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Open Innovation Exchange

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Authors: Petros Lameras, Maurice Hendrix, Denise Lengyel, Sara de Freitas, Brian More

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Author(s)	Petros Lameras, Denise Lengyel, Maurice Hendrix, Sara de Freitas, Brian More		
Project Role(s)	Researcher, Developer, Project Manager, Director of Research, Director of IP Services		
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Table of Contents

Executive summary

The purpose of this report is to provide a review of current literature on open innovation in the frame of the Open Innovation Exchange Programme (OpEx). The aim of the OpEx project is to produce a sustainable and scalable online marketplace for fostering innovation between academia and industry. The report is part of scoping work undertaken to inform the development of the OpEx system and to provide evidence-based work upon which the system may be best designed, deployed and evaluated. In particular the aim of the report is to present and analyse current best practices in innovation between industry and academia. It selects and reports on case studies and key resources (e.g. books, journals, articles, conference papers) for drawing special attention to exemplar practices on capitalizing on firm's innovative potential and knowledge through the participation of external actors and resources. It also provides a synthesis on the methods and processes Universities currently use in order to establish connections with the industry for technology transfer and for commercializing their scientific outcomes.

The OpEx project is being taken forward against a background of widespread theoretical and practical considerations, which suggest that firms develop processes to ensure a flow of information and knowledge outside of their traditional boundaries. This constructs and reinforces the need to open up the innovation process outside for new paths to innovation. It has been argued from the wider evidence base that a paradigm shift is taking place in how companies conceptualise and commercialise knowledge and inventions, resulting the boundaries of the firm to become permeable (Trott & Hartmann, 2009) and also a propensity has been observed to integrate a number of external parties such as universities, research organisations, suppliers, customers and competitors in the innovation process (Wallin & von Krogh, 2010). Henry Chesbrough meant to explain this paradigm shift by introducing the notion of 'open innovation' in 2003. Chesbrough defined open innovation as a model in which firms commercialise external ideas by deploying outside (as well as inside) pathways to the market (Chesbrough, 2003b). Literature suggests that there is mixed and inconclusive evidence in understanding the meaning of open innovation from a business perspective and this has led to subjective use of the term in different domains.

For the purposes of the OpEx project, our focus in on open innovation from the business model perspective as its distinctive hallmarks are: 'more extensive, more collaborative, and more engaging with a wider variety of participants' Chesbrough (2012: 20) in general and in establishing and sustaining university-industry relationships via participatory platforms, tools and services in particular. We propose a number of open innovation frameworks, which may be used as means to examine the applicability and implications of open innovation in firms but also in creating certain kinds of relationships between universities and industry. These frameworks include the outside-in, inside-out and coupled process, absorptive capacity, innovation communities and crowdsourcing. We also highlight the role of search to find people and resources applicable to technology transfer and technical knowledge (i.e. knowledge that is derived from R&D work).

Intellectual property (IP) rights are fundamental for establishing solid university-industry relationships. For the purposes of the OpEx project, the term IP is used to refer to all technology-based intangible assets of a firm including a project that encompasses an idea which will eventually be materialized to a new product or process.

Our approach for identifying best practices in open innovation is through case studies identified from the literature for providing suggestions in terms of how other firms can conceptualise and deploy open innovation. Examples of implementation strategies include Procter and Gamble, VOLVO, Unilever, BT among others.

The report explicitly focuses on explaining issues surrounding the creation of university-industry relations as well as the tools that may be used to foster such relationships for open innovation. We present the factors that influence collaborations between universities and industry and we elaborate on certain strategies for strengthening the realization of open innovation. As the Internet offers unprecedented possibilities for communication and interaction between innovation contributors for a relatively low cost, it has become the key driver for introducing new forms of collaboration and community participation as a way of creating, utilizing and disseminating innovation. Digital tools and applications specifically developed for supporting innovation purposes are referred to as Computer Aided Innovation (CAI) tools (Hüsig & Kohn, 2011). Typical tools for creating collaborations for open innovation are online open innovation communities, innovation contests, online toolkits, and virtual worlds. An interesting and viable approach for enacting open innovation is to disclose university-industry collaborations via open innovation platforms on the Web.

