantitative method in order to design and administer questionnaire. However, survey strategy of variables such as new product innovativeness, new product advantage, organizational declarative memory and R&D expenditures are incorporated according to existing scales from peer-reviewed, high quality academic papers and journals. The in-depth interview was done because even though different sources of inbound open innovation as independent variables were identified and recognized based on the study of Van de Vrande et al (2009) and inspired from their study, the constructs of different sources of inbound open innovation was unpacked and decomposed from their study. Therefore, up to now there were not any measurement scales to assess or measure the impacts of each of these five sources of inbound open innovation on new product innovativeness.

In the same vein, it was a crucial and critical action, which required to be done for this research to interview with managers and CEOs of SMEs in Petroleum and Gas equipment industry. It was important to do so to develop the concept of inbound open innovation sources from their views, create and design the questions of these five sources of inbound open innovation through their responses to the open questions of in-depth interview. As a result, in light of the research design concept, the approach of this research for contributing to theory development can be considered as deductive. "Deductive reasoning occurs when the conclusion is derived logically from a set of premises, the conclusion being true when all the premises are true" (Ketokivi and Mantere, 2010, Saunders et al, 2016). If the research starts with theory, most frequently and commonly developed from scholar's reading of the academic literature, and the scholar try to design a research project strategy to test the theory, the researcher is using a deductive approach. This research also started with studying a large numbers of theories and literatures about open innovation, new product innovativeness, new product advantage and organizational memory for reviewing the relevant literatures in order to design the research strategy and to test the hypotheses relevant to the effects of different sources of inbound open innovation on new product innovativeness. To test the effect of R&D expenditures as R&D intensity on new product innovativeness. To test the effect of new product innovativeness on new product advantage, and to test the effect of organizational declarative memory on new product advantage of SMEs as theoretical model of the research. In addition, this research was started to find the most appropriate and suitable constructs to measure the effects of inbound open innovation sources and their influential practices on new product innovativeness by reviewing extensive literatures. However, there have been lacks of sufficient antecedent empirical studies as quantitative method to measure the effects of different inbound open innovation practices on new product innovativeness of SMEs as different, distinctive and solely sources of inbound open innovation in a whole and general theoretical model. Previous studies tried to test and analyze the impact of inbound, outbound and coupled open innovation on firm performance in general and no structured questionnaire was created before to test the effect of inbound open innovation practices on innovation performance. That is why this research started its research design by in-depth interview with managers and CEOs of SMEs in order to find and extract the questions of five inbound open innovation components (Sources or Practices) from the interview. Therefore, this research has built and established new questions for five components of inbound open innovation sources such as *Customer Involvement, Industrial Network Partnership, External Participation, R&D and Academic Outsourcing, and Inward licensing* based on the study of Van de Vrande et al (2009) from the in-depth interview.

Deduction is extensively and substantially used in scientific research. It includes the development of a theory, which is conditional upon strict and meticulous test through a series of hypotheses and propositions. It is the most applicable and common approach in scientific research, where rules of research demonstrate the foundation and basis of explanation, which permit the forecasting, and foresight of phenomena, predict their occurrence and allow them to be controlled. The main research idea regarding the exploitation of inbound open innovation in SMEs and its effect on new product innovativeness was inspired from previous studies and literatures such as Van de Vrande (2009), Inauen and Schenker-Wicki (2011), and Cheng and Huizingh, (2014). However, their studies have not measured the effect of different components of inbound open innovation practices on new product innovativeness distinctively and differently in general. This is important to note that none of the inbound open innovation sources are in equal value and their effects on innovation performance vary according to firm's size and industry type which they have not investigated and surveyed in mentioned earlier studies either. In addition, it is noteworthy to note that this study is initiated from an In-depth interview strategy and is based on prediction and contributing to developing theory of open innovation and new product innovativeness and it could contribute to create the theoretical model of this research. Even though there are various literatures and studies regarding investigating the effects of inbound open innovation on innovation performance, none of them has measured the effects of different types of inbound open innovation sources on new product innovativeness entirely and outright. Therefore, it would help to explore more deeply the knowledge of open innovation theory as this research conceptual model can be incorporated into the existing theory of inbound open innovation in SMEs. Moreover, theoretical model of this research can be considered as contribution of developing theoretical model in open innovation literature which is based not only on in-depth interviews with managers and experts but also from antecedent and previous literatures relevant to open innovation activities and its effect on firm's innovation performance. "Quantitative research is usually associated with a deductive approach, where the focus is on using data to test theory" (Saunders et al, 2016). In this research, it can be noted that deductive approach can be applied as the research method to contribution of theory development which was started by in-depth interview and then designing and administering of questionnaire have been used to contribute to develop theory which is based on partial least square structural equation modeling (PLS-SEM).

### *2.4. The Research Method and the Empirical Analysis*

The research method of this study is a survey, causal (Explanatory) and descriptive quantitative research method based on structural equation modeling (SEM). The *survey research strategy* is commonly related to a deductive research approach. It is a well-known, favored and commonly used research strategy in business and management science research.

It is more intended to be used for exploratory and descriptive research methods. Survey strategy utilizing questionnaires are well known as they permit the collection of standardized data from a sizeable, fairly large and substantial population in an extremely economical method. It permits easy and convenient comparison. Likewise, the survey research strategy is comprehended as a valid and reliable by people in general and is too easy to explain and to understand. The survey research strategy permits scholars to collect and gather quantitative data, which can be analyzed quantitatively by using descriptive and inferential statistics data, which is collected by researcher. Using survey strategy is appropriate to be exploited to suggest possible reasons for specific relationships between variables and to generate and create theoretical models of these relationships. Survey strategy has to give scholars more control regarding the research processes and in the condition of probability sampling is being used. It is feasible and practical to create and produce findings that are statistically example and representative of the whole statistical population at a lower and cheaper cost than gathering and collecting the data for the whole population (Saunders et al, 2016). In addition, research and studies which build and create causal relationships between variables is being named as *explanatory research* (refer to *causal quantitative research method*). The emphasis in explanatory or causal research method is to study a situation or a problem in order to explain the relationships between variables (Saunders et al, 2016). Likewise, "The purpose of *descriptive research* is to gain an accurate profile of events, persons or situations. Descriptive research may be an extension of a piece of exploratory research or a forerunner to a piece of explanatory research. It is necessary to have a clear picture of the phenomenon on which you wish to collect data prior to the collection of the data" (Saunders et al, 2016).

### *3.4. The Structural Equation Modelling (SEM) as Quantitative Research Method*

According to the continuous adoption of the requirements to empirically validate and legalize theories in the social science disciplines (e.g., Sheth, 1971), data and multivariate analysis techniques are considered as the most important research method (e.g., Hair et al., 2010; Hair et al., 2011b; Mooi and Sarstedt, 2011). SEM is regarded as a second-generation multivariate analysis technique and approach, which incorporates features of the first generation techniques, such as principal and main parts or components of linear regression analysis (Fornell, 1982, 1987). SEM is specifically useful for the procedure and process of developing, expanding and testing theories and has become as a standard in research process (e.g., Hair et al., 2012; Ringle et al., 2012; Shook et al., 2004; Steenkamp and Baumgartner, 2000, Hari et al, 2012).

Structural equation modeling (SEM) is one of the most prominent and remarkable research methods in a wide range of other research methods (SEM; Rigdon, 1998). The ability of SEM is to examine thoroughly and concurrently sets of interrelated dependent relationships between groups of constructs demonstrated by multiple variables while accounting for measurement error has contributed and aided SEM's broad range of applications (Ali et al, 2018). From statistical point of view, SEM shows an advanced and progressed version of general common linear modelling procedures like multiple regression analysis and is widely used to assess ‘‘whether a hypothesized model is consistent with the data collected to reflect [the] theory’’ (Lei & Wu, 2007, p. 34, Astrachan et al, 2014).

Structural equation modelling is considered as a multivariate analytical approach and method used and applied to simultaneously test, estimate and predict complex causal relationships among different variables, even in those cases which the relationships are hypothetical, or not directly and straightly observable (Williams, Vandenberg, & Edwards, 2009). Combining factor analysis and linear regression models at the same time, SEM permits the researcher to statistically test and examine the relationships between theory based latent variables and their indicator variables by measuring straightly observable indicator variables (Hair, Hult, Ringle, & Sarstedt, 2014). Whereas SEM is identical and similar to multiple regression in a situation that both techniques test and examine relationships between variables, SEM is considered a possible technique to simultaneously examine and test multi-level dependence relationships. ‘‘where a dependent variable becomes an independent variable in subsequent relationships within the same analysis’’ (Shook, Ketchen, Hult, & Kacmar, 2004, p. 397) also it applies for relationships between multiple dependent variables (Joreskog, Sorbom, du Toit, & du Toit, 1999, Astrachan et al, 2014).

### *4.4. The Covariance Based Structural Equation Modeling (CB-SEM) or Partial Least Square Structural Equation Modeling (PLS-SEM)*

There are two important approaches and methods to estimate or predict the relationships in a structural equation model (Hair et al., 2010; Hair, Ringle, & Sarstedt, 2011; Hair et al., 2012a). CB-SEM and PLS-SEM are two various methods and approaches to the same problem in quantitative data analysis which is naming the analysis of ‘"Cause–effect relations between latent constructs" (Hair, Ringle, & Sarstedt, 2011a, p. 139). They are distinctive approaches not only in terms of their basic and fundamental assumptions and results, but also in terms of their estimation procedures (Hair et al., 2014; Shook et al., 2004, Astrachan et al, 2014). The first one which is more widely used and applied as a very common method is covariance based SEM (CB-SEM) approach. The second one is partial least square SEM (PLS-SEM) approach. Each of these approaches is appropriate and suitable for a various research area, and researchers and scholars require deciding the differences between these two approaches in order to apply and use the correct and suitable method (Hair et al, 2016).

CB-SEM approach utilizes different technique comparing to PLS-SEM approach when assessing and evaluating the quality of a structural model. CB-SEM is based on meticulously and exact estimating the observed covariance matrix, whereas, PLS-SEM is based and constructed on accounting for and relying on explained variance in the endogenous constructs (Hair et al., 2014, Astrachan et al, 2014). Both CB-SEM and PLS-SEM methods differs from statistical perspectives. Neither of these approaches is usually more appropriate and superior to the other and neither of them is suitable and applicable for all situations. Generally, the positive aspect and strengths of PLS-SEM are CB-SEM's weaknesses, and vice versa. The research depends to use and apply the SEM approach and technique that best suits the research objective and aim, research data characteristics and model specifications (Hari et al 2016). These two approaches are describing as following:

➢ ***Covariance Based SEM (CB-SEM) Attributes***

CB-SEM is used essentially and substantially to confirm or reject theories, for instance, a collection of systematic relationships between multiple variables that are possible to be tested empirically. It is being done and carried out by determining how appropriate a proposed theoretical model can estimate the covariance matrix for a sample data set (Hair et al, 2016).

CB-SEM should be considered as a quantitative method when the concentration lies on confirming theories of assumed relationships. CB-SEM presumes a maximum likelihood (ML) estimation procedure and items at ‘‘reproducing the covariance matrix by minimizing the difference between the observed and estimated covariance matrix without focusing on explained variance’’ (Hair et al., 2011a, p. 139, Astrachan et al, 2014).

CB-SEM is based on confirmatory approach that concentrates and focuses on the created and established relationships of theoretical model and its main purpose is to minimizing the differences between the model applied covariance matrix and the sample covariance matrix (Hair et al, 2012). Moreover, CB-SEM extends a theoretical covariance matrix based on a determined and particular specified established set of structural equations. This approach focuses on estimating a collection of model parameters in a method that difference between the theoretical covariance matrix and the covariance matrix is decreased and minimized (e.g., Rigdon 1998). CB-SEM emphasizes on constructs as common factors that explain the covariation between considered and associated indicators (Ali et al, 2018).

In addition, if the research objective is theory testing, theory confirmation or comparison of alternative theories, the best approach is CB-SEM. The approach of CB-SEM considers and associates with the constructs as common general factors that explain the covariation between their associated indicators (Sarstedt et al, 2016). The CB-SEM methodology and its estimation needs a combination and collection of assumptions to be accomplished and attained, including the multivariate normality of data, minimum sample size and other specifications (Diamantopoulos and Siguaw 2000). When CB-SEM assumptions are not fulfilled with concern to normality of distributions, minimum sample size, and maximum model complexity, or related methodological abnormalities exist in the process of model estimation, PLS-SEM can be applied as a good methodological approach for theory testing (Hair et al, 2016). Likewise, If CB-SEM assumptions and criteria cannot be fulfilled, or the research objective is prediction instead theory testing and confirmation of structural relationships, Thus, CB-SEM is not an appropriate approach and PLS-SEM must be applied and preferred to CB-SEM. CB-SEM approach is not based on the prediction target and aim. This approach disregards prediction technique. If the structural relationships between the latent constructs are the main and early concern in theory testing, researchers are confronting less precision of prediction by using CB-SEM (Hair et al, 2011).

In CB-SEM, model complexity can affect different goodness of fit measures, such as the chi-square value. For example, the chi-square value will be decreased when parameters of model such as complexity are added to the model (Richter et al, 2016).

➢ ***Partial Least Square SEM (PLS-SEM) Attributes as Research Method***

As a new structural equation path modelling is generally and crucially used to develop theories in exploratory research. In PLS-SEM it is concentrating on explaining the variance in the dependent variables when examining and testing the model. In research and situations when the theory is not developed well and sufficiently, researchers should refer to the use of PLS-SEM approach as an alternative approach to CB-SEM. This is specifically applicable and practical if the preliminary objective of applying structural equation modeling is prediction, description and explanation of target constructs. PLS-SEM estimates and predicts coefficients (i,e. path model relationships) which maximize and increase the $R^2$ values of the target endogenous (dependent) constructs and variables. This peculiarity causes to meet the prediction objective of PLS-SEM. Therefore, PLS-SEM is the preferred method when the research objective is theory development and explanation of variance (prediction of the constructs). Consequently, PLS-SEM is considered as a variance based approach to SEM.

Generally, PLS-SEM comparing to CB-SEM, emphasizes prediction and exploration, that is able to run and manage complex models, and concurrently relaxes the demands on data as well as the characteristics of relationships (Jöreskog and Wold, 1982, Richter et al, 2016).

PLS-SEM is substantially important for predictive and exploratory purposes, because "the extractions of latent variable scores in conjunction with the explanation of a large percentage of the variance in the indicator variables are useful for accurately predicting individuals' scores on the latent variables" (Anderson and Gerbing, 1988; Wold, 1982, 1985, Richter et al, 2016). If the goal and objective of the research is to create, generate or determine new and novel hypotheses in a precedent unexplored and unknown field of study or in fields, which have shortage of empirical foundations and theory, predictive or exploratory research approaches are considered as the first preferred method. "Prediction is the process of applying a statistical model to data to forecast an output value for new or future observations given their input values" (Richter et al, 2016). Therefore, the goal of predictive and exploratory research is not only focused on forecasting, but also in contributing to developing new and extending current existing theory. "PLS-SEM is a causal modeling approach aimed at maximizing the explained variance of the dependent latent constructs. This is contrary to CB-SEM's objective of reproducing the theoretical covariance matrix, without focusing on explained variance" (Hair et al, 2011). Nevertheless, if CB-SEM assumptions cannot be fulfilled, or the research objective is prediction instead of confirmation of structural relationships, then variance based approach of PLS-SEM would be considered as the preferred method. If the research objective is prediction and theory development, then the best, most applicable and appropriate method is PLS-SEM. Theoretically and practically, PLS-SEM is like and equivalent to multiple regression analysis. "The initial objective is to maximize explained variance in the dependent constructs but additionally to evaluate the data quality on the basis of measurement model characteristics"(Hair et al, 2011).

Characteristics of PLS-SEM are that this method works appropriately and efficiently with small sample sizes and complex models and particularly makes no assumptions about the principal and underlying data set like data distributions (Cassel, Hackl, and Westlund, 1999). Furthermore, PLS-SEM can simply run and manage both reflective and formative measurement models, and single item constructs as well without any identification problems.

Thus, it can be used in a wide range of research areas. Researchers can benefit from high efficiency in estimations, which considered in statistical methods with greater power than CB-SEM. At the time of applying and using PLS-SEM, researchers gain advantage of high efficiency in estimation parameters which revealed much more and higher level of statistical power than CB-SEM. Greater and higher level of statistical power implies that PLS-SEM is most probably has to present and provide a specific and peculiar relationship when it is significant in the population (Hari et al 2016). There are some specific cases when there is particularly little prior and antecedent knowledge on structural model relationships or the measurement of the constructs or when the emphasize is more on exploration than confirmation, in this case PLS-SEM is the most appropriate alternative to CB-SEM. In addition, where data is non-normal in distribution, there is a minimum sample size, and maximum model complexity, or there are other related methodological abnormalities occur in the process of model estimation; PLS-SEM is the best method of theory testing. In addition, it is more logical and noteworthy of using PLS-SEM when (1) The goal is predicting key target constructs or identifying key driver constructs. (2) The structural model is complex (there are many constructs and many indicators), because PLS-SEM has higher levels of statistical power in situations with complex model structure or small sample size. (3) The sample size is small and or the data are non-normally distributed (Hair et al, 2016). In comparison with covariance based SEM, PLS-SEM has approved and demonstrated higher levels of statistical power in situations and conditions with complex model structure and small sample size. PLS-SEM that is specifically appropriate for contribution to early phases of theory development and testing such theory (Hair et al., 2014; Ringle et al., 2013), allows examination and testing of constructs and relationships in complex structural models (Astrachan et al, 2014).

In PLS-SEM approach, complexity of model is not a problem if the sample size is sufficient. Furthermore, PLS-SEM is regarded as a superior approach according to prediction, contributing to theory development and exploratory research that has been examined and validated in a study of Reinartz et al (2009). This method confirmed and demonstrated a strong belief that PLS is preferable and more suitable to maximum-likelihood-based CB-SEM when the research objective focuses in identifying and recognizing relationships such as prediction or theory development instead of confirming them (Reinartz et al., 2009, p. 340, Richter et al, 2016). The prediction and exploratory research aims are not only based and found in forecasting, but also in developing new and extending existing theory. (Fornell, 1982; Wold, 1985, Richter et al, 2016).

In comparison with CB-SEM outputs and results, which can be enormously and greatly inaccurate when the assumptions are violated, PLS-SEM mostly presents more robust estimation of the structural model (e.g., Lohmöller 1989; Reinartz, Haenlein, and Henseler

2009; Ringle et al. 2009; Wold 1982). PLS-SEM minimizes the residual variances of the endogenous constructs. Comparing to CB-SEM approach, PLS-SEM is more robust with fewer and least amount of identification issues, applies with much smaller and larger sample sizes, and both formative and reflective constructs can be run in this approach. Although the results of PLS-SEM as estimates are on average biased, they also indicate a lower and fewer degree of variability than those generated by CB-SEM (e.g., Reinartz, Haenlein, and Henseler 2009; Ringle et al.2009). This crucial and prominent aspect is regarded and considered especially for research situations in which maximum likelihood based CB-SEM usually shows inflated standard errors (Sosik, Kahai, and Piovoso 2009) and the methods standards are not fulfilled, for example, small sample size, non-normal data and high model complexity. This considerable and increased efficiency in standard parameters estimation is displayed in PLS-SEM's greater and higher statistical power than that of CB-SEM. When the research objective is prediction orientation, PLS-SEM is the most appropriate method for contribution to theory development and prediction. Also, when CB-SEM presumptions have not been met and fulfilled regarding to normality of distributions, minimum sample size, and maximum model complexity, PLS-SEM can be considered as a good methodological strategy for theory testing (Hair et al, 2011). PLS-SEM analyses can simply and largely combine and synthesize single-item measures, and can achieve and gain solutions to much more highly complex models. For instance, models with a large number of constructs, indicators and structural relationships (Hair et al., 2014; Ringle, Sarstedt, & Hair, 2013, Astrachan et al, 2014).

Accordingly, as the objective of this research is prediction oriented, therefore, it has used PLS-SEM method to estimate and predicts the coefficients in order to maximize the $R^2$ value of target dependent (endogenous) variables (New product innovativeness and new product advantage) in theoretical model. Thus, in order to test and examine the hypotheses of the research theoretical model, the PLS-SEM method is used to test each of the hypotheses for testing, predicting and explaining key target constructs such as new product innovativeness and new product advantage. PLS-SEM method has been analyzing the effect of each independent or exogenous latent variables such as (1) Inbound open innovation sources: (*Customer involvement, Industrial network partnership, External participation, R&D and Academic outsourcing and Inward Licensing*). (2) R&D Expenditure. (3) New product innovativeness. (4) Organizational declarative memory on dependent or target endogenous variables such as (1) New product innovativeness and (2) New product advantage to predict, explain and describe the variance of the dependent variables. Additionally, the theoretical model of this research consists a complex model, where there are so many constructs and indicators, in particular, inbound open innovation constructs comprises five components as each of them includes 5 questions (indicators) for each of the construct. Moreover, other constructs such as new product innovativeness, new product advantage and organizational declarative memory comprises more than 6 questions (indicators), Moreover, this research consists 4 control variables: (1) Firm size, (2) Technology turbulence, (3) Competition intensity, and (4) Market turbulence. Apart from firm size, which is one single item, the other three controls include several questions.

Therefore, the theoretical model of this research comprises large number of variables with many indicators (questions). As the goal of this research is not only based on predictive approach and focused on forecasting, but in developing and extending current existing theory. Thus, this research contributes to theory development of surveying and examining the exploitation of different inbound open innovation sources and their effects on new product innovativeness performance in small and medium sized enterprises (SMEs). Moreover, this research investigates the effect of R&D expenditure on new product innovativeness performance in small and medium sized enterprises (SMEs). It also investigates the effect of new product innovativeness on new product advantage of small and medium sized enterprises (SMEs) as one of the components of new product success in the marketplace. In addition, as last part, this research investigates the effect of organizational declarative memory on new product advantage of small and medium sized enterprises (SMEs). In general, this research has used PLS-SEM in order to contribute to developing the theory of inbound open innovation activities and the role of inbound open innovation sources on innovativeness and advantage of new products in SMEs.

This research includes two single item constructs. R&D expenditure, which is considered as one of the main independent (exogenous) variables of the theoretical model where its effect on new product innovativeness is being measured by only one question. The question of R&D expenditure is measured according to the percentage of sales of SME where it divides R&D expenditure into 7 scales such as: (1) below 1%. (2) Between 1 to 3%. (3) Between 4 to 6%. (4) Between 7 to 9%. (5) Between 10 to 12%. (6) Between 13 to 15%. (7) Above 15%. In addition, firm size as control variable is another one single item construct, which its measurement is divided according to the number of full time employees of SMEs. Thus, using two, one single item constructs in the research model is another reason of using PLS-SEM method.

This research is based on prediction approach, because it aims to contribute to develop the theory of inbound open innovation practices in SMEs. The aim of this research is to generate hypotheses in precedent less explored theory of empirically measuring the effects of utilizing various sources of inbound open innovation on new product innovativeness and new product advantage in SMEs. Since there have been shortage of empirical foundations in the theory and literature of quantitatively empirical testing and analyzing the effects of different inbound open innovation sources on new product innovativeness in SMEs. Even though researchers have started to address and explore the knowledge gaps around open innovation in small and medium-sized enterprises (SMEs), there is still much required to be done to develop more systematic evidence on the open innovation practices of SMEs. Regarding this, and in order to develop a greater understanding of open innovation practices at the SMEs level, PLS-SEM as a predictive research approach is preferred to be used in this research. Furthermore, the theoretical model of this research is reflective because of the following reasons:

- Causal priority is from the constructs to the indicator (Diamantopoulos and Winklhofer, 2001, Hair et al, 2016).
- The constructs are traits, which are explaining the indicators (Fornell and Bookstein, 1982, Hair et al, 2016).
- The indicators represent the consequences (Rossiter 2002, Hair et al, 2016).

Lastly, data, which collected according to the distributed and administered questionnaires among statistical target population of this research, which are SMEs in Petroleum and Gas equipment industry, is non-normal data.

### *5.4. The Target Population and the Data Collection Instrument of the Study*

The intended participants in this study as the statistical target population are small and medium sized enterprises (SMEs) operating in Petroleum and Gas equipment industry in Iran. This is because that measurement of inbound open innovation activities and the effects of their different sources on new product innovativeness, the effect of R&D expenditures on new product innovativeness, the effect of new product innovativeness on new product advantage, and the effect of organizational declarative memory on new product advantage are being measured at firm level. The definition of SMEs in this research is very important prior to research design phase, determining of the statistical target population and method of sampling from such firms. Generally, according to the definition of European Union, firms with less than 250 employees and annual financial turnover not beyond or more than 50 million euro are considered as SMEs (European Commission, 2003). SMEs were categorized previously into three main groups: (1) Micro enterprises: less than ten employees and above two million annual turnover, (2) Small enterprises: less than 50 employees and above 10 million annual turnover and (3) Medium sized enterprises: less than 250 employees and above 50 million annual turnovers (Hossain, M., & Kauranen, I, 2016). However, SMEs in this research is defined according to the statistical target population of SMEs in Iran and Iran's national definition of SMEs where observation was done and data were collected from these firms in Petroleum and Gas equipment industry.

National definition of SMEs in Iran was defined by central bank of Iran[1] which classified Iranian firms according to the number of full time employees as follow: (1) Micro enterprises: employees between 1 to 9 persons. (2) Small enterprises: employees between 10 to 49 persons. (3) Medium enterprises: employees between 50 to 99 persons, and (4) Large enterprises: employees above 100 persons. However, the main statistical target groups were micro, small and medium sized firms in this research and observation and data collection task was carried out in these groups of firms.

The technique of sampling in this research is probability sampling. According to Saunders et al, (2016), the logic of using this technique was because of the fact that most survey research strategies are most frequently being used in order to make inferences from samples which is

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relevant to population to respond to research questions and meet research objectives. Furthermore, as the research questions and objectives are all concerned to inbound open innovation activities and their effects on new product innovativeness, the effect of R&D expenditures on new product innovativeness, the effect of new product innovativeness on new product advantage, and the effect of organizational declarative memory on new product advantage in SMEs of Petroleum and Gas equipment industry in Iran. Therefore, the sampling frame of this research is directly associated with SMEs of this industry. According to the general director's statements and explanations of Society of Iranian Petroleum Industry Equipment Manufacturers (SIPIEM), which is considered as the most prominent non-governmental organization (NGO) in Petroleum and Gas equipment industry in Iran. In addition, after receiving the complete list of members of this association, the total numbers of firms, which are members of this association as manufacturers of Petroleum and Gas equipment in Iran, are 700 firms. 90% equal to 600 of these firms are small and medium sized enterprises, and the remained 10%, which means nearly the rest of 100 firms, are considered as large firms. As a result, since the statistical target population of this research is SMEs operating as manufacturers of Petroleum and Gas equipment, questionnaires were distributed and administered for data collection by simple random procedure between 150 firms in Tehran as the capital region of Iran where the main head offices of these 150 firms are located. 150 (One hundred fifty) out of 600 small and medium sized enterprises (SMEs) where the questionnaire was distributed have responded to the questionnaires. No questionnaire was distributed to any large firms, and all of them were collected from 150 small and medium sized enterprises where the CEOs, marketing managers, R&D managers and new product development managers had responded to the questionnaire. The geographical domain of the statistical target population is in Tehran because the most head offices of these manufacturing firms are located in Tehran area as the capital city. Therefore, the samples have been selected in this region and all of them responded to the questionnaire of this research.

The method of this research is quantitative, and surveying method and the instrument of data collection in this research is questionnaire and all the procedure of data collection was conducted by distributing and administering of collecting questionnaire. The questionnaire was designed based on two approaches: (1) In-depth interview and (2) Previous and prior structured questionnaires of literatures and academic papers of highly ranked peer-reviewed journals. The questions of five inbound open innovation sources were created and built according to the in-depth interviews with CEOs and managers of Petroleum and Gas equipment industry, while there have not been any antecedent questionnaire measuring the scales of these five inbound open innovation sources and activities. Apart from inbound open innovation sources, the rest of the questions of variables and their scales were inspired from prior studies.

### *6.4. The Petroleum and Gas Equipment Industry in Iran*

As the reference of Iran's Petroleum Equipment Industry, the Society of Iranian Petroleum Industry Equipment Manufacturers (SIPIEM) which is considered as an industry's leading voice in Petroleum and Gas industry, is a private and non-profit organization which is founded in the year 2000. Members of SIPIEM are active in different aspects of Oil and Gas upstream and downstream industry including: (1) Design and Engineering, (2) Manufacturing, (3) Maintenance, (4) After sales services, (4) Training.

### *7.4. The Classification and Grouping of Petroleum and Gas Equipment Manufacturer SMEs in Iran*

The manufacturer SMEs of Petroleum and Gas equipment industry in Iran are divided into 10 industrial equipment groups as following:

- Rotary equipment manufacturers (Pumps, Turbines, Compressors)
- Fixed equipment manufacturers (Exchangers, Boilers, Tanks and Steel structures)
- Drilling equipment manufacturers
- Electrical equipment manufacturers
- Safety and Firefighting equipment manufacturers
- Industrial Valves and Wellhead equipment manufacturers
- Pipe and Fittings manufacturers
- Automation, instrument and control systems manufacturers
- Chemical materials and catalysts manufacturers
- Technical service providers and general goods manufacturers

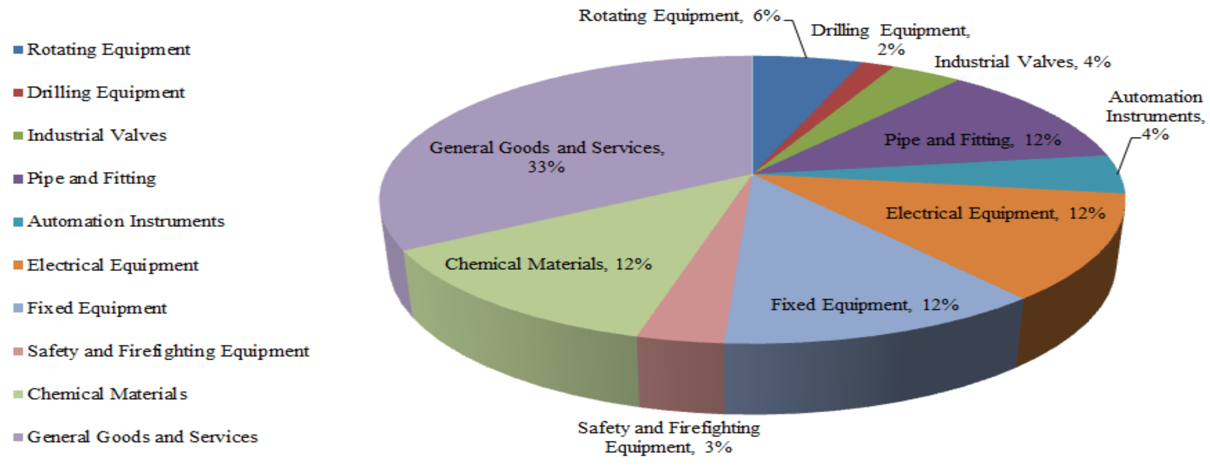


**Figure 3- Classification of 10 groups of Petroleum and Gas Equipment Manufacturer SMEs in Iran** (Source: Society of Iranian Petroleum Industry Equipment Manufacturers) (SIPIEM) www.sipiem.com

| Short Term Objectives | Middle Term Objectives | Long Term Objectives |
|---|---|---|
| ➢ Improving quality, price and delivery time<br>➢ Enhancement of management capacity and capability, and structure and capacity building in internal and national manufacturing<br>➢ Goal oriented investment and purchasing<br>➢ Enhancement and completion of production capability of internal and national manufacturers<br>➢ Investment facilitation | ➢ Development of internal and national technologies<br>➢ Promotion of products and after sales services quality<br>➢ Technology commercialization<br>➢ Removing impediments and problems regarding price, quality and delivery time<br>➢ Enhancement and improvement of production ability and capability of needed equipment | ➢ Achieving to national manufacturing brand<br>➢ Achieving to standardized procedures of manufacturing according to international standards<br>➢ Institutionalizing scientific and operational levels of human resources<br>➢ Institutionalizing of production costs with national approaching and expansion of national manufacturing<br>➢ Sustainable development of export capacity of Iranian national manufacturer SMEs in order to achieve to market share growth in regional and international scale |

**Table 23- Short, Middle, and Long Term Objectives of Petroleum and Gas Equipment SMEs Manufacturer in Iran**

(Source: Society of Iranian Petroleum Industry Equipment Manufacturers, SIPIEM, www.sipiem.com)

### *8.4. The Challenges and Impediments in Petroleum and Gas Equipment Industry in Iran*

#### *1.8.4. From Manufacturer's Perspective:*

- **Insufficient Financial Resources:** SMEs as manufacturer of Petroleum and Gas equipment industry are suffering from inadequate and lack of sufficient financial resources and capabilities.
- **Weaknesses in processes and production factors:** Production process factors in SMEs as manufacturer of Petroleum and Gas equipment industry are weak in terms of efficiency, effectiveness and productivity.
- **Weaknesses of technological competence and capability:** Technological competence and capabilities are not at high level in SMEs as manufacturer of Petroleum and Gas equipment. Most SMEs technological capabilities are not compatible with the latest and state of the art international standards and international technological competences, and because of this fact, not only cannot compete with foreign competitors, but also they confront with some internal problems and inability at national manufacturing level.
- **Weakness of capability and capacity for technology development:** Internal resources, technology capability and capacity of SMEs as manufacturer of Petroleum and Gas equipment industry in order to strengthen technology development projects and acquire technological capacities and resources are not sufficiently powerful.
- **Inappropriate economic dimensions comparing to international competitors:** Instability of economic condition and existence of environmental turbulence, which particularly affect industrial manufacturer by decreasing their strengths and capabilities comparing to international competitors.

- **Difficulty of technology transfer and required machinery because of sanctions and embargoes:** SMEs are not able to transfer technology by licensing-in and buying patents of other international firm's products or required machineries because of sanctions and embargoes.
- **Inappropriate and inefficient supply chain management, which results to lack of commitment to pricing strategies and quality:** There is a lack of efficiency in defining an appropriate supply chain management in this industry. However, customers, suppliers, competitors, designing and R&D departments of firms, and end users, are members of this supply chain, but an appropriate managing of this supply chain has not been specified, clarified or defined by any institutions, associations, governmental organizations and so on. It causes some ineffective functions or deals between supply chain members and makes the procedure of supply chain activities such as pricing or quality issues more complicated and inefficient.

#### *2.8.4. From Customer's Perspective:*

- **Improper culture of dependence on foreign suppliers:** SMEs in Petroleum and Gas equipment industry do not intend to cooperate with external partners such as foreign and international suppliers. One reason might be due to constrained international rules, embargoes and sanctions that prevent them to have a legal cooperative partnership with international suppliers and access to their knowledge sources and technological capabilities. The second reason arises from lack of sufficient culture of cooperation with foreign suppliers among SMEs as they got used to depend merely on internal suppliers at national levels because of constraints and limitations for international cooperation.

### *3.8.4. From Government's Perspective:*

- **High Bureaucratic procedures:** According to government's rules and regulations, there is high level and degree of bureaucratic procedures, which hinder SMEs of this industry to extend their activities and participate in collaborative partnerships. As a result, the open innovation collaboration partnering between firms can be affected by existence of these rules which cause great deal of barriers and impediments for firms.
- **Improper policy making and management of importing:** SMEs in Petroleum and Gas equipment industry could be harmed from instable and insecure policymaking procedures, which sometimes are being enacted, As a result, this generates and creates much more impediments for these firms. In addition, improper managing procedures of importing relevant products of Petroleum and Gas equipment could be disadvantageous and detrimental to the continuation of SMEs activities in this industry.
- **Custom's problems in terms of goods clearance process:** The existence of high and rough customs burecratic affairs causes serious and long process of goods clearance for SMEs as manufacturers of Petroleum and Gas equipment, which can negatively affect their production process, new product innovativeness or new product development projects.
- **Inadequate and insufficient financial resources to support internal national producers:** Lack of financial resources and budget to support legally SMEs of this industry. There is inappropriate policy making in allocating sufficient and targeted budget for national manufacturer firms.
- **Lack of proper completion and implementation of plans and public policies regarding granting and offering facilitator loans and financial aids:** Ratified plans and public policies relevant to SMEs in general and in Petroleum and Gas equipment industry in

particular regarding granting financial assistance, aid and loans have not been fulfilled, completed and implemented most frequently. (Source: Society of Iranian Petroleum Industry quipment Manufacturers, SIPIEM, www.sipiem.com)

### *9.4. The Characteristics of Petroleum and Gas Equipment Industry*

Referring to studies and surveying of current existing documents and specialized reports in Society of Iranian Petroleum Industry Equipment Manufacturers (SIPIEM), the most significant and substantial non-governmental organization in Petroleum and Gas equipment industry in Iran and also according to in-depth interviews with CEOs and high ranked managers of small and medium sized firms operating in Petroleum and Gas equipment industry in Iran, the main important and accurate specifications and characteristics of this industry were acquired and extracted from the reports and interviews. These particular specifications from the expertized reports of SIPIEM and CEOs and top managers of SMEs in this industry are as following:

| R&D and Academic Collaborative approach | Customer Centric Role | Cooperative Technological and Knowledge based Sourcing | IP and Licensing agreement Driven | Industrial Networking | External Corporate Venturing |
|---|---|---|---|---|---|
| **1.** High and great reliance on R&D functions and practices, design and engineering departments<br><br>**2.** Benchmarking through buying innovative ideas, developing and expanding of these kinds of ideas<br><br>**3.** Necessity of investment on new ideas from individual experts or universities<br><br>**4.** Cooperation with universities and researchers in case of requirements to technical knowledge<br><br>**5.** The necessity of using other's experiences such as consultant's ideas in order to get familiar with new technology | **1.** High important role of customers and their ideas, needs, priorities and preferences. As these knowledge based firms are in small and medium sized scale, thus, their end users are customers.<br><br>**2.** The importance of receiving feedbacks from external resources of firms for innovating and developing new products<br><br>**3.** Need of innovation practices in SMEs operating in Petroleum and Gas equipment industry to achieve sustainable competitive advantage<br><br>**4.** The necessity of optimization, modifications and improvements in new innovative product in order to improve production process | **1.** Necessity of buying technologies and its tools or machineries in order to perform required processes on it according to the firm's requirements<br><br>**2.** Institutionalization of external knowledge and innovation resources for internal exploitation inside firm's boundaries<br><br>**3.** Need of technology transfer in Petroleum and Gas equipment industry<br><br>**4.** The important role of standards in Petroleum and Gas equipment industry according to the most updated and state of the art international standards | **1.** The necessity of buying other firms and manufacturer's products through licensing-in<br><br>**2.** Lack of generating patents by SMEs operating in Petroleum and Gas equipment industry and necessity of exploiting and licensing external IPs and patents inside these firms | **1.** Necessity of cooperation with new manufacturers to produce new products<br><br>**2.** The important role of partners as influencers on organizational growth<br><br>**3.** Learning function, and knowledge enhancement as the main required factor for SMEs of Petroleum and Gas equipment industry<br><br>**4.** The necessity of interactions with external resources, because all are not happening inside organizations. In addition, the necessity of utilizing external capacities because of limited internal resources of SMEs operating in Petroleum and Gas equipment industry | **1.** Need of joint venturing with pioneering companies. |

**Table 24- Grouping of Specifications and Characteristics of Petroleum and Gas Equipment Industry**

**Continue of table 24**

| R&D and Academic Collaborative approach | Customer Centric Role | Cooperative Technological and Knowledge based Sourcing | IP and Licensing agreement Driven | Industrial Networking | External Corporate Venturing |
|---|---|---|---|---|---|
| | | **5.** Need of monitoring market condition and latest current technology due to SMEs requirements<br><br>**6.** Technological orientation and entrepreneurship orientation of SMEs in Petroleum and Gas equipment industry | | **5.** The necessity of external environment monitoring such as monitoring of suppliers, new products and technologies as the essence of this industry<br><br>**6.** The necessity of being concerned about competitor's products and practices in the market in order to sustain market share and condition<br><br>**7.** The necessity of being aware to supplier's new ideas | |

# *Chapter 5: Data Analysis*

### *1.5. The Face Validity of the Questionnaire*

Face validity implies to whether or not the measurement of a construct is valid. According to Rust and Golombok (1999), they believe that this is better to evaluate and assess the face validity by asking it from potential respondents whose main professional or academic characteristics are relevant to the questionnaire and or whether questionnaire name and the items (scales) are acceptable from their opinions (Brinkman 2009). Face validity of this research has been used before data collection in order to check the appropriateness and suitability of questionnaire's questions according to the understandability and comprehension of written questions. As the questionnaire was prepared in English from in-depth interview as the first step of the research design, and other available construct's questions, therefore, there was a necessity to check the suitability of all questions by professors. Thus, all questions of inbound open innovation which were drawn from in-depth interviews with CEOs, top and highly ranked mangers of Petroleum and Gas equipment industry, plus questions of other constructs from previous and antecedent scales of existing relevant literature was checked in English language by (1) Italian professors, (as the supervisor and other professors of Management Science) to check if the questions were well written according to the grammatical and editing points. Then (2) It was translated into Persian (Farsi) language in order to be distributed and administered among Iranian SMEs as the respondents of the questionnaire, therefore, the Persian (Farsi) language version of the questionnaire was submitted to Iranian professors. Afterward, both types of English and Farsi languages versions of questionnaire were accepted and approved by both Italian and Iranian professors, and then the face validity of the questionnaire was accepted.

### *2.5. The Content Validity of the Questionnaire*

Even though the first idea of inbound open innovation sources were driven and inspired from the study of Van de Vrande et al (2009), there have not been any antecedent scales to measure directly the effects of different inbound open innovation sources on product innovation performance. Thus, the questions of various inbound open innovation sources were driven and created from in-depth interviews with CEO and managers of Petroleum and Gas equipment industry in order to understand better their ideas and insights about inbound open innovation sources definition and types of inbound open innovation activities in their SMEs in order to design and create the questions of the inbound open innovations constructs such as: (1) Customer Involvement, (2) Industrial Network Partnership, (3) External Participation, (4) R&D and Academic outsourcing, (5) Inward Licensing. In addition, the rest of the questions of other constructs were formulated based on the prior and antecedent peer-review highly ranked literatures relevant to new product innovativeness, R&D expenditure, new product advantage and organizational declarative memory. In this regard, it was crucial to assess the content validity of the whole questionnaire by experts of Petroleum and Gas equipment industry in Iran before distributing the questionnaire and collecting data.

Content validity implies to this question that whether the full content of a construct is displayed or shown in the measurement or some aspects or dimensions are left. In content validity, experts have to agree that the construct has been appropriately operationalized achieving all aspects of the constructs (Brinkman 2009). For content validity purposes, CVI[2] as the first step and the first form was calculated based on Waltz and Bausell content validity index. The CVI form which included all construct's items and questions were translated from English into Farsi (Persian) language. Also, in order to calculate CVI, questionnaire were

Content Validity Index - [2]

given to 12 experts and specialists in Petroleum and Gas equipment industry and also to university professors and academicians in the field of innovation and technology management in Iran and they were asked to explain and express their views to each questions. The CVI for each item was obtained based on three dimensions and criterion (relevancy, clarity, and simplicity). They were asked to respond to these three dimensions according to four-part Likert scale such as: (1) irrelevant, (2) somewhat relevant, (3) relevant, (4) complete relevant. CVI is calculated according to the following formula:

$$\text{CVI} = \frac{\text{The number of experts who chose 3 and 4}}{\text{Total number of respondents}}$$

The minimum acceptance rate and score of CVI should be 0.78. After analyzing the results, the CVI score for 50 questions out of 60 was acceptable. Based on this evaluation, 11 questions of the original items, which were translated from English into Farsi, did not meet pre-assumed criteria and minimum acceptance rate and had to be modified and changed due to lack of minimum content validity based on the ideas, insights and judgment of 12 experts, professors and academicians. The number of modified questions based on three dimensions of relevance, simplicity and clarity is as following:

| | | | Rating on 61 items (Questions) scaled by 12 experts: Items rated 3 or 4 on 4-Point Relevance Scale | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Questions | Expert 1 | Expert 2 | Expert 3 | Expert 4 | Expert 5 | Expert 6 | Expert 7 | Expert 8 | Expert 9 | Expert 10 | Expert 11 | Expert 12 | Experts in Agreement | Accepted Rates should be above 78% | |
| 1 | • | | • | • | | • | • | • | • | • | • | • | 10 | 0.83 | |
| 2 | • | • | | • | • | | • | • | • | • | • | • | 10 | 0.83 | |
| 3 | • | • | • | • | • | | | • | • | • | • | • | 10 | 0.83 | |
| 4 | • | • | • | • | • | • | • | | • | • | • | | 10 | 0.83 | |
| 5 | • | • | • | • | • | | • | • | • | • | • | • | 11 | 0.92 | |
| 6 | • | • | • | | | • | • | • | • | • | • | • | 10 | 0.83 | |
| 7 | | | | | • | • | • | • | • | • | • | • | 8 | 0.67 | Revised |
| 8 | • | • | • | • | • | • | • | • | • | • | | • | 11 | 0.92 | |
| 9 | • | • | • | | • | • | • | • | • | • | • | | 10 | 0.83 | |
| 10 | • | • | • | • | • | • | • | • | | | • | • | 10 | 0.83 | |
| 11 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 12 | • | • | • | • | • | | | • | • | • | • | • | 10 | 0.83 | |
| 13 | • | • | • | • | • | • | • | • | • | • | • | | 11 | 0.92 | |
| 14 | • | | | • | • | • | • | • | • | | | | 7 | 0.58 | Revised |
| 15 | • | • | • | • | • | • | • | • | • | • | | | 10 | 0.83 | |
| 16 | • | | | • | • | • | • | • | • | • | • | • | 10 | 0.83 | |
| 17 | • | • | • | • | • | • | | • | • | • | • | • | 11 | 0.92 | |
| 18 | • | • | • | • | • | • | • | • | • | | | • | 10 | 0.83 | |
| 19 | • | | • | • | | • | • | | • | • | | • | 8 | 0.67 | Revised |
| 20 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 21 | • | • | | | | • | • | • | | | • | | 6 | 0.50 | Revised |
| 22 | • | • | • | • | • | • | • | • | • | • | • | | 11 | 0.92 | |
| 23 | | • | • | • | • | | | • | • | | | | 6 | 0.50 | Revised |
| 24 | | • | • | • | • | • | • | • | • | • | • | • | 11 | 0.92 | |
| 25 | | • | • | • | • | | | • | • | | • | | 7 | 0.58 | Revised |
| 26 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 27 | • | • | • | • | • | • | • | • | • | | | • | 10 | 0.83 | |
| 28 | | • | | • | | • | | • | | • | | | 5 | 0.42 | Revised |
| 29 | | | • | • | • | • | • | • | • | • | • | • | 10 | 0.83 | |
| 30 | • | • | • | • | • | • | • | • | • | • | | | 10 | 0.83 | |
| 31 | • | | | • | • | • | • | • | • | • | • | • | 10 | 0.83 | |
| 32 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 33 | • | • | • | • | • | • | • | • | • | • | • | | 11 | 0.92 | |
| 34 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 35 | | • | • | • | • | • | • | • | • | • | • | • | 11 | 0.92 | |
| 36 | • | • | • | • | • | | • | • | • | • | • | | 10 | 0.83 | |
| 37 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 38 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 39 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 40 | • | • | • | • | • | | | • | • | • | | | 8 | 0.67 | Revised |
| 41 | • | • | • | • | • | • | • | • | • | • | | | 10 | 0.83 | |
| 42 | | • | • | • | • | • | • | • | • | • | • | • | 11 | 0.92 | |
| 43 | • | | • | • | • | • | • | • | • | • | • | • | 11 | 0.92 | |
| 44 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 45 | • | • | • | • | • | • | • | • | • | • | • | | 11 | 0.92 | |
| 46 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 47 | • | • | • | • | • | • | • | • | • | • | • | | 11 | 0.92 | |
| 48 | • | | | • | • | • | | • | • | | | • | 7 | 0.58 | Revised |
| 49 | • | • | • | • | | | | • | • | | | | 6 | 0.50 | Revised |
| 50 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 51 | • | • | • | • | • | • | • | | | • | • | • | 10 | 0.83 | |
| 52 | | • | • | • | • | • | • | • | • | • | • | • | 11 | 0.92 | |
| 53 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 54 | • | • | • | • | • | • | • | • | • | • | | | 10 | 0.83 | |
| 55 | | • | • | • | • | • | • | • | • | • | • | • | 11 | 0.92 | |
| 56 | • | • | • | • | | | • | • | • | • | • | • | 10 | 0.83 | |
| 57 | • | • | • | • | • | • | | • | • | • | | • | 10 | 0.83 | |
| 58 | • | • | • | • | • | • | • | • | | • | • | • | 11 | 0.92 | |
| 59 | • | | | • | | • | • | • | | | • | | 6 | 0.50 | Revised |
| 60 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 61 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |

**Table 25- The CVI Relevance Dimensions and Number of Revised Questions**

| | | | Rating on 61 items (Questions) scaled by 12 experts: Items rated 3 or 4 on 4-Point Simplicity Scale | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Questions | Expert 1 | Expert 2 | Expert 3 | Expert 4 | Expert 5 | Expert 6 | Expert 7 | Expert 8 | Expert 9 | Expert 10 | Expert 11 | Expert 12 | Experts in Agreement | Accepted Rates should be above 78% | |
| 1 | | • | • | • | • | • | • | • | • | • | • | • | 11 | 0.92 | |
| 2 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 3 | • | • | • | • | • | • | | | • | • | • | • | 10 | 0.83 | |
| 4 | • | • | • | • | • | • | • | • | • | • | | • | 11 | 0.92 | |
| 5 | • | • | • | • | | • | • | • | • | • | • | | 10 | 0.83 | |
| 6 | • | | | • | • | • | • | • | • | • | • | • | 10 | 0.83 | |
| 7 | • | • | • | • | • | • | • | • | | | | | 8 | 0.67 | Revised |
| 8 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 9 | • | • | • | • | • | | | • | • | • | • | • | 10 | 0.83 | |
| 10 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 11 | • | • | • | • | • | • | • | | | • | • | • | 10 | 0.83 | |
| 12 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 13 | • | • | • | | | • | • | • | • | • | • | • | 10 | 0.83 | |
| 14 | | | • | • | • | • | • | • | • | | | | 7 | 0.58 | Revised |
| 15 | | | • | • | • | • | • | • | • | • | • | • | 10 | 0.83 | |
| 16 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 17 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 18 | • | • | • | • | • | • | • | • | • | • | | | 10 | 0.83 | |
| 19 | • | • | • | | | | • | | | • | | • | 6 | 0.50 | Revised |
| 20 | • | • | • | • | • | • | • | • | • | • | • | | 11 | 0.92 | |
| 21 | • | • | • | • | • | • | • | • | | | | | 8 | 0.67 | Revised |
| 22 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 23 | • | • | • | | | | • | • | • | • | • | • | 9 | 0.75 | Revised |
| 24 | • | • | • | • | • | • | • | • | • | • | • | | 11 | 0.92 | |
| 25 | | | | | | • | • | • | • | • | • | • | 7 | 0.58 | Revised |
| 26 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 27 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 28 | • | | • | • | | | • | | • | | | • | 6 | 0.50 | Revised |
| 29 | • | • | • | • | • | • | • | • | • | • | | | 10 | 0.83 | |
| 30 | | • | • | • | • | • | • | • | • | | • | • | 10 | 0.83 | |
| 31 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 32 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 33 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 34 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 35 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 36 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 37 | | • | • | • | • | • | • | • | • | • | • | • | 11 | 0.92 | |
| 38 | • | • | • | • | • | • | • | • | • | • | • | | 11 | 0.92 | |
| 39 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 40 | | • | • | • | | | • | • | • | • | • | • | 9 | 0.75 | Revised |
| 41 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 42 | • | • | • | • | • | • | • | • | • | • | | | 10 | 0.83 | |
| 43 | | • | • | • | • | • | • | • | | | • | • | 9 | 0.75 | |
| 44 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 45 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 46 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 47 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 48 | | | • | • | • | • | • | • | • | • | • | | 9 | 0.75 | Revised |
| 49 | • | • | • | | | • | • | | | • | | | 6 | 0.50 | Revised |
| 50 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 51 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 52 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 53 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 54 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 55 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 56 | • | • | • | • | • | | | • | • | • | • | • | 10 | 0.83 | |
| 57 | | | • | • | • | • | • | • | • | • | • | • | 10 | 0.83 | |
| 58 | • | • | • | • | • | • | • | • | • | • | • | | 11 | 0.92 | |
| 59 | | • | | | | | • | • | • | • | • | • | 7 | 0.58 | Revised |
| 60 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 61 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |

**Table 26: The CVI Simplicity Dimension and Number of Revised Questions**

| | | | Rating on 61 items (Questions) scaled by 12 experts: Items rated 3 or 4 on 4-Point Clarity Scale | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Questions | Expert 1 | Expert 2 | Expert 3 | Expert 4 | Expert 5 | Expert 6 | Expert 7 | Expert 8 | Expert 9 | Expert 10 | Expert 11 | Expert 12 | Experts in Agreement | Accepted Rates should be above 78% | |
| 1 | • | • | • | • | • | • | • | • | • | • | | | 10 | 0.83 | |
| 2 | | • | • | • | • | • | • | • | • | • | • | • | 11 | 0.92 | |
| 3 | • | • | • | • | • | • | • | • | • | • | | | 10 | 0.83 | |
| 4 | | • | | • | • | • | • | • | • | • | • | • | 10 | 0.83 | |
| 5 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 6 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 7 | • | • | • | • | • | • | • | | | | | | 7 | 0.58 | Revised |
| 8 | | • | • | • | • | • | • | | • | • | • | • | 10 | 0.83 | |
| 9 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 10 | • | • | • | • | • | • | | | • | • | • | • | 10 | 0.83 | |
| 11 | | • | • | • | • | • | | • | • | • | • | • | 10 | 0.83 | |
| 12 | • | • | • | • | • | • | • | • | • | • | • | | 11 | 0.92 | |
| 13 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 14 | | • | • | • | • | • | • | | • | • | • | | 9 | 0.75 | Revised |
| 15 | • | • | • | • | • | • | | • | • | • | | • | 10 | 0.83 | |
| 16 | • | • | • | • | • | • | • | • | • | • | • | | 11 | 0.92 | |
| 17 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 18 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 19 | | • | • | • | | | • | | • | | | • | 6 | 0.50 | Revised |
| 20 | • | • | • | • | • | • | • | • | • | • | • | | 11 | 0.92 | |
| 21 | | | | | • | • | • | • | • | • | • | • | 8 | 0.67 | Revised |
| 22 | • | • | • | • | • | • | • | • | • | • | | | 10 | 0.83 | |
| 23 | • | • | • | | • | | | • | | • | | • | 7 | 0.58 | Revised |
| 24 | • | • | • | • | • | • | • | • | • | • | | | 10 | 0.83 | |
| 25 | | | | | • | • | • | • | • | | | • | 6 | 0.50 | Revised |
| 26 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 27 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 28 | | • | • | • | • | • | • | • | • | • | | | 9 | 0.75 | Revised |
| 29 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 30 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 31 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 32 | | • | • | • | • | • | • | • | • | • | • | • | 11 | 0.92 | |
| 33 | • | • | • | • | • | | • | • | • | • | • | | 10 | 0.83 | |
| 34 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 35 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 36 | • | • | • | • | • | • | • | • | • | | • | • | 11 | 0.92 | |
| 37 | • | • | • | • | • | • | • | • | | • | • | • | 11 | 0.92 | |
| 38 | | • | • | • | • | • | • | • | • | | • | • | 10 | 0.83 | |
| 39 | • | • | • | • | • | • | • | • | • | | | • | 10 | 0.83 | |
| 40 | | | | • | • | • | • | • | • | • | • | | 8 | 0.67 | Revised |
| 41 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 42 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 43 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 44 | • | • | • | • | • | • | • | • | • | • | | | 10 | 0.83 | |
| 45 | | • | • | • | • | • | | • | • | • | • | • | 10 | 0.83 | |
| 46 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 47 | • | • | • | • | • | • | • | • | • | • | • | | 11 | 0.92 | |
| 48 | • | | | | | • | • | • | • | • | • | • | 8 | 0.67 | Revised |
| 49 | | | • | • | • | • | • | • | | | • | | 7 | 0.58 | Revised |
| 50 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 51 | • | • | • | • | • | • | • | • | • | • | • | | 11 | 0.92 | |
| 52 | • | • | • | • | • | • | • | • | • | • | | | 10 | 0.83 | |
| 53 | | • | • | • | • | • | • | • | • | • | • | • | 11 | 0.92 | |
| 54 | • | • | | • | • | • | • | • | | • | • | • | 10 | 0.83 | |
| 55 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 56 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 57 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 58 | • | • | • | • | • | • | • | • | • | • | • | • | 12 | 1.00 | |
| 59 | • | | • | • | | • | | • | • | • | | | 7 | 0.58 | Revised |
| 60 | • | • | • | • | • | • | • | • | • | • | | | 10 | 0.83 | |
| 61 | | • | • | • | • | • | • | • | • | • | • | • | 11 | 0.92 | |

**Table 27- The CVI Clarity Dimension and Number of Revised Questions**

After modification and editing of 11 questions, which were judged by 12 experts in CVI form, CVR form was used. For quantitative assessment of content validity ratio (CVR), the model of Lawshe was used in this research. In order to make sure that the chosen and selected content of questions are substantial, remarkable and accurate, Content Validity Ration (CVR) was applied in order to ensure that questions of data collection tools are best designed and formulated. CVR form was distributed between other 12 experts, professors and academicians. Based on Lawshe (1975), opinions of experts in CVR form were categorized according to three dimensions: (1) Essential, (2) Useful but not essential, (3) Not necessary. CVR was calculated according to the following formula:

$$CVR = \frac{ne - N/2}{N/2}$$

ne is the number of experts that rated the item as "Essential", and N is the total number of respondent experts. As the number of respondents to CVR form was another 12 experts, professors and academicians, the numbers higher than 0.56 were accepted as following:

| Questions | Expert 1 | | | Expert 2 | | | Expert 3 | | | Expert 4 | | | Expert 5 | | | Expert 6 | | | Expert 7 | | | Expert 8 | | | Expert 9 | | | Expert 10 | | | Expert 11 | | | Expert 12 | | | Experts in Agreement | CVR | Accepted Rates for 12 experts should be above 56% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Essential | Usefull but not essential | Not Necessary | Essential | Usefull but not essential | Not Necessary | Essential | Usefull but not essential | Not Necessary | Essential | Usefull but not essential | Not Necessary | Essential | Usefull but not essential | Not Necessary | Essential | Usefull but not essential | Not Necessary | Essential | Usefull but not essential | Not Necessary | Essential | Usefull but not essential | Not Necessary | Essential | Usefull but not essential | Not Necessary | Essential | Usefull but not essential | Not Necessary | Essential | Usefull but not essential | Not Necessary | Essential | Usefull but not essential | Not Necessary | | | |
| 1 | • | | | • | | | • | | | • | | | • | | | • | | | | • | | • | | | • | | | • | | | • | | | | | • | 10 | 0.66 | accepted |
| 2 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | | | • | • | | | • | | | • | | | • | | | 11 | 0.83 | accepted |
| 3 | | | • | • | | | • | | | • | | | • | | | • | | | • | | | | • | | • | | | • | | | • | | | • | | | 10 | 0.66 | accepted |
| 4 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 5 | • | | | • | | | • | | | | • | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | | | • | 10 | 0.66 | accepted |
| 6 | • | | | • | | | • | | | | • | | • | | | • | | | | | • | • | | | • | | | • | | | • | | | • | | | 10 | 0.66 | accepted |
| 7 | | | • | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 11 | 0.83 | accepted |
| 8 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 9 | • | | | • | | | • | | | • | | | | | • | • | | | • | | | | • | | • | | | • | | | • | | | • | | | 10 | 0.66 | accepted |
| 10 | • | | | | | • | • | | | • | | | • | | | | • | | • | | | • | | | • | | | • | | | • | | | • | | | 10 | 0.66 | accepted |
| 11 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | | | • | 11 | 0.83 | accepted |
| 12 | • | | | • | | | • | | | • | | | • | | | | • | | • | | | • | | | • | | | • | | | • | | | • | | | 11 | 0.83 | accepted |
| 13 | • | | | | | • | • | | | • | | | • | | | | • | | • | | | • | | | • | | | • | | | • | | | • | | | 10 | 0.66 | accepted |
| 14 | | • | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 11 | 0.83 | accepted |
| 15 | • | | | • | | | • | | | • | | | • | | | | • | | • | | | • | | | | • | | • | | | • | | | • | | | 10 | 0.66 | accepted |
| 16 | • | | | • | | | • | | | • | | | • | | | | • | | • | | | • | | | • | | | • | | | • | | | | | • | 10 | 0.66 | accepted |
| 17 | | • | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 11 | 0.83 | accepted |
| 18 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | | | • | • | | | • | | | • | | | 11 | 0.83 | accepted |
| 19 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 20 | • | | | • | | | • | | | • | | | | • | | • | | | • | | | • | | | • | | | • | | | • | | | | • | | 10 | 0.66 | accepted |
| 21 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | | • | | 11 | 0.83 | accepted |
| 22 | • | | | • | | | • | | | • | | | • | | | • | | | | | • | • | | | • | | | • | | | • | | | | • | | 10 | 0.66 | accepted |
| 23 | • | | | • | | | • | | | • | | | | • | | • | | | | • | | • | | | • | | | • | | | • | | | • | | | 10 | 0.66 | accepted |
| 24 | | • | | • | | | • | | | • | | | • | | | • | | | | • | | • | | | • | | | • | | | • | | | • | | | 10 | 0.66 | accepted |
| 25 | • | | | • | | | • | | | | • | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 11 | 0.83 | accepted |
| 26 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 27 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 28 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 29 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 30 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 31 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 32 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 33 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 34 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 35 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 36 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | | | • | 11 | 0.83 | accepted |
| 37 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | | • | | • | | | • | | | 11 | 0.83 | accepted |
| 38 | • | | | • | | | • | | | • | | | • | | | | • | | • | | | • | | | • | | | • | | | • | | | • | | | 11 | 0.83 | accepted |
| 39 | • | | | | • | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 11 | 0.83 | accepted |
| 40 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 41 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 42 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 43 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 44 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 45 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 46 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 47 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 48 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 49 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 50 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 51 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 52 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 53 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 54 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 55 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 56 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 57 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 58 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 59 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 60 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |
| 61 | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | 12 | 1.00 | accepted |

**Table 28- The CVR Form and Accepted Questions**

Overall, at this stage, after collecting CVI, modifying some questions, then preparing, distributing CVR form, and then analyzing these forms after collecting from experts, implies to this notion that both of these forms have met the standard criterion and sufficient support from experts as the respondents shown to the questions. It demonstrates that the questionnaire as data collection instrument has content validity and it is suitable and appropriate to distribute the questionnaire among SMEs as statistical target population.

### *3.5. The Missing Data Analysis*

Missing data is occurring when a respondent from the statistical population either intentionally and purposefully or unintentionally forgot or failed to respond one or more questions. When the number and amount of missing data on a questionnaire is beyond or exceed 15%, the observation and the process of data collection is normally will be removed and omitted from the data file (Hair et al, 2016). In this research as it is shown on table 29, there is no missing data for all 61 questions in the questionnaire, which are named as abbreviation of each construct in theoretical model. (i.e., CI stands for Customer Involvement, INP= Industrial Network Partnership, EP= External Participation, R&D= R&D and Academic Outsourcing, and IL= Inward Licensing, and all of these five constructs are related to Inbound Open Innovation sources and activities). Moreover, other constructs are listed by their abbreviated names and with their number of questions according to the theoretical model construct's names such as NPI=New Product Innovativeness, R.D Exp= R.D Expenditure, NPA=New Product Advantage, ODM=Organizational Declarative Memory, FS=Firm Size, TT=Technology Turbulence, COMPIN=Competition Intensity, MT=Market Turbulence. This table was provided by descriptive statistics, frequencies commands in SPSS software. It shows that respondents responded all questions properly and no question was remained unanswered.

| | N: Valid | Missing | Mean | | N: Valid | Missing | Mean |
|---|---|---|---|---|---|---|---|
| CI1 | 150 | 0 | 6.47 | INP1 | 150 | 0 | 5.07 |
| CI2 | 150 | 0 | 6.65 | INP2 | 150 | 0 | 5.45 |
| CI3 | 150 | 0 | 6.59 | INP3 | 150 | 0 | 5.48 |
| CI4 | 150 | 0 | 5.35 | INP4 | 150 | 0 | 5.21 |
| CI5 | 150 | 0 | 5.11 | INP5 | 150 | 0 | 4.78 |
| EP1 | 150 | 0 | 4.35 | RD1 | 150 | 0 | 4.01 |
| EP2 | 150 | 0 | 4.82 | RD2 | 150 | 0 | 4.25 |
| EP3 | 150 | 0 | 4.87 | RD3 | 150 | 0 | 4.06 |
| EP4 | 150 | 0 | 3.40 | RD4 | 150 | 0 | 4.21 |
| EP5 | 150 | 0 | 4.17 | RD5 | 150 | 0 | 5.33 |
| IL1 | 150 | 0 | 3.81 | NPI1 | 150 | 0 | 5.71 |
| IL2 | 150 | 0 | 3.93 | NPI2 | 150 | 0 | 5.08 |
| IL3 | 150 | 0 | 3.09 | NPI3 | 150 | 0 | 5.25 |
| IL4 | 150 | 0 | 4.01 | NPI4 | 150 | 0 | 5.28 |
| IL5 | 150 | 0 | 4.51 | NPI5 | 150 | 0 | 5.33 |
| | | | | NPI6 | 150 | 0 | 4.50 |
| NPA1 | 150 | 0 | 5.59 | ODM1 | 150 | 0 | 5.62 |
| NPA2 | 150 | 0 | 5.97 | ODM2 | 150 | 0 | 5.11 |
| NPA3 | 150 | 0 | 5.66 | ODM3 | 150 | 0 | 5.26 |
| NPA4 | 150 | 0 | 5.46 | ODM4 | 150 | 0 | 5.86 |
| NPA5 | 150 | 0 | 5.81 | ODM5 | 150 | 0 | 5.33 |
| | | | | ODM6 | 150 | 0 | 5.36 |
| | | | | ODM7 | 150 | 0 | 5.55 |
| | | | | ODM8 | 150 | 0 | 5.59 |
| | | | | ODM9 | 150 | 0 | 6.15 |

| | N: Valid | Missing | Mean | | N: Valid | Missing | Mean |
|---|---|---|---|---|---|---|---|
| R.DExp | 150 | 0 | 2.61 | TT1 | 150 | 0 | 5.15 |
| COMPIN1 | 150 | 0 | 5.69 | TT2 | 150 | 0 | 5.45 |
| COMPIN2 | 150 | 0 | 5.15 | TT3 | 150 | 0 | 5.51 |
| COMPIN3 | 150 | 0 | 4.96 | TT4 | 150 | 0 | 5.23 |
| COMPIN4 | 150 | 0 | 6.28 | MT1 | 150 | 0 | 4.31 |
| COMPIN5 | 150 | 0 | 4.80 | MT2 | 150 | 0 | 5.53 |
| | | | | MT3 | 150 | 0 | 4.42 |
| | | | | MT4 | 150 | 0 | 4.79 |
| | | | | FS | 150 | 0 | 2.61 |

**Table 29- Frequencies Statistics for Missing Data**

### *4.5. The Suspicious Response Patterns Analysis*

Before starting to analyze the data, researchers should consider to examine and test response patterns done by respondents. In this case, the researcher should start to look for a pattern most likely explained as straight lining. Straight lining is used when a respondent marks or responds the response for a high degree, amount and proportion of the questions. For instance, if a 7- point scale is used to attain and achieve answers, and the response pattern is all 4s (as the middle response rate), therefore, that response in most cases should be removed from the data set. Likewise, if a respondent choses only 1s or only 7s, then that respondent should be removed. In addition, if a respondent gives a very distinctive and various response to the same question asked in a little different way, this shows that the respondent was not reading and considering the questions meticulously or simply was marking answers to complete and exit the survey very rapidly (Hair et al, 2016). Thus, standard deviation should be calculated for each respondent to know if there is any requirement to keep or remove each of respondents. If standard deviation is below 0.3, that respondent must be removed from the list. Accordingly, in this research this was done by Excel file for all 150 respondents (SMEs).

Results in Excel file shows that all standard deviation for each 150 respondents answered to 61 questions are above 0.3, and there were no suspicious response pattern from SMEs as respondents to empirical data, which are collected using questionnaire in this research.

### ***5.5. The Data Distribution Analysis***

It is logical to use non-normal data to some extent in PLS. PLS-SEM is considered as a nonparametric statistical method. It is different from covariance bases structural equation modelling (CB-SEM). In PLS-SEM, it is not crucial and necessary the data to be normally distributed. Nonetheless, it is a substantial issue to realize and verify that the data are not considered as an extreme non-normal data. It can cause a problem in the assessment of the parameters' significances. In particular, extremely non-normal data inflate and increase standard errors gained and attained from bootstrapping function in PLS. Therefore, it decreases the likelihood of some relationships which should be assessed as significant (Hair, Ringle, & Sarstedt, 2011; Henseler et al., 2009). For assessing and examining the data distribution in PLS-SEM, Skewness and Kurtosis of data should be measured (Hair et al, 2016).

"A general guideline for skewness is that if the number is greater than + 1 or lower than -1, this is an indication of a substantially skewed distribution. For kurtosis, the general guideline is that if the number is greater than + 1, the distribution is too peaked. Likewise, a kurtosis of less than -1 indicates a distribution that is too flat. Distributions exhibiting skewness and or kurtosis that exceed these guidelines are considered non-normal" (Hair et al, 2016). In this regard, the data of this research are considered in both formats of normal and non-normal data. Some data are normal and some of them are non-normal. Accordingly, as some of the data are considered as non-normal, and even if some other are normal data, thus, all types of data are not regarded as normally distributed data, then the CB-SEM method is not an appropriate method and approach to be used. Thus, the PLS-SEM method has been applied and used in this research.

| | N | Skewness | | Kurtosis | |
|---|---|---|---|---|---|
| | Statistic | Statistic | Std. Error | Statistic | Std. Error |
| CI2 | 150 | -1.274 | .198 | - | - |
| CI3 | 150 | -1.071 | .198 | - | - |
| INP1 | 150 | -1.035 | .198 | - | - |
| INP3 | 150 | -1.062 | .198 | 1.002 | .394 |
| RD4 | 150 | - | - | -1.032 | .394 |
| RD5 | 150 | -1.076 | .198 | 1.616 | .394 |
| IL5 | - | - | - | -1.022 | .394 |
| NPI1 | 150 | -1.232 | .198 | 1.537 | .394 |
| NPI6 | - | - | - | -1.257 | .394 |
| NPA1 | 150 | -1.212 | .198 | - | - |
| NPA2 | 150 | -1.346 | .198 | 2.435 | .394 |
| NPA5 | 150 | -1.190 | .198 | 1.727 | .394 |
| ODM1 | 150 | -1.062 | .198 | 1.848 | .394 |
| ODM4 | 150 | -1.418 | .198 | 3.006 | .394 |
| ODM5 | 150 | -1.008 | .198 | - | - |
| ODM7 | 150 | -1.022 | .198 | 1.163 | .394 |
| ODM8 | 150 | -1.046 | .198 | 1.441 | .394 |
| ODM9 | 150 | -1.942 | .198 | 5.592 | .394 |
| R.DExp | 150 | 1.254 | .198 | - | - |
| COMPIN1 | 150 | -1.267 | .198 | 2.018 | .394 |
| COMPIN4 | 150 | -1.223 | .198 | 1.172 | .394 |
| TT3 | - | - | - | 1.266 | .394 |
| MT2 | 150 | -1.125 | .198 | 2.035 | .394 |

**Table 30- Descriptive Statistics for Non-Normal Data (Questions)**

In table 30, all non-normal data have been organized according to skewness and kurtosis of each questions in order to show that these questions which each of them is related to one of the constructs of the questionnaire were responded by 150 firms as respondents. However, according to the rule of thumb of skewness and kurtosis, which should be between the range of +1 and -1, this criteria has not been met by these questions and standards. Therefore, even though the rest of the data set and responded questions are normal, apart from those normal data, we conclude that the data set of this research must be considered as non-normal data. In addition, the most important and the highest non-standard and non-normal data were selected from table 30 in order to show their non-normality status and situations by normal curve in histogram graph. It is apparent that these selected data distributions displaying that their skewness and kurtosis exceed the required guidelines of normal data. Thus, these graphs visually display the non-normality of data set in this research. As a result, the best and appropriate empirical quantitative method in this regard is PLS-SEM, which has been applied in this research. Figures 4 to 11 show histograms of non-normal data distributions for question number 2 of customer involvement, question number 3 of industrial network partnership, question number 5 of R&D and academic outsourcing, question number 2 of new product advantage, question number 4 of organizational declarative memory, question number 9 of organizational declarative memory, question number 1 of competition intensity, and question number 2 of market turbulence as random examples of non-normal data distribution respectively. These sample of non-normal distributed questions show that neither skewness nor kurtosis are normal. Normal skewness must involve a perfectly symmetric distribution. Positive skewed distribution has scores inclined to the left side, with the tail extending to the right. Here in these examples, all sample questions have scores inclined to the right side, with the tail extending and following to the left, it shows that they are not positively and normally distributed. In addition, skewness with normal condition should be 0, the farther away from 0 means the more non-normal data distribution. In these question examples, all skewness is much farther away from 0 and shows more non-normal data distribution. In addition, not all of these sample questions have possessed the perfect peakedness as kurtosis and they inclined to the right side with not a perfect degree of peakedness. Thus, all showed in histogram that they are non-normal distributed questions of constructs.