We conclude by making special recommendations for facilitating the conceptual design and implementation of the OpEx online marketplace:

1. The OpEx online marketplace to be a web-based platform where the principle of broadcast search is incorporated into the overarching architecture of the project's online marketplace as an effective mechanism for discovering, accessing and retrieving ideas, projects, information and resources.
2. The OpEx online marketplace to offer the tools and services for users to be able to externalize both their own innovation to interested parties and also to be able to find expertise and skills from partners through an online matching tool that will twin academic staff with industry.
3. The OpEx online marketplace to offer the tools and services (e.g. crowdsourcing and crowd assessment) for creating, exploiting and sustaining innovation communities that will benefit the development of projects and innovations between academics and industry managers.
4. The OpEx online marketplace to create IP disclosure mechanisms for the user/proposer to decide how IP will be dealt with.
5. The OpEx online marketplace to allow open access to new ideas emerging from different research communities, to be able to rate ideas and annotate feedback.

1 Context

This report is part of the Open Innovation Exchange Programme (OpEx) being funded by the JISC funding programme, and being delivered by the Serious Games Institute, Coventry University. The aim of the project is to develop an online marketplace to support the university wide best practices of open innovation between academic and business partners.

OpEx provides a Centre for Excellence and Forum in academic-industrial community building and open innovation. OpEx produces a sustainable and scalable Online Marketplace with a virtual Showcase area, an Ideas Factory for directly fostering innovation and IP and a demonstrator social networking platform for partner matching, community formation and support. OpEx web services will include: an innovation readiness toolkit and mobile game apps for business and community engagement, linking seamlessly with selected JISC BCE resources and a resource area.

OpEx brings together large companies, business communities (e.g. Chambers of Commerce) and SMEs with all CU academics and postgraduate students to support open innovation and nurture economic growth. Led by Coventry University Enterprises Ltd (CUE Ltd), with an established expertise in BCE, the OpEx programme will reach a large number of SMEs and large companies, through: i-UEN, v-Trade, Cluster 2020 and EEN, which support over 1,000 business organizations in the digital creative economy, scientific and manufacturing, design and engineering sectors. OpEx will also bring together communities and community building methods, as developed in the JISC-funded BRAIN and INSPIRES projects. OpEx will meet the objective of increasing institutional and disciplinary engagement in innovation, knowledge exchange and technology transfer, through close involvement with all the University's Faculties, Institutes and Schools. Beyond the programme, there is scope to make the project scalable and sustainable, through membership to the Centre and facilities via open access and the JISC.

This report is part of scoping work undertaken to inform the development of the OpEx system and to provide evidence-based work upon which the system may be best designed, deployed and evaluated.

The research team includes: Drs Petros Lameras, Maurice Hendrix and Prof Sara de Freitas. The development team is headed by Denise Lengyel. The team has expertise in research in educational technology and adaptive information systems. The team is supported by the University Director of Intellectual Property, Dr Brian More, the Deputy Vice Chancellor for Research Prof. Ian Marshall and the head of the Institute for Applied Entrepreneurship, Prof Gideon Maas. The team have been assisted by the JISC Programme Manager Simon Whittemore. Together the research team has undertaken a literature review and scoping study of current literature and available open innovation tools. The report is divided into a methodology section, literature review findings and a review of current open innovation tools.

3 Research review

3.1 Introduction

This report provides a review of the current literature related to the processes and practices of the open innovation. The report also includes a particular focus on the creation and maintenance of university-industry relations for the purpose of developing and sharing ideas and innovations. It draws special attention to exemplar practices on capitalizing on firms' innovative potential and knowledge resulting in a seamless integration of external actors and their resources. It also provides a synthesis on the methods and processes Universities currently use in order to establish connections with the industry for technology transfer and for commercializing their scientific outcomes. The emergence of the Internet has facilitated the creation of such relationships through what has been termed Computer Aided Innovation (CAI) (Hüsig & Kohn, 2011). Instead of taking place in the physical world, interactions occur via the Internet, mediated by representational rich-mediated interfaces and environments. The integration of open innovation platforms and virtual worlds could further enhance accessibility to academics, researchers, entrepreneurs and business consultants offering intrinsic enjoyment and knowledge diversity to all kinds of academic-industry projects. We recommend the incorporation of certain principles and mechanisms into open innovation practices by allowing media-rich and highly interactive collaborations between universities and industries.