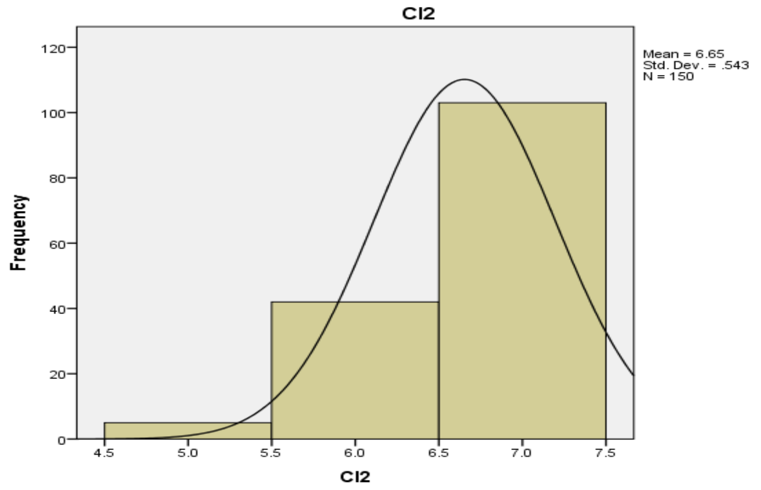


**Figure 4- Histogram Non Normal Data Distribution of Question Number 2 of Customer Involvement**

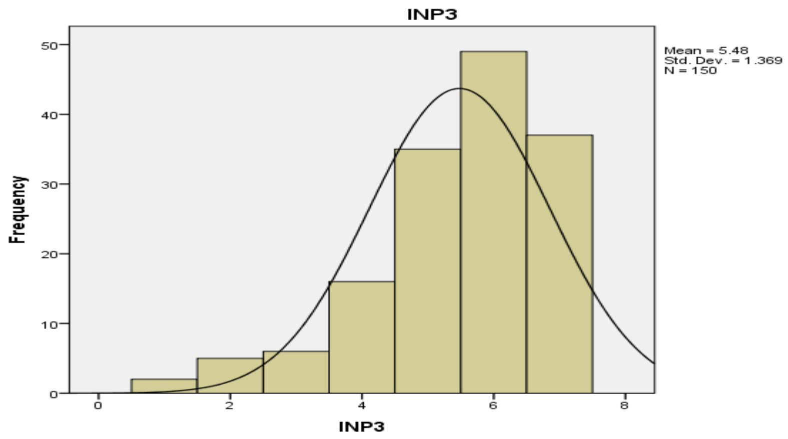


**Figure 5- Histogram Non Normal Data Distribution of Question Number 3 of Indutrial Network Partnership**

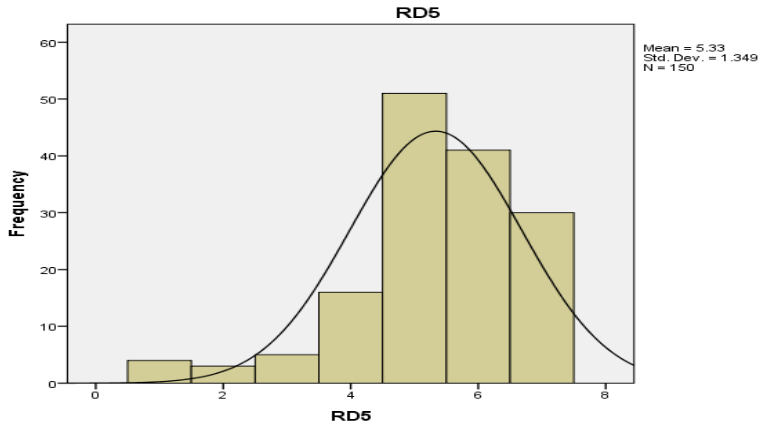


**Figure 6- Histogram Non Normal Data Distribution of Question Number 5 of R&D and Academic Outsourcing**

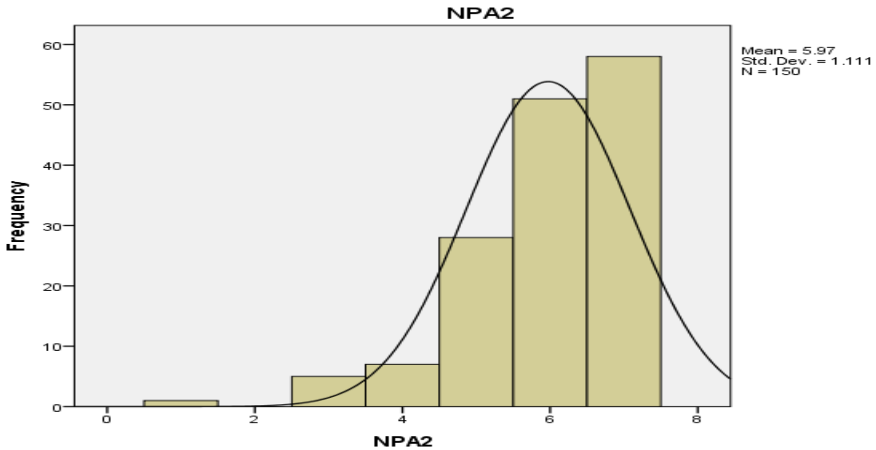


**Figure 7- Histogram Non Normal Data Distribution of Question Number 2 of New Product Advantage**

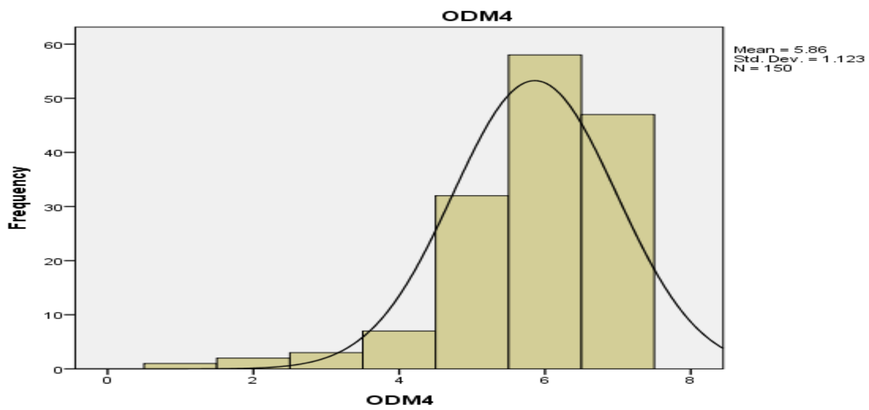


**Figure 8- Histogram Non Normal Data Distribution of Question Number 4 of Organizational Declarative Memory**

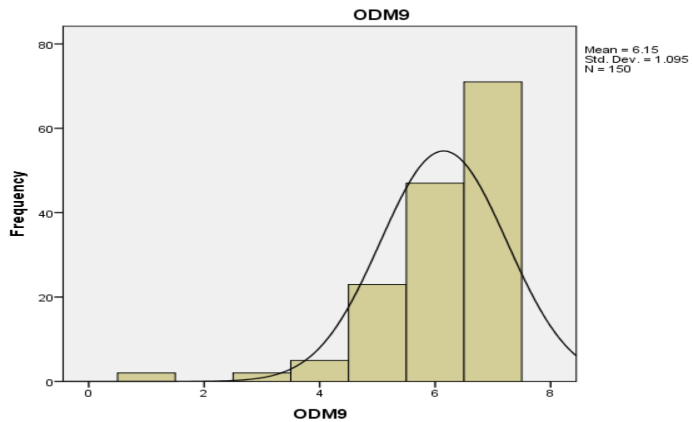


**Figure 9- Histogram Non Normal Data Distribution of Question Number 9 of Organizational Declarative Memory**

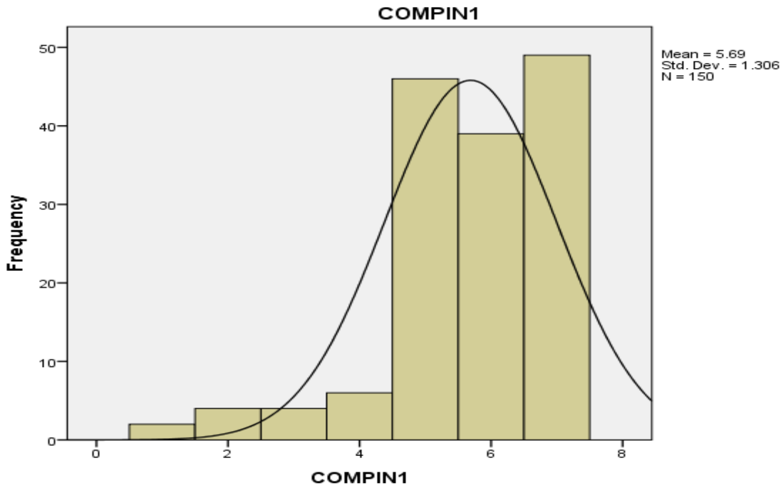


**Figure 10- Histogram Non Normal Data Distribution of Question Number 1 of Competition Intensity**

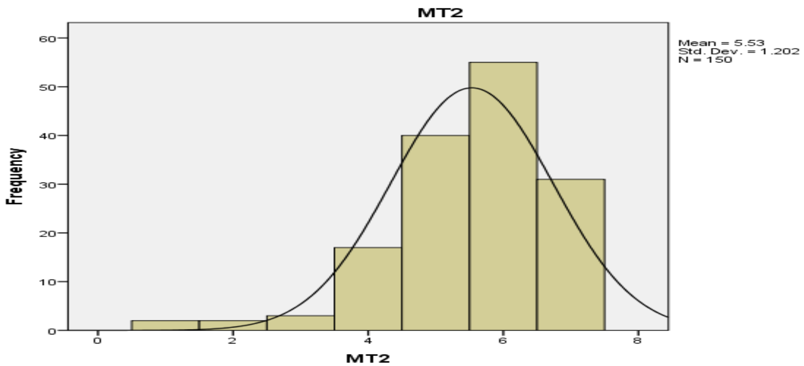


**Figure 11- Histogram Non Normal Data Distribution of Question Number 2 of Market Turbulence**

| | | CI | INP | EP | R.D | IL | NPI | NPA | ODM | COMPIN | TT | MT | FS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | Valid | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| | Missing | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Skewness | | -.454 | -.775 | -.407 | -.369 | -.166 | -.624 | -1.042 | -1.043 | -.332 | -.771 | -.180 | -.196 |
| Std. Error of Skewness | | .198 | .198 | .198 | .198 | .198 | .198 | .198 | .198 | .198 | .198 | .198 | .198 |
| Kurtosis | | -.491 | .446 | -.317 | -.491 | -.634 | .341 | 2.163 | 2.171 | -.326 | .477 | -.272 | -.549 |
| Std. Error of Kurtosis | | .394 | .394 | .394 | .394 | .394 | .394 | .394 | .394 | .394 | .394 | .394 | .394 |

**Table 31- Descriptive Statistics for Non-Normal Constructs (Variables)**

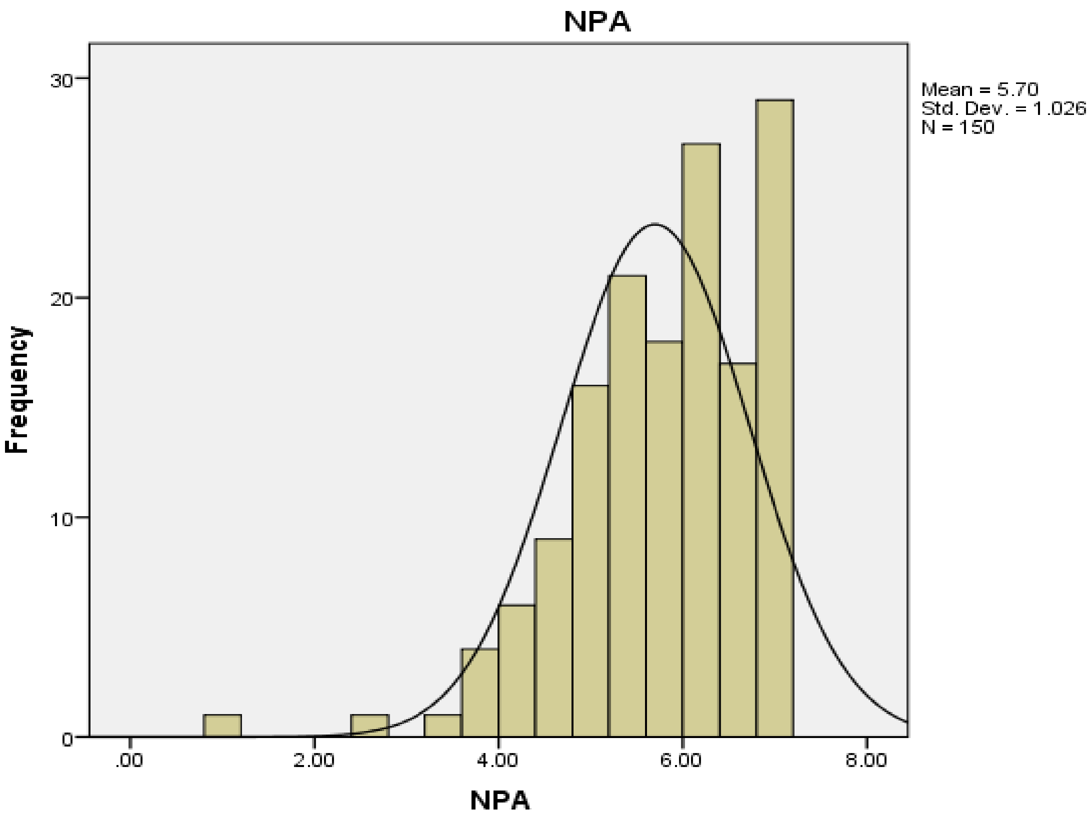


**Figure 12- Histogram Non-Normal Data Distribution of New Product Advantage Variable**

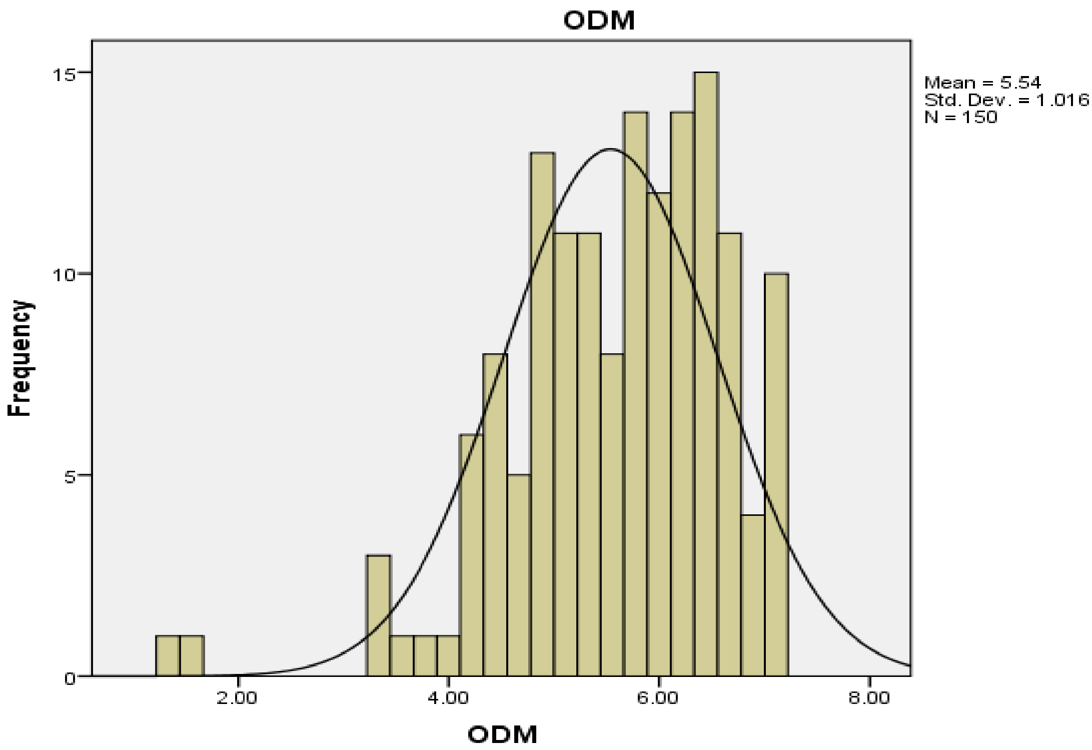


**Figure 13- Histogram Non-Normal Data Distribution of Organizational Declarative Memory Variable**

As it is shown in table 31, the data distribution for 12 variables (constructs) are seemed to be normal except New Product Advantage and Organizational Declarative Memory as they are not regarded as normally distributed variables, because they are not indicated in the range of +1 and -1 of skewness and kurtosis. In addition, figures number 12 and 13 show the non-normality of these two variables.

### *6.5. The Main Descriptive Statistics*

#### *1.6.5. The Job Title of Managers as Respondents in SMEs*

Table 32, as the descriptive data of respondents to questionnaire at the stage of empirical data collecting displays the frequency of CEOs and managers of SMEs operating in Petroleum and Gas equipment industry in Iran, which participated in empirical data collection and responded to questions. The questionnaire was distributed between CEOs, R&D managers, Managers of product design and development, Marketing managers and Managers of factory and manufacturing as these types of managers are most likely involved with topics, notions and trends of open innovation practices, new product innovation or new product success in the marketplace. Each questionnaire was submitted and given to one of the mangers in one of these SMEs. The highest number of respondents to questionnaire is (1): Marketing managers (41%) who are equal to 62 managers from 62 firms. (2) CEOs (29.3%) who are equal to 44 CEOs from 44 firms, and (3) R&D managers (14.7%) who are equal to 22 managers form 22 firms respectively.

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| CEO | 44 | 29.3 | 29.3 | 29.3 |
| R&D Manager | 22 | 14.7 | 14.7 | 44.0 |
| Manager of Product Design and Development | 13 | 8.7 | 8.7 | 52.7 |
| Marketing Manager | 62 | 41.3 | 41.3 | 94.0 |
| Manager of Factory and Manufacturing | 9 | 6.0 | 6.0 | 100.0 |
| Total | 150 | 100.0 | 100.0 | |

**Table 32- Job Title of Managers as Respondents in SMEs**

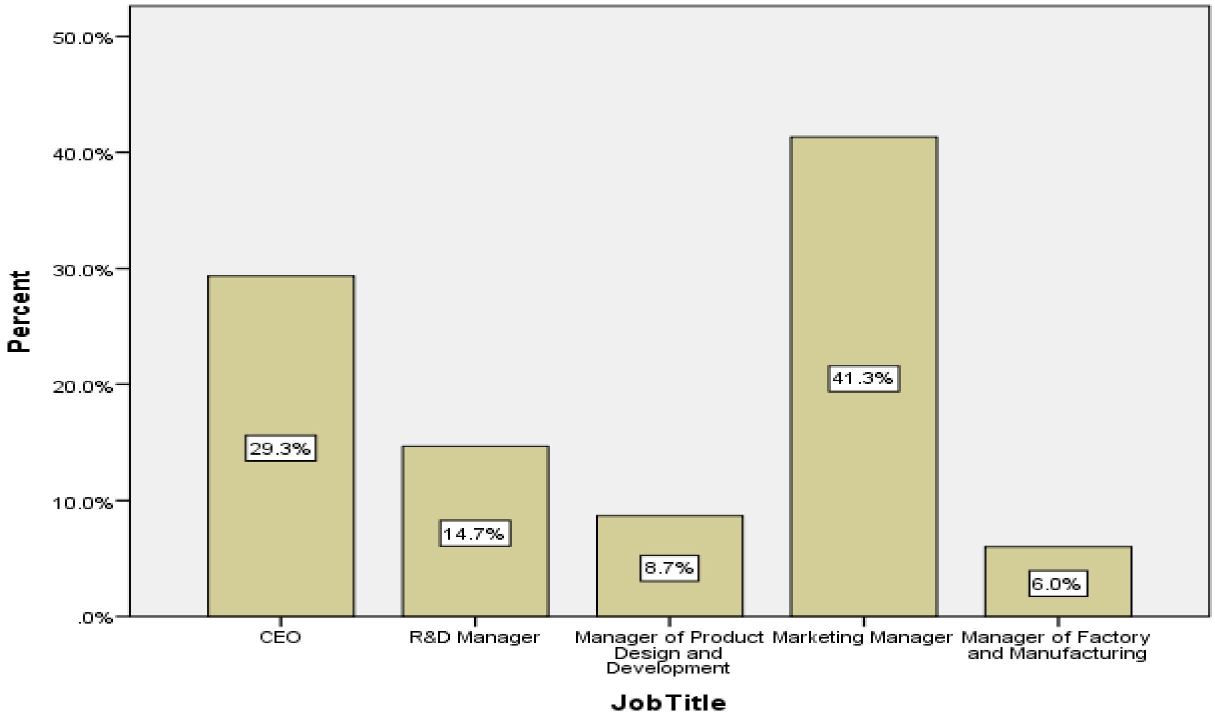


**Figure 14- Job Title of Managers as Respondents in SMEs**

### *2.6.5. The Educational Level of Managers as Respondents in SMEs*

Table 33 indicates that the highest educational levels of respondent managers are bachelor degree (48.7%), and Master degree (43.3%) respectively. Only 7.3% of managers hold PhD degree.

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| PhD | 11 | 7.3 | 7.3 | 7.3 |
| Master Degree | 65 | 43.3 | 43.3 | 50.7 |
| Bachelor Degree | 73 | 48.7 | 48.7 | 99.3 |
| Diploma | 1 | .7 | .7 | 100.0 |
| Total | 150 | 100.0 | 100.0 | |

**Table 33- Educational Level of Managers as Respondents in SMEs**

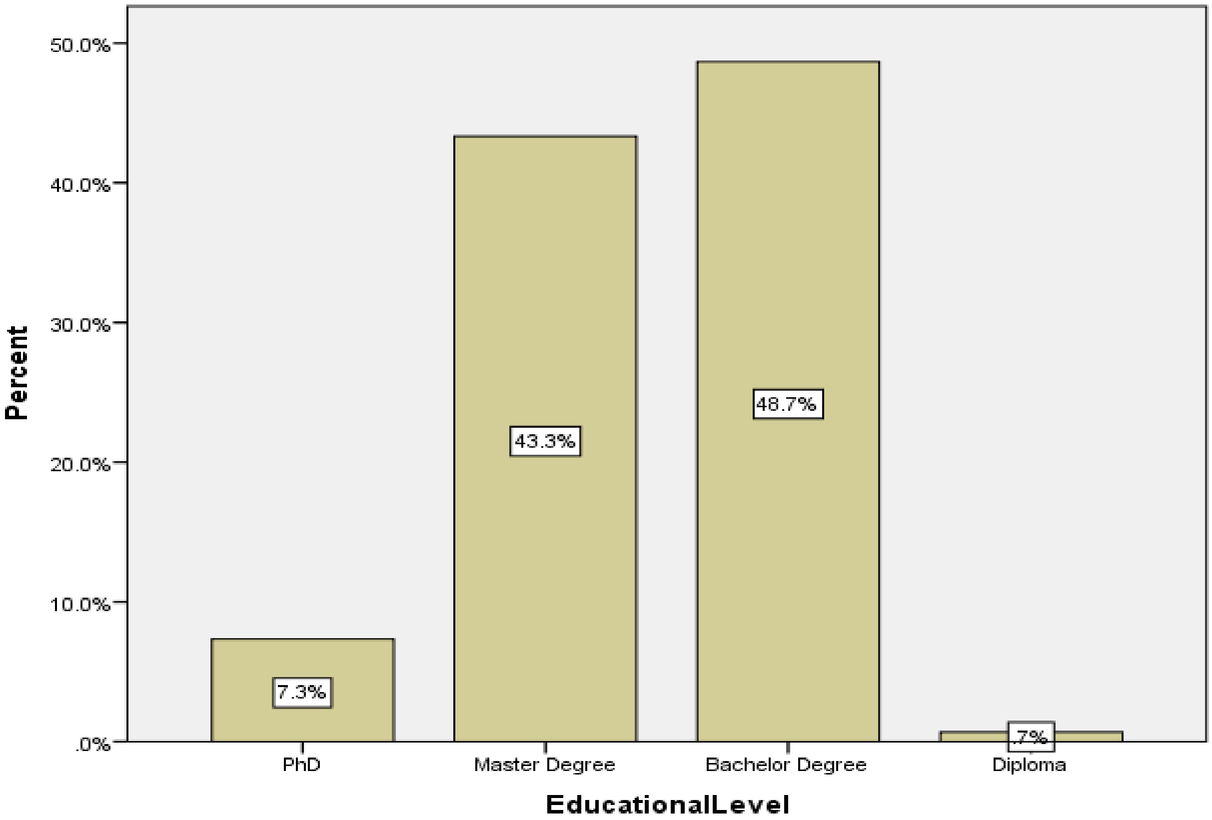


**Figure 15- Educational Level of Managers as Respondents in SMEs**

### *3.6.5. The Firm Size*

Three groups of small and medium sized enterprises are existed and categorized in Iran. This classification is based on the national standard definition of central bank of Iran. SMEs classified in such groups were considered as the target statistical population of this research. Table 34 shows that the empirical data collection was conducted between 10.7% equal to 16 firms as Micro firms with full time employees of 1 to 9 personnel. 46.7% equal to 70 firms as small firms with full time employees of 10 to 49 personnel, and 42.7% equal to 64 firms as medium firms with full time employees of 50 to 99 personnel.

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| 1-9 | 16 | 10.7 | 10.7 | 10.7 |
| 10-49 | 70 | 46.7 | 46.7 | 57.3 |
| 50-99 | 64 | 42.7 | 42.7 | 100.0 |
| Total | 150 | 100.0 | 100.0 | |

**Table 34- Firm Size (1-9=Micro, 10-49=Small, 50-99=Medium)**

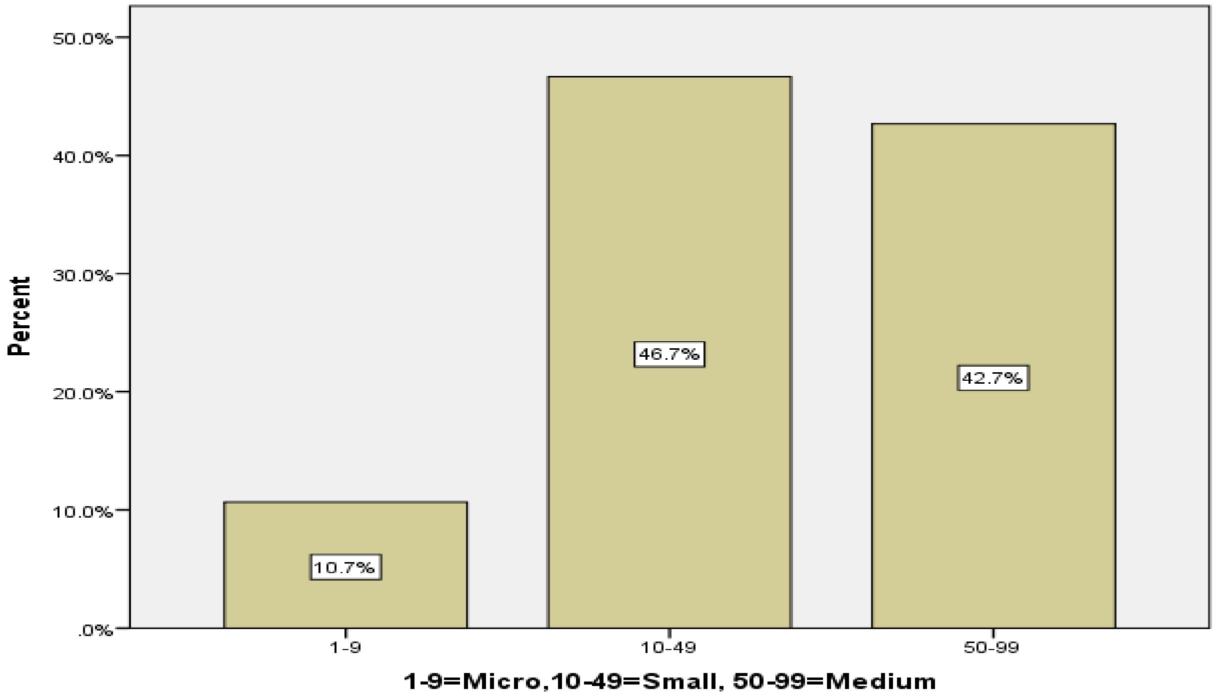


**Figure 16- Firm Size as Micro, Small and Medium Sized**

### *4.6.5. The Descriptive Statistics of the Questionnaire Items*

As it is shown in table 35, the interpretation of minimum and maximum range of this research is based on Likert scale, which is between 1 to 7. Data distribution of these variables are not normal, even though most of the minimum and maximum ranges are being between 1 to 7 as it is shown in table 35, there are some misalignment in some questions which is not classified in this range and indicate that there are minor outliers in total empirical surveying dataset which can be overlooked. These slight outliers were not removed and revised. Variance measures how far each number in the dataset is from the mean, and standard deviation (SD) is a number used to tell how measurements for a group are spread out from the average (mean), or expected value. A low standard deviation means that most of the numbers are very close to the average. A high standard deviation means that the numbers are spread out. Therefore, the variance and standard deviation (SD) of responses from SMEs managers as respondents of target statistical population were so important and crucial to be kept for researcher in order to know and recognize the different and distinctive approaches of their answers to the questions and to identify better their understanding, comprehension and perception of inbound open innovation notion activities and their effects on new product innovativeness, the effect of R&D expenditures on new product innovativeness, the effect of new product innovativeness on new product advantage, and the effect of organizational declarative memory on new product advantage. The variance of dataset in this research indicates that the number in the dataset is far from the mean of each questions, Moreover, high standard deviation (SD) in this research indicates that the numbers are spread out from the mean and are not close to the means. Therefore, the approach and way of responding to questionnaire was different between managers of SMEs and there existed various points of views by managers to answer to the questions.

| | N | Minimum | Maximum | Sum | Mean | Std. Deviation | Variance |
|---|---|---|---|---|---|---|---|
| CI1 | 150 | 5 | 7 | 970 | 6.47 | .598 | .358 |
| CI2 | 150 | 5 | 7 | 998 | 6.65 | .543 | .295 |
| CI3 | 150 | 5 | 7 | 988 | 6.59 | .581 | .338 |
| CI4 | 150 | 1 | 7 | 803 | 5.35 | 1.327 | 1.760 |
| CI5 | 150 | 1 | 7 | 766 | 5.11 | 1.443 | 2.083 |
| INP1 | 150 | 1 | 7 | 760 | 5.07 | 1.596 | 2.546 |
| INP2 | 150 | 1 | 7 | 818 | 5.45 | 1.369 | 1.874 |
| INP3 | 150 | 1 | 7 | 822 | 5.48 | 1.369 | 1.875 |
| INP4 | 150 | 1 | 7 | 781 | 5.21 | 1.627 | 2.648 |
| INP5 | 150 | 1 | 7 | 717 | 4.78 | 1.446 | 2.092 |
| EP1 | 150 | 1 | 7 | 652 | 4.35 | 1.655 | 2.738 |
| EP2 | 150 | 1 | 7 | 723 | 4.82 | 1.580 | 2.498 |
| EP3 | 150 | 1 | 7 | 731 | 4.87 | 1.530 | 2.340 |
| EP4 | 150 | 1 | 7 | 510 | 3.40 | 1.667 | 2.779 |
| EP5 | 150 | 1 | 7 | 625 | 4.17 | 1.628 | 2.650 |
| RD1 | 150 | 1 | 7 | 602 | 4.01 | 1.703 | 2.899 |
| RD2 | 150 | 1 | 7 | 637 | 4.25 | 1.734 | 3.006 |
| RD3 | 150 | 1 | 7 | 609 | 4.06 | 1.758 | 3.090 |
| RD4 | 150 | 1 | 7 | 631 | 4.21 | 1.866 | 3.480 |
| RD5 | 150 | 1 | 7 | 800 | 5.33 | 1.349 | 1.821 |
| IL1 | 150 | 1 | 7 | 572 | 3.81 | 1.811 | 3.280 |
| IL2 | 150 | 1 | 7 | 590 | 3.93 | 1.744 | 3.043 |
| IL3 | 150 | 1 | 7 | 464 | 3.09 | 1.680 | 2.823 |
| IL4 | 150 | 1 | 7 | 602 | 4.01 | 1.835 | 3.369 |
| IL5 | 150 | 1 | 7 | 676 | 4.51 | 2.026 | 4.104 |
| NPI1 | 150 | 1 | 7 | 856 | 5.71 | 1.344 | 1.806 |
| NPI2 | 150 | 1 | 7 | 762 | 5.08 | 1.412 | 1.994 |
| NPI3 | 150 | 1 | 7 | 788 | 5.25 | 1.410 | 1.989 |
| NPI4 | 150 | 1 | 7 | 792 | 5.28 | 1.357 | 1.841 |
| NPI5 | 150 | 1 | 7 | 800 | 5.33 | 1.505 | 2.264 |
| NPI6 | 150 | 1 | 7 | 675 | 4.50 | 2.026 | 4.104 |
| NPA1 | 150 | 1 | 7 | 838 | 5.59 | 1.660 | 2.754 |
| NPA2 | 150 | 1 | 7 | 896 | 5.97 | 1.111 | 1.234 |
| NPA3 | 150 | 1 | 7 | 849 | 5.66 | 1.247 | 1.555 |
| NPA4 | 150 | 1 | 7 | 819 | 5.46 | 1.314 | 1.727 |
| NPA5 | 150 | 1 | 7 | 872 | 5.81 | 1.261 | 1.589 |
| ODM1 | 150 | 1 | 7 | 843 | 5.62 | 1.180 | 1.392 |
| ODM2 | 150 | 1 | 7 | 767 | 5.11 | 1.298 | 1.685 |
| ODM3 | 150 | 1 | 7 | 789 | 5.26 | 1.328 | 1.764 |
| ODM4 | 150 | 1 | 7 | 879 | 5.86 | 1.123 | 1.262 |
| ODM5 | 150 | 1 | 7 | 799 | 5.33 | 1.445 | 2.087 |

| | N | Minimum | Maximum | Sum | Mean | Std. Deviation | Variance |
|---|---|---|---|---|---|---|---|
| ODM6 | 150 | 1 | 7 | 804 | 5.36 | 1.425 | 2.031 |
| ODM7 | 150 | 1 | 7 | 833 | 5.55 | 1.303 | 1.698 |
| ODM8 | 150 | 1 | 7 | 838 | 5.59 | 1.205 | 1.452 |
| ODM9 | 150 | 1 | 7 | 922 | 6.15 | 1.095 | 1.200 |
| R.DExp | 150 | 1 | 7 | 391 | 2.61 | 1.828 | 3.341 |
| COMPIN1 | 150 | 1 | 7 | 853 | 5.69 | 1.306 | 1.707 |
| COMPIN2 | 150 | 2 | 7 | 773 | 5.15 | 1.278 | 1.634 |
| COMPIN3 | 150 | 1 | 7 | 744 | 4.96 | 1.295 | 1.676 |
| COMPIN4 | 150 | 3 | 7 | 942 | 6.28 | .942 | .888 |
| COMPIN5 | 150 | 1 | 7 | 720 | 4.80 | 1.442 | 2.081 |
| TT1 | 150 | 1 | 7 | 772 | 5.15 | 1.467 | 2.153 |
| TT2 | 150 | 2 | 7 | 817 | 5.45 | 1.179 | 1.390 |
| TT3 | 150 | 1 | 7 | 826 | 5.51 | 1.225 | 1.500 |
| TT4 | 150 | 2 | 7 | 784 | 5.23 | 1.327 | 1.760 |
| MT1 | 150 | 1 | 7 | 647 | 4.31 | 1.618 | 2.619 |
| MT2 | 150 | 1 | 7 | 830 | 5.53 | 1.202 | 1.445 |
| MT3 | 150 | 1 | 7 | 663 | 4.42 | 1.547 | 2.393 |
| MT4 | 150 | 1 | 7 | 719 | 4.79 | 1.471 | 2.165 |
| FS | 150 | 1 | 3 | 339 | 2.26 | .607 | .368 |
| Valid N (listwise) | 150 | | | | | | |

**Table 35- Descriptive Statistics of Construct's Questions**

As this research was empirical surveying and quantitative method and dataset is responded based on Likert scale, according to table 36, it can be inferred that mean (average) of constructs above 3 shows the relative satisfaction and success of that construct (variable) in the statistical population. Accordingly, except R&D expenditures (R&D Exp) and firm size (FS) which are single item indicator, and were measured by one type of questions, the mean (average) of all other 11 variables (constructs) are above 3 and it demonstrates the success of all variables (constructs) in the statistical population of this research. Likewise, apart from R&D expenditures (R&D Exp) and firm size (FS) which explained in above lines, in this research the mean of "Customer Involvement" with 6.033 has the highest and the most appropriate, and the mean of "Inward Licensing" with 3.872 has the lowest and the worst success and presence in the statistical population of this research.

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| CI | 150 | 4.00 | 7.00 | 6.0333 | .67214 |
| INP | 150 | 1.80 | 7.00 | 5.1973 | 1.05652 |
| EP | 150 | 1.00 | 6.80 | 4.3213 | 1.24024 |
| R.D | 150 | 1.00 | 7.00 | 4.3720 | 1.37534 |
| IL | 150 | 1.00 | 7.00 | 3.8720 | 1.41957 |
| NPI | 150 | 1.00 | 7.00 | 5.1922 | 1.10853 |
| NPA | 150 | 1.00 | 7.00 | 5.6987 | 1.02551 |
| ODM | 150 | 1.33 | 7.00 | 5.5363 | 1.01580 |
| COMPIN | 150 | 3.00 | 7.00 | 5.3760 | .86107 |
| TT | 150 | 1.75 | 7.00 | 5.3317 | 1.09395 |
| MT | 150 | 1.75 | 7.00 | 4.7650 | 1.10946 |
| FS | 150 | 1 | 3 | 2.26 | .607 |
| R.DExp | 150 | 1 | 7 | 2.61 | 1.828 |
| Valid N (listwise) | 150 | | | | |

**Table 36- Descriptive Statistics of Constructs**

### *7.5. The Inferential Statistics*

#### *1.7.5. The Regression Analysis for Testing the Multicollinearity of Independent Variables*

For testing that if there is any strong correlation between independent variables, the collinearity diagnostics test was used by SPSS for testing if there is any autocorrelation and/ or multicollinearity relation between 5 independent variables of inbound open innovation sources and new product innovativeness as dependent variable. Table 37 indicates that all five independent variables of inbound open innovation have entered in order to test their overall correlation and collinearity, as they are all involved in the research theoretical model. Moreover, due to research objectives, research questions and hypotheses, which, all were based according to theoretical model, the effects of all five independent variables on new product innovativeness had to be measured.

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | IL, CI, INP, R.D, EPb | | Enter |

a. Dependent Variable: NPI

b. All requested variables entered.

**Table 37- Variables Entered/Removed.a**

One of the assumptions of regression analysis is that the observations and collected datasets must be independent. In multicollinearity condition, the predictors that are highly related to each other can cause problems in estimating the regression coefficients. If there is no correlation or multicollinearity between independent variables, the Durbin-Watson statistic should be between 1.5 and 2.5. As it is indicated in table 38, the Durbin-Watson statistic in this research is 1.764, which is between 1.5 and 2.5 and therefore, the data of these 5 independent variables is not auto correlated.

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| 1 | .601a | .362 | .340 | .90088 | 1.764 |

a. Predictors: (Constant), IL, CI, INP, R.D, EP

b. Dependent Variable: NPI

**Table 38- Model Summary.b**

The information in table 39 definitely allows checking for multicollinearity in research multiple linear regression models. Two most important parts of this model to check the multicollinearity of independent variables are Tolerance and VIF[3]. Tolerance should be above > 0.1, and VIF should be below <5 (e,g. Hair et al, 2016) for all variables which they are indicated in this table. Furthermore, "In the context of PLS-SEM, a tolerance value of 0.20 or lower and a VIF value of 5 and higher respectively indicate a potential collinearity problem" (Hair, Ringle, & Sarstedt, 2011). As a consequence, this table and its information shows that there is not any multicollinearity between five independent variables of inbound open

Variance Inflation Factor -[3]

innovation activities in the research theoretical model, as all tolerance are above 0.20 and VIF values are below 5. Consequently, these five variables can measure the effects of inbound open innovation sources and/ or activities on new product innovativeness properly and efficiently.

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | 1.212 | .673 | | 1.800 | .074 | | |
| | CI | .351 | .130 | .213 | 2.709 | .008 | .717 | 1.395 |
| | INP | .103 | .103 | .098 | .999 | .319 | .460 | 2.176 |
| | EP | -.004 | .097 | -.005 | -.045 | .964 | .376 | 2.661 |
| | R.D | .419 | .075 | .520 | 5.571 | .000 | .509 | 1.966 |
| | IL | -.126 | .071 | -.161 | -1.769 | .079 | .532 | 1.879 |

a. Dependent Variable: NPI

**Table 39- Coefficients.a**

Lastly, it is logical to check for normality of residuals with a normal P-P plot. The plot in figure 18 shows that the points generally follow the normal line with no strong and considerable deviations. This indicates that the residuals are normally distributed. The P-P plot compares the observed cumulative distribution function (CDF) of the standardized residual to the expected CDF of the normal distribution. It demonstrates that the probability of observed cumulative distribution function is equal to the probability of expected cumulative distribution. In other words, the higher cumulative distribution around diagonal, the larger accuracy of predicting dependent variable.

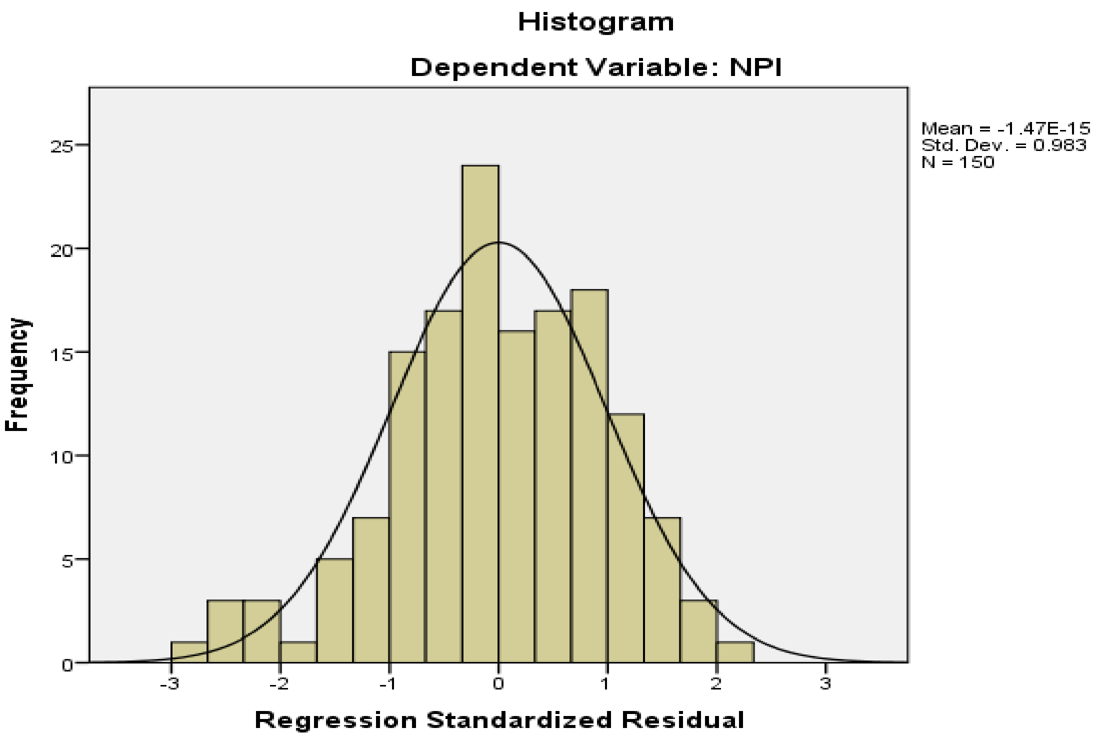


**Figure 17- Regression Standardized Residual for Dependent Variable: NPI**

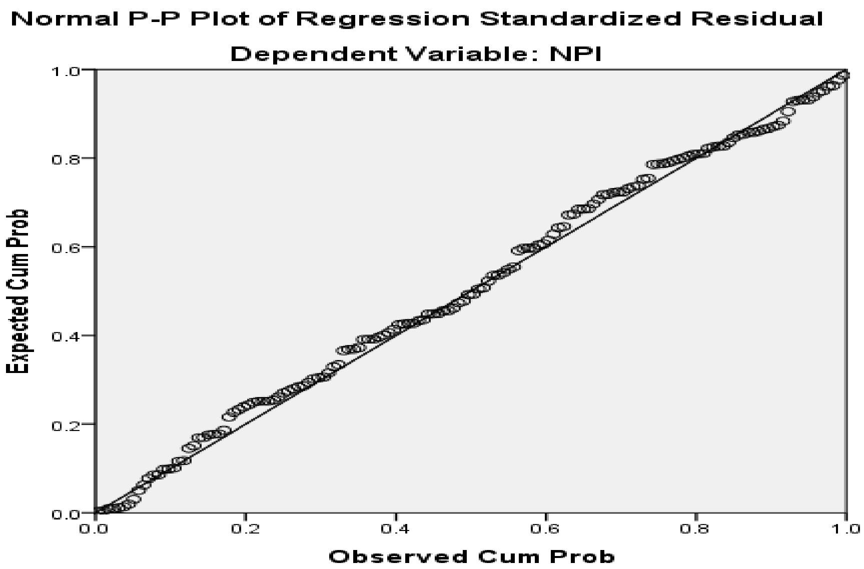


**Figure 18- Normal P-P Plot of Regression Standardized Residual Dependent Variable: NPI**

### *8.5. Reflective Measurement Model in PLS-SEM*

### *1.8.5. The Outer Loading Relevance Test*

The first step of reflective measurement model constructs assessment in PLS-SEM is examining the indicator loadings. The theoretical model of this research involves 13 constructs, namely: five constructs for inbound open innovation sources such as: (1) Customer Involvement (CI), (2) Industrial Network Partnership (INP), (3) External Participation (EP), (4) R&D and Academic Outsourcing, (5) Inward Licensing (IL). Moreover, the rest of the constructs of theoretical model are respectively: (6) R&D Expenditure, (7) New Product Innovativeness (NPI), (8) New Product Advantage (NPA), (9) Organizational Declarative Memory (ODM), (10) Firm Size (FS), (11) Technology Turbulence (TT), (12) Competition Intensity (COMPIN), and (13) Market Turbulence (MT). After running the reflective measurement model of the research by Smart PLS software, outer loadings of each construct's indicators below 0.7 were removed. However, the researcher first analyzed the impact of indicator deletion on AVE and composite reliability; it means that it was considered that if outer loadings are > 0.4 but < 0.7, the deletion can increase measures above threshold, which for AVE is > 0.5 and for CR[4] is > 0.7. If the deletion could have increased the measures above threshold of AVE and CR, then the reflective indicator of that construct was deleted. However, if the deletion did not increase the measures above threshold of AVE and CR, then the reflective indicators were retained (e.g. Hair et al, 2016).

Therefore, in this research, all indicators above 0.7 were remained, and all other construct's indicators have followed this rule of thumb. In other word, the indictors were deleted if construct's indicators could have increased the measures above threshold of AVE and CR. Moreover, the indicators were retained if the deletion has not caused increasing the measures

Composite Reliability - [4]

above threshold of AVE and CR. Table 40 indicates the remained construct's indictors in final reflective measurement model after deletion of some of indicators of constructs. Moreover, it should be pointed out that loadings above 0.70 indicate that the construct explains more than 50% of the indicator’s variance, demonstrating that the indicator exhibits a satisfactory degree of reliability (Sarstedt et al, 2017).

| | CI | COMPIN | EP | FS | IL | INP | MT | NPA | NPI | ODM | R.D | R.DExp | TT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CI4 | 0.925454 | | | | | | | | | | | | |
| CI5 | 0.899691 | | | | | | | | | | | | |
| COMPIN1 | | 0.831238 | | | | | | | | | | | |
| COMPIN2 | | 0.864346 | | | | | | | | | | | |
| EP1 | | | 0.829173 | | | | | | | | | | |
| EP2 | | | 0.81952 | | | | | | | | | | |
| EP3 | | | 0.748065 | | | | | | | | | | |
| EP4 | | | 0.764976 | | | | | | | | | | |
| EP5 | | | 0.678268 | | | | | | | | | | |
| FS | | | | 1 | | | | | | | | | |
| IL1 | | | | | 0.894176 | | | | | | | | |
| IL2 | | | | | 0.84631 | | | | | | | | |
| IL3 | | | | | 0.664431 | | | | | | | | |
| IL4 | | | | | 0.720854 | | | | | | | | |
| IL5 | | | | | 0.673939 | | | | | | | | |
| INP2 | | | | | | 0.788623 | | | | | | | |
| INP3 | | | | | | 0.804917 | | | | | | | |
| INP5 | | | | | | 0.788229 | | | | | | | |
| MT1 | | | | | | | 0.564563 | | | | | | |
| MT2 | | | | | | | 0.809681 | | | | | | |
| MT3 | | | | | | | 0.66893 | | | | | | |
| MT4 | | | | | | | 0.869794 | | | | | | |
| NPA2 | | | | | | | | 0.843652 | | | | | |
| NPA3 | | | | | | | | 0.882111 | | | | | |
| NPA4 | | | | | | | | 0.883739 | | | | | |
| NPA5 | | | | | | | | 0.873443 | | | | | |
| NPI1 | | | | | | | | | 0.715842 | | | | |
| NPI2 | | | | | | | | | 0.862138 | | | | |

| | CI | COMPIN | EP | FS | IL | INP | MT | NPA | NPI | ODM | R.D | R.DExp | TT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NPI3 | | | | | | | | | 0.842629 | | | | |
| NPI4 | | | | | | | | | 0.850065 | | | | |
| NPI5 | | | | | | | | | 0.749024 | | | | |
| ODM1 | | | | | | | | | | 0.741076 | | | |
| ODM2 | | | | | | | | | | 0.825294 | | | |
| ODM3 | | | | | | | | | | 0.805869 | | | |
| ODM4 | | | | | | | | | | 0.797864 | | | |
| ODM5 | | | | | | | | | | 0.805781 | | | |
| ODM6 | | | | | | | | | | 0.838459 | | | |
| ODM7 | | | | | | | | | | 0.847582 | | | |
| ODM8 | | | | | | | | | | 0.831248 | | | |
| ODM9 | | | | | | | | | | 0.684391 | | | |
| R.DExp | | | | | | | | | | | | 1 | |
| RD1 | | | | | | | | | | | 0.831285 | | |
| RD2 | | | | | | | | | | | 0.841836 | | |
| RD3 | | | | | | | | | | | 0.82597 | | |
| RD4 | | | | | | | | | | | 0.890474 | | |
| RD5 | | | | | | | | | | | 0.653299 | | |
| TT1 | | | | | | | | | | | | | 0.663758 |
| TT2 | | | | | | | | | | | | | 0.890253 |
| TT3 | | | | | | | | | | | | | 0.882903 |
| TT4 | | | | | | | | | | | | | 0.888341 |

**Table 40- Outer Loadings**

### *2.8.5. The Internal Consistency*

Second step in reflective measurement model constructs assessment in PLS-SEM is the assessment of construct's internal consistency reliability. This second assessment step consist two criterions: Cronbach's alpha and composite reliability (CR). Researchers should therefore consider both measures in their internal consistency reliability assessment (Sarstedt et al, 2017).

Cronbach's alpha provides and shows an estimate of the reliability according to the inter correlations of the observed indicator variables. The threshold value of Cronbach's alpha normally should be above > 0.7 for each constructs. Table 41 indicates that the entire construct's Cronbach's alpha have met the standard value of alpha which usually and normally should be above >0.7. It therefore shows that according to Cronbach's Alpha criteria all constructs has internal reliability.

| | Cronbach's Alpha |
|---|---|
| CI | 0.800413 |
| COMPIN | 0.610057 |
| EP | 0.827335 |
| FS | 1 |
| IL | 0.838731 |
| INP | 0.710834 |
| MT | 0.749511 |
| NPA | 0.894158 |
| NPI | 0.863316 |
| ODM | 0.92876 |
| R.D | 0.86783 |
| R.DExp | 1 |
| TT | 0.865053 |

**Table 41- Cronbach's Alphas of Constructs for Assessing Internal Consistency Reliability**

The second strongest criterion to measure internal reliability of constructs is Composite Reliability (CR). The composite reliability differs between 0 and 1, which higher values demonstrating higher and greater levels of reliability. CR is usually interpreted and explained in the same method as Cronbach's Alpha. In particular, CR values of 0.60 to 0.70 are appropriate and acceptable in exploratory research, whereas, in more progressed and advanced stages of theories and research, values between 0.70 and 0.90 can be considered as adequate and satisfactory values (Nunally & Bernstein, 1994). Therefore, in this research, according to table number 42, composite reliability as the second criteria of measuring internal consistency reliability of all constructs are between 0.70 and 0.90 which show very strong, high and great reliability of construct's indicators. Even though values of CR above > 0.95 is not acceptable because of highly inter correlation between indicators and "are not desirable because they indicate that all the indicator variables are measuring the same phenomenon and are therefore unlikely to be a valid measure of the construct" (Hair et al, 2016). As it is shown in table 42, the value of R&D expenditure and Firm size is equal to 1 because these two types of variables are single item constructs which are being measured by one indicator (question). That is the reason that their Cronbach's Alphas and CRs are becoming 1.

| | Composite Reliability |
|---|---|
| CI | 0.908849 |
| COMPIN | 0.836498 |
| EP | 0.878676 |
| FS | 1 |
| IL | 0.874662 |
| INP | 0.83649 |
| MT | 0.823259 |
| NPA | 0.926226 |
| NPI | 0.902247 |
| ODM | 0.940596 |
| R.D | 0.905875 |
| R.DExp | 1 |
| TT | 0.902231 |

**Table 42- Composite Reliability for Assessing Internal Consistency Reliability**

### *3.8.5. The Convergent Validity*

Third step in reflective measurement model constructs assessment in PLS-SEM is measuring convergent validity. "Convergent validity is the extent to which a measure correlates positively with alternative measures of the same construct" (Hair et al, 2016). Thus, the items that are regarded as indicators of a particular and specific construct should converge, share and contribute a high and great proportion of variance. High degree of outer loadings of a construct show that the intended indicators possess much in common, that is taken and captured by the construct. This kind of characteristic is also usually called indicator reliability. The rule of thumb is that the standardized outer loadings should be 0.70 or higher. The logic behind this rule can be realized in the condition of the square of a standardized indicator's outer loading which is called as the communality of an item. "The square of a standardized indicator's outer loading demonstrates how much of the variation in an item is explained by the construct and is described as the variance extracted from the item" (Hair et al, 2016). A common rule of thumb is that a latent variable should explain a prominent and substantial part of each indicator's variance, generally at least should be 50%. Therefore, the average variance extracted (AVE) should be higher than 0.50 (Hair et al, 2016, Hari et al, 2011). In this regard, the communality of latent variables in this research can explain an important part of each indicator's variance which all of them are above > 50% and have met the rule of thumb of explaining substantial part of indicator's variance.

This scale and standard is defined as the grand mean value of the squared loadings of the indicators correlated and connected to the construct. Therefore, the AVE is equivalent to the communality of a construct, which means that both of them should be above 0.5. By having the same logic, which is used with the individual indicators, an AVE value of 0.50 or higher demonstrates that, by mean, and on average, the construct explains and describes more than half of the variance of its indicators. In order to establish convergent validity, the outer loadings of indicators and the average variance extracted (AVE) should be considered as well. In addition, AVE is a common measure to establish convergent validity on the construct level (Hair et al, 2016). The rules of thumb for convergent validity are: (1) Meaningful loadings. (2) Loadings should be above > 0.5. (3) AVE > 0.5. (4) CR> AVE.

As it is shown in table 43, all AVE of variables are above > 0.50, indicate that all variables have met the rule of thumb for AVE which should be greater than 0.50. Moreover, all loadings are meaningful and are above 0.50, AVEs are higher than 0.50 and all CR values are greater than AVE values. Therefore, the indicators of all variables have the convergent validity, means that measure of one-indicator correlates positively with alternative measures of the same construct.

| | AVE | Composite Reliability | Communality |
|---|---|---|---|
| CI | 0.832954 | 0.908849 | 0.832954 |
| COMPIN | 0.719025 | 0.836498 | 0.719025 |
| EP | 0.592796 | 0.878676 | 0.592796 |
| FS | 1 | 1 | 1 |
| IL | 0.586217 | 0.874662 | 0.586217 |
| INP | 0.630374 | 0.83649 | 0.630374 |
| MT | 0.544581 | 0.823259 | 0.544581 |
| NPA | 0.758441 | 0.926226 | 0.758441 |
| NPI | 0.649876 | 0.902247 | 0.649876 |
| ODM | 0.638486 | 0.940596 | 0.638486 |
| R.D | 0.660338 | 0.905875 | 0.660338 |
| R.DExp | 1 | 1 | 1 |
| TT | 0.700448 | 0.902231 | 0.700448 |

**Table 43- Comparison of Average Variance Extracted (AVE) and Composite Reliability for Convergent Validity**

### *4.8.5. The Discriminant Validity*

Discriminant validity is the amount or extent by which a construct should be truly different and distinctive from other constructs by empirical standards. Therefore, creating and establishing discriminant validity indicates that a construct is distinctive, unique and achieves and captures phenomena and cases, which are not represented by other constructs in the theoretical model. Cross loadings and Fornell-Larcker test are used to test the discriminant validity of constructs. In cross loadings, an indicator’s loadings should be higher than all of its cross loadings (Hari et al, 2011).  In addition, an indicator's outer loading on the associated construct should be larger than all of its loadings on other construct (Hair et al, 2016).

In table 44, all indicators' outer loadings show that the entire associated individual indicator of each construct is higher and greater than all of the other peer loadings on other peer constructs. For instance, the indicator's loading of CI4 as one of the indicators of Customer Involvement construct is 0.92, which by comparing it to all of its loadings on other constructs, it can be inferred and concluded that this value is higher rather than all of the other construct's loadings. This rule is also implies to all of the construct's indicators. In this research, cross loading table indicates that all constructs are distinctive, unique, achieves, and captures phenomena and cases, which are not represented by other constructs in the theoretical model. Therefore, this addresses and emphasizes to the existence of discriminant validity of all constructs and their indicators.

| | CI | COMPIN | EP | FS | IL | INP | MT | NPA | NPI | ODM | R.D | R.DExp | TT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CI4 | **0.925454** | 0.281878 | 0.370808 | -0.11488 | 0.321093 | 0.518107 | 0.387002 | 0.44879 | 0.46497 | 0.503701 | 0.322981 | 0.118581 | 0.296628 |
| CI5 | **0.899691** | 0.265536 | 0.436766 | -0.10087 | 0.28418 | 0.50838 | 0.400963 | 0.47932 | 0.40354 | 0.535954 | 0.279474 | 0.171223 | 0.25926 |
| COMPIN1 | 0.178228 | **0.831238** | 0.048871 | -0.0066 | 0.204418 | 0.020128 | 0.174165 | 0.11166 | 0.00116 | 0.152661 | -0.08751 | -0.16158 | 0.175056 |
| COMPIN2 | 0.324087 | **0.864346** | 0.198376 | -0.19018 | 0.173277 | 0.22254 | 0.253278 | 0.12343 | 0.0858 | 0.262024 | 0.060124 | 0.146628 | 0.402564 |
| EP1 | 0.363562 | 0.184089 | **0.829173** | 0.103473 | 0.585059 | 0.501385 | 0.341712 | 0.31299 | 0.24838 | 0.258712 | 0.433183 | 0.003225 | 0.150948 |
| EP2 | 0.317057 | 0.030114 | **0.81952** | 0.014137 | 0.507191 | 0.536258 | 0.291053 | 0.27676 | 0.26401 | 0.312437 | 0.488476 | 0.02644 | 0.208148 |
| EP3 | 0.275489 | 0.015468 | **0.748065** | -0.03659 | 0.460792 | 0.579602 | 0.300243 | 0.31554 | 0.3725 | 0.288283 | 0.58739 | 0.138097 | 0.251786 |
| EP4 | 0.332643 | 0.095359 | **0.764976** | 0.002654 | 0.45462 | 0.354665 | 0.341802 | 0.34889 | 0.33352 | 0.33979 | 0.45351 | 0.010133 | 0.157674 |
| EP5 | 0.399529 | 0.264351 | **0.678268** | -0.07814 | 0.491704 | 0.367331 | 0.344094 | 0.28367 | 0.32149 | 0.390617 | 0.475961 | 0.087594 | 0.283692 |
| FS | -0.11863 | -0.12136 | -0.00718 | **1** | 0.047721 | -0.19 | -0.05775 | 0.09478 | 0.00071 | -0.07966 | -0.03422 | 0.074673 | -0.13641 |
| IL1 | 0.287905 | 0.218451 | 0.536248 | 0.044458 | **0.894176** | 0.334361 | 0.29955 | 0.31697 | 0.2721 | 0.257321 | 0.54923 | 0.004028 | 0.086179 |
| IL2 | 0.350754 | 0.159551 | 0.598628 | -0.03424 | **0.84631** | 0.524219 | 0.257821 | 0.36038 | 0.34333 | 0.31175 | 0.533936 | -0.03565 | 0.140484 |
| IL3 | 0.085761 | 0.163139 | 0.389099 | 0.114272 | **0.664431** | 0.103397 | 0.170799 | 0.15825 | 0.08893 | 0.106361 | 0.436533 | -0.11471 | -0.04858 |
| IL4 | 0.224118 | 0.174624 | 0.477554 | 0.026997 | **0.720854** | 0.265879 | 0.274926 | 0.28738 | 0.17581 | 0.102614 | 0.485413 | 0.013577 | 0.089766 |
| IL5 | 0.169294 | 0.149935 | 0.403413 | 0.197863 | **0.673939** | 0.162616 | 0.166826 | 0.29518 | 0.11524 | 0.147864 | 0.390561 | 0.106745 | 0.070288 |
| INP2 | 0.457253 | 0.122524 | 0.41933 | -0.15094 | 0.36228 | **0.788623** | 0.214351 | 0.38405 | 0.36457 | 0.345249 | 0.437108 | -0.09993 | 0.365051 |
| INP3 | 0.492137 | 0.062715 | 0.476487 | -0.13504 | 0.303543 | **0.804917** | 0.336406 | 0.40328 | 0.47608 | 0.413914 | 0.423985 | -0.00987 | 0.338315 |
| INP5 | 0.379321 | 0.185189 | 0.564129 | -0.17144 | 0.379495 | **0.788229** | 0.300973 | 0.30028 | 0.37439 | 0.302739 | 0.468156 | 0.066052 | 0.274025 |
| MT1 | 0.256577 | 0.389422 | 0.227871 | -0.18603 | 0.215539 | 0.097434 | **0.564563** | 0.08219 | 0.17806 | 0.121301 | 0.095844 | 0.071436 | 0.353766 |
| MT2 | 0.408101 | 0.24603 | 0.342434 | -0.01656 | 0.246918 | 0.36272 | **0.809681** | 0.4129 | 0.41159 | 0.443489 | 0.288688 | 0.00448 | 0.382605 |
| MT3 | 0.220479 | 0.096724 | 0.276469 | -0.05992 | 0.24687 | 0.175879 | **0.66893** | 0.20244 | 0.21101 | 0.146425 | 0.166656 | 0.082556 | 0.283623 |
| MT4 | 0.339695 | 0.156464 | 0.377566 | -0.03713 | 0.25804 | 0.299001 | **0.869794** | 0.34018 | 0.38711 | 0.359754 | 0.259053 | 0.086858 | 0.389662 |
| NPA2 | 0.434879 | 0.163916 | 0.246613 | 0.14974 | 0.29499 | 0.337838 | 0.251343 | **0.84365** | 0.43861 | 0.467811 | 0.218053 | 0.117091 | 0.112216 |
| NPA3 | 0.415437 | 0.064319 | 0.411187 | 0.055529 | 0.334859 | 0.406245 | 0.315161 | **0.88211** | 0.53146 | 0.61124 | 0.351969 | 0.105835 | 0.140573 |
| NPA4 | 0.477117 | 0.143424 | 0.416759 | 0.008923 | 0.350172 | 0.432579 | 0.43513 | **0.88374** | 0.5973 | 0.640414 | 0.412874 | 0.103784 | 0.28159 |
| NPA5 | 0.437123 | 0.118874 | 0.315805 | 0.134069 | 0.362424 | 0.415864 | 0.410552 | **0.87344** | 0.52325 | 0.54432 | 0.324799 | 0.026176 | 0.161835 |
| NPI1 | 0.432104 | 0.053576 | 0.323468 | 0.020082 | 0.246978 | 0.525517 | 0.278523 | 0.45865 | **0.71584** | 0.484708 | 0.430538 | 0.242334 | 0.242455 |
| NPI2 | 0.476793 | 0.058187 | 0.391507 | -0.07928 | 0.260114 | 0.446114 | 0.456274 | 0.42546 | **0.86214** | 0.534296 | 0.523325 | 0.225521 | 0.343813 |
| NPI3 | 0.397569 | 0.081649 | 0.298838 | -0.04611 | 0.283752 | 0.385141 | 0.362083 | 0.48826 | **0.84263** | 0.514472 | 0.420388 | 0.130036 | 0.201088 |
| NPI4 | 0.415606 | 0.059889 | 0.327261 | 0.025111 | 0.245078 | 0.393509 | 0.368563 | 0.55389 | **0.85007** | 0.537119 | 0.422255 | 0.234167 | 0.342144 |
| NPI5 | 0.179585 | -0.04338 | 0.315756 | 0.088211 | 0.192998 | 0.320386 | 0.30813 | 0.50946 | **0.74902** | 0.362302 | 0.444882 | 0.206613 | 0.286254 |

| | CI | COMPIN | EP | FS | IL | INP | MT | NPA | NPI | ODM | R.D | R.DExp | TT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ODM1 | 0.473865 | 0.171659 | 0.245899 | -0.05795 | 0.154171 | 0.357877 | 0.327872 | 0.59559 | 0.55119 | **0.741076** | 0.250086 | 0.113862 | 0.284734 |
| ODM2 | 0.511268 | 0.214364 | 0.448694 | -0.06322 | 0.269035 | 0.389298 | 0.37586 | 0.52226 | 0.54151 | **0.825294** | 0.365076 | 0.188631 | 0.247445 |
| ODM3 | 0.377458 | 0.110016 | 0.33588 | -0.06779 | 0.220384 | 0.359692 | 0.310561 | 0.54424 | 0.58948 | **0.805869** | 0.388894 | 0.271859 | 0.295006 |
| ODM4 | 0.384264 | 0.138741 | 0.24346 | -0.0447 | 0.148503 | 0.362621 | 0.29394 | 0.5635 | 0.4953 | **0.797864** | 0.344915 | 0.185446 | 0.296956 |
| ODM5 | 0.486411 | 0.280337 | 0.355863 | -0.08222 | 0.275184 | 0.303696 | 0.381217 | 0.42151 | 0.40654 | **0.805781** | 0.293129 | 0.201478 | 0.273735 |
| ODM6 | 0.511424 | 0.215639 | 0.400875 | -0.05464 | 0.318686 | 0.357681 | 0.339501 | 0.50263 | 0.41982 | **0.838459** | 0.339928 | 0.170683 | 0.214266 |
| ODM7 | 0.42708 | 0.167036 | 0.386419 | -0.12374 | 0.256958 | 0.428346 | 0.360006 | 0.52753 | 0.50266 | **0.847582** | 0.378327 | 0.280747 | 0.356344 |
| ODM8 | 0.493365 | 0.236271 | 0.347176 | -0.07233 | 0.230536 | 0.413443 | 0.422066 | 0.56151 | 0.53025 | **0.831248** | 0.342181 | 0.13289 | 0.313604 |
| ODM9 | 0.424807 | 0.291268 | 0.267137 | 0.002827 | 0.136644 | 0.235858 | 0.232536 | 0.41774 | 0.25136 | **0.684391** | 0.146225 | 0.119515 | 0.170044 |
| R.DExp | 0.156588 | 0.000283 | 0.0773 | 0.074673 | -0.00835 | -0.01698 | 0.066478 | 0.10035 | 0.25984 | 0.231671 | 0.05803 | **1** | 0.124954 |
| RD1 | 0.313281 | 0.032783 | 0.622992 | -0.07483 | 0.547314 | 0.505404 | 0.327689 | 0.33136 | 0.47959 | 0.442294 | **0.831285** | 0.044826 | 0.252816 |
| RD2 | 0.188213 | -0.06914 | 0.469645 | -0.00396 | 0.391215 | 0.342359 | 0.127708 | 0.24525 | 0.45766 | 0.22571 | **0.841836** | 0.020233 | 0.115035 |
| RD3 | 0.193805 | 0.046834 | 0.595314 | -0.08393 | 0.590779 | 0.413121 | 0.278354 | 0.29341 | 0.39109 | 0.334798 | **0.82597** | 0.036636 | 0.228127 |
| RD4 | 0.275285 | -0.06395 | 0.502241 | -0.03593 | 0.528733 | 0.471708 | 0.24631 | 0.30564 | 0.47648 | 0.316776 | **0.890474** | 0.067298 | 0.254676 |
| RD5 | 0.361719 | 0.015008 | 0.433565 | 0.057374 | 0.50043 | 0.510323 | 0.262741 | 0.37098 | 0.44204 | 0.300465 | **0.653299** | 0.064396 | 0.245399 |
| TT1 | 0.233602 | 0.354957 | 0.219195 | -0.15619 | 0.120738 | 0.182029 | 0.334004 | 0.04113 | 0.09808 | 0.199491 | 0.141218 | 0.03667 | **0.663758** |
| TT2 | 0.206025 | 0.318087 | 0.241354 | -0.15406 | 0.072422 | 0.298836 | 0.418192 | 0.18386 | 0.31592 | 0.238203 | 0.217482 | 0.072738 | **0.890253** |
| TT3 | 0.306759 | 0.285966 | 0.195036 | -0.07008 | 0.113766 | 0.408204 | 0.41726 | 0.18276 | 0.32073 | 0.308578 | 0.222368 | 0.1256 | **0.882903** |
| TT4 | 0.292552 | 0.292836 | 0.300045 | -0.12371 | 0.107932 | 0.403706 | 0.395887 | 0.19858 | 0.33415 | 0.373465 | 0.285878 | 0.142174 | **0.888341** |

**Table 44- Cross Loading for Assessing Discriminant Validity**

The second criteria and tools which is considered as a more conservative and substantial approach to assessing discriminant validity is The Fornell-Larcker test. This test compares the square root of the AVE values with the latent variable correlations. In particular, the square root of each construct's AVE must be higher and greater than its highest correlation with any other construct (Hair et al, 2016). In this regard, by comparing all square root of each construct's AVE with the latent variable correlation of other constructs, according to table 45, it is concluded that all of the square root of each construct's AVE is higher and greater than latent variable correlation of other constructs. This second conservative and prominent factor and test of discriminant validity indicates that all constructs have discriminant validity. It means that, by doing the Fornell-Larcker test each construct is thoroughly and substantially different and distinctive from other constructs. Furthermore, Fornell-Larcker test indicates that all constructs are distinctive, unique and achieves and captures phenomena and cases, which are not represented by other constructs in theoretical model.

| | CI | COMPIN | EP | FS | IL | INP | MT | NPA | NPI | ODM | R.D | R.DExp | TT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CI | **0.912** | | | | | | | | | | | | |
| COMPIN | 0.300263 | **0.847** | | | | | | | | | | | |
| EP | 0.439477 | 0.150087 | **0.769** | | | | | | | | | | |
| FS | -0.11863 | -0.12136 | -0.00718 | **1** | | | | | | | | | |
| IL | 0.332728 | 0.221615 | 0.647756 | 0.047721 | **0.765** | | | | | | | | |
| INP | 0.56223 | 0.14895 | 0.611839 | -0.19 | 0.433484 | **0.793** | | | | | | | |
| MT | 0.430756 | 0.25418 | 0.424284 | -0.05775 | 0.317016 | 0.363405 | **0.737** | | | | | | |
| NPA | 0.506821 | 0.138863 | 0.405313 | 0.094783 | 0.387017 | 0.46016 | 0.41125 | **0.870** | | | | | |
| NPI | 0.477762 | 0.053727 | 0.41284 | 0.000706 | 0.306028 | 0.51742 | 0.44208 | 0.60504 | **0.806** | | | | |
| ODM | 0.567812 | 0.247555 | 0.419907 | -0.07966 | 0.277906 | 0.451706 | 0.425 | 0.65556 | 0.60764 | **0.799** | | | |
| R.D | 0.331441 | -0.01178 | 0.646958 | -0.03422 | 0.629496 | 0.555467 | 0.30657 | 0.38214 | 0.55759 | 0.40115 | **0.812** | | |
| R.DExp | 0.156588 | 0.000283 | 0.0773 | 0.074673 | -0.00835 | -0.01698 | 0.06648 | 0.10035 | 0.25984 | 0.23167 | 0.05803 | **1** | |
| TT | 0.305715 | 0.347041 | 0.281076 | -0.13641 | 0.114434 | 0.410786 | 0.4643 | 0.20488 | 0.35384 | 0.34527 | 0.27084 | 0.12495 | **0.836** |

**Table 45- Latent Variable Correlation after Fornell-Larcker test**

| | AVE |
|---|---|
| CI | 0.83295 |
| COMPIN | 0.71903 |
| EP | 0.5928 |
| FS | 1 |
| IL | 0.58622 |
| INP | 0.63037 |
| MT | 0.54458 |
| NPA | 0.75844 |
| NPI | 0.64988 |
| ODM | 0.63849 |
| R.D | 0.66034 |
| R.DExp | 1 |
| TT | 0.70045 |

**Table 46- Average Variance Extracted (AVE)**

### *9.5. Reflective Structural Model in PLS-SEM*

### *1.9.5. The Structural Model Path Coefficients*

After running the PLS-SEM algorithm, estimates are achieved and obtained for the structural model relationship, which is called the path coefficients. It demonstrates the hypothesized relationships among the constructs of theoretical model. The path coefficients have standardized values between -1 and +1. Estimated and calculated path coefficients close to +1 show and offer strong positive relationships that often are statistically significant. On the other hand, estimated and calculated path coefficients close to -1 show negative relationship, which is not statistically significant. Likewise, the closer the estimated coefficients are to 0, the weaker the relationships. Very low values close to 0 are usually nonsignificant (Hair et al, 2016).

In figure number 19 of next page, structural model path coefficients are indicated as following:

1. Out of 5 inbound open innovation variables and constructs, Customer Involvement (CI) with path coefficient of 0.235, Industrial Network Partnership (INP) with coefficient of 0.224, and R.D and Academic Outsourcing with path coefficient of 0.457 are statistically significant respectively. It means and interprets that there is a positive and significant relationships between these constructs as sources of inbound open innovation and new product innovativeness in small and medium sized enterprises (SMEs). Whereas, other 2 constructs External Participation (EP) with coefficient of -0.066 and Inward Licensing (IL) with coefficient of -0.112 are not statistically significant as they show negative relationships and close to -1, which is interpreted that there is not any significant relationship between these two constructs as the other sources of inbound open innovation and new product innovativeness.

2. R&D Expenditure with coefficient of 0.205 shows a positive and statistically significant relationship with new product innovativeness.
3. New product innovativeness with coefficient of 0.310 indicates a positive and statistically significant relationship with new product advantage.
4. Organizational declarative memory with coefficient of 0.452 indicates a positive and statistically significant relationship with new product advantage.
5. Out of 4 control variables, there are only firm size (FS) and market turbulence (MT) with coefficients of 0.126 and 0.136 which are statistically significant. Technology turbulence is negative and not statistically significant and competition intensity holds a very low value, which shows that it is nonsignificant.

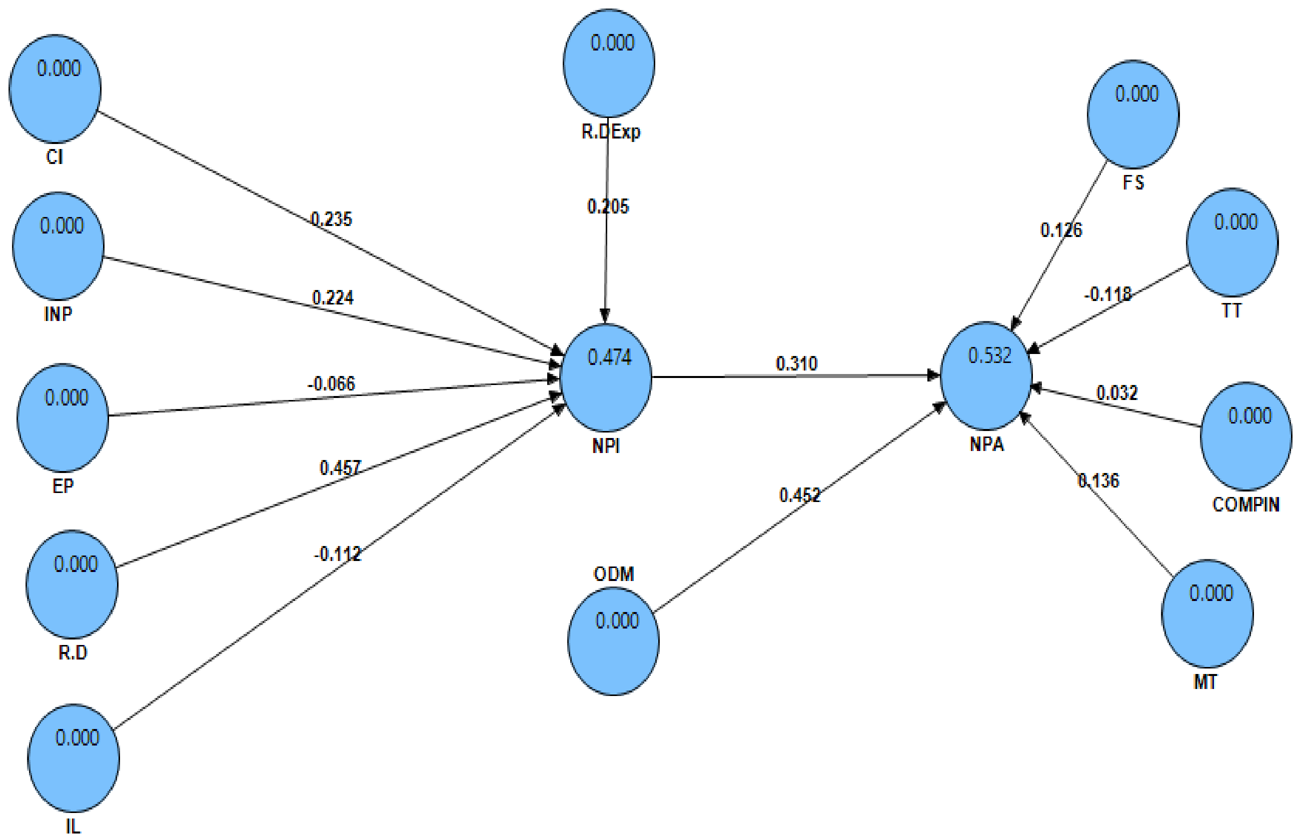


**Figure 19- Outer Model (Measurement Model) Path Coefficients**

### *2.9.5. The Bootstrapping Procedure in PLS-SEM*

PLS-SEM does not consider and presume that the data are normally distributed. It implies and conveys the notion that parametric significance tests, which are used in regression analyses, are not appropriate to be used and applied to test whether coefficients such as outer loadings and path coefficients are significant. Alternatively, PLS-SEM depends and relies on a nonparametric bootstrap procedure (Davison & Hinkley, 1997; Efron & Tibshirani, 1986) to test coefficients for their significance. In bootstrapping stage, a large number of subsamples (bootstrap samples) are taken and drawn from the original sample with replacement. In this stage, replacement means that each time an observation is drawn and taken at random from the sampling population; it is backed and returned to the sampling population prior the next observation is taken or drawn. Furthermore, the population from that the observation is taken and drawn often contains and possess all the same elements and factors. The number of bootstrap samples should be high number but must be at least equal to the number of valid observation in the data set. The adopted and routinized guideline is that each bootstrap sample should have the same number of observation as the original sample. It is called bootstrap cases in PLS-SEM. In this research, the bootstrap sample, which is equal to 150 firms as the number of statistical sample size, has the same number of observation or bootstrap cases as the original sample. "The bootstrap samples are used to estimate the PLS path model" (Hair et al, 2016).