Section 3 discusses the methodology used for the search design, search implementation and review process, the historical background, theoretical and research rationales and key concepts and frameworks for practice as the basis of designing and implementing open innovation. Special attention is given to emerging phenomena namely innovation communities and crowdsourcing as overarching instruments for CAI. The section continues by discussing intellectual property as key issue for capturing value and sharing ideas and resources. Then the section provides an analysis of business case studies from the open innovation literature and highlights some challenges for entrepreneurs, companies, universities and other organisations. The central focus is then placed on establishing university-industry collaborations and on the explicit factors that influence such partnerships. Technological tools such as open innovation platforms; toolkits and virtual worlds are also discussed for offering an understanding in terms of how digital technologies can be used as a valuable source to capitalize on creating rich-mediated interactions. The section then offers exemplar practices that facilitate the creation of partnerships by enabling physical university-industry collaborations as well as virtual. Finally, section 4 concludes the report by providing recommendations for the practice of open innovation and OpEx project.

3.2 Methodology

The review of evidence in this report is based on the process of search, retrieval, appraisal, extraction, synthesis and interpretation of relevant literature in the public domain. The search and review process is illustrated in Figure 1.

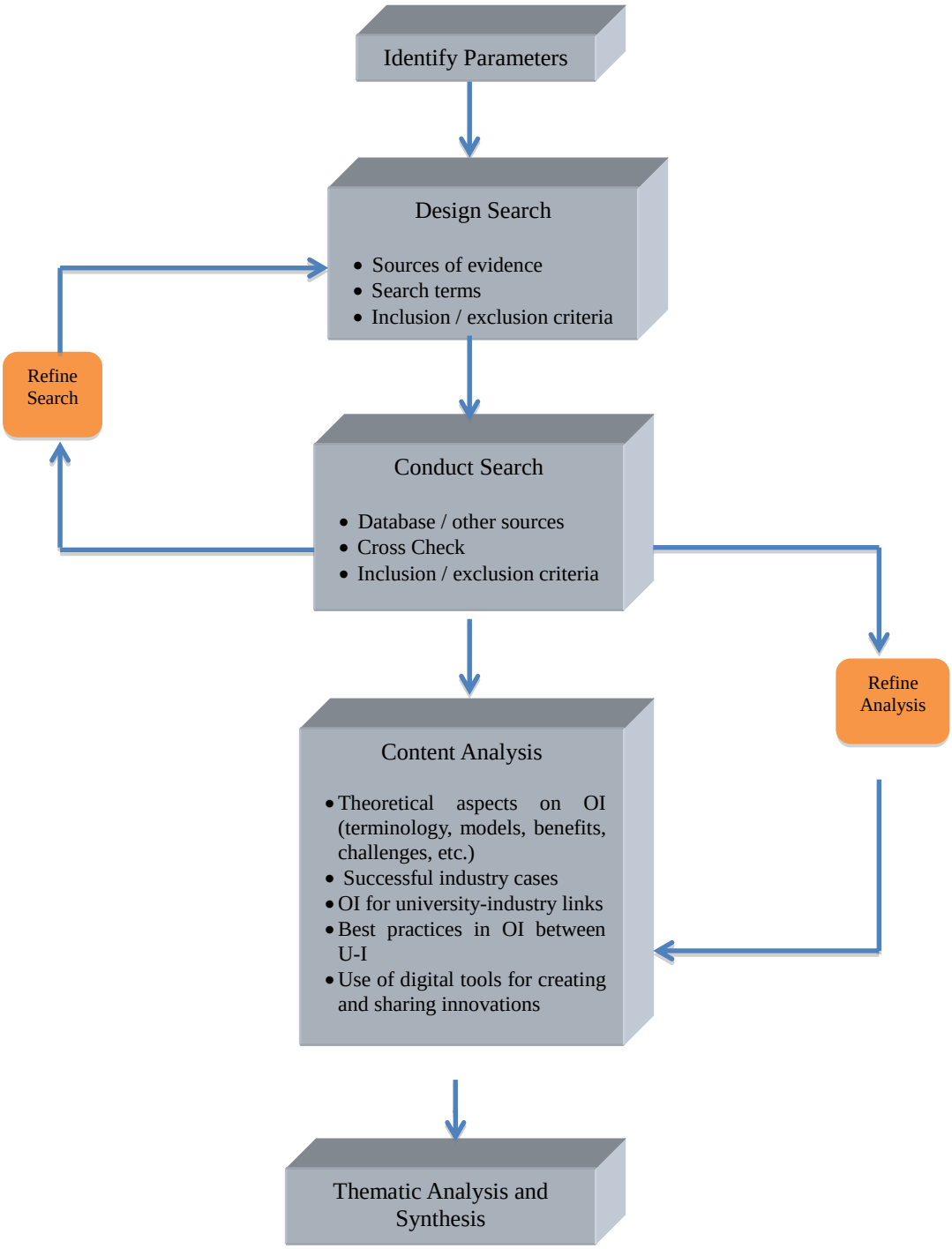

Figure 1: Stages of the search and review process

The main evidence-base for the discussion that follows of "best practices of Open Innovation" is drawn from a range of sources including (mainly) journal articles and additionally conference papers, book chapters and policy documents. The search was