It must be noted that whether a coefficient is significant finally and lastly depends on its standard error that is obtained and achieved by means of bootstrapping. The bootstrap standard error allows computing the empirical t value. Generally, common and generic critical and theoretical **t** value for a two tailed test is 1.96 ($\alpha = 0.05$). But, since the hypotheses of this research are based on theories of each hypothesis that are one tailed tests, which means that they have direction for measuring the positive and significant effects of independent (Exogenous) latent variables on dependent (Endogenous) latent variables. Moreover, this research specifically has hypotheses about the direction of an effect, it therefore can be inferred that critical and theoretical **t** value of this research for a one tailed test is 1.65 ($\alpha$= 0.05) at 5% level. In this research, in order to test ultimately the significance of coefficients, the standard error, which computes the empirical **t** values, was obtained by bootstrapping procedure and function by PLS-SEM software as figure 20:

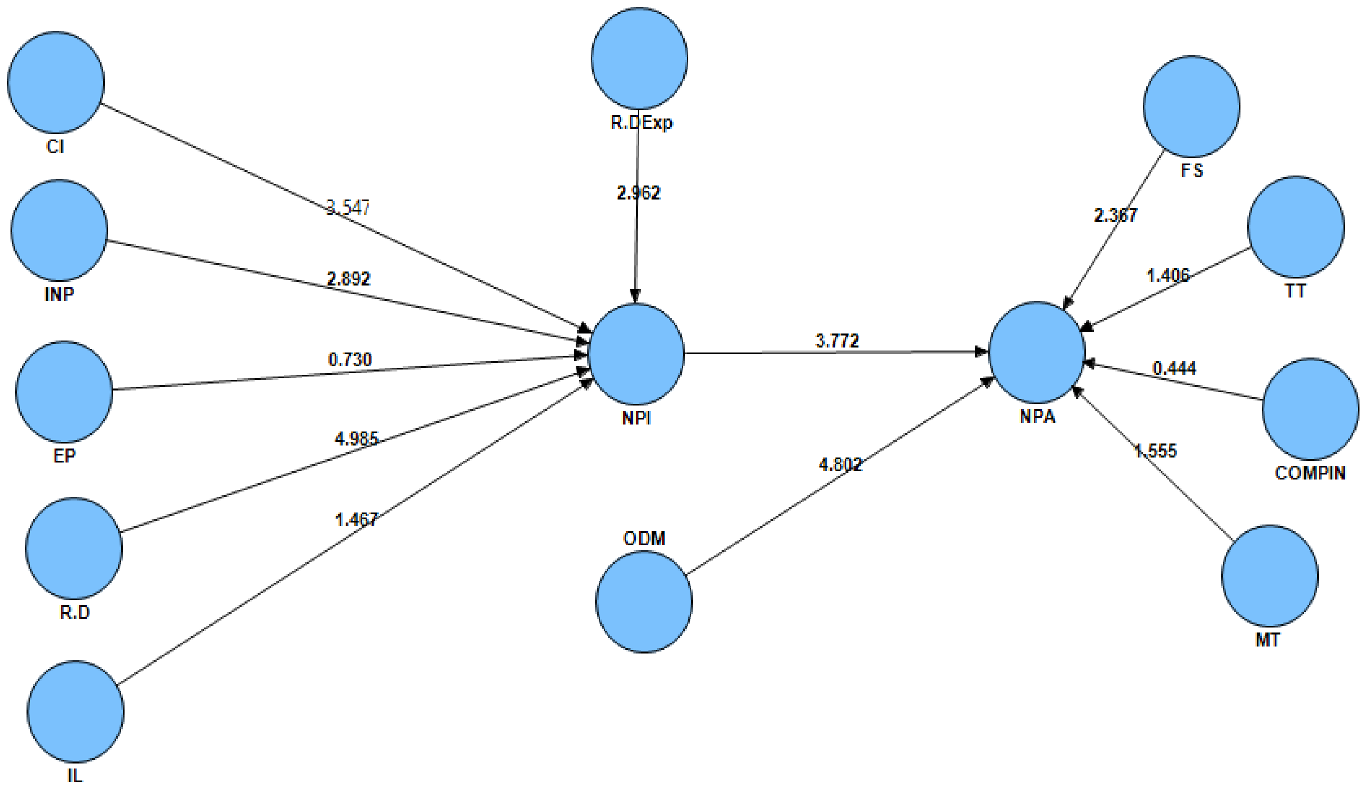


**Figure 20- Inner Model (Structural Model) Path Coefficients with Statistical t Values (T-Statistics)**

| | NPI | NPA |
|---|---|---|
| CI | **3.547** | |
| INP | **2.892** | |
| EP | 0.730 | |
| R.D | **4.985** | |
| IL | 1.467 | |
| R.DExp | **2.962** | |
| NPI | | **3.772** |
| ODM | | **4.802** |
| FS | | **2.367** |
| TT | | 1.406 |
| COMPIN | | 0.444 |
| MT | | 1.555 |

**Table 47- Inner Model T-Statistic**

| Hypotheses | Supported | Not Supported |
|---|---|---|
| ***H1*** | | ✓ |
| ***H1a*** | ✓ | |
| ***H1b*** | ✓ | |
| ***H1c*** | | ✓ |
| ***H1d*** | ✓ | |
| ***H1e*** | | ✓ |
| ***H2*** | ✓ | |
| ***H3*** | ✓ | |
| ***H4*** | ✓ | |

**Table 48- Significance and Non-Significance of Hypotheses**

In the condition that the empirical **t** value is larger than the critical value, it is inferred and concluded that the coefficient is significant at a certain significant level. Usually used critical value for two tailed tests is 1.96 at significant level= 5%. However, critical value for one tailed tests is 1.65 at significant level= 5%. One tailed test was applied in this research as the hypotheses have directions, because the hypotheses are measuring the direct positive and significant effects of independent variables on dependent variables. In this regard, and concerning to the empirical value obtained in this research based on table 47, it is concluded that:

1. Customer involvement (CI) with empirical **t** value of 3.547 as hypothesis (H1a), industrial network partnership (INP) with empirical **t** value of 2.892 as hypothesis (H1b), R.D and academic outsourcing with empirical **t** value of 4.985 as hypothesis (H1d), which are hypotheses relevant to inbound open innovation sources and their effects on new product innovativeness are above the threshold of one tailed test 1.65 at significant level= 5%. Therefore, these hypotheses are positively meaningful, significant and statistically supported.
2. R&D expenditure as the second hypothesis (H2) with **t** value of 2.962 and its effect on new product innovativeness is above the threshold of one tailed test 1.65 at significant level= 5%. Therefore, this hypothesis is positively meaningful, significant and statistically supported.
3. New product innovativeness (NPI) as the third hypothesis (H3) with **t** value of 3.772 and its effect on new product advantage (NPA) is above the threshold of one tailed test 1.65 at significant level= 5%. Therefore, this hypothesis is positively meaningful, significant and statistically supported.
4. Organizational declarative memory (ODM) as the fourth hypothesis (H4) with **t** value of 4.802 and its effect on new product advantage (NPA) is above the threshold of one tailed test 1.65 at significant level= 5%. Therefore, this hypothesis is positively meaningful, significant and statistically supported.

### *3.9.5. The Determination Test ($R^2$ Value)*

The most critical and prominent measure which is being used in PLS-SEM to assess and evaluate the structural model is the coefficient of determination ($R^2$ Value). "This coefficient is a measure of the model's predictive accuracy and is calculated as the squared correlation between a specific endogenous construct's actual and predicted values" (Hair et al, 2016). The coefficient offers and demonstrates the exogenous latent variable's combined effects on the endogenous latent variable. As the coefficient is the squared correlation of actual and predictive values, it offers and shows as well as the amount and degree of variance in the endogenous constructs explained by all of the exogenous constructs linked and related to it.

The $R^2$ value ranges from 0 to 1 with higher and greater levels indicating higher and greater levels of predictive accuracy. According to Hair et al, (2016) and (2011), Sarstedt et al, (2017), and Henseler et al., (2009), "$R^2$ values of 0.75, 0.50, or 0.25 for endogenous latent variables can, as a rough rule of thumb, be respectively described as substantial, moderate, or weak". As it is indicated in table 49, $R^2$ values for new product innovativeness (NPI) and new product advantage (NPA) as endogenous constructs are **0.474** and **0.532** respectively. It represents and offers that $R^2$ for NPI is slightly moderate and for NPA is moderate. In other words, they are moderately predicted the accuracy of the model. $R^2$ values of NPI and NPA show the amount and degree of variance predictive accuracy changes done by exogenous constructs of the model. In addition, five inbound open innovation constructs as exogenous latent variables could explain and predict 47% new product innovativeness (NPI) variance as endogenous construct. In addition, new product innovativeness (NPI) as exogenous latent variable could explain and predict 53% new product advantage (NPA) variance. The exogenous latent variable's combined effects on $R^2$ of these two endogenous constructs show that they could affect 0.474 and 0.532 as the amount and degree of variance predictive accuracy changes of endogenous constructs.

| | R Square |
|---|---|
| CI | - |
| COMPIN | - |
| EP | - |
| FS | - |
| IL | - |
| INP | - |
| MT | - |
| NPI | **0.474** |
| NPA | **0.532** |
| ODM | - |
| R.D | - |
| R.DExp | - |
| TT | - |

**Table 49- $R^2$ (R Square) of Theoretical Model's Endogenous Variables**

### *4.9.5. The Effect Size Test ($f^2$)*

In addition to assessing and evaluating the $R^2$ values of all endogenous constructs, the change and alteration in the $R^2$ value when a particular and determined exogenous construct is removed and omitted from the model is essential to be used to evaluate and assess whether the omitted and removed construct has a critical and substantial effect on the endogenous constructs. This measurement implies to Effect Size or $f^2$ test (Hair et al, 2016, Sarstedt et al, 2017). The effect size can be calculated as follow:

$$f^2 = \frac{R^2 \text{ included} - R^2 \text{ excluded}}{1 - R^2 \text{ included}}$$

In the formula of effect size, $R^2$ included and $R^2$ excluded mean the $R^2$ values of the endogenous latent variable when a chosen exogenous latent variable is included in or excluded from the model. The change and alteration in the $R^2$ values is calculated by estimating the PLS path model twice. First time, it is estimated with the exogenous latent variable with $R^2$ included and the second time with the exogenous latent variable $R^2$ excluded. 0.02, 0.15, and 0.35 values show respectively small, medium and large impacts of the exogenous latent variable (Cohen, 1988, Hair, et al, 2016).

| | $R^2$ | NPI $R^2$ Included | NPA $R^2$ Included | | NPI $R^2$ Excluded | NPA $R^2$ Excluded |
|---|---|---|---|---|---|---|
| NPI | 0.474 | - | - | - | - | - |
| NPA | 0.532 | - | - | - | - | - |
| CI | - | 0.474 | | CI | 0.440 | - |
| INP | - | 0.474 | | INP | 0.450 | - |
| EP | - | 0.474 | | EP | 0.472 | - |
| R.D | - | 0.474 | | R.D | 0.379 | - |
| IL | - | 0.474 | | IL | 0.468 | - |
| R.D Exp | - | 0.474 | | R.D Exp | 0.435 | - |
| ODM | - | | 0.532 | ODM | - | 0.417 |
| FS | - | | 0.532 | FS | - | 0.518 |
| TT | - | | 0.532 | TT | - | 0.523 |
| COMPIN | - | | 0.532 | COMPIN | - | 0.532 |
| MT | - | | 0.532 | MT | - | 0.520 |

**Table 50- $R^2$ Included and Excluded for Exogenous and Endogenous Constructs**

| | CI | INP | EP | RD | IL |
|---|---|---|---|---|---|
| Included | 0.474 | 0.474 | 0.474 | 0.474 | 0.474 |
| Excluded | 0.440 | 0.450 | 0.472 | 0.379 | 0.468 |
| 1-Included | 0.526 | 0.526 | 0.526 | 0.526 | 0.526 |
| f2 | **0.065** | **0.046** | **0.004** | **0.181** | **0.011** |

**Table 51- Effect Size Tests for Inbound Open Innovation Constructs**

As it is indicated in table 50 and table 51, the $R^2$ included (Related to NPI[5] as endogenous construct) for five inbound open innovation constructs as exogenous latent variables (CI[6], INP[7], EP[8], RD[9], and IL[10]) are 0.474. In contrast, according to table 50 and table 51, $R^2$ excluded for CI, INP, EP, RD, and IL after removing each construct once are 0.440, 0.450, 0.472, 0.379 and 0.468 respectively. Consequently, referring to table 51, the exogenous constructs CI, INP, EP, R.D and

New Product Innovativeness- [5]

Customer Involvement - [6]

Industrial Network Partnership- [7]

External Participation- [8]

R.D and Academic Outsourcing- [9]

Inward Licensing- [10]

IL for explaining the endogenous latent variable NPI (New Product Innovativeness) have $f^2$ effect size of 0.065, 0.046, 0.004, 0.181, and 0.011, respectively. According to Cohen, (1988), Hair et al, (2016), and Sarstedt et al, (2017), 0.02, 0.15, and 0.35 values show respectively small, medium and large impacts of the exogenous latent variable in $f^2$ effect size test. Therefore, the effect size of constructs CI, INP, EP and IL on the endogenous latent variable NPI are small, and R.D and academic outsourcing has a large effect size.

| | R.D EXP | ODM | FS | TT | COMPIN | MT |
|---|---|---|---|---|---|---|
| Included | 0.474 | 0.532 | 0.532 | 0.532 | 0.532 | 0.532 |
| Excluded | 0.435 | 0.417 | 0.518 | 0.523 | 0.532 | 0.520 |
| 1-Included | 0.526 | 0.468 | 0.468 | 0.468 | 0.468 | 0.468 |
| f2 | **0.074** | **0.246** | **0.030** | **0.019** | **0** | **0.026** |

**Table 52- Effect Size Tests for other Exogenous and Control Variables**

In addition, again as it is shown in table 50 and table 52, the $R^2$ included related to NPI[11] as endogenous construct for R.D Expenditure as exogenous latent variable is 0.474. In addition, $R^2$ included related to NPA[12] as endogenous constructs for ODM[13] as exogenous latent variable and FS[14], TT[15], COMPIN[16], and MT[17] as exogenous control latent variables is 0.532. In contrast, according to table 50 and table 52, $R^2$ excluded for R.D Expenditure, ODM, FS, TT, COMPIN, and MT after removing each construct once are 0.435, 0.417, 0.518, 0.523, 0.532, and 0.520 respectively. As a result, referring to table 52, the exogenous construct R.D Expenditure for explaining the endogenous latent variable NPI (New Product Innovativeness) and ODM, FS, TT,

New Product Innovativeness- [11]

New Product Advantage- [12]

Organizational Declarative Memory- [13]

Firm Size- [14]

Technology Turbulence - [15]

Competition Intensity- [16]

Market Turbulence- [17]

COMPIN, and MT for explaining the endogenous latent variable NPA (New Product Advantage) have f2 effect size of 0.074, 0.246, 0.030, 0.019, 0, and 0.026 respectively. Therefore, the effect size of R.D Expenditure on the endogenous latent variable NPI, and FS, TT, COMPIN, and MT on the endogenous latent variable NPA are small and ODM has a large effect size on new product advantage (NPA).

#### *5.9.5. The Predictive Relevance ($Q^2$) of the Model*

In addition to assessing and evaluating the $R^2$ values as a measurement criterion of predictive accuracy, researchers have to examine and analyze Stone-Geisser's $Q^2$ value (Geisser, 1974; Stone, 1974). This kind of measure and criteria is an indicator of the model's predictive relevance. In the structural model, $Q^2$ values larger and greater than zero for a certain and specified reflective endogenous latent variable show the path model's predictive relevance for a particular construct. The $Q^2$ value is achieved and obtained by blindfolding procedure. The blindfolding procedure is merely applied to endogenous constructs, which have a reflective measurement model specification and characteristics to endogenous single item constructs.

$Q^2$ values higher than 0 offer and suggest that the model has predictive relevance for endogenous construct. In contrast, values of 0 and below demonstrate a lack and inadequacy of predictive relevance. It should be noted that the $Q^2$ value has this possibility to be calculated by using two various approaches. The cross-validated redundancy approach is built on the path model estimates of both the structural model (scores of the antecedent constructs) and the measurement model (target endogenous construct) of data prediction. There is another alternative approach, the cross validated communality exploits only the construct scores estimated and predicted for the target endogenous construct (without involving and including the structural model information) to predict the omitted and removed data points. It is recommended and suggested that cross validated redundancy as a measure of $Q^2$ to be used and calculated since it includes and involves the key aspect and element of the path model, the structural model, in order to predict omitted and removed data points (Hair et al, 2016). Consequently, the cross-validated redundancy table (shortly abbreviated as CV Red) after running blindfolding procedure is as following:

| | 1-SSE/SSO |
|---|---|
| CI | 0.832901 |
| COMPIN | 0.72113 |
| EP | 0.594014 |
| FS | 1.00000 |
| IL | 0.584986 |
| INP | 0.628851 |
| MT | 0.544227 |
| NPA | 0.393075 |
| NPI | 0.299965 |
| ODM | 0.638055 |
| R.D | 0.661123 |
| R.DExp | 1.00000 |
| TT | 0.699925 |

**Table 53- Cross-Validated Redundancy (CV Red) after Blindfolding Procedure for Measurement of Structural Model Quality**

The interpretation of table 53 as CV Red table is that all $Q^2$ values of table are above 0, indicate that the exogenous constructs have predictive relevance for the endogenous constructs which are under consideration in this research. "As a relative measure of predictive relevance ($Q^2$), values of 0.02, 0.15, and 0.35 respectively indicate that an exogenous construct has a small, medium, or large predictive relevance for a certain endogenous construct" (Hair et al, 2016). In this regard, as $Q^2$ values are being used for reflective endogenous variables, it indicates the path model's predictive relevance for endogenous constructs NPI and NPA, Therefore, $Q^2$ values higher than 0 offers and suggests that the model has predictive relevance for endogenous constructs NPI and NPA. It is demonstrated that $Q^2$ values of exogenous variables are all above 0.35, which shows the great, strong and a very large predictive relevance of exogenous constructs for NPI and NPA as endogenous constructs. NPI with $Q^2$ of 0.299 has a minor and slight greatness and highness of predictive relevance, whereas, NPA with $Q^2$ of 0.393 possess a large and high $Q^2$ predictive relevance in the model. Furthermore, according to the results it can be concluded that the structural model of this research has a great predictive quality and high power in interpretation of research hypotheses results.

### *6.9.5. The Goodness of Fit (GoF) Index of the Model*

Tenenhaus et al, (2004) propose the GoF as a means to validate a PLS path model globally (Henseler & Sarstedt, 2013). GoF is being measured by the following equation in PLS-SEM:

$$GoF = \sqrt{Communality * R2}$$

The left term of the formula indicates as an index measuring the predictive performance of the measurement model, which is called communality index. It is achieved and gained as the mean of the squared correlation linking observed and obvious variable to the matching and correlated variable. The term on the right side of the formula, the average $R^2$ is an index measuring the predictive performance of the structural model. According to this statement, the GoF can be inferred as the geometric mean of two types of $R^2$ values' averages: the average communality, which is the average amount and proportion of variance explained when regressing the reflective indicators on their latent variables (Fornell and Larcker 1981), and the average $R^2$ of the endogenous latent variables (Henseler & Sarstedt, 2013). In this research, the GoF of the whole model is 0.60.

$$GoF = \sqrt{Communality * R2} \quad =0.60$$

According to Cohen, (1988), Hair et al, (2016), and Sarstedt et al., (2017), 0.02, 0.15, and 0.35 values show respectively small, medium and large impacts of the exogenous latent variable. In this regard, the GoF of this research model is 0.60, which indicates a very high and large impact of exogenous latent variables in the model, so that it can be inferred that the whole quality of this research model is so high and great.

# *Chapter 6: Discussion and Conclusion*

## *1.6. The Main Results in Brief*

In order to interpret the results of research hypotheses obtained by analyzing data, table 55 indicates the results of supported and not supported hypotheses. By summarizing the results, Firstly, it was expected that all outside-in (Inbound) open innovation sources can positively and significantly affect and increase new product innovativeness in SMEs of Petroleum and Gas equipment industry. According to this hypothesis, it was expected that all outside-in (Inbound) open innovation sources and practices as external sources of knowledge, innovation ideas and technological capabilities are in equal value and have the same equivalent and identical positive impact on new product innovativeness of SMEs in Petroleum and Gas equipment industry. But, we can observe that hypothesis 1 (H1) which is about the impact of all outside-in (Inbound) open innovation sources on new product innovativeness has not been supported. Statistical data analysis shows that ***not*** all different types of outside-in (Inbound) open innovation sources positively and significantly affected new product innovativeness in SMEs. Hypothesis (H1a) which is about customer involvement as the first source of outside-in (Inbound) open innovation in this research has been supported. According to this hypothesis, it was expected that customer involvement could positively and significantly affect new product innovativeness of SMEs in Petroleum and Gas equipment industry. Statistical data analysis shows that customer involvement positively and significantly affects new product innovativeness in SMEs as manufacturer of Petroleum and Gas equipment industry. Furthermore, hypothesis (H1b) which is about industrial network partnership as the second source of outside-in (Inbound) open innovation in this research has been supported. According to this hypothesis, it was expected that industrial network partnership could positively and significantly affect new product innovativeness of SMEs in Petroleum and Gas equipment industry. Statistical data analysis shows that industrial network partnership positively and significantly affects new product innovativeness in SMEs as manufacturer of Petroleum and Gas equipment industry. However, hypothesis (H1c) which is about external participation as the third source of outside-in (Inbound) open innovation in this research has ***not*** been supported. According to this hypothesis, it was expected that external participation as equity investment in new venture startups and small firms as external knowledge sourcing strategy can increase new product innovativeness. Nevertheless, statistical data analysis shows that external partnership ***has not*** positively and significantly affects new product innovativeness in SMEs as manufacturer of Petroleum and Gas equipment industry. Nonetheless, hypothesis (H1d) which is about R.D and academic outsourcing as the fourth source of outside-in (Inbound) open innovation in this research has been supported. According to this hypothesis, it was expected that R.D and academic outsourcing could positively and significantly affect new product innovativeness of SMEs in Petroleum and Gas equipment industry. Statistical data analysis shows that R.D and academic outsourcing positively and significantly affects new product innovativeness in SMEs as manufacturer of Petroleum and Gas equipment industry. Nevertheless, hypothesis (H1e) which is about inward licensing as the fifth and last source of outside-in (Inbound) open innovation in this research has ***not*** been supported. According to this hypothesis, it was expected that inward licensing could positively and significantly affect new product innovativeness of SMEs in Petroleum and Gas equipment industry. Statistical data analysis shows that inward licensing ***has not*** positively and significantly affects new product innovativeness in SMEs as manufacturer of Petroleum and Gas equipment industry.

Secondly, we can observe that hypothesis 2 (H2) which is about the impact of R.D expenditures on new product innovativeness has been supported. According to this hypothesis, it was expected that R.D expenditures could positively and significantly affect new product innovativeness of SMEs in Petroleum and Gas equipment industry. Statistical data analysis shows that R.D expenditures positively and significantly affect new product innovativeness in SMEs as manufacturer of Petroleum and Gas equipment industry.

Thirdly, we can observe that hypothesis 3 (H3) which is about the impact of new product innovativeness on new product advantage has been supported. According to this hypothesis, it was expected that new product innovativeness could positively and significantly affect new product advantage of SMEs in Petroleum and Gas equipment industry. Statistical data analysis shows that new product innovativeness positively and significantly affects new product advantage in SMEs as manufacturer of Petroleum and Gas equipment industry. Lastly, we can observe that hypothesis 4 (H4) which is about the impact of organizational declarative memory on new product advantage has been supported. According to this hypothesis, it was expected that organizational declarative memory could positively and significantly affect new product advantage of SMEs in Petroleum and Gas equipment industry. Statistical data analysis shows that organizational declarative memory positively and significantly affects new product advantage in SMEs as manufacturer of Petroleum and Gas equipment industry.

| Hypotheses | Supported | Not Supported |
|---|---|---|
| ***H1*** | | ✓ |
| ***H1a*** | ✓ | |
| ***H1b*** | ✓ | |
| ***H1c*** | | ✓ |
| ***H1d*** | ✓ | |
| ***H1e*** | | ✓ |
| ***H2*** | ✓ | |
| ***H3*** | ✓ | |
| ***H4*** | ✓ | |

**Table 54- Supported and Not Supported Hypotheses**

### *2.6. The Discussion of the Main Results*

In hypothesis (H1) which is about the effect of Outside-In (Inbound) open innovation sources on new product innovativeness, according to Faems et al, (2005), Roper et al, (2008). Tether and Tajar, (2008), by increasing the number of different types of external partners, firms can anticipate the innovation performance of new products to be increased. In addition, according to the study of Amara and Landry (2005) and Bahemia & Squire, (2010) which suggest that firm's dependency and relying on a large number of external knowledge sources, they are more intending to develop new innovative products. In this research, it can be observed that not all of the outside-in (Inbound) open innovation sources can positively and significantly affect new product innovativeness of SMEs in an equal value. According to the results of this research, three inbound open innovation sources namely customer involvement, industrial network partnership, and R&D and academic outsourcing are important and positively affect new product innovativeness in SMEs. While the other two inbound open innovation sources such as external participation and inward licensing are not important and have not positively affect new product innovativeness in SMEs.

Among important and substantial outside-in (Inbound) open innovation sources, *first*, customer involvement should be regarded as the first important effective and influential external source of open innovation for SMEs. Rothwell and Gardiner (1985) argue that there is a remarkable and significant emphasize to achieve substantial gain through involving and engaging users and customers in the product design and product development process. The achievements are categorized in four groups: First, firms would be able to support and complement their internal design and development activities by obtaining and accessing the technical and managerial skills and insights of their customers. Second, user and customer involvement can be the supreme and excellent method to make the optimized price and performance combination for firms. Consequently, it can lead to optimized attributes and specifications in product design and innovation and new product development. Third, involving and engaging customers and users in product design, product innovation and product development projects in firms can result to reduce the future learning experience of market after supplying and launching the new innovated product. Accordingly, this could result in strong effects to accelerate attracting other customers and innovation acceptance and adaptation process. Customer and user involvement and engagement generates a strong relationship, that will lead to receive user and customer feedbacks and relevant required product improvement and advancing new innovative products which indicate the product life cycle lengthier (Freel, 2000a). Besides, close contact and interaction with innovative users and customers would lead to feasibility and applicability of manufacturing firms to absorb and obtain radical new product ideas and concepts, so that enable firms to choose the most promising and appropriate initial and prototype samples. Utilizing this method of open innovation practice enables manufacturing firms to improve and develop the efficiency of the innovation process, speed up and accelerate the innovation process, and decreases the risks relevant to market introduction of new innovative products (Clark 1989; Clark and Fujimoto 1991). Furthermore, customer and user collaboration allows firms to obtain and acquire new innovative and technological skills, learn easily about relevant technological trends and innovation movement and orientation. Also develop and expand their product innovation and technological related collaborative networks (Lettl, Herstatt, and Gemuenden 2006; Petersen, Handfield, and Ragatz 2003, Lasagni, 2012).

In this regard, customer involvement in SMEs in general and SMEs in Petroleum and Gas equipment industry in particular, are playing the main role to enhance and increase the level of new product innovativeness practices and new product development projects by contributing to product design, increasing the product quality by specifying the drawbacks and weaknesses of products. It also contributes to the awareness of customers' preferences and priorities by SMEs. Customers and users enable SMEs to increase the performance of new product innovativeness and new product development projects by receiving their feedbacks, ideas and insights for improving and developing new innovative products. The requirements and needs of customers can particularly enhance product's quality and can affect product's design according to the needs of customers and users. Customers would push and force manufacturers to produce the products with the desirable attributes and features aligned to their needs and requirements. Customers specify and determine the needs of markets and based on their activities in the market they cause SMEs to start to modify product attributes and specifications and initiate to change and improve firm's products. Customers and users of SMEs in Petroleum and Gas equipment industry are ordering and instructing manufacturers to produce a specific product that they need and require, thus, SMEs in this industry are producing and manufacturing new innovative products or develop new products according to the order and instruction of customers. SMEs can boost their internal new product innovativeness strategy and product design capabilities by receiving and adopting customers' new innovative and market driven ideas and insights.

Customers' technological comprehensions can help firms to design better superior and optimized new innovative products, or modify and develop attributes and peculiarities of new products. By receiving customer's and user's feedbacks and ideas about product improvements or developing and innovating in some aspects of products' applicability can lead to better radical product innovation performance and prolong the length of product life cycle in the market. Furthermore, customer involvement would lead industrial firms to increase and enhance the efficiency and productivity of new product innovation process, so that will result to accelerate the new product innovation process and decrease the risks of launching and introducing new innovative products to the markets.

*Second*, industrial network partnership should be regarded as the second important effective and influential external source of open innovation for SMEs. There are several studies confirm and acknowledge that network relationship can be considered as a high valuable source for leveraging innovation performance (e.g., Chen, Chen, and Vanhaverbeke 2011; Freeman 1991; Love and Roper 2001; Nieto and Santamaria 2007; Rammer, Czarnitzki, and Spielkamp 2009; Rogers 2004; Zeng, Xie, and Tam 2010, Lasagni, 2012). External networking which has been widely studied is "a firm's set of relationships with other organizations" (Pittaway et al. 2004). Based on the study of Powell and Grodal (2005), inter firm network collaborations are a source and method by which organizations can stock and reserve or exchange resources and cooperatively develop and extend new ideas, skills, innovation and technological sources (Lasagni, 2012). Networking has been found and considered as a suitable and desirable format of collaboration for SMEs. It often has been considered as an important, possible and feasible way of innovation as much as large firms do (Narula 2004), because there is evidence shows the success of SMEs to have ability and potential capability of utilizing external networks more effectively and efficiently than large firms (Rothwell & Dodgson 1994). According to the study of Van de Vrande et al (2009), external networking is a kind of external collaboration to acquire and obtain new knowledge as a crucial and substantial open innovation activity among SMEs. Small and medium sized enterprises (SMEs) obviously and apparently benefit and take advantage of collaboration relationships in networks that are well created, constructed and managed in an appropriate way (Inkpen & Tsang 2005). It helps firms to leverage their competitive advantage (Bougrain & Haudeville 2002), to provide more facilities to their innovation capacities and capabilities (Lee et al. 2010), and most importantly to become more productive in developing countries (Biggs & Shah 2006). Network collaboration assists SMEs to co-develop products and services and leverage innovativeness of new products (Gulati 1998); also, it contributes to all the network members to share experience, skills, and increasing learning effects for prospective and future innovation practices (Lundvall 1993; Argote & Ingram 2000). Since SMEs usually confront more uncertainties, turbulence and impediments to innovation activities, networks are recognized and known to play a supplementary resource to the lack of security and existence of turbulence caused from development and utilizing of new technologies, while decreasing and diminishing uncertainties in innovation practices (Diez 2000, Vrgovic et al, 2012). Many knowledge and technological breakthrough outcomes are coming out and caused from several extensive contribution and collaboration of many actors and partners working in networks (Bougrain and Haudeville, 2002) and required necessary standards for a technology to operate and function in various markets depend progressively on inter organizational collaboration in the form of network partnership (Munir, 2003).

Networking partnership by firms has some innovation benefits such as: risk sharing (Grandori, 1997); achieving access to new markets and technologies (Grandori and Soda, 1995); accelerating new products to markets (Almeida and Kogut, 1999); obtaining and achieving complementary skills (Eisenhardt and Schoonhoven, 1996; Hagedoorn and Duysters, 2002); and playing the role of a mechanism to access to external knowledge (Powell, Koput, and Smith-Doerr, 1996; Cooke, 1996). Network partnership is not only useful and critical for obtaining and achieving knowledge to generate and build in-house innovations or for the dissemination of technological innovation but they are crucial and prominent in parallel for learning about innovative practices which other firms and organizations have developed and adopted (Erickson and Jacoby, 2003). This process and fact can influence on firms in different methods. Firstly, by increasing access to knowledge, developing awareness and early adoption of innovation, secondly, it can be fulfilled by developing mutual interaction which making bilateral trust that will lead to knowledge transfer. Network collaboration enhances the success rate of innovative and entrepreneurial practices (Baum, Calabrese and Silverman, 2000), because interpersonal and inter-organizational relationships allow and assist players to access to various resources owned by other members and partners. Network collaboration permits small firms to connect to innovative R&D practices that are contracted by larger firms, to involve in joint R&D ventures and to establish marketing and manufacturing mutual relationships (Rothwell and Dodgson, 1991). Referring to the study of Baum et al (2000), small business can increase and leverage their initial performance at the time of establishment by making an alliance network, arranging the network to supply efficient access to various knowledge, and innovative capabilities. Moreover, it can be acquired by joint collaboration with potential and capable competitors, which offer more opportunity for learning and less risk of intra network partnering competition. The most usual and ordinary reason to do this strategy is to obtain access to new or supplementary resources, competencies, technologies and markets (Pittaway et al, 2004).

Establishing relationships with network partners are usually based on a long-term condition and its objective is making and generating joint and common value creation rather than efficient transactions. This reciprocal collaboration as the form of network partnership builds trust and cause mutual understanding among partners (Nooteboom et al. 2007). Simultaneously, network partners provide SMEs access to supplementary innovation sources and also operational supplementary know-hows such as manufacturing, marketing, and access channels (Christensen, Olesen, and Kjær 2005; Teece 1986). These resources normally and generally take years to generate and build (Baum, Calabrese, and Silverman 2000). According to the contributory essence of interactions in network partnerships, network relationships based on mutual collaboration make it easier to recognize access and receive external ideas. Considering the critical role of network relationships in innovation for SMEs, network partners and members can be a crucial and prominent source for new innovative ideas if SMEs utilize them consciously (Brunswicker & Vanhaverbeke, 2015).

In this regard, industrial network partnership in SMEs in general and SMEs in Petroleum and Gas equipment industry in particular, are considered as a critical and important outside-in (Inbound) open innovation source and practice which enables SMEs to leverage the level of new product innovativeness by close collaborating and partnering with other network members and industrial network parties. They can mutually share their knowledge, innovative ideas and technological know-hows and industrial expertise to other firms.

Inter-organizational collaboration as industrial network partnership is a method of acquiring new external knowledge, innovative ideas and technological sources in order to deepen cooperatively these new ideas and innovative knowledge and expertized technologies to increase the innovation performance in firms. External industrial network partnership in SMEs is an external knowledge sourcing which is based on mutual cooperation and crucial and critical issue to foster accessing to required knowledge and expertized innovative ideas. This kind of collaboration helps firms to acquire lost knowledge, which is essential to increase the level of new product innovativeness and new product development activities in SMEs. In addition, this collaboration in networked context facilitates firms to boost and surge their innovation capabilities by close linkages between network parties, which can provide more extended span of specialized knowledge relevant to industry that SMEs are operating and cooperating by co-developing new innovative products, which ultimately can leverage the new product innovativeness of SMEs.

Industrial network partnership can facilitate sharing skills, expertize and technological breakthrough and innovation advancement between firms as member of network. It also diminishes and reduces manufacturing costs, risk of production or market introduction, and also can provide the opportunity of rapid penetration into new market by acquiring new technologies, achieving to complementary skills, accelerating launching new innovative products into market. By industrial network partnership, firms are enabled to work closely with each other, so that it provides the possibility of building mutual trust between members in order to transfer new technology or exchange new innovative knowledge, which can affect positively new product innovativeness of SMEs. Network partnerships open a new horizon to SMEs to exploit external new complementary innovation sources, knowledge, technologies, operational manufacturing methods, strategies, and new markets that take years for SMEs to obtain by individually working.

*Third*, R&D and academic outsourcing should be regarded as the third important effective and influential external source of open innovation for SMEs. There are two major reasons support this concept that R&D outsourcing with universities and research institutions can improve small firm innovation performance and capabilities. First, it is believed that university research outputs are sources of substantial innovation producing knowledge, which disseminates primarily through close contacts and cooperative approach with partner firms (Acs et al. 1994: 2). Second, it is suggested that small firms can diminish and reduce internal resource and capacity deficiencies by applying and utilizing university resource networks (Westhead and Storey 1995). There are linkages between small firms and research institutions and universities that are likely to have a substantial effect on innovation performance (Johnson and Tilley 1999, Freel, 2000). Industry-science collaborations offer firms the possibility of accessing to new knowledge and innovative research outputs, expand, and develop their understanding regarding emerging scientific and research developments and outputs.

Universities and research institutions can be considered as prominent partners that offer new scientific research and technological knowledge into the firm (Lundvall 1992). According to the study of Perkmann and Walsh (2007), the university-industry relationships and partnership are greatly practiced. Close and relative collaboration with universities and research institutions seems to provide easy breakthrough product innovations (Belderbos et al. 2004a, 2004b). Firms, which accepted to use open search strategies and try to collaborate in R&D practices and invest in R&D activities are more in a condition of utilizing the outcomes and results of universities and research institutions than other firms. It shows that managerial approach is important in constructing the tendency of firms to exploit from universities (Lasagni, 2012).

Both universities and research institutions are relevant and suitable sources for inventive and innovative knowledge for the purpose of exploiting in industry before commercialization since scientific and research outputs have the prominent competence to change the search for inventions and innovative and creative ideas (Fabrizio 2006; Fleming and Sorenson 2004; Shinn and Lamy 2006; Tsai 2009). Industry-university and research institution relationships also present better suitable access to inventive and innovative trends and propensities (Fabrizio 2009, Brunswicker & Vanhaverbeke, 2015). Furthermore, the instances of R&D and academic outsourcing can be named in the collaborative format of technical service providers such as engineering firms and high tech institutions, which have become more critical and prominent issues in the innovation process. Collaborative R&D and academic outsourcing seems apparently to be instructive and helpful sources by which strategic flexibility and the power of leveraging new product innovativeness increasing and possibility of access to new knowledge and innovative ideas has been recognized (Pisano, 1990; Quinn, 2000; Fritsch and Lukas, 2001; Gassmann, 2006).

In this regard, R&D and academic outsourcing by SMEs in general and SMEs in Petroleum and Gas equipment industry in particular, is considered as a critical and important outside-in (Inbound) open innovation source and practice. This type of inbound open innovation practice enables SMEs to leverage the level of new product innovativeness by close collaborating and partnering with universities and research institutions which can share their R&D and scientific research outputs, knowledge and innovative ideas with industrial firms. Scientific research outputs of universities and research institutions should be discussed as the innovative and technological knowledge sources of firms as it has been formed in collaborative approach and shaped in a partnership strategy between firms and universities. It is associated with a positive relationship of industry-university collaboration, which can reduce and decrease firms' internal scarcity of resources and boosting innovation capacities and capabilities as university and firm network. This R&D collaboration between SMEs and universities can accelerate acquiring new specialized knowledge, innovative and technological propositions and ideas as the scientific research outputs, which can boost the level of new product innovativeness in SMEs. Moreover, it can be derived that leveraging new product innovativeness through R&D and academic outsourcing and collaboration can be acquired by R&D and academic supportive services from science and technology parks, technical engineering firms or inventors as main sources of R&D and research resources.

Universities and academic research institutions can be appropriate sources of invention, generate new academic knowledge and new innovative scientific outputs relevant to industrial context contributing to leveraging new product innovativeness and developing new products according to the requirements of the marketplace and customers by increasing firms' innovation capabilities and capacities. As R&D is considered a major resource for innovation, the problem of insufficient or scarcity of internal organizational capabilities and competences has received a substantial attention according to large R&D intensive firms, based on their absorptive capacity structure (Spithoven, Clarysse, and Knockaert 2011). Cohen and Levinthal (1990) emphasize that internal activities, such as R&D, not only provide and make new information, but also can progress and develop the firm's capability and ability to absorb and utilize existing knowledge and information. According to Zahra and George (2002), the amount and level of external knowledge that a firm can perceive should be regarded as increasing and boosting function of its absorptive capacity. Simultaneously, considering a special quantity and degree of recognized external knowledge flows, the level and degree by which the firm get benefits and take advantages depends on its absorptive capacity (Caloghirou and Kastelli, 2004, Lasagni, 2012). There is possibility for SMEs' absorptive capacity, which enables them to access external R&D and knowledge sources and is regarded as an important issue in SMEs capability to search and use external R&D, research and knowledge sources in surrounding environment.

According to Cohen and Levinthal (1990, p. 128), the ability and potential capability to evaluate, assess and exploit external R&D and knowledge sources is extensively a function of antecedent knowledge. Absorptive capacity in SMEs should be reflected as an organizational capability and competence that indicates firms' openness and adaptability to technological and knowledge alterations (Kedia and Bhagat 1988), and the ability of firms to effectively and efficiently use external R&D and knowledge (Fabrizio 2009, Koza and Lewin 1998). In addition to implementing innovation processes to permit integration of external knowledge and R&D activities, to utilize external R&D and innovative ideas inside firms' new product innovation process, the firm needs distinctive ability and capability to implement and utilize the open innovation activities more significantly and efficiently. For new product innovativeness process in firms, it is required to have different types of capability and potential practices. In this regard, the absorptive capacity should have a relevant and close linkage with relational capability as complementary source and concept. The beneficial aspect and efficiency of both knowledge creation and knowledge utilization is based on the notion of absorptive capacity (Gassmann and Enkel, 2004).

Absorptive capacity in firms permits them to employ and apply external knowledge, R&D and innovation sources as a complementary element to their internal practices due to innovation and development activities inside the firms. It also enables firms to obtain more capability and competence to boost innovation performance and leverage the effectiveness of research and development projects. When there is sufficient absorptive capacity in an organization, external research activities of R&D and knowledge sources can be acting as a supportive and complementary practice of internal research and development projects, which lead to gaining high level of synergies and high innovation performance (Arora and Gambardella, 1990, Macpherson, 1997). These synergies emphasize that internal R&D have not been decreased or become obsolete, as the openness approach of firms can help firms to get advantage for internal

R&D practices (Howells, 1999, Veugelers, 1997). Accordingly, as results of this research show, SMEs in Petroleum and Gas equipment industry have exploited and utilized customer involvement, industrial network partnership and R&D and academic outsourcing as outside-in (Inbound) open innovation sources inside their firms. These external knowledge and innovation sources have been considered as important and critical inbound open innovation resources for SMEs in this industry. Thus, absorptive capacity is a noteworthy notion in SMEs in general and SMEs in Petroleum and Gas equipment industry in particular, for leveraging the level of new product innovativeness. There is an important aspect that the level and degree of using external knowledge sources for SMEs should be closely linked to the possibility of increasing and leveraging internal absorptive capacity in SMEs. In addition, the potential degree and amount of external knowledge and technological capabilities outside SMEs, which can exploit and use these external resources for leveraging new product innovativeness and developing new products depends on their absorptive capacity.

Among unimportant and insignificant outside-in (Inbound) open innovation sources, *First*, External Participation should be regarded as outside-in (Inbound) open innovation source which was an ineffective external source of open innovation on new product innovativeness of SMEs. The *second* unimportant and insignificant outside-in(Inbound) open innovation source which was another ineffective external source of open innovation on new product innovativeness of SMEs is Inward Licensing. These two sources of outside-in (Inbound) open innovation were not important for SMEs of Petroleum and Gas equipment industry due to two major reasons. First, there are several general, common and extensive negative points, disadvantages and drawbacks, which are related to the weaknesses and challenges of SMEs. This raises this question that why all outside-in (Inbound) open innovation sources have not been important and prominent for SMEs and why not all of those sources have been used by these firms and why not all of them were in equal value for SMEs in Petroleum and Gas equipment industry? In addition, why SMEs have not been able to deal with external participation and inward licensing as two sources of outside-in (Inbound) open innovation positively and utilize them appropriately? Second, there are some specific aspects and drawback reasons, which are particularly relevant to the type and context of external participation and inward licensing activities as other two types of external open innovation sources in this research. For instance, there are some specific direct points, which make the reason of not using external participation by SMEs more clear as rational and logical causes in this research. Furthermore, some logical purposes exist in this research, which justifies the reason of why SMEs in Petroleum and Gas equipment industry have not used inward licensing. These special reasons are related directly to the type and essence of these two inbound open innovation sources. First and Foremost, the general reasons that are related to SMEs challenges or weaknesses is explaining to justify why SMEs have not used external participation and inward licensing, then, the specific and particular reasons related to external participation and inward licensing that have not used by SMEs will be explained respectively as following:

SMEs are weaker and have fewer competencies than large firms in order to overcome challenges and impediments in practicing open innovation. Resource limitation for R&D, disorganized innovation activities, complexity of scientific and research practices, insufficient coordination of innovation practices with operational functions, and lack of sufficient access to scientific and research output superiority and advantage are the main issues and challenges of SMEs in open innovation activities (Kim and Park, 2010; Abouzeedan et al., 2013, Hossain & Kauranen, 2016). SMEs are operating in a very turbulent and dynamic business and industrial environment and changes are occurring in short time within SMEs. According to this notion, there are various reasons need to be noticed as weaknesses of SMEs which can be called as: lack of prepaid planning, lack of cash flows, lack of ability and expertise to capture and manage innovation, lack of skills, time and resources, inability of investment at the right and proper time, deficiency of business experience, and lack of receiving and even sometimes no external helps (Antony, 2008).

SMEs in general and in Petroleum and Gas equipment industry in particular in this research are suffering from insufficient capital and financial resources to invest at the right and proper time in all kinds of external knowledge and open innovation sources to increase the level of new product innovativeness. In addition, SMEs in general and in Petroleum and Gas equipment industry in particular confronting inability of fully skilled and highly expertized human resources to search, find, obtain, exploit and manage all open innovation sources. Moreover, constraints of time and organizational resources do not allow these firms to be able to exploit all outside-in (Inbound) open innovation sources. It should be noted that SMEs in general and SMEs in Petroleum and Gas equipment industry in particular are weak in strategic planning and do not possess enough competency to have a long run planning to exploit all types of external knowledge and outside-in (Inbound) open innovation sources in a suitable duration of time. Generally, as SMEs are operating in small scale of size and might not be adequately efficient to have business experience, they may be unable to benefit from all external knowledge and innovation sources across external innovation ecosystem. In addition, SMEs in general and SMEs in Petroleum and Gas equipment industry in particular are not in a proper stance of receiving financial and institutional contributions from external environment. It can decrease their internal organizational capacities and capabilities to use all external open innovation sources. Furthermore, there are not completely fulfilled and implemented legislated plans and public policies relevant to financial assistance to SMEs in Petroleum and Gas equipment industry in order to grant financial resources, aid and loans, which have been emerged as a serious problem for such firms. Additionally, the increasing degree of bureaucratic procedures and instability and absence of proper accomplishment and implementation of governmental plans and public policies, create impediments for Iranian

SMEs to increase and develop their partnerships and collaborations with all external partners to acquire external knowledge and innovative sources more appropriately (Society of Iranian Petroleum Industry Equipment Manufacturers, www.sipiem.com). Consequently, all types of outside-in (Inbound) open innovation practices can be affected and violated by burdening complicated rules or even lack of appropriate rules, regulations and public policies and supportive strategies can establish great barriers for SMEs to exploit all types of open innovation sources in Petroleum and Gas equipment industry.

SMEs' weaknesses and challenges in innovation practices arise from their size (Freel, 2000, Narula, 2004, Teece, 1986, Ahn et al, 2015). SMEs in general and in Petroleum and Gas equipment industry in particular in this research are in small size and size can limit SMEs potential capacity and organizational capability to use all external sources and that could be a matter for such firms. Therefore, small size makes these firms to have a fear to largely invest in large number of external knowledge and innovation sources, they are not able to exploit or handle all kinds of outside-in (Inbound) open innovation practices as external knowledge sources. Additionally, most SMEs do not possess sufficient capacity and organizational capability and there are some constraints for systematic R&D activities (Hossain, 2013). Moreover, these enterprises with scarce degree of intensive R&D capacity and capability cannot use external knowledge sources efficiently and effectively (Rosenberg and Steinmueller, 1988, Zeng et al, 2010). Thus, lack of adequate capacities confines expanding the span of utilizing all outside-in (Inbound) open innovation sources in SMEs.

In this regard, SMEs of Petroleum and Gas equipment industry are not excluded from this fact that size and limited resources restrict their capacity and organizational capability to use and benefit from all external sources of open innovation. Innovation practices in SMEs have emerged as a much complicated issue (Diez, 2000, Zeng et al, 2010). The SMEs' weaknesses and lack of organizational capability in innovation processes and product development resulted from their size and constrained organizational resources. SMEs with lower degree and limited level of capacity and organizational capability might not possess the ability to exploit all external open knowledge and technological sources at the same level/ value, which implies to this fact that, they cannot use all external sources much more productive and profitable inside their firms. Furthermore, according to the firm size and existence of economic and industrial obstacles and impediments that SMEs of Petroleum and Gas equipment industry are confronting (Society of Iranian Petroleum Industry Equipment Manufacturers, www.sipiem.com), it is not a simple action for these firms to obtain economies of size and scope. Moreover, based on the study of Hossain, (2013) in which addresses that SMEs encounter much complicated impediments for innovation practices and commercialization of their technology and products. Thus, it can be inferred that SMEs in this research generally are not able to acquire all necessary and required external knowledge and innovative sources for new product innovation and new product development projects all together due to firm size. Firm size lead the firm condition to limited and scarcity of organizational resources and complicated economic and industrial impediments for SMEs in this industry. These barriers for further new product innovation and new product development make SMEs to become weaker in terms of acquiring economies of scales and scope. SMEs should be able to collaborate in innovation practices in various forms comparing to large firms, and more deeply relying upon establishing network relationship with other open innovation partners outside the firms which the essence of their relationships are more partnering approach. It can be based on collaboration with other companies, other new manufacturers, research institutions, customers and suppliers (Kleinknecht &Reijnen 1992, Bullinger et al, 2004).

SMEs are more willing to establish networking partnerships with technology and innovative knowledge idea providers (Chesbrough and Crowther 2006, Vanhaverbeke and Cloodt 2006, Vrgovic, Petar, et al, 2012). In addition, generally, it should be noted that, although the reasons for utilizing external sources for developing and improving innovation performance and competitive advantage are extensively recognized, there are various conceptual framework related to the involvement of external innovation sources (Sofka and Grimpe, 2010). One method to look at different external innovation sources is by considering them as the number of sources or search breadth. According to the work of Laursen and Salter (2006), they point out that there is restriction of gaining advantage by involving external partners for innovation practices. There is negative effect of being too much openness for firms that might be due to the firms' allocating resources and cash flows when the number of external knowledge partners increasing (Laursen, 2011) or high level of cost because of the large number of external innovation sources (Leiponen and Helfat, 2010). In addition, SMEs are confronting some major difficulties and weaknesses namely as: insufficient internal capital and equity, inability of extending capital and investment, unreliability of investment practices in other sources (Gallois, 2012, Moeuf et al, 2016). Therefore, generally, according to the aforementioned essence and nature of SMEs which also suffer from resource limitation or traditional closed innovation model, and in particular SMEs of Petroleum and Gas equipment industry in which the firms are rather technological based, it can be driven that they require more technological partnerships and collaboration with their peer companies and counterparts. These counterparts can be such as new manufacturers, suppliers, customers, research and academic institutions and even competitors. It is noteworthy to state that there is no necessity of investing a huge amount of financial resources in external participation and inward licensing and these outside-in (Inbound) open innovation are based on mutual partnership and long lasting collaboration. Thus, in this research, SMEs concentrate more on external knowledge, technological and innovation sources by selecting those sources that are based more on mutual partnership and collaboration approach instead of financial based external knowledge sourcing. SMEs tend to utilize external open innovation sources and focus more on establishing networks of collaboration with other firms, academic research institutions, customer groups and suppliers. Because they confront more challenging and complicated procedures for product innovation and commercialization of their technology as some of them are even at the early age of their industrial activities. Therefore, they prefer to collaborate with sources that can foster and increase their internal organizational and innovation capabilities and capacities based on partnering approach which do not require investment strategies in external innovation sources in order to leverage the level of new product innovativeness.

SMEs require applying and implementing an integrated management system to support both outside-in (Inbound) and inside-out (Outbound) open innovation. In order to accomplish greater involvement in boundary spanning in innovation activities, openness of SMEs and inter organizational collaboration present new managerial challenges in SMEs (Brunswicker and Ehrenmann, 2013). Many firms encountered and experienced different challenges and difficulties to manage proactively the processes of open innovation activities (Lichtenthaler 2010, Brunswicker and Ehrenmann, 2013). Settled and determined managerial approach and practices for innovation activities are prior important factors of firms' absorptive capacity that can facilitate open innovation. Both formal and informal managerial practices are substantial to obtain and capture value created from openness in SMEs. Practicing and investing into potential innovation strategic planning, innovation developing processes, innovation control, and culture of innovation practices indicate initial organizational requirements of firm's and managerial ability to successfully search, explore, transform and utilize external innovation and knowledge sources (Brunswicker and Ehrenmann, 2013). The changing approach from closed innovation to open innovation needs both large and small firms to perform and implement new managerial practices and structures according to the conditions of how to do and utilize open innovation sources (Huizingh 2011). Antecedent studies on firms that benefited and took advantage from a closed towards open innovation depict that firms implement and perform new managerial capabilities and practices for open innovation at various managerial levels (Chiaroni 2011). Managing open innovation in SMEs requires designing an integrated fundamental managerial system in order to support both inbound and outbound open innovation practices (Brunswicker and Ehrenmann, 2013).

In this regard, SMEs in this research in Petroleum and Gas equipment industry are confronting lack of integrated management systems to support and assist all outside-in (Inbound) open innovation activities inside SMEs. There seem lack of integrated system of management exist at different level to manage the flow of external knowledge and open innovation process across firms. There has been less concern to the necessity of exploitation of all outside-in (Inbound) open innovation in management team levels in SMEs of Petroleum and Gas equipment industry. The logic that why all outside-in (Inbound) open innovation sources have not been considered as equal valuable and substantial external knowledge sources for SMEs implies to this fact that SMEs managerial levels and management teams in SMEs of this industry have been experiencing challenges and difficulties to actively and effectively manage the processes of different types of outside-in (Inbound) open innovation practices in their firms. It can be driven that all managerial levels in SMEs have not believed boundary spanning of innovation activities by their firms in particular to transform from closed to open innovation business model equally and have not emphasized the usefulness of all types of outside-in (Inbound) open innovation as external knowledge and technology sources. It is inferred that there are not existence of any systematic understanding and comprehension of proper management processes for utilizing all outside-in (Inbound) open innovation sources between all managerial levels of SMEs. Both formal and informal managerial practices of SMEs in this industry at different organizational levels have not fully supported the notion of all outside-in (Inbound) open innovation practices in their firms at the same value. Results of this research show that some of them have addressing much intensely on partnering approach and collaboration with external knowledge and technology sources based on partnership rather than financial based external knowledge and technology sourcing strategies such as external participation and inward licensing. The insufficient integrated management system in SMEs of Petroleum and Gas equipment industry causes managerial challenges for inter-organizational cooperation that makes the managing process of open innovation practices more difficult and strict for these firms. There were not any considerable common understanding and comprehension of open innovation notion among different managerial levels and there were lack of integrated practices from managers of different SMEs in innovation strategic planning, new product innovativeness control, and culture of open innovation in these firms. This implies to this concept that open innovation varies from different management level perspectives and this is the reason of why all outside-in (Inbound) open innovation sources are not in equal value for SMEs. That resulted into all outside-in (Inbound) open innovation sources have not been equally valuable and important for SMEs in Petroleum and Gas equipment industry. It can be derived that SMEs in Petroleum and Gas equipment industry are not well organized to practice new managerial capabilities for utilizing all kinds of outside-in (Inbound) open innovation practices at different management levels. There are large gaps between different managerial levels of SMEs in this industry in terms of their insights, comprehensions and views about utilizing all types of external open innovation sources and their beliefs about the effects of all external knowledge and open innovation sources on new product innovativeness. Furthermore, high level of emphasizing on openness of firms may cause in greater and higher costs (Hossain & Kauranen, 2016). Insistence on being too openness by firms may lead to higher unnecessary and inessential costs, whereas lack of insisting and emphasizing might result in missing opportunities. In this research, the reason and rational logic behind this fact that SMEs in Petroleum and Gas equipment industry have not responded positively to all outside-in (Inbound) open innovation practices, and all of these external innovation partners and sources were not equally important for SMEs is due to the difficulty of allocation all required internal capacities, organizational capabilities and resources to exploit all external knowledge, innovation and technology sources. Thus, being too open toward external knowledge, innovation and technology sources would lead to increasing firms' costs.

The economic condition has not been stable for Iranian SMEs in Petroleum and Gas equipment industry according to the existence of environmental turbulence such as sanctions, embargoes, instability of rules, regulations and public policy that affect industrial manufacturer activities by lessening and reducing their production strengths and capabilities (Society of Iranian Petroleum Industry Equipment Manufacturers, www.sipiem.com). As a result, less serious attention is being paid to open innovation practices to utilize all types of outside-in (Inbound) open innovation sources by SMEs to increase new product innovativeness specifically those outside-in (Inbound) sources which is based on technology transfer such as buying patents, IPs through licensing or investing in other firms by acquisition or corporate venture capital investment. The issue of using all outside-in (Inbound) open innovation has emerged as less prominent external knowledge sources and factors that need to be exploited by Iranian SMEs.

Transforming SMEs activities from closed to open innovation approach are a demanding, substantial and challenging issue. According to Lichtenthaler (2008) study, most SMEs are still following and performing closed innovation instead of using open innovation practices inside their firms (Hossain & Kauranen, 2016). In addition, because of resource scarcity, SMEs are not able to exploit and apply all structured innovation models (Albors-Garrigós et al, 2011, Hossain & Kaurannen, 2016). As a result, SMEs still prefer do not use too much external knowledge, innovation and technological sources and pursuing closed innovation approach or prioritize outside-in (Inbound) open innovation sources based on their limited internal capabilities and power of manufacturing. According to the study of Van de Vrande et al, (2009), Harryson, (2008), Brunswicker and Vanhaverbeke, (2011), outside-in (Inbound) open innovation search strategies that are non-monetary and not based on financial sources in essence may be highly attractive and interesting to SMEs in order to improve their own innovation performance. In this vein, results of this research show that external participation and inward licensing as outside-in (Inbound) open innovation sources are not commonly used as widespread sources among SMEs in general and specifically in Petroleum and Gas equipment industry. It is inferred that these two methods of external knowledge sourcing are based on financial resources and need cash flows and huge investment in these two outside-in (Inbound) open innovation sources. SMEs have limited cash flows and resources, in many cases of new product development; they are not able and capable enough to afford building and making progress of product development projects (Woy & Qing 2007, Woy & Wang 2007, Vrgovic et al 2012). Therefore, it is derived that SMEs in general and SMEs in Petroleum and Gas equipment industry in particular do not possess adequate and large amount of organizational capabilities and financial resources to practice by directly investing corporate funds as external participation practice into external startup companies. Lack of capacity and adequate financial sources to invest in other firms make SMEs more depending on their own internal financial resources to innovate and prefer to collaborate with other external sources in partnering forms. Moreover, it is important to note that inward licensing requires SMEs to possess sufficient, massive and enormous internal financial resources and other organizational capabilities, capacities and resources to buy patents, IP, copyrights and trademarks from other companies. SMEs in Petroleum and Gas equipment industry are not in a stance and position to successfully participate in inward licensing or patenting IPs agreements as they confront to lack of enough internal sources in particular financial sources to invest on this type of outside-in (Inbound) open innovation source.

Accordingly, SMEs instead of spending cash flow and budget in external open innovation resources and buying other firms by acquisition or investing in other firm's equities, or investing and buying IPs, patents, technology and products' license, would prefer and are more willing to participate in partnering approach and collaboration with external knowledge and technological sources. The reason of why external participation and inward licensing as two sources of external knowledge, technology sourcing and open innovation practices are not considered as important external open innovation sources for SMEs is the scarcity of financial sources and monetary bases in these firms. It is noteworthy to note that SMEs, which are not using external participation or inward licensing strategies of outside-in (Inbound) open innovation are not willing to spend much financial resources as they are suffering from insufficient cash flows and financial resources inside their firms to invest in external innovation sources. In the lieu, they would much prefer to invest in internal and in-house R&D activities to increase their internal R&D strengths and capabilities in order to increase their absorptive capacity.

According to Faems, Van Looy, and Debackere, (2005), Tether and Tajar, (2008), and Cheng & Huizingh, (2014), it is inferred that inbound open innovation is practice of obtaining and investigating knowledge from external partners. These partners are suppliers, customers, competitors, consultants, research institutions, universities, or even governments. Likewise, Mazzola et al (2012) mention previous studies proposed that firms could get advantage and leveraging innovation performance by collaborating with different external partners like customers, suppliers, competitors, and research institutions by mutual partnerships. Therefore, SMEs are more willing to use external knowledge and open innovation sources, which are more based on partnerships and collaboration with external sources such as customers, suppliers, competitors, universities, research institutions, or consultants, which these kinds of relationships are non-monetary or non-financial collaborations. The reason of this willingness and tendency toward this type of relationship is lack of sufficient firms' internal sources and organizational capabilities, specifically financial resources are the main barriers for SMEs.

Hence, the reasons of why customer involvement, industrial network partnership, R.D and academic outsourcing are considered as substantial and important external knowledge, innovation and technology sources for SMEs is that these kinds of outside-in (Inbound) open innovation sources are partnering and collaborative based sources for SMEs in general and SMEs in Petroleum and Gas equipment industry in particular. The reason of why SMEs of Petroleum and Gas equipment industry in this research have not equally utilizing and exploiting all outside-in (Inbound) open innovation sources is that as empirical results of this research and results of hypotheses indicate, SMEs in Petroleum and Gas equipment industry have not been tending to expand their external search breadth strategy in open innovation practices and technology sourcing from external environment due to lack of internal sources and organizational capabilities. Breadth search practices and strategies to use external resources measures the level of being openness according to the number of different external knowledge, innovation and technology parties that are engaged in the innovation processes of firms. According to different studies, there are various partners such as customers, suppliers, research institutions and universities, (Laursen and Salter 2006, Bahemia & Squire 2010). Results show that the degree and level of openness in SMEs to different external knowledge, innovation and technology sources as external search breadth was weak and it was limited to three types of external knowledge and innovation sources. Firms have not positively responded to all types of outside-in (Inbound) open innovation sources, because the external search breadth strategy was not powerful enough in such firms because of weakness of internal organizational capabilities and lack of sources.

Another reason of why SMEs in Petroleum and Gas equipment industry have not applied and used all types of outside-in (Inbound) open innovation sources, and why all of these external sources have not been important for them is linked to the mode of closed or open innovation type of their business models and its relationship with particular type of business model of such firms. Chesbrough (2003) argue that the exact and special level, degree and mode of open or closed innovation practices for firms is dependent and contingent on the specific business models applied and selected by firms particularly in technological and industrial area. The important factor of creating a business model is to determine the two objectives of the value chain. First, it should establish and build value across the chain and second, permit the firm to show and acknowledge that the firm possesses adequate component and segment of the value to maintain its position in the system (Chesbrough, 2003, pp. 66–67). It presents two significant concepts for the meaning of Open Innovation. First, there will often be a degree and level of "closedness" in innovating firms that are depending and relying on how big and how extensive a segment and portion of the general and overall value they try to endeavor to exploit appropriately. Second, particularly in industrial area and contexts, there is not any requirement and need to apply a constant and fixed linear change and movement from closed to open methods of innovation (Christensen et al, 2005). In this vein, SMEs in general and SMEs in Petroleum and Gas equipment industry in particular are differing according to their business model openness and "closedness". We can observe that in manufacturing SMEs of Petroleum and Gas equipment industry that are locating and operating in an industrial and technological context have determined their open or closed innovation according to their business model types. However, important factor of creating business model in SMEs of Petroleum and Gas equipment industry is based on the objectives of the value chain. SMEs in this industry have not successfully fulfilled the first rule that they should establish and create value throughout the chain. Second, they have not indicated and approved that such firms have sufficient portion and component of the required value to sustain their position in the system. Thus, first, it is inferred that there is still level of "closedness" in SMEs as innovating firms that depends on how large and how extensively a portion of overall value they endeavor to exploit in an appropriate manner. Second, it is derived that in Petroleum and Gas equipment industrial and technological context, there have not been any direct, consistent and prompt change and movement from closed innovation to open innovation based on the type of business models of these firms. It can be inferred from these reasons that why all outside-in (Inbound) open innovation sources were not prominent and substantial external sources for SMEs in Petroleum and Gas equipment industry.

SMEs in Petroleum and Gas equipment industry are confronting an extensive and high production costs in their manufacturing process, because of instable economic and business environment, which can be considered as environmental turbulence for such SMEs, (Society of Iranian Petroleum Industry Equipment Manufacturers, www.sipiem.com). Furthermore, SMEs are lacking resources, capacities and organizational capabilities in manufacturing, distribution, marketing, and developed R&D funding, which are substantial for making and transforming inventions, knowledge and innovative ideas into products or processes (Lee et al. 2010). Therefore, the high and great level of manufacturing costs hinders them to invest in all types of external knowledge, open innovation and technology sources. In addition, processes and production factors are not powerful enough due to lack of efficiency, effectiveness and productivity in Iranian SMEs of Petroleum and Gas equipment industry because of high manufacturing cost which arisen from lack of organizational capability and financial sources. It is inferred that SMEs do not benefit from every kind of external knowledge and technology sourcing and outside-in (Inbound) open innovation practices because of instable economic and business environment, firms' size, lack of adequate organizational capability and capacity that resulted into higher production costs rather than other firms.

There are some special reasons of why SMEs in Petroleum and Gas equipment industry in this research have not used external participation and inward licensing as outside-in (Inbound) open innovation sources. These special reasons are addressing on external participation and inward licensing respectively as following: *First,* firms have become progressively aware and conscious about some strategic sources such as corporate venture capital (VC) investment activity (Dushnitsky and Lenox, 2005a,b) to increase the level of innovation performance. In this regard, external corporate venturing is approximately can be considered as explorative method and the commercial value of the technologies gained by this method is extremely uncertain. There is a great and prominent level of industry and external uncertainty, which is out of firm's control.

External uncertainty is the outcome of the future potential ambiguity and competences of a new and novel technology. *Second*, in inter-organizational relationships, there exists uncertainty among partners, which is called internal uncertainty. *Third*, new business and innovation development is a dynamic, lively and potent process with different stages. To become aware of this process is a fundamental requirement to clarify why and how innovating firms invest in internal uncertainty reduction and how they choose for special managing modes on each step (Chesbrough and Rosenbloom, 2002; Afuah, 2004). Internal uncertainty is becoming as the form of relationship-special uncertainty in case that firms are sourcing technologies from external environment for the development of new businesses. This type of uncertainty is not in a usual and common way among the partner, such as the technological distance and differences between the investing firm and the collaborative target firm. Technological distance and differences (Nooteboom, 2004) implies to lack of adaptation between the knowledge basis of the investing firm and the knowledge that is obtained and achieved from external source. When the technological adaptation is small or not existed, and the absorptive capacity of the investing company is low, it can be observed that there is a high level of technological distance and difference.

Consequently, when firms are investing in technologies that are very far from their technological capabilities, firm's internal technological distance and difference could be very high. Then firms will require enormously increasing and maximizing flexibility in order to be able to exit from the venture when it seems that there are not any business and partnership opportunities. It was shown empirically that when the knowledge bases of the firms involved in venture capital investment practices are not adaptable and are not similar to each firm's technological competences, firms prefer less integrated managing and investing strategies in those targeted firms (Folta, 1998).

Furthermore, there is another type of uncertainty in technology sourcing decisions in new business development projects, which is called as industrial uncertainty or external uncertainty. Industrial uncertainty is more relevant to the stages of developing the new technology. Utterback (1994) has called four stages in the technology life cycle: *fluid*, *transitional*, *mature* and *discontinuous*. Most appealing opportunities and stages for new business development are happening in the earliest stages of the technology life cycle.

Nevertheless, a high level of product and market uncertainty, high rate of product innovation and a high level of process flexibility (Roberts and Liu, 2001) determine the initial and early stages of the product life cycle. Hoskisson and Busenitz (2002) find that when market uncertainty is high, companies would be better to move forward to joint ventures instead of acquisition of other firms. Likewise, Steensma and Corley (2000) indicate a positive relationship between dynamism of technology and useless condition of coupled agreements such as licensing (Van de Vrande et al, 2006). In this regard, SMEs in general and SMEs in Petroleum and Gas equipment industry in particular might not intend to invest in external participation as the outside-in (Inbound) open innovation source which implies to corporate venture capital (VC) investment strategy in another firms, because there is high risk of gaining uncertain commercial and business values of technologies.

This arises due to industrial and external uncertainty that makes this situation to become out of control of these firms. External uncertainty and ambiguity resulted from unknown future potentials and strengths of new incoming technology and knowledge which is in the process and stages of developing; as this is uncertain and obscure for SMEs, it can hinder these firms to invest in new technological area through external participation such as corporate venture capital investment. SMEs are not willing to leverage their new product innovativeness by acquisition or corporate venture capital investment due to high product and market uncertainty and ambiguity at the early phases of new product life cycle, as at this stage there is a high rate of product innovation. Moreover, in inter-firms collaboration and partnership, internal uncertainty is another impediment for SMEs to invest in other firms through acquisition or corporate venture capital investment. Internal uncertainty and ambiguity is occurred when firms are sourcing the required technology externally to develop new business or for leveraging new product innovativeness and new product development projects. Internal uncertainty is not similar and at the same level for each partners, because the level of technology as technological distance is different between SMEs as investing firms and targeted partner firms. There might be technological gaps between investor and collaborative partner firm. These gaps resulted from lack of knowledge and technological basis adaptability between investing firm and the knowledge and technology that is acquired from external sources. SMEs as investing firms will confront problems when they see small scale or lack of knowledge and technological adaptation and if they have low level and degree of absorptive capacity, which both will result into large technology distance and differences. As a result, when SMEs investing in technologies that are distant and far from their technological capabilities, firm's internal technological distance and difference can be very great and in a high degree. Therefore, SMEs need to increase their flexibilities to exit from the venture when they realize and recognize lack of profitability and advantage from the venturing practices. Therefore, external participation, which is considered as corporate venturing investment or corporate venture capital strategy can be very rarely applied in SMEs of Petroleum and Gas equipment industry according to the mentioned results.

The importance of technology licensing strategy of the firm should be considered as the buy in the literature of make or buy technology decision. Practicing for technology purchase might be done for various reasons involving insufficient internal (In-House) organizational resources or gaps in R&D capability and ability of providing knowledge resources for innovation activities which arises from small scale, risk, and low investment in research or diversifications which shows weakness and low existing research competencies. There might be lack of enough information in technology markets. The information deficiencies and existence of transaction costs cause the tasks of finding technology suppliers for transferring the technology inside firms, and absorbing it very challenging in order to successfully commercialize new products and process, which hinder firms to utilize licensing agreements for technology acquisition (Lowe & Taylor 1998).

Successful technology licensing depends on a number of firm, technologies, geographic, and legal factors. The sale and transferring of technology, forces a transfer of dedicated and appropriate rights, but the cost of these rights normally indicate only part of overall technology transfer costs. It was shown by Lowe and Crawford (1984) that 29% of the licensing agreements analyzed in their study covered and showed training activities and technical assistance. These kinds of costs of transferring might result into reducing of licensing activity. When knowledge is transferred, there are important costs to completing the transaction. These include costs related to searching, finding and negotiating with a licensor as well as the costs of acquisition and utilization of the transferred technology (Lowe & Taylor 1998). Moreover, in accordance with Society of Iranian Petroleum Industry Equipment Manufacturers, (www.sipiem.com), some products and equipment do not have sufficient capacity and organizational capability to be manufactured inside Iranian context, and this is not rational to be produced by Iranian SMEs. In addition, due to impediments and barriers existing, accomplishing to economies of size and scope would be a hard and strict action for SMEs (The same reference). Consequently, they may not be able to transfer and make their technologies into product lines in order to design and manufacture new innovative products (Teece, 1980, 1982, Ahn et al, 2015).

Accordingly, technology licensing by SMEs in general and in Petroleum and Gas equipment industry in particular, is the decision of technology buy for new product development projects or make new innovative products by in-house R&D capabilities. It all depends to the sufficient capacity and organizational capability of firms. For instance, there might be inadequate information about technological knowledge in the market or high transaction costs for finding technology licensor, transferring technology and knowledge to the firm and utilizing it for commercializing new innovative products.

Technology transferring almost burdens some specific rights for licensing agreements, which these rights such as technical and supportive assistance can generate high costs as a proportion of overall costs for SMEs. Therefore, these rising costs of transferring can reduce licensing activities of SMEs. Moreover, low capacity and weak organizational capability of manufacturing for some Petroleum and Gas equipment products not only do not allow SMEs in this industry to produce these products but also do not allow them to transfer technological licensing due to high transaction costs and technological transferring costs.

It should be noted that enterprises in this industry do not prefer to invest in those open innovation and external knowledge and technology sources, which are based on financial resources and transaction cost. Also because, these sources do not propose and offer any value added benefit or advantage for new product innovativeness and new product development projects of these firms. It is driven that SMEs exclude some new product innovation and new product development phases from the manufacturing process and product development projects and ignore to utilize some external open innovation sources such as licensing that contribute to produce such products. In this regard, they are overlooking leveraging the level of new product innovativeness.

New small firms often do not have enough resources or experiences to manage and organize a great and extensive set of R&D projects. New ventures and small firms are not only having problems of resource constraints but also they have some problems with their founders' motivation to utilize and exploit their inventive ideas and discoveries (Bhide, 2000). These motivations are probably different from one industry to another. The knowledge based view addresses the types of knowledge required and their strategic prominence and importance vary between various industries (Leonard-Barton, 1995).

Technological dynamism is a factor that can affect inward licensing decision making in small firms. It was shown by Clegg (1990) that a firm's intention for inward licensing is positively related to its industry's technological dynamism. Dynamism implies to an industry's fast technological change, increasing R&D investments, surged and increased patenting, and the production of new products. In those industries with the characteristics of technological dynamism, knowledge progresses in an ascending way, but can also rapidly becomes obsolete in more stable environment (Zahra and Bogner, 2000). Moreover, industrial dynamism creates new challenging problems for new ventures and small business to increase their knowledge bases repeatedly, by using either internal or external knowledge and innovation sources. However, new ventures and small businesses mostly investing on existing opportunities available by current quick technological alterations (Bhide, 2000), their products often rapidly become obsolescent. New ventures and small businesses that have not been succeeded to own the essential skills to adapt them to these changes are suffering to fail in new product development. The knowledge-based view proposed that these rapid changing situations for small firms require strong R&D capabilities and external sourcing like inward licensing as well in order to reduce their product development process. It was explained by Mowery et al. (1996)

that inward licensing is an extensive and broadly used in those industries that are facing rapid technological alterations (Zahra et al, 2005). Therefore, as results of this research indicate, technological turbulence as a control variable has not significantly affect new product advantage as new product success of new innovated products which exploited external knowledge and open innovation sources. Technology turbulence did not make changes on new product aspect and did not have any impact on new product aspect of SMEs in Petroleum and Gas equipment industry. As a result, in Petroleum and Gas equipment industry, there is not a high technological change as technology turbulence.