conducted principally via a number of bibliographic databases such as: Web of Knowledge (WoK), Web of Science via Scopus (WoS), and EBSCO. The database searches were conducted in Summer-Autumn 2012. Normally using Boolean and Proximity search the term Open Innovation was combined with university and industry (and specific discipline-industry identifiers) to retrieve items only where these combinations featured in title and/or abstract fields. Items relating to the Open Source Software (OSS) paradigm as a close inter-link with the open innovation model were excluded. Items relating to high-tech open innovations from a business model perspective were included. Open innovation developments with stronger emphasis on large and Small and Medium Enterprises (SMEs) were also included. Finally, detailed technical descriptions of integrating open innovation in system architectures and interoperability standards were excluded. Database searches were supplemented by use of: a citation alert service (British Library ZETOC), consultation of a special issue for Open Innovation from Technovation 31(2011); a Google Scholar Web search and items already in the Coventry University library collection. Items were included in the review corpus if they:

- Included the term 'open innovation' or close synonyms such as 'collaborative innovation', 'networked innovation', 'interactive innovation' and 'open innovation development' at the level of title and/or abstract.
- Reported on open innovation as a business model.
- Reported on industry generally.
- Reported on both large companies and SMEs.
- Reported on different types of industries (manufacturing and services) and in different sectors (technology, engineering, automotive, food, pharmaceutics, medicine).
- Reported on research and practice in University-Industry links and between different disciplines and business sectors (computer science and engineering, sciences, medicine etc.).
- Were written in English and very few in German translated and summarized in English by a bilingual researcher.
- Were published between 2000-2012 with the exception of selected prior items.

Finally, for the purposes of this review, items were excluded if they used the OSS without using the term open innovation or close synonyms, as our (pragmatic) focus was on items that explicitly privileged the open innovation paradigm as a business model.

Items were also excluded from the review corpus in cases where our broad inclusion criteria were satisfied but the content of items was highly specialised and technical in nature. These included a large number of items in the research field of CAI with complex interoperability and re-usability protocols and standards.

There are a number of other limitations on the corpus established for this review. Where it did not prove possible to acquire the full text of some items for which title and/or abstract were available, these items normally were excluded. In some cases, titles and abstracts do not highlight the primary or secondary focus of the article; some useful items therefore may have slipped through the net. Useful book chapters and conference papers not indexed by the databases used or identified by Google Scholar may have been missed. Sources providing

access to Masters and PhD theses were not searched and items written in languages other than (predominantly) English and (few) German were not retrieved.

Given the nature of the OpEx project and constraints on time, we did not aim for comprehensiveness or to adopt a full-scale 'systematic review' approach. However, while inevitably selective, highly incomplete and partial in its consideration, we believe the corpus provides a reliable representation of the current evidence-base on 'best practices in open innovation.'

The best 'practices in open innovation' review corpus contains 126 items in total, including 100 journals, 2 book chapters, 2 policy reports, 3 conference papers and 19 web sites. Most items were from US (105) because of the prevailing research interest generated by high-tech industries to change traditional business models and commercialisation processes towards disseminating information, knowledge and competence outside the boundaries of their normal operation. Items were also from UK (17) and Germany (4), as it seems open innovation has made significant inboards for tackling major technological, business, policy and societal challenges. 32 articles report on open innovation in U-I links, 55 articles report on open innovation in industries (47 in manufacturing and 3 in services and 5 in mixed types of firms). 39 report on a generic theme of open innovation drawing on theoretical considerations, implications and future directions of research within a neutral business context.

Each one of these items was entered into a Zotero[1] Web-based database with the following fields:

- Reference type (Journal article, book section, book, conference paper, conference proceedings, Web page and report)
- Author
- Year
- Title
- Source (e.g. for a journal article, journal name, volume, issue, pages)
- Abstract
- Research notes (for identifying and classifying key papers)
- URL
- File attachment
- Tags (for matching similar themes e.g. U-I links; crowdsourcing; absorptive capacity etc.)

For each database entry we attached the actual paper file and a snapshot of the item's Web-based location for allocating the relevant paper to each entry, and for capturing the root source for future reference. The database was shared via the creation of a dedicated group through an integrated cloud-based service for facilitating researchers' contributions in terms of discovering, retrieving and sharing an item from the database.