SMEs in this industry do not experience and suffer from technological dynamism with high rate of technological changes in Petroleum and Gas equipment industry. Therefore, due to this reason, SMEs in this research did not have any tendency to exploit and utilize inward licensing. Moreover, it is noteworthy to mention that firms' tendency and willingness to use inward licensing is depending on industry innovation regime. Industries are growing and evolving because of innovation (Porter, 1980, 1985). These innovations could be incremental or disruptive (Christensen, 1997). Incremental innovation creates, boost, and develop the industry's current technologies and thus are known as ‘creative accumulation’ (Malerba and Orsenigo, 1997). Consecutive innovations make and create knowledge that increases industry's existing current knowledge. Thus, firms would be able to simply predict the future path and rout of particular technology. These innovations and the ability to predict and forecast alterations in them contribute firms to grow with the technology through either internal R&D practices or external sources. This kind of innovation is usual and common in industries that built and operating on mechanical engineering, that are known as M-type industries (Kotabe et al., 1996). Although, incremental innovations can increase the need of using inward licensing by firms to boost new ventures' and small firms' product success, decrease costs, maintain strategic flexibility, and develop product variety. Inward licensing is anticipated to be higher and more needed when innovations are disruptive in nature according to the essence of industry (Zahra et al, 2005). Accordingly, it is derived that as SMEs in this research as manufacturers of Petroleum and Gas equipment industry are operating in a Mechanical Engineering industry (M-Type), which means that the innovation regime of this industry is incremental due to its nature. Although incremental innovation requires using inward licensing to develop new products, reduce manufacturing costs and sustain organizational flexibilities, inward licensing is not a proper open innovation strategy for firms in this industry to be exploited as external knowledge source due to existence of incremental innovation. It therefore shows the reason that why SMEs in this research have not intended to use inward licensing, because SMEs in this industry using and implementing incremental innovation. There are some other factors that firms may suffer and getting disadvantage when they are using inward technological licensing from other firms at their new product development process. They are calling inadequate information transfer to licensee firms (Atuahene-Gima, 1993), limited and constrained available technologies on the market, high transaction costs because of weak and lack of proper regimes and insufficient developed technology in the markets (Contractor, 1981; Teece,1977), and the risk of changing internal developed technologies with new one (Cassiman and Veugelers, 2006, Wang and Li-Ying 2014).

When a firm licensing in technology, the transfer of tacit knowledge such as information and knowledge about procedures, and practices, rules of thumb, trade secrecy, standards, testing methods, and quality control are important issues for licensee firm to completely apply and use licensed technology in new product development projects. However, the transfer of tacit knowledge is not constantly and continually effective due to two impediments (Wang and Zhou,2013). First, tacit knowledge is built on cumulative experience and knowledge of licensor about the process as it operates and functioning under some special conditions. Tacit knowledge is geographically limited according to the requirement of closeness and vicinity for the transfer of this tacit knowledge (Jaffe and Trajtenberg, 1993). Second, technology licensing continuously and persistently suffers from double moral and ethical problems between licensor and licensee firms (Arrow, 1962). For instance, a licensor firm may not send its best and most professional engineers to licensee firms to support and offer adequate and enough technical services or some critical and prominent trade secrets may not be shown, offered and provided to licensee firms. On the other hand, licensee firm is normally unconcern and unwilling to show and announce new improvement or development of licensed technologies to the licensor due to the existence of potential opportunities of getting advantage and gaining profits in the future. Hence, the successful and productive transfer of important knowledge and technology from a licensor to a licensee is not always being supported and guaranteed. In these cases, the possibility of access to local complementary knowledge and technological resources is an important issue for licensee firms to reimburse and take advantage of inadequate knowledge and technology transfer from licensor firms. Knowledge and technological information flows much easier between firms located around the same place and geographical areas than those located in distant places due to the social bonds that can assist and simplify mutual trust and better face to face interactions and contracts (Breschi and Lissoni, 2001, Wang and Li-Ying 2014).

In this regard, SMEs in general and in Petroleum and Gas equipment industry in particular in this research may find so many barriers and uncertainties to use inward technological licensing. These barriers can cause SMEs as licensee firms to face with lack of adequate transferable technological knowledge and information, lack of advanced existing technology in the market when there might be improper innovation ecosystem and high transaction costs when there is lack of sufficient advanced technology in the market. In addition, SMEs in general and SMEs in Petroleum and Gas equipment industry in particular as licensee firms anticipate to properly use and access to all knowledge and information gained from licensor firms. These knowledge and information are standards, rules of thumb, procedures and relevant practices, and firms expect to receive assistance in testing methods and quality control from licensor firms in new product innovation and new product development processes. If it is not being met, SMEs may not have tendency to use technological licensing. In addition, there might be some impediments for SMEs in general and SMEs in Petroleum and Gas equipment industry in particular when transferring tacit knowledge as inward technological licensing. For instance, Transferring tacit knowledge might be difficult because of geographical distance between licensor and licensee, which makes it difficult to have a mutual trust because of far and remote places between those firms, one as a licensor, and one as a licensee. Moreover, SMEs my not be willing to use inward technological licensing because licensors might not support licensee SMEs to provide them technical services such as giving best engineering consultancy. On the other hand, SMEs also as licensee may not reveal improvements and development of licensed technology when they believe that there will be benefits from these developed licensed technologies in the future. Thus, licensor firms on the other side might not trust to SMEs according to this challenge, which can arise by SMEs. It is a rough and hard decision to say that all inward technological licensing can be successfully guaranteed. SMEs as licensee need to access to local complementary knowledge and technological resources in order to better benefit and take advantage of external knowledge and technological capabilities from the proximity aspect of licensing. Technology and knowledge transfer can be easily flowing and moving between firms in a close and nearby places than those firms that are located in distant places. Accordingly, it can be inferred that SMEs in general and SMEs in Petroleum and Gas equipment industry in particular as licensee firms and other firms as technology licensors have difficulty to transfer knowledge and technology, which are not locating in a proximate geographical places. They are not willing to participate in inward technological licensing due to lack of trust and far reaching resources.

In some developing countries, there might be lack of outstanding and prominent inventors whose intellectual property to be engaged and regarded in the government improvement and development programs and supporting policies (Hossain, & Kauranen, 2016). The lack of legal enforcement and relevant public policies and strategies for law and admiring to legal contracts caused licensing practices, buying IPs and patents very difficult procedure for SMEs in developing countries. 'Inadequate regulation and legal infrastructure' has the fourth place on the list of barriers and impediments in the private equity sector in developing countries in Middle East and North Africa (Eid, 2006, Vrgovic et al, 2012). Developing countries own more difficulties and troubles to legislate and enact effective and applicable combination of laws and regulations to support collaboration practices and protect from the practices of both sides. Most developing and emerging economies encounter continuous alteration and changes in their regulatory infrastructure and have experience that directly affected by intervention of different levels and layers of government (Luo 2002). It is worthy to note that developing countries also lack and suffer from the scarcity of judicial efficiency when decide to solve the problems at the time that collaborating is going in an indirect and wrong pathway. Furthermore, amazingly, developing countries are enduring and experiencing unsatisfactory and unacceptable situations facing paradox which they either possess weak intellectual property rights regimes. In this case, weak intellectual property regime makes impediments and barriers to have innovative collaboration and partnership (Li & Kozhikode 2009). In some cases they have a very powerful and strong property right and patent protection rules and regulations, which cause scientific communities (such as inventor pools) to become defenseless and vulnerable to the limitations of collaboration and access to information (Forero-Pineda 2006, Vrgovic et al, 2012).

Accordingly, there are insufficient and lack of supporting rules, regulations and enforced public policy from inventors whose IPs or patents can be exploited and applied in relationships with SMEs of Petroleum and Gas equipment industry. Due to the lack of relevant public policies and weak intellectual property right regimes to protect law of legal contracts of IPs and patents make the inward licensing and IPs and patent purchasing very difficult for SMEs in general and SMEs in Petroleum and Gas equipment industry in particular. Lack of adequate regulations and legal framework to protect any IPs and patent agreements in inward licensing practice causes the process of accessing to these external knowledge and technology resources more complicated and provide more impediments for SMEs to exploit inward licensing as outside-in (Inbound) open innovation source. There are complicated enacted public policies, rules and regulations, instable and insecure policy that make the procedures for small businesses and small enterprises more complicated that could generate and create much more impediments for these firms to benefit and get advantage from IPs and licensing agreements. In this research, one of the reasons that buying patents, IPs in the form of inward licensing have not been used by SMEs in Petroleum and Gas equipment industry is because of repetitive and continual changes of laws and regulations by different levels of governmental sectors.

Second hypothesis is about the effect of R&D expenditures on new product innovativeness. Previous studies of Cohen and Levinthal, (1990). Rosenberg, (1994) and Ahn et al. (2015), show that internal R&D not only generates new knowledge but also can increase absorptive capacity of firms. Specific internal and in-house R&D strengths and expenditures, and external knowledge and innovation sources cause advancement innovation performance in enterprises. Firms should consider the combination of internal R&D practices and external knowledge sourcing as a critical issue that can affect the innovation performance. Leveraging innovation performance is crucially linked to internal capabilities and capacities such as R&D strengths, manufacturing and commercialization (Schewe 1994). According to Rosenberg (1990), firm's collaboration with other knowledge and innovation sources for increasing innovation values and leveraging its performance, push them to have great and extensive R&D capabilities as basic internal sources. Internal R&D intensity not only contributes firms to leverage innovative capabilities, but also to increase the firm's absorptive capacity (Cohen & Levinthal, 1989, Zahra & George, 2002, Todorova and Durisin, 2007).

Rosenberg, (1990), Cassiman, Perez-Castrillo and Veugelers, (2002), found that influential and successful external innovation sources could be obtained and exploited when firms investing sufficient expenditures in internal R&D practices. R&D intensity and strengths is not only used as a measurement of internal learning, but also as an essential of external learning because firms need to develop a specific level of internal knowledge in order to be able to apply and use external knowledge (Bierly and Chakrabarti, 1996, Cohen and Levinthal, 1990). R&D expenditures in some industries have been used as the expenses of shareholders, which are means of leveraging and increasing product innovation and diversification (Dial and Murphy, 1995, Hill and Snell, 1989). Absorptive capacity in firms permits them to utilize and exploit external knowledge and innovation sources as complementary factors to their internal capabilities in innovation and R&D practices. Absorptive capacity enables firms to gain more capability and capacity to increase the effectiveness of R&D activities. In the case of availability of absorptive capacity in any organization, external research practices for knowledge sources can be supportive and complementary function of internal research activities. It can create high level of synergy and increasing the best results in terms of innovation practices (Arora and Gambardella, 1990, Macpherson, 1997). The internal R&D can be regarded as an essential factor to develop firm's absorptive capacity, increasing the overall condition of knowledge based skills and expertise inside firm (Cohen and Levinthal, 1989, Lane et al, 2006).

By increasing internal R&D capability, not only the level of knowledge and innovation is increasing, but also absorptive capacity of SMEs can be leveraged. Internal R&D strengths and expenditures and external knowledge and innovation sources can simultaneously increase the innovation performance of firms. This implies that combination of internal R&D strengths and external knowledge and innovation sources can affect innovation performance in SMEs. Regarding this, leveraging product innovation in SMEs is directly linked to internal R&D strengths and capabilities. SMEs external knowledge sourcing and technological collaboration for increasing innovation performance and adding new product innovativeness values for firms require that such firms have high level of R&D capability. Internal R&D capability can help SMEs to leverage innovation performance and increase absorptive capacity. R&D intensity can increase the product innovation and diversification of SMEs. Absorptive capacity permits firms to use external knowledge and technology sources as supplementary sources to their internal capabilities in innovation and technology development practices. Absorptive capacity can enhance firm's capacity and capability to leverage R&D and innovation performance in SMEs.

Third hypothesis is about the effect of new product innovativeness on new product advantage. It should be noted that new product development mostly and normally try to increase and maximize the innovativeness of new product in order to attain customers' attentions and solve their problems and difficulties related to product consumptions. There are some effort and attempts to sustain customer loyalty. It is also believed that development and growth of product innovativeness will lead to increasing and boosting product sales and more profits. Millson (2013), show that product innovativeness is the level of product uniqueness and novelty known and recognized by customers processing substantial knowledge related to the development and improvement of new products similar to competitor's products.

Literature has shown and accepted that the relationship between product innovativeness and product financial performance has indicated a significant relationship. According to Kleinschmidt and Cooper, (1991), Song and Parry, (1996), it is rationally anticipated that there should be a positive relationship between newness, novelty and uniqueness of innovative products and a sustainable advantage against movement of competitors' product. It will lead to achieve and attain more opportunities for product differentiation and is likely to offer patentable products. In addition, according to resource based view (RBV), when firms have resources, which are valuable, rare, unique, and not possible to be substituted and changed, they can obtain sustainable competitive advantage by performing novel values making strategies that cannot be simply repeated by competitor firms (Barney, 1991, Conner and Prahalad, 1996, Nelson, 1991, Peteraf, 1993, Eisenhardt & Martin, 2000). Furthermore, the knowledge based view of the firm (KBV) which is part of the resource based view (RBV) assumes that the firm's capability and capacity to use and exploit knowledge is the most critical and important source of a firm's sustainable competitive advantage (Grant, 1996, Kogut and Zander, 1992, Nonaka, 1991, Prahalad and Hamel, 1990). Nonaka (1991, P.96) argue that the most reliable and confident long lasting source of competitive advantage is knowledge (Zheng et al 2010).

New product innovativeness which was achieved and obtained by using and exploiting external knowledge and innovation sources as outside-in (Inbound) open innovation sources by SMEs accelerate achieving new product advantage as part of the product success in the market. By doing and obtaining this, SMEs in this research could attain customer's consent and solving their problems related to product utilization. These effort done by SMEs to increase the level of new product innovativeness through exploiting external innovation sources cause firms to retain and sustain customer loyalty.

This increased product innovativeness which met the customer demand and enhanced their loyalty was led to boosting and leveraging product sales and profits. The reason of achieving new product advantage is due to newness, novelty and uniqueness of new innovated products by SMEs in general and SMEs in Petroleum and Gas equipment industry in particular because these attributes can solve the problems of customer's consumptions comparing to competitor's products in the market. This achievement to new product advantage in the market is a product market success, which increases the financial performance of SMEs. By increasing new product innovativeness and achieving new product advantage, firms can implement product differentiation strategy inside their organizations to sell the patent and IPs of their new innovative products to other firms.

Additionally, according to RBV, new product innovativeness which acquired by exploiting external knowledge can be considered as unique, inimitable and valuable resource that cannot be imitated and duplicated by competitors in the market. New product innovativeness offers new values for products, which is very difficult for competitors to use and repeat. Therefore, SMEs are able to achieve competitive advantage in the market according to new product innovativeness. In addition, KBV represents that SMEs have the organizational ability and capability to use external knowledge sources to increase new product innovativeness, so that by using external knowledge that caused increasing level of new product innovativeness, firms can leverage new product advantage. Knowledge is considered as the most prominent source of SMEs to leverage and enhance new product advantage.

Fourth hypothesis is about the effect of organizational declarative memory on new product advantage. Camisón, Boronat, and Villar, (2010), argue that organizational memory like declarative memory accelerate accessing to organization's previous and prior knowledge, this knowledge includes information and knowledge about the competitive market, the present market condition and current customers or other market factors. This kind of knowledge is particularly difficult to be transferred or imitated by other firms and competitors. Thus, this knowledge is a valuable asset for firms (Ebbers and Wijnberg, 2009). Moorman and Miner's (1997), believe that organizational memory is a type of resource that firms can extend and develop it to improve and enhances financial performance. In B2B markets, if firms aim to learn and get more information about its customers, declarative memory offers knowledge and information about customers, firms strategic goals and objectives, market position of firms, marketing plans, strategies and competitive position. According to some studies, it is addressed that learning capacity that organizational memory is a part of that can take advantage comparing to other competitors as the only applied source of a firm's competitive advantage (De Geus, 1988, Dickson, 1992, Slater and Narver, 1995). It is derived that organizational learning and knowledge, and information processing capabilities that organizational memory is involved in it are the major key substantial sources of new product development success in the marketplace (Leonard-Barton, 1992, Lynn et al, 2000, Madhavan and Grover, 1998). Some studies show that there are positive effects of organizational memory on firm's new product performance. Organizational memory should enhance and boost new product performance of firms, because firm's long experience and knowledge can increases firm's effective performance (Cyert and March, 1963, Duncan andWeiss, 1979, Chang and Cho, 2008).

According to resources based theory, if firms possess resources that are strong, worthy, valuable, peculiar and have a kind of advantage that cannot be changed with any other resources, or that is not possible to be imitated by competitors, it means that the firm has a competitive advantage. Barney (1991) indicate that, according to resource based view, firm's competitiveness can be built and created due to unique, distinctive, and inimitable groups of tangible and intangible assets which are valuable, scarce, difficult to be imitated, and sustainable. Daft (1995) note that firm resources include all types of assets, capabilities, organizational processes, firm characteristics, information and knowledge that is possible to be controlled by firms. These resources as internal organizational capabilities can provide competitive advantage position for firm. According to the knowledge-based view of the firm, firm's capability and capacity to generate and utilize knowledge is the most important source of firm's competitive advantage (Grant, 1996, Kogut and Zander, 1992, Nonaka, 1991, Prahalad and Hamel, 1990). The most confidential long lasting source of competitive advantage is knowledge (Nonaka 1991, P.96, Zheng et al 2010). In addition, dynamic capability indicates firm's ability and capability to achieve new and innovative methods of competitive advantage (Leonard-Barton, 1992, Teece et al, 1997).

Organizational declarative memory as stored internal knowledge is important for firm's performance. Organizational memory such as declarative memory for SMEs in general and SMEs in Petroleum and Gas equipment industry in particular is firm's antecedent and prior knowledge and information which is stored and accumulated in these firms. Organizational declarative memory speed up and sharpen accessing to firm's previous and antecedent knowledge and information about market condition, market competitive position and customer's preferences. This kind of knowledge and information is difficult to be transferred or imitated by other competitors and this knowledge is a worthy and valuable asset for SMEs. As a result, this kind of firm's knowledge can create product competitive advantage position for SMEs. Organizational declarative memory enables firms to increase and leverage their new product performance, because long time experience and knowledge of SMEs can increase firm's performance. This knowledge and information stocked in organizations are about competitive markets, existing market condition, firm's market position, customers preferences, product development factors (designing, packaging, etc.), product features and other market factors. These kinds of knowledge and information are internal organizational capabilities and resources that SMEs should develop and increase in order to leverage financial performance. SMEs in industrial markets can benefit from learning by declarative memory, which can give firms information about customers, firm's strategic position and competitive position. The learning function which organizational declarative memory is part of learning process can be stored in firms to help increasing their performance. SMEs that have declarative memory as a component of learning capacity are able to benefit and take advantage of organizational declarative memory against competitors to use this source as a competitive advantage. Organizational learning, knowledge and information processing capability that organizational declarative memory is part of it in SMEs in general and SMEs in Petroleum and Gas equipment industry in particular, are the main source of new developed product success in the market. Organizational declarative memory in SMEs can increase performance of new innovated product in such firms due to long time stored knowledge and experience.

According to resource based view (RBV), SMEs, generally, and SMEs in Petroleum and Gas equipment industry in particular, that possess special, worthy and valuable resources or any strong internal resources that cannot be changed with any other resources or cannot imitated by competitors, show its competitive advantage in the market. In this regard, organizational declarative memory in SMEs of this research which are created according to valuable, scarce and inimitable and sustainable organizational knowledge are considered as internal organizational capabilities which can lead SMEs to achieve new product advantage in the market. In addition, knowledge based view note that firm's ability and capability of generating and using knowledge is the main reason and important source of competitive advantage for SME. Thus, according to KBV, organizational declarative memory as internal capability and stocked knowledge can help SMEs to increase their new product's competitive advantage position in the market.

### *3.6. The Theoretical Implications of the Study*

Referring to the role of inbound open innovation sources and relationships between these sources and new product innovativeness in SMEs, it is worthy to note that open innovation practices in SMEs is usually be managed to complement and complete inadequate resources of SMEs (Lee et al, 2010). By using open innovation activities, SMEs are being able to overcome lack of R&D and knowledge resources. SMEs can develop and improve their internal R&D capabilities by using open innovation sources to develop their product innovation practices. In addition, SMEs are more confronting lack of ability and capability to transform and change innovation activities into new products and processes (Lee et al, 2010). Regarding the notion of open innovation and partnership with external knowledge sources and innovative networks, in addition to work and cooperation with specialized experts and internal resources inside firms, SMEs require to collaborate with other specialized innovation and knowledge sources in external environment. None of the firms has comprehensive and broad knowledge, and innovative ideas, each organization regardless of how much are their internal R&D and knowledge resources, require to be involved deeply and extensively with external knowledge partners and innovation communities. There are general and frequent goals and objectives to facilitate and provide the acquisition and integration of innovation from external resources by sharing knowledge resources and innovation process with external partners of SMEs (West and Bogers, 2014, Tsinopoulos et al, 2018).

Innovation practices and skills (Innovativeness) are spread among several partners and external sources (Öberg, 2016). Access and using external knowledge and innovation sources through open innovation activities is broadly known as an important source of SMEs innovativeness (Duysters and Lokshin, 2011). External knowledge sources have become very prominent and substantial sources for firms, these external channels are becoming as valuable and significant sources (Chesbrough 2004). Open innovation search strategies determine how firms arranging and organizing their exploratory and search methods for external knowledge sources. For instance, R&D and knowledge sources such as universities, research labs or institutions, or suppliers seem to be extremely relevant knowledge and innovation sources (Huston and Sakkab, 2006, Brunswicker & Vanhaverbeke, 2011). Firms must be able to increase and boost their absorptive capacity, innovation performance, and market share if they attain external developed and leveraged technology and or utilize a large number of players and actors as network partnership such as customers, competitors, suppliers, and research institutions from external boundaries of firms (Chesbrough, H.W 2003a). The second notion related to open innovation is value creation through external R&D, and innovation network partnership.

External R&D and innovation network partnership enable firms to create and build important values for firms. In addition, internal R&D and knowledge sources are needed to be as complementary part of that value. Open innovation is critical and substantial for accessing new complementary, supportive knowledge in an efficient and effective method (Chesbrough, 2003, Asakawa et al, 2010). Moreover, open innovation development objective is to simplify the use of external knowledge and innovative sources as firms aim to progress and increase their technological and knowledge capabilities (Chesbrough, 2003b). Open innovation encompasses external ideas and knowledge sources relevant to internal R&D that makes and builds new methods and solutions to create value for firms.

Based on collaborative approach with external R&D sources, firms try to establish partnership and collaborate regarding R&D activities and take advantage not only from internal R&D capabilities, but also from external R&D and innovation network partnership. Firms can be successful if they create the most comprehensive and the best combination of internal and external knowledge and innovation sources and utilize them in order to offer their products to the market and industry. According to the approach of successful firms by both types of internal and external ideation and commercialization of innovative ideas, it can be concluded that open innovation activities facilitate the pathway and permits firms to investigate and search for external knowledge and innovation sources to use current existing internal resources by which firms can obtain competitive advantage in the marketplace (Drechsler and Natter, 2012). According to Laursen and Salter (2006, p. 146), “firms which are more open to external sources or search channels are more likely to have higher level of innovative performance. Firm's openness to external knowledge and innovation sources permits firms to use ideas and knowledge from outside to develop accessible technological opportunities (Parida et al 2012).

Firms can also have horizontal technology collaboration with other company partners from the same or other industries, such as competitors. SMEs can benefit from innovation development and expansion of commercializing opportunities with other small firms, because they can collaborate with each other to enter to new markets and improve their opportunities versus large firms as their rivals (Christensen, Olesen, and Kjær 2005, Lee et al, 2010, Parida et al, 2012). In addition, SMEs try to develop network relationships that have a positive effect on SMEs capability and ability to access several unique and various types of information and resources (Burt 2004). Firms can cooperate with other competitors, which usually based on form of inter-firm collaboration. It can cause a firm to develop and expand special features and characteristic of products that increase and enhance its efficiency and effectiveness through acquisition of complementary knowledge and technology (Wang et al, 2015). Innovation collaboration with competitors in horizontal collaboration can bring much positive effect on incremental perspective of innovation performance (Belderbos, Carree, and Lokshin 2004). Moreover, competitor firms meet similar technologies, customers, and markets. Collaboration with competitors permits firms to not only acquire and create new technological value but to use and access to other knowledge resources (Quintana-García and Benavides-Velasco, 2004, Gnyawali and Park, 2011, Wu, 2012, Wang et al, 2015). Cooperation among competitors in innovation practices may lead to development and expansion of integrative knowledge and technologies help to creation and formation of new markets, exploration of new business opportunities, and increased profits and advantages from utilizing innovation activities (Wang et al, 2015).

In addition to horizontal collaboration, there is vertical technology collaboration. This is a collaborative relationship with customers, which is a kind of vertical downstream collaboration or with suppliers, which is a kind of upstream collaboration. Vertical technology collaboration with current customers, potential customers, and end users can increase and leverage internal innovation process and performance (Chesbrough, Vanhaverbeke, and West 2006, Gassmann 2006, Henkel 2006, Von Hippel 2005). SMEs are mostly concerned about collaboration with large customers, because they possess strong and potent resources to transform knowledge, innovative ideas and inventions into innovative products of firms, which can be commercialized. Vertical technology collaboration can leverage and enhance the capability of a firm to create values, because firms can obtain more awareness of customer's requirements, priorities and expectations (Dyer and Singh 1998). Customer collaboration in innovation process can have a positive effect on ideation, product concept development, prototype testing and market launch that can result into innovation success (Gruner and Homburg 2000).

Using external knowledge and open innovation sources accelerate the progress of firms in boosting overall performance in particular it can provide them to access to rapid product development and innovativeness. It is practical for them to be succeeded in their product innovation or product development projects by achieving new knowledge sources and use them in their innovation processes and practices. Broad collaboration and communication of firms with other organizations can result to greater options to access to external knowledge sources, ideas, competences, technologies and other assets. It can increase the chance of innovation performance successfully. Collaboration with external sources of knowledge would enhance the interchange of tacit and explicit knowledge (Faems, Janssens, & van Looy, 2007. Mowery, Oxley, & Silverman, 1996), it may decrease lack of technological competence (Lichtenthaler, 2013) and some existent risks and expenditures of technological practices (Belderbos, Faems, Leten, & Van Looy, 2010).

Research collaboration, R&D, and academic partnership with universities and research institutions can decrease cost of innovation practices inside firms and can boost innovation performance. Additionally, R&D and academic outsourcing can improve and increase the internal capabilities of firms to remove innovation impediments and can reduce the risk of new product innovation. Research and academic collaboration can facilitate the utilization of economies of scale and scope in R&D, consequently, decreasing innovation costs and permit to share the risk of innovation and production (Roller et al. 1997).

Absorptive capacity in SMEs allows these firms to use knowledge sources and has a very important role in their capability to search, explore and exploit knowledge sources in the outside environment. Cohen and Levinthal (1990, p. 128) discuss that *'the ability to evaluate and utilize outside knowledge is largely a function of prior knowledge'*. Prior and previous knowledge that are existent, offers an ability or capability to recognize the value of new information and knowledge, assimilate it, and apply or exploit it to commercial outputs. Theses abilities and capabilities jointly establish what is called *absorptive capacity.* Absorptive capacity is an organizational capability and ability, which shows firm's openness to technological changes (Kedia and Bhagat 1988), and the ability of a firm to utilize effectively and efficiently external knowledge (Fabrizio 2009, Koza and Lewin 1998). Absorptive capacity inside the firm permits to use external knowledge and innovation sources as complementary sources for their internal activities regarding innovation practices inside firms. In addition, firms would be able to acquire more capability and ability to leverage innovation performance and increase the effectiveness of research and development. If firms have absorptive capacity, external research activities of knowledge sources can be a supportive and complementary action of internal research and innovation activities, obtaining high degree of synergies and increasing the best results based on innovation approach (Arora and Gambardella, 1990, Macpherson, 1997). Firm's R&D departments and innovation labs should absorb external knowledge resources and try to integrate and combine them with internal R&D knowledge and innovation practices. Firm's R&D labs are important tools for receiving external ideas and resources to integrate and combine external knowledge into internal innovation process (Chesbrough et al, 2006).

External R&D and knowledge sources are playing important role to obtain knowledge resources that might be used with current existing resources in a way, which is much greater and more preferable to competitors exploiting these external R&D resources (Barthelemy and Quelin, 2006, Desarbo, Benedetto, Song, and Sinha, 2005, Ebers and Maurer, 2014). Receiving and achieving external R&D and the method that new products have developed and innovated (Koufteros et al, 2005. Petersen, Handfield, and Ragatz, 2003, 2005), make an argument that resource based view increases an organization's ability to innovate (Ebers and Maurer, 2014). The resource based view (RBV) and other relevant theories such as knowledge based view (KBV), address that firms should make collaboration networks with external partners in order to access and get benefit from external networked technologies, skills, knowledge and expertise (Ahuja, 2000, Huggins and Thompson, 2015, Lavie, 2006, Meroño-Cerdan et al, 2008, Popa et al, 2016).

SMEs accept open innovation in order to respond properly to market turbulence, to respond to customer demands and develop new sales channels (Lee et al, 2010, Van de Vrande et al, 2009). In order to overcome insufficiency and inadequacy of R&D expertise, SMEs are trying to search and investigate a wide span of external knowledge and information sources (Lee et al, 2010). SMEs use firm's specialization by designing and formulating alliances to access to complementary assets (Ahern, 1993, Nooteboom, 1994, Teece et al, 1997, Van Dijk et al, 1997, Ahn et al, 2015). In addition, new product development (NPD) performance cannot be particularly determined by internal R&D activities, but also depending on the contribution of a broad range of external partners, from individual customers to large research institutions

(Bahemia & Squire 2010). Positive effects by value creation can be acquired through integration and combination of a wide range of external partners such as suppliers, customers, competitors, consultants, universities and research institutions in the innovation process (Faems et al, 2005, Love and Roper, 1999, Tether and Tajar, 2008, Bahemia & Squire 2010). Firms can extend the span of finding different external sources of knowledge and innovation by external search breadth strategy. External search breadth strategy measures the level of openness of firms according to the number of different external partner, which can be included in innovation process of firms. There are different external knowledge and innovation partners, such as suppliers, competitors, customers, university and research institutions (Laursen and Salter 2006, Bahemia & Squire 2010). In external search breadth strategy, there are various channels that firms are able to collect and use knowledge resources. It can cause firms to access to innovation and producing capabilities that the firms do not own (West & Bogers, 2014, Greco et al, 2016). There are various types of external partners included in innovation process of firms. Opening up the innovation process by firms to different external sources bring value creating effect to innovation performance of firms (Bahemia & Squire 2010). Incremental innovation aims to utilize the perception of customers or other sources to provide and offer better solutions which are attractive and absorbing, it would be a suitable way of providing profit and advantage from the existent products (Pavitt 1998, Xin, Yeung, and Cheng 2008). According to Faems, Van Looy, and Debackere (2005), it is perceivable that collaboration with partners in the value chain (Customers and Suppliers) provides a potent and strong basis for incremental developing of available products.

This research contributes to developing theory of open innovation in SMEs. This research particularly addresses the exploitation of outside-in (Inbound) open innovation sources and their effects on new product innovativeness, the effect of R&D expenditure as internal R&D intensity on new product innovativeness, the effect of new product innovativeness on new product advantage, and the effect of organizational declarative memory as internal organizational knowledge and information on new product advantage. This is measuring empirically the effects of independent variables on dependent variables. Even though previous studies measured the effect of open innovation (such as inbound open innovation, outbound open innovation and coupled open innovation) on innovation performance of firms, not any of them has measured different items of outside-in (Inbound) open innovation sources distinctively and separately as different constructs. According to study of van de Vrande et al (2009), inbound open innovation sources were defined as technology exploration notion, which consists five sources: (1) Customer Involvement, (2) External Networking, (3) External Participation, (4) Outsourcing R&D, (5) Inward IP Licensing. The main theoretical contribution of this research is measuring the effects of these different sources of inbound open innovation based on study of van de Vrande et al, (2009), such as customer involvement, industrial network partnership, external partnership, R&D and academic outsourcing and inward licensing as inbound open innovation sources on innovation performance, which have not been studied in previous literature of open innovation in SMEs.

The theoretical implication of this research is that the first 3 important sources of inbound open innovation are customer involvement, industrial network partnership, and R&D and academic outsourcing. These three types of external open innovation sources are more collaborative and partnership based that need more collaborative relationships and mutual partnering rather than investing in other partner's knowledge, innovation or technological sources. But the other two sources: external participation and inward licensing do require more financial resources and cash flows because firms must invest and buy other firms by acquisition strategy or buy IPs and patents of other firms in the form of technological licensing that in both cases SMEs need to invest a lot of financial resources. Thus, theoretically and according to these results, and scarcity of financial resources in SMEs, it is driven that SMEs do prefer to participate in activities to leverage partnership and collaboration in open innovation activities rather than investment in open innovation sources. Even if SMEs of this research had enough financial resources, they would not have invested in acquisition, or buying IPs and patents, because of so many barriers argued in discussion part and also due to high and expensive cost. Instead, they would prefer to collaborate with external knowledge sources in partnership format and also to invest in internal R&D activities to increase in-house R&D intensity and leveraging absorptive capacity of firm. By investing and strengthening internal R&D capability, firms are being able to leverage and exploit external knowledge and open innovation resources through enough internal sources. It is noteworthy to state that, open innovation activities in SMEs is a kind of strategy that manage by firms to complement lack of resources and scarcity of internal capabilities of SMEs.

Theoretically, according to the relationships between inbound open innovation sources and new product innovativeness in SMEs in this research, it implies to this notion that SMEs can overcome inadequacy and insufficiency of R&D, knowledge and innovation capabilities and resources by utilizing inbound open innovation sources. Internal R&D strengths and capability of SMEs can be developed and improved by using external open innovation sources in order to reinforce and develop product innovation practices in such firms. In addition, SMEs can learn better and improve their innovation practices and innovativeness skills among extensive and broad range of external partners and knowledge sources. Using external knowledge and innovation sources through open innovation projects and collaboration with different sources such as customers, suppliers, competitors, consultants, universities and research institutions is extensively perceived as prominent and valuable sources of innovativeness for SMEs. Increasing absorptive capacity, innovation performance, and market share of SMEs can be achieved if they attain external enhanced and progressed technology or if collaborate with a large number of players as network partnership. Network partnership and R&D collaboration can enable SMEs to establish and create substantial values for firms. In addition, internal R&D intensity and knowledge strengths should be regarded as supplementary section of value obtained from external resources. SMEs objectives for using external knowledge and innovation sources are to leverage firm's technological and knowledge capabilities. Likewise, SMEs participate in collaborative relationship with external R&D and knowledge resources, these firms make effort to collaborate regarding R&D practices and use not only internal R&D capabilities, but also participate in external innovation network partnership. SMEs can successfully develop new products and leverage the level of new product innovativeness by making the most general, comprehensive and the best composition of internal and external knowledge, R&D capability and innovation sources, and use them as innovative products to offer to the market. The results of this research indicates that if the degree of openness in SMEs is wider to external knowledge and innovation resources, they will have more and higher level of innovation performance. For instance, this level of openness can be acquired through horizontal technology collaboration with other firm partners such as competitors. SMEs are able to take advantage from innovation activities and new product development process and commercializing practices with other small firms. This mutual collaboration can provide the opportunity of entering to new markets and developing their opportunities against other large firm competitors. SMEs generally can expand network relationships that can positively affect their capability and ability to access to unique and special knowledge and information resources. The two-sided collaboration between firms with other SMEs as competitors is based on inter-firm collaboration, which can increase the effectiveness of new product innovativeness through obtaining complementary knowledge and technology. Innovation and knowledge-based relationships with competitors in horizontal collaboration can provide and offer much positive influence on incremental aspect of innovation performance. Firms by this kind of collaboration with competitors can achieve and generate technological value and use them to access to other knowledge resources. SMEs can create and achieve to new markets by innovation collaboration with competitors by which they can expand innovation practices lead them to develop integrative knowledge and technological capabilities. This collaboration can facilitate searching for new business opportunities, and increasing profits and advantages by innovation practices. In addition, SMEs can increase new product innovativeness through vertical technology collaboration. This kind of relationship based on collaboration with customers that are considered as vertical downstream collaboration, or with suppliers that are considered as upstream collaboration. SMEs vertical collaboration with current customers or end-users is leveraging internal innovation process and performance. Moreover, vertical collaboration can increase the capability of SMEs to create values; this is due to receiving customer's requirements, preferences and expectations. SMEs collaboration with external knowledge and open innovation sources can increase and facilitate the flow of tacit and explicit knowledge into firms. It can also decrease weakness of technological capability, risks and expenditure of technological practices.

Among other external knowledge and open innovation resources, research collaboration and R&D and academic partnership with universities and research institutions help SMEs to decrease cost of innovation practices and leverage new product innovativeness performance. R&D and academic outsourcing increase internal capabilities of firms to overcome innovation deficiencies and reduce risk of new product innovativeness. Research and academic collaboration make the possibility of exploitation of economies of scale and scope in R&D that can strengthen SMEs ability to share risk of product innovation.

The notion of absorptive capacity is important issue for firms because absorptive capacity allows SMEs to use external knowledge and sources, which act as complementary sources for these firm's internal capabilities and activities. Using external research activities and knowledge sources can support and complement internal R&D and innovation practices.

Moreover, according to resource based view (RBV) and knowledge based view (KBV), SMEs are encouraged to make collaboration networks with external partners and players outside firm's boundaries, in order to utilize outside technological capabilities, skills and knowledge resources in networked collaboration format.

Internal R&D practices depend on a broad range of external partners and sources contribution such as customers, suppliers, competitors, consultants, universities and research institutions. Collaboration with these forms of external resources can create values that are achievable through integration and combination of different external knowledge and innovation sources. Collaboration with different sources of knowledge and innovation depends on external search breadth strategy of SMEs that is the firm's level of openness to number of different external partners in innovation process. In external search breadth strategy, there exist different methods and channels that SMEs can use the knowledge and innovative ideas of these resources. Accordingly, it can increase firm's innovation and manufacturing capability that did not have before. Incremental innovation can be acquired by exploitation customer's insights or using other relevant sources to equip better innovation solution that is attractive to be achieved. That could contribute to provide profit and advantage for the current products. In this regard, partnership with value chain members such as customers and suppliers can create a powerful and capable basis for incremental innovation for current products of SMEs. But, following to the relationship between external participation and new product innovativeness which was considered as unimportant outside-in (Inbound) open innovation sources for SMEs of Petroleum and Gas equipment industry, it is substantial issue to be noted that external participation which leads firms to venture capital investment is a difficult task for SMEs of this industry due to internal and external uncertainties. Internal uncertainty is when there is a wide technological gap between investing firm and partner firms, which receive investment. Internal uncertainty between firms creates a technological distance between investor firm and partner firm. The technological gap arises due to lack of knowledge and technological basis adaptation and readiness inside investing firms and external knowledge and technology sources. This might result that SMEs may not be tending to invest in external participation and do venture capital investment in other small or startup firms. In addition, external uncertainty, which is a kind of industrial uncertainty, makes the situation out of control of firms. External or industrial uncertainty arises from unobvious and vague future of new technology or new knowledge. Thus, there is a high risk of receiving and obtaining uncertain business, technological and industrial values that might be risky and invaluable for investing firm. SMEs might not be able or willing to invest or make acquisition in other firms in order to leverage new product innovativeness as there are high product and market uncertainty at the first stage of new product life cycle. There is a high level of product innovation in the market at this stage that can be an uncertain and ambiguous condition for investing firms. In this regard, SMEs will need more ability, capability and flexibility to exit from this venture when they are confronting lack of profit and advantage from venturing practice. Also, following to the relationship between inward licensing and new product innovativeness which was considered as another unimportant outside-in (Inbound) open innovation sources for SMEs of Petroleum and Gas equipment industry, there are theoretical reasons that explain why this source of outside-in (Inbound) open innovation has not been regarded as an important source. The existence of high transaction cost makes finding of technology suppliers for transferring the technology too difficult. Additionally, if the absorptive capacity of firms were at low level, it would be very challenging for firms to commercialize successfully new innovative products. It can make the process of utilizing licensing agreement more difficult. After transferring knowledge and technology, there are additional important costs in order to complete the transaction. These costs related to searching, finding, and negotiating with licensor and costs of obtaining, acquisition and utilization of the transferred technology. Furthermore, inward technology licensing offers a contradictory benefit as a new challenge and problem between licensor and licensee firms. Licensor firms usually do not intend to have a comprehensive collaboration and do not offer all kinds of licensing services to the licensee firm. On the other hand, sometimes it may occur that licensee firm hides some new improvement or development of new licensed knowledge and technology to the licensor because of eventual opportunity of gaining profit and advantage in the future. Thus, these two inconsistent and conflicting points hinder both partners to collaborate in inward technological licensing.

Another problem of inward licensing for SMEs especially in developing countries is the lack of adequate legal laws, rules and regulations as public policies to support licensing agreements, buying IPs and patents in open innovation practices and strategies. Lack of legislating laws and protective policies to support technology licensing, protecting IPs and patents of inventors, experts or technology and product innovation of firms is the main problem of inward licensing in developing countries. In most developing countries, firms confront changing and uncertain regulation and policy making regarding intellectual property rights, patents and technology and product licensing. SMEs in particular are suffering from unstable rules and regulations or even intervention of different layers of governmental and public sector in inward licensing as open innovation source.

Following to the relationship between R&D expenditures and new product innovativeness in SMEs, it is considerable to state that according to Cohen and Levinthal, (1990). Rosenberg, (1994) and Ahn et al, (2015), internal R&D not only generate new technological knowledge but also increases absorptive capacity. Developing absorptive capacity often depends on the level of previous knowledge. The complementary role of firm's internal R&D activities and expenditures and relationship with external knowledge and technology acquisition has been in the core consideration since Cohen and Levinthal's first study about absorptive capacity (1980, 1990). The complementary role of R&D expenditure through both types of internally R&D

practices or sourcing from external environment implies that one practice can increase the marginal revenue of other practice (Arora and Gambardella, 1990, Cassiman and Veugelers, 2006). Peculiar internal R&D activities and expenditures, and external knowledge, innovation and technological sources can leverage the innovation performance of firms. The composition of internal R&D and external technological knowledge sourcing affect the efficiency of innovation practices. According to the study of Schewe (1994), innovation high performance and success is substantially relevant to internal capabilities like R&D, manufacturing, and commercialization.

Rosenberg (1990) addresses if firms collaborate with other external sources concerning knowledge basis and technological innovation activities in order to gain innovative values; they require having extensive and great R&D capabilities. Internal R&D intensity and strengths is not only causing to increase the firm's innovative capabilities but improve the firm's absorptive capacity (Cohen & Levinthal, 1989, Zahra & George, 2002, Todorova and Durisin, 2007). In addition, internal R&D capabilities determine how an innovative firm recognizes, absorb, and utilize external knowledge and innovation sources appropriately. Referring to Rosenberg, (1990), Cassiman, Perez-Castrillo and Veugelers, (2002) studies, successful external knowledge and external innovative sources can be attained and used when firms capitalize and invest adequate expenditures in internal R&D practices. According to Teresko, (2004), Chesbrough, (2006), Chen and Vanhaverbeke, (2011), internal R&D capabilities and abilities are key factors to use and apply open innovation. Open innovation is not only a strategy of outsourcing R&D and knowledge sources and just ignoring internal R&D. Open innovation practices is a kind of strategy of searching, finding and utilizing external knowledge and innovation sources that can be supplementary to the firm's internal R&D projects. Mowery (1983) note that internal R&D is important to lessen costs of organizing R&D activities inside firm's boundaries at a lower level in comparison to achieving external innovative ideas and knowledge from the market. According to Cohen and Levinthal’s (1989), Cohen and Levinthal, (1990) and Dahlander and Gann, (2010), firms should develop and extend new internal R&D activities and try to generate absorptive capacity to assess the condition of developing in external environment of firms. Firms with large investment in R&D should be more capable to take advantage of spillover knowledge.

Theoretically, according to the relationship between R&D expenditure and new product innovativeness in SMEs in this research, it implies to this notion that in order to develop absorptive capacity, SMEs normally depends on the degree of prior knowledge such as R&D intensity and strengths. Internal R&D activities and capabilities not only make new technological and innovation knowledge but also boost absorptive capacity. R&D expenditures have complementary role, which can be acquired through in-house R&D practices, and sourcing external knowledge and R&D sources, which contribute to this notion that one of these practices can increase the profit of other practice. Internal R&D projects and expenditures, and external knowledge, innovation and technological sources increase firm's innovation performance. In this research, the combination of internal R&D strengths and external knowledge sourcing can leverage innovation efficiency and performance. When SMEs collaborate with other external knowledge and innovation sources regarding knowledge basis and innovative and technological collaboration in order to attain innovative values, they need to possess extensive and great in-house R&D capabilities. In-house R&D intensity is not only be used to increase firm's knowledge basis and innovative capabilities, but also can improve the firm's absorptive capacity. Internal R&D abilities specify how innovative SMEs can identify, assimilate, and use external knowledge and technology sources in a proper method. By investing adequate expenditures in internal R&D practices, SMEs are enabled to attain and achieve to successful external knowledge and external innovative sources. Internal powerful R&D capabilities and abilities should be considered as crucial and central factors to use open innovation sources. Open innovation sources and practices to utilize them are kinds of strategy for exploring and exploiting external knowledge and innovation sources, which can be complementary to firm's internal R&D intensity. In addition, absorptive capacity of SMEs in general and in Petroleum and Gas equipment industry in particular should enable them to access external R&D, innovation and knowledge sources and provide the strength and capability to these firms to search and utilize external innovation sources to increase innovation performance. The potential capability of firms to evaluate and utilize external knowledge sources is depending on their internal knowledge. Absorptive capacity of SMEs in Petroleum and Gas equipment industry indicates that these firms possess relevant internal organizational capability and competence to have openness and adaptability approach toward external partnership, innovation and technological knowledge collaboration with external sources such as customers, industrial networking and collaboration with universities and research and academic institutions.

SMEs in general and in Petroleum and Gas equipment industry in particular not only require fulfilling new product innovation processes by utilizing integrated external innovation and knowledge sources, but they also need more different and various types of competence and capabilities in order to effectively and more remarkably use external open innovation sources in new product innovation projects. SMEs for leveraging new product innovativeness need to possess various types of internal capacities and capabilities, which absorptive capacity is one of these relevant complementary resources that helps SMEs to better implement outside-in (Inbound) open innovation sources and strategies inside firms.

Generally, absorptive capacity in SMEs and in industrial contexts such as Petroleum and Gas equipment industry particularly would be an appropriate and proper combination of both internal and external knowledge and innovation competencies, capabilities and capacities. Absorptive capacity should be implemented properly based on both knowledge creation and knowledge utilization in SMEs, which means that SMEs in industrial context should hold and create internal knowledge capabilities to enable these firms to use better external knowledge and innovation sources. As it is observed in this research, SMEs in Petroleum and Gas equipment industry would possess a good absorptive capacity as they generating internal R&D and integrate it with external knowledge sources.

Following to the relationship between new product innovativeness and new product advantage in SMEs, new product development projects usually attempt to increase and leverage the innovativeness of new products in order to absorb customer's attention and solve their problems and issues related to product consumption. Additionally, this strategy aims to acquire and maintain customer loyalty. Tatikonda and Montoya-Weiss, (2001), Cooper, (1992), Griffin and Hauser, (1992) discuss that new product specifications and features such as new product quality, novelty, newness, uniqueness and peculiarities provide and offer more integrated and practical overview of firm's ability and capability to respond to customer's requirements and diversities between other choices regarding important attributes which can provide advantage position (Day and Wensley, 1988, p. 14). Hsieh et al. (2008, p. 2) note that many high-tech firms follow new product innovativeness and new product advantage strategy when offering and supplying new products. These firms have this objective and purpose to introduce and offer highly innovative products and start to compete with rivals and competitor firms by producing and introducing high quality products to achieve competitive advantage. In addition, Gatignon and Xuereb’s (1997) address that higher and greater product radicalness, the limited and less resemblance of products with competitor's products. It finally leads to sustainable product advantage. This indicates that firms, which are innovative and have radical product innovation strategy, are linked to leveraged product advantage. Lee and Colarelli O'Connor, (2003) emphasize that making any relationship or communication with customers to manage their understanding and comprehension of new product innovativeness is significantly prominent and critical, especially when launching and introducing a highly level innovative products which customers may not accept and adopt it due to lack of product knowledge.

Theoretically, according to the relationship between new product innovativeness and new product advantage in SMEs in this research, it implies to this notion that in order to receive customer's attention, solve and eliminate their consumption problems related to product, and ultimately attains new product advantage, new product innovation projects in SMEs generally should make the best effort to leverage the level of new product innovativeness.

This strategy aims to attain and sustain customer loyalty in order to achieve to product competitive advantage in the marketplace. New product attributes and specifications in SMEs such as novelty, newness and uniqueness can show more comprehensive and practical horizon of SMEs capability to meet customer's needs and it enables customers to perceive differences between other product alternatives concerning crucial attributes, which can provide competitive advantage for SMEs. Firms should have this objective to introduce and offer innovative products and competing with competitor firms by launching and supplying high quality products in order to obtain competitive advantage position.

Firm's high radical products can make less resemblance of their products comparing to competitor's products in order to reach to sustainable competitive advantage. SMEs with innovative approach and radical product innovation strategy are more desired to leverage and increase product advantage. Furthermore, SMEs are more flexible and have less bureaucratic structure to focusing on new product development and product innovation projects, and can start to adopt new knowledge and technologies for new product innovation. These product innovation practices can lead SMEs innovativeness to new product advantage in the market.

Referring to the relationship between organizational declarative memory and new product advantage in SMEs, it is crucial to cite that firms which own the capacity of learning to store knowledge as organizational memory, have better opportunity to confront different condition, trends and procedures in the market (Day, 1994, Sinkula, 1994, Tippins and Sohi, 2003). As a result, learning organizations are more intended to indicate rapid reaction to competitor's activities in the marketplace (Day, 1994, Slater and Narver, 1995), which provide appropriate context for firms to maintain competitive advantage position (Dickson, 1996, Jiménez & Sanz Valle, 2011). The ability of using organizational memory implies that firms should be regarded as a knowledge based mechanism that have capability of storing and accumulating knowledge from previous knowledge, information and experience (Sandelands and Stablein, 1987, Weick, 1979). New product development is based on learning process (Leonard-Barton, 1992, Madhavan and Grover, 1998), which the existing knowledge development and improvement and also development of new knowledge is a critical fact (Andriopoulos and Lewis, 2010, Choi and Phan, 2014).

Organizational memory as a knowledge source affects firm performance which can contribute to leverage firm competencies, and firm's adaptation capabilities (Moorman and Miner, 1998) and also increase learning capacities and capabilities (Camisón and Villar-López, 2011). Firms that stored amount of knowledge and information about new product development, (Madhavan and Grover, 1998), as organizational memory assists firms to perceiving better new information, and develop future new product development strategy (Cohen and Levinthal, 1990, Walsh and Ungson, 1991, Lee and et al, 2017). Regarding the notion of organizational memory, the resource based view (RBV) presumes that firm's competitive advantage can be built according to unique, different and inimitable groups of assets which are valuable, scarce, and sustainable (Barney,1991). Resource based view (RBV) of firms explain how competitive advantage of firms can be obtained and how competitive advantage can be sustained for a long time.

Firms by having valuable, scarce and unique resources which is difficult to be substituted can achieve sustainable competitive advantage by implementing strategies which creates novel values that is very difficult for competitors to imitate (Barney, 1991, Conner and Prahalad, 1996, Nelson, 1991, Peteraf, 1993, Eisenhardt & Martin, 2000). In addition, the knowledge based view of the firms implies that firm's capability to exploit knowledge is the most important and critical source of a firm's sustainable competitive advantage (Grant, 1996, Kogut and Zander, 1992, Nonaka, 1991, Prahalad and Hamel, 1990). According to Nonaka (1991, P.96), the most reliable and confidential source of competitive advantage is knowledge (Zheng et al 2010). If there are resources for firms that are strong, worthy, peculiar, valuable and possess an advantage that cannot be changed with any other resources or is not in such position to be imitated by competitors, it means that the firm has a competitive advantage according to resource-based theory.

Theoretically, according to the relationship between organizational declarative memory and new product advantage in SMEs in this research, it implies to this notion that SMEs which have learning capability to maintain and store knowledge as organizational memory have more chance to respond to different market condition. SMEs as learning organization can show more tendencies to respond quickly to market changes and competitor's new movements and activities. It can provide more suitable context for firms to attain competitive advantage positon. In this vein, organizational memory as a knowledge source positively affects SMEs performance, which can leverage firm's competencies and power of achieving to competitive advantage position. SMEs that store knowledge and experience about new product development as organizational memory contribute firms to understand better new knowledge and information and try to develop new product development strategy for future in order to increase competitive advantage. According to resource-based view (RBV), SMEs by sustaining stored knowledge like organizational declarative memory can gain competitive advantage due to its unique, distinctive and inimitable sets of assets, which are considered as valuable, scarce and sustainable attributes of organizational memory. Having valuable and unique resources such as organizational memory will enable SMEs to obtain sustainable competitive advantage by performing innovation strategies that build new values and can protect the firm's product innovativeness from competitors.

### *4.6. The Managerial Implications of the Study*

From managerial perspective, it should be considered that neither of SMEs is able to manufacture and procure all necessary resources inside firms, therefore, they require to utilize and recruit external knowledge and innovation resources such as customers, suppliers, consultants, competitors, expert's knowledge and expertise, new technological techniques, universities and research institutions. In this research, out of five outside-in (Inbound) open innovation sources, customer involvement, industrial network partnership (Collaboration with suppliers, competitors, and new manufacturers in industrial networked context), and R&D and academic outsourcing are important practices for managers and CEOs of SMEs in Petroleum and Gas equipment industry in Iran. Also, inward licensing and external participation were not important for managers of SMEs in this industry according to numerous factors which limited financial resources and cash flows is one of the major reasons of inability of SMEs to acquire and utilize these two types of external sources. From managerial aspect, this is important to know that SMEs collaboration with customers in innovation process can help them to make actively and progressively new innovative ideas, develop new product concept and first stage product market testing which ultimately can result into higher innovation performance. Participation of customers in designing and developing products of Petroleum and Gas equipment industry is crucial and important because it can increase the level of new product innovativeness in SMEs.

This can be done by receiving and assessing customer's needs, requirements and their demands by proposing new ideas. This can be followed by proactive marketing practices and marketing research to recognize what are the main requirements of the market and customers. SMEs can reinforce and boost marketing information systems (MIS) to extensively monitoring, surveying and identifying customer's exact needs and requirements. Customer's needs and requirements cause SMEs to understand better market condition and try to modify product's attributes and increase innovativeness of new products. This will lead SMEs to use external R&D and knowledge sources and increase internal R&D capabilities and activities. It is recommended that SMEs to expand customer relationship management department (CRM) to receive customer's needs and preferences to transfer them to R&D department in order to improve, modify and develop new product features and attributes. By doing this and making a close collaborative relationship with customers, continuous new product innovativeness and new product development strategy should be expanded by SMEs in order to achieve to sustainable competitive advantage. The main reason is that in SMEs and in industrial contexts in general and SMEs in Petroleum and Gas equipment industry in particular, customers are the main factor and players which enforce manufacturers and producers, what kind of crucial products must be produced by determining the type of attributes, specifications or characteristics. Customer's needs and requirements cause SMEs to improve or modify product's characteristics and features and try to innovate and develop new products. The main and substantial customer role that should be considered by managers in SMEs is that customers can directly indicate failures, drawbacks and disadvantages of products to manufacturers.

Accordingly, customers in Petroleum and Gas equipment industry can order what kind of products they require and desire, and enterprises based on their customer's product orders initiate and start to produce new innovative products or to develop products. CEOs and managers of SMEs in Petroleum and Gas equipment industry should be conscious that outstanding and crucial role of customers and propositions of their ideas, needs, priorities and preferences, receiving customer's feedbacks and comments regarding different aspects of products cause SMEs to apply and perform these suggestions for leveraging the level of new product innovativeness. In addition, customer's feedbacks as an important input from external environment can contribute firms to develop new product projects more successful. This is a prominent and remarkable issue to CEOs and manages that customer in SMEs in general and SMEs in Petroleum and Gas equipment industry in particular have a very constructive and important role in optimization, modifications, and improving new products, which contribute firms to improve production process for increasing the level of new product innovativeness. This is an important issue has to be suggested to CEOs and managers of SMEs in Petroleum and Gas equipment industry that industrial network partnership as outside-in (Inbound) open innovation source is important. The main reason is that it provides firms the possibility of establishing collaborative partnership with industrial network members, so that to benefit from the core competence of network members and partners such as suppliers, competitors and new manufacturers. It could lead SMEs to cooperate and partnering with new manufacturers, benefit and take advantage of exploiting partner's experts as human capitals and expert human resources who have creative and innovative knowledge and ideas which work inside the industrial network and can leverage new product innovativeness in SMEs. Network partnership and participation in networking practices as a collaborative relationship is crucial fact because it enables SMEs to seek, explore and find new technologies, new innovative ideas and new developed products when they encountering lack of adequate internal R.D capabilities and sufficient capacities and resources after knowing customer needs and requirements. According to this established collaborative relationship, partnership with new manufacturers and suppliers in the shape of industrial network collaboration can contribute SMEs to produce better and extensively new innovative products. Industrial network partnership is a crucial and substantial function accepted by SMEs because there is a necessity of interactions and collaboration with external resources, as all knowledge and innovative ideas or technological capabilities and capacities are not existed inside enterprises. In addition, it is necessary to use external capabilities, because of limited internal resources of SMEs.

CEOs and managers of SMEs are recommended to participate in industrial network partnership as this is an important outside-in (Inbound) open innovation strategy due to its capability and ability to enhance and reinforce the learning function and increase the knowledge level of SMEs in general and firms in Petroleum and Gas equipment industry in particular. Network partnership by other network members can affect leveraging new product innovativeness of SMEs and contribute to organizational growth. This is noteworthy to know that industrial network partnership is crucial and important function for SMEs in general and in this industry in particular to collaborate proactively with external innovative resources, since internal resources are not sufficient and adequate for such firms and there are limited internal resources for SMEs to increase the level of new product innovativeness. It also necessitates firms to monitor suppliers, competitors, new technologies, and new products in external environment as members and players of network in order to help developing new innovative product projects. Furthermore, insourcing the knowledge and technological resources from industrial network contribute SMEs to lessen and decrease process time of new product innovation and new product development. Consequently, firms will spend shorter time of innovating and developing new products.

By observing the importance and significance of industrial network partnership for SMEs in Petroleum and Gas equipment industry, it is inferred that SMEs in general and SMEs in Petroleum and Gas equipment industry in particular can benefit and take advantage of becoming member of industrial network by interacting and partnering with network members such as competitors, suppliers or new manufacturers. In this case, firms will be able to collaborate with network members as the main important players of supply chain.

For instance, suppliers can play a very influential role in supply chain of Petroleum and Gas equipment industry as they can help firms to innovate and develop new products by giving and providing new, modern and novel technical, innovative and technological ideas to SMEs. In addition, CEOs and managers of SMEs in Petroleum and Gas equipment industry can benefit from human resources and technology of suppliers in networked partnership and collaboration. R&D practices and designing for innovating new products from suppliers can leverage and boost the organizational capability of R&D practices and increase design ability of SMEs in supply chain of Petroleum and Gas equipment industry in networked partnership and collaborative format. Supplier's feedbacks and ideas can contribute firms to develop, modify and improve new products. Suppliers can propose new technologies to SMEs, which can surge the level of new product innovativeness. In addition, competitors and new manufacturers in a networked partnership can help SMEs in order to leverage new product innovativeness. If R&D capabilities of suppliers are powerful enough and competent in this industry, it will help SMEs to leverage their R&D and designing capabilities and has a direct effect and influence on new product innovativeness and new product development. Suppliers can introduce and recommend new applying technologies to SMEs. Collaboration with competitors provides new benefits and advantages for SMEs in industrial networks. Firms will be able to evaluate their market competitive position with other competitors when cooperating in industrial network partnership. SMEs in Petroleum and Gas Equipment industry can monitor and pursue competitors' new products, standards and new technologies in order to manufacture new innovative and developing new products. It contributes firms' R&D and design engineering teams to develop new products portfolio.

It is important at managerial level of SMEs in Petroleum and Gas equipment industry to know that R.D and academic outsourcing is a very critical and helpful factor for SMEs in general and for firms in Petroleum and Gas equipment industry in particular. It enables them to get advantage of getting and receiving innovative ideas through collaborative relationships with universities, academic and research institutions, individual experts, consultants, to receive and utilize their new ideas and scientific research outputs.

This function facilitates acquiring technical and technological knowledge in the form of research and academic outputs from consultants, researchers, universities and academic research institutions by SMEs in this industry. R.D and academic outsourcing is a crucial and prominent outside-in (Inbound) open innovation source for SMEs in general and SMEs in Petroleum and Gas equipment industry in particular, because of high dependence and reliance of SMEs on R&D and academic practices, design and engineering practices.

R&D and academic outsourcing can help SMEs in Petroleum and Gas equipment industry to improve their R&D capability, engineering skills in product design for improving new product development and increasing new product innovativeness. Buying innovative and inventive ideas in the form of research outputs as R&D collaboration and try to developing these kinds of ideas are important aspects of R&D and academic outsourcing need to be regarded by managers of SMEs in Petroleum and Gas equipment industry. Managers of SMEs require considering this aspect of R&D and academic outsourcing that it can be fulfilled through benchmarking research as a study of competitor's products in order to develop and improve new product innovativeness performance of SMEs in Petroleum and Gas equipment industry. In R&D and academic outsourcing collaboration, SMEs can use consultant's ideas or engineering consultancy firms offering innovative services for product innovation process.

External participation is not accepted as a significant source of inbound open innovation in this research. CEOs and managers of SMEs should consider this fact that venture capital investment as external participation strategy can be challenging and risky source of inbound open innovation. This is due to high risk of investment when there might be external uncertainty existing in the market and industrial context, and internal uncertainty between firms. In external or industrial uncertainty, SMEs should be cautious and careful about unknown and obscure future of new technology, which is attained by external participation in the form of venture capital investment. It is recommended that in the case of high market and industry uncertainty, SMEs would be better to apply for joint venture strategy instead of venture capital investment and acquisition of other firms. Furthermore, in internal uncertainty, there is a wide gap between technology of investing firm and technology of partner firms therein is being invested. This kind of uncertainty makes technological distance between investing firm and invested target firm. The technological gap and distance between two firms is a challenging issue in the context of SMEs activities. The main reason is the existence of minimum amount of knowledge and technological background and basis to become ready to accept new technology and knowledge sources in investing firm and lack of compatibility with technological capability of target firm as external knowledge and technology source. Therefore, according to these impediments and difficulties, managers of SMEs in Petroleum and Gas equipment industry should be aware of investing in such external source or it is recommended not to utilize this kind of inbound open innovation source in this industry.

Inward licensing is another inbound open innovation activity, which is not accepted as a significant source in this research. Industrial dynamism is an important issue that CEOs and managers of Petroleum and Gas equipment industry should consider, as it is different from one industry to another. Industrial dynamism makes new challenging difficulties for small firms to leverage knowledge and innovation bases over time by using both internal and external knowledge and innovation resources. Industrial dynamism is related to rapid technological changes. Some SMEs cannot be adopted with external rapid technological changes, as they do not have enough internal capabilities and cannot manage new product development practices. Although managers and CEOs of SMEs in Petroleum and Gas equipment industry should know that according to knowledge based view, the rapid changing condition in technological and industrial market for SMEs force these firms to acquire external R&D capabilities and using external source like inward licensing. SMEs in Petroleum and Gas equipment industry have not encountered any technological and industrial dynamism or turbulence due to results of this research. SMEs in Petroleum and Gas equipment industry are not operating in rapid changing and turbulent technological environment. Therefore, it is recommended to managers of SMEs in this industry not to invest and use inward licensing, because, using inward licensing is too expensive, and only can burden transaction costs of inward technology licensing to SMEs in Petroleum and Gas equipment industry. Likewise, managers and CEOs of SMEs in this industry should be more cautious and aware about innovation regime of this industry. Innovation regime in each industry can be either incremental or disruptive. According to the essence and nature of Petroleum and Gas equipment industry, incremental innovation emphasizes to increase, leverage and develop the industry's current technological advancement and activities. SMEs in this industry should be able to predict easily and precisely the future technology trends. Incremental innovation and the capability of SMEs to predict technological changes in the future help these firms to leverage innovation performance through both internal R&D activities and external knowledge sources.

Incremental innovation is widely used and applied in industries with mechanical engineering with the name of M-type industry. Petroleum and Gas equipment industry is an engineering M-type industry, and however, incremental innovation in this industry needs to be leveraged by inward licensing, this kind of inbound open innovation activity is much expected to be used by those industries that the nature of their innovation activities is based on disruptive innovation. Inward licensing is more suitable and applicable in industries with disruptive innovation system. Exploiting inward licensing by Iranian SMEs in Petroleum and Gas equipment industry is not a proper strategy as this source can be too expensive and just increases transaction costs of firms in this industry. Moreover, the innovation regime of this industry is incremental which inward licensing cannot be a suitable inbound open innovation practice for this kind of innovation system and strategy in firms.

Internal R&D practices as R&D expenditure and intensity is important aspect for managers of SMEs because internal R&D intensity is not only causing progress and development of the firm's innovative capacities and capabilities, but can contribute to leverage the firm's absorptive capacity. As a result, in addition to exploiting external R.D and academic outsourcing activities, SMEs in general and SMEs in Petroleum and Gas equipment industry in particular are not solely dependent on external knowledge sources. Therefore, the investment on their internal R.D capabilities and their R&D department and engineering design teams is noteworthy and prominent in these firms to increase the level of new product innovativeness in order to respond to customer's preferences and requirements properly. Managers and CEOs of SMEs should consider this fact that R&D expenditures and allocating some percentage of annual sales as R&D expenditure is a crucial and prominent aspect for SMEs because the impactful and influential external knowledge, innovation and technological sources can be obtained and utilized when firms have sufficient internal capabilities. Moreover, this can be acquired by investing adequate expenditures in internal R&D practices. This capability as R&D intensity and strengths can contribute to boosting the growth of organizational absorptive capacity, and lastly increasing the level of new product innovativeness in SMEs, which can be obtained from both external and internal R&D and knowledge sources. Internal R&D activities are important for SMEs owing to the fact that these firms have to extend new internal R&D practices and to build and increase the absorptive capacity in order to evaluate the potential capabilities of external knowledge and innovation sources outside firms. R&D intensity is a prominent aspect of SMEs since it has not been used just for assessing internal learning; In addition, this capability helps as a crucial factor of external leaning, as firms need developing a specified degree of internal knowledge and R&D capacities to acquire external knowledge sources.

The positive and significant relationship between new product innovativeness and new product advantage in SMEs of Petroleum and Gas equipment industry indicates the fact that products of these firms were found novel and unique by customers, bring benefits and advantage for customers comparing to competitor's products. Because of this reason, new innovative products of SMEs in Petroleum and Gas equipment industry can be succeeded and get product competitive advantage in the marketplace. The high level of new product innovativeness, which can lead new product innovativeness to new product advantage for customers and gain competitive advantage position in the marketplace, indicates firm's products are more desirable than other competitor's products from customer's perspective in the market of Petroleum and Gas equipment industry. It shows the prominent advantage of new products as product's supremacy and dominance relevant to other products in the market. This is based on aspects such as quality, benefit, and functions. The positive relationship between new product innovativeness and new product advantage as the success of new products of SMEs in the market implies to important notion that significant and considerable new product innovation practices by SMEs provide this opportunity for firms to create a dominant and competitive position in the competitive market. This is important for SMEs to achieve and access new customers and new market segments as they launch their new innovative and developed products to the market. Management teams in SMEs should be notified that exploiting both external knowledge and innovation sources and using internal R&D capability can leverage new product innovativeness that it will result into new product advantage in the market. It can cause SMEs to be successful to obtain a competitive position in the market.

This fact is crucial to be considered by CEOs and managers of SMEs in Petroleum and Gas equipment industry that organizational memory as the last component of organizational learning is known as an important internal knowledge source for performance. Organizational memory is considered as a crucial and prominent factor for SMEs as it indicates the amount and degree of stored and accumulated knowledge sources and required information inside SMEs, which is about a special and peculiar experience and prior phenomenon. Management teams of SMEs in Petroleum and Gas equipment industry should be concerned that organizational memory contains organizational knowledge and experienced skills, expertise, rules, and regulations or shared beliefs. This is important issue for managerial level of SMEs that organizational declarative memory as stocked and stored knowledge about customers, product features and attributes, and competitive market condition enables SMEs to locate, set, develop and use the knowledge to increase their competitive advantage position in the marketplace. They could leverage financial performance by interpretation of organizational memory, which is stored inside firms as well. Organizational memory as organizational knowledge is an important phenomenon for SMEs since it is being considered as a latent and hidden knowledge inside enterprises that can offer especial and peculiar situations and events that has been made and shaped based on antecedent experiences. This hidden knowledge could be beneficial and advantageous for SMEs as they can increase competitive advantage and leverage financial and firm's performance in the marketplace and can be considered as sustained source of competitive advantage.

High level of organizational memory in SMEs indicates organization's capacity and capability to attain and achieve new innovative forms of competitive advantage by great potential and high degree of dynamic capabilities inside SMEs. The important aspect of organizational memory is that what has already learned in the form of organizational beliefs, knowledge, reference, models, values, organizational norms, principles, rules and regulations can be stored as stocked knowledge and information in the form of organizational memory leading to innovation outputs and competitive advantage performance. In this regard, CEOs should be aware that organizational declarative memory, which contains knowledge of facts and events such as practical and genuine knowledge that are accumulated and gathered as information and stored knowledge about customer's preferences and priorities, product features, product specifications and attributes such as product design and product packaging, firm's strategic goals and objectives, firm's market conditions and positions, firm's marketing strategies and firm's competitive positions are substantial and significant knowledge for SMEs. This knowledge enables innovation and marketing aspects of new innovative products or new developed products to be concerned for SMEs to achieve to product competitive advantage position. This knowledge can contribute firms to better decision making for product designing and improving product attributes according to the customer's and market's requirements to achieve competitive advantage position and increasing market performance. Managers and CEOs of SMEs in Petroleum and Gas equipment industry should be aware that organizational declarative memory as an important aspect of knowledge management in SMEs for increasing innovation and market performance and its potential can strengthen new product advantage as the success of the new products in the market. This is due to fact that SMEs with prior stored and repository information and factual knowledge of market from customer's insights and their preferences, customer participation as information source or development source, or previous experiences or knowledge about product features, market condition and competitive positions in the market could contribute to make and turn the possibility and potential of new products of SMEs to be succeeded in the market and gain competitive advantage.

### *5.6. Conclusion*

All firms must look at the overview of their future activities. They need to use external ideas and innovative products. The ideas of external sources is a crucial and critical factor for innovation and firm's moving forward to grow for further new product innovativeness and new product development process. None of SMEs is able to solely increase and leverage their innovation performance by entirely relying on internal knowledge and R&D capabilities. They require utilizing and exploiting external knowledge and innovation sources such as new technology providers, customers, suppliers, inventors, consultants, competitors, universities and research institutions in order to contribute them to use the latest novel new manufacturing technologies to increase their innovation performance. Acquiring new knowledge and innovation sources can expedite the process of new product development in SMEs. Collaboration with external sources of knowledge and innovation lessen the process of achieving to new products, shorten manufacturing process and enable SMEs to supply faster and offer new innovated and new developed products to the market that ultimately can cause the success of new products. In order to remain stable and lack of innovating practices in SMEs will lead these firms to lose market position against competitors, and due to this fact, firms must constantly develop and innovate new products. First, this is important to recognize customer's needs and requirements, customers can state the failures and drawbacks of products. Customer's needs and requirements urge SMEs to realize the necessity of changes and modifications in products.

Firms will try to add or modify product's attributes and specifications according to the market needs. As a result, SMEs will expand and develop R&D activities and capabilities by using internal R&D and utilizing external knowledge and innovation sources to leverage innovation performance. If customer's needs and requirements in Petroleum and Gas equipment industry cannot be fulfilled inside SMEs, firms must refer to external knowledge and innovation sources like universities and research institutions, suppliers, new manufacturers, or other resources. Internal R&D activities and capabilities in SMEs are important to solve the production problems of new innovative and new developed products in Petroleum and Gas equipment industry. In addition to internal R&D practices that should contribute to leveraging product innovation performance, firms will use external knowledge and innovation sources in order to increase absorptive capacity and innovation performance. Collaboration with customers is an important aspect of inbound open innovation for SMEs, as customers are the main factor to determine the type, specifications and attributes of product that firms should develop or innovate. In addition to customers, suppliers can help SMEs to develop new products and increase innovation performance as both customers and suppliers are in vertical collaboration mode. This kind of collaboration can expand and develop firm's innovation practices to increase its performance. Customers and suppliers are two most important inbound open innovation sources for SMEs in Petroleum and Gas equipment industry that can highly contribute firms for new product development and innovation process in vertical collaboration form. In addition, collaboration with suppliers and new manufacturers in industrial networks is another type of inbound open innovation activity for SMEs, which can benefit and take advantage of membership and collaboration with new manufacturer, supplier's new innovative ideas, firms' human resource and expert's novel and innovative ideas. Using supplier's technology and human resources has the highest value for SMEs in this industry. Powerful R&D capabilities and design activities by suppliers can help SMEs in Petroleum and Gas equipment industry to enhance and improve their R&D and innovation capabilities and can positively affect new product innovativeness and new product development.

Monitoring and survey of competitor's latest new products and standards by SMEs in Petroleum and Gas equipment industry can be another type of collaborative relationship with external partners which can help R&D and engineering teams to improve and develop firm's products portfolios. Exploiting research outputs of universities and research institutions is another important inbound open innovation source for SMEs in Petroleum and Gas equipment industry. Universities and research institutions can contribute firms to design new innovative products by productive research and scientific outputs. The outputs of this collaboration can be attained through buy and receive scientific research outputs, academic and R&D supportive services from science and technology parks, receiving inventor's innovative ideas, and receiving new innovative ideas from consultants. SMEs can establish collaboration relationship with external sources through two groups: (1) Scientific and research groups, which can help firms to manufacture and develop new products. (2) Professional groups and their feedbacks such as customers and suppliers that can change, modify and improve new products. By using and collaborating with inbound open innovation sources which are significant for SMEs in Petroleum and Gas equipment industry such as customers, network partnership with suppliers and new manufacturers, and R&D and academic collaboration with universities and research institutions, firms can leverage new product innovativeness. In addition, internal R&D activities and capabilities in such firms can leverage new product innovation performance. Consequently, using both internal and external R&D, knowledge and innovation sources in SMEs in Petroleum and Gas equipment can increase new product innovativeness that can be transformed into new product advantage in the market. The ability of using both internal and external knowledge and R&D sources can increase absorptive capacity of SMEs in Petroleum and Gas equipment industry.

#### *1.5.6. The Research Limitations and the Suggestions for Future Research*

This research includes some limitations like many other researches. First and foremost, as data was distributed and collected by questionnaire thorough face to face referring of the researcher, there were some barriers to collect data and administer questionnaires between respondent firms. Some firms as manufacturer of Petroleum and Gas equipment industry did not cooperate properly to respond to questionnaire. Second, geographical dispersion of SMEs in this industry in different geographical location of Iran in the form of industrial cluster and far distance of reaching to other SMEs in different parts of Iran in order to distribute and collect questionnaire in person was another problem and difficulty for researcher to collect sufficient data from other firms. Some of important SMEs are locating and operating in different geographical areas that accessing to some of them was impossible in order to increase the sample size of the research. Third, there have been so many burecratic barriers and complicated procedures of gathering data from SMEs in this industry. It was necessary to proceed administrative procedure in order to be permitted to access to firms for data gathering. Fourth, some firms did not respond in a proper time. Fifth, there is not any specific, predefined, and predesigned supply chain for Petroleum and Gas equipment industry. The only existent supply chain is related to Oil and Gas industries. For future studies and research, it is suggested first, a comparative study of the effects and role of outside-in (Inbound) open innovation sources on new product innovativeness and new product advantage of SMEs in Petroleum and Gas equipment industry between one or more than one country with different culture to be fulfilled. Second, there is a need to study the effects and role of outside-in (Inbound) open innovation sources on new product innovativeness and new product advantage between small and medium sized enterprises (SMEs) and large firms as manufacturer of Petroleum and Gas equipment industry to compare the effect of inbound open innovation between these two groups. Third, it is necessary to study the different role and effect of outside-in (Inbound) open innovation sources on innovativeness and competitive advantage of service firms which are operating as service providers or contractors in Petroleum and Gas industry. The main reason is that most of the SMEs or even large firms in Petroleum and Gas equipment industry or Oil and Gas industry are operating as contractors, which only provide main important services to manufacturers. Future studies should broaden the scope of outside-in (Inbound) open innovation in SMEs in broader samples in manufacturing SMEs of Petroleum and Gas equipment industry.

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