Following selection of items for the review corpus, preliminary analysis of content related to 'best practices in open innovation' was conducted according to the framework presented below:

[1] https://www.zotero.org/

Themes	Description
Resource identifier	Title, author, date of publication
Resource type	Research report, journal article, conference paper, policy document, book chapter
Research approach and methods	e.g. case study; survey; empirical research; quantitative; qualitative, mixed methods approach; review/policy
Definitions of open innovation	What open innovation means? Types of innovation; Differences between open and close innovation; historical facts.
Frameworks/approaches to open innovation	Outside-in; inside-out; coupled, absorptive capacity; communities of practice; innovation contests etc.
Best practices from business case studies	Best practices examples from manufacturing; services; automotive; technology and engineering; food; consulting; pharmaceutics; medicine; biotechnology
Best practices through U-I collaborations	Examples of successful collaborations and partnerships between firms and universities and associated disciplines; drivers for initiating partnerships;
Technological tools and multimedia	Web-based platforms; online toolkits; OI software; semantic web for OI; R&D platforms; design and ideas platforms; prediction platforms; Web2.0
Intellectual Property	Key intellectual property issues for enabling U-I collaborations; models of exploiting IP issues; avoiding IP conflicts etc.
Benefits, barriers and challenges	Implications from technology transfer; ways of inspiring actors to engage in OI and explore new relations; incentives/motives for co-creation od value.
Key findings / basic argument	Main outcomes and / or basic argument of the resource.

Table 1: Framework for content analysis

3.3 Background to open innovation

The OpEx project is being taken forward against a background of widespread theoretical and practical considerations, which suggest that firms develop processes to ensure a flow of information and knowledge outside of their traditional boundaries. This constructs and reinforces the need to open up the innovation process outside for new paths to innovation (Chesbrough, 2003a). The term open innovation has since then come to be associated in the context of inter- and intra-organisational technology transfer as a source of new innovations to the development of products and services and for establishing the necessary conditions for sustaining competitive advantages (Lee et al., 2010). To cope with the increasingly competitive environment, firms invest in innovative activities through technology transfer. Nevertheless, the predominant model to create value through internal R&D may be not sufficient for addressing greater technological complexities. Shifting from in-house R&D structures to an open R&D structured may be seen as an open system where the focus in on

external sources of knowledge through licensing, partnerships and technology agreements (Berchicci, 2012).
Many commentators describe history of the awareness of innovation as playing a central role for entrepreneurial performance with the work of Josef Schumpeter in the early 20th century. In the context of innovation, knowledge constitute the fundamental resource of creativity and production and brings to the fore the benefits of expanding value creation for organisations. Innovation is situated in the wider context of business strategy as a way of making strategic sense of innovation and its implications for creating competitive advantage (Chesbrough and Appleyard, 2007).

A traditional approach to business strategy based upon ownership and control is the so-called Closed Innovation (CI) model which takes a linear approach as organizations rely merely on internal competences (e.g. internal Research and Development (R&D) strategies, processes and practices for value creation and ideas generation which accords to the development of innovation projects (Lichtenthaler, 2008)). In addition, traditional approaches to innovation assumed that scientists working in the firm who designed and developed the products to meet customer needs possess expertise and rarely, if never, looked externally for new inventions or ideas (Conboy & Morgan, 2011). This results in viewing innovation as being an isolated process where the essence of value creation and growth depended on the internal capacity of certain individuals and small groups within the firm. Consequently, the firm uses its own distribution channels in order to generate, produce and commercialize their own inventions and ideas informed by the theoretical and philosophical tenets of the closed model of innovation. Even in this model though sourcing knowledge from universities and other public research organizations in not unknown, especially if the firm is in the science and technology sector where specialized knowledge and expertise are required for producing competitive products (Tether & Tajar, 2008). Under this model, firms need to be self-reliant as there is uncertainty with skills, quality and overall capability of external collaborators (Talaga, 2009). Accordingly, there is no role for the public and private science base as well as for consultants for sharing and co-creating value with the firm. According to Chesbrough (2012) an overarching characteristic of the closed innovation model is that research projects are launched from the science and technology base of the firm. Chesbrough describes the process as: all projects arrive at the development process, some of them are stopped, while others are seen as potentially creating value and are selected for further work. The ‘closeness’ of the model is depicted by the tendency of projects to enter (from the company’s internal base) and exiting the market in one way (penetrating into the market) (see Figure 2). Moreover, after the production of the innovative product through this one-way process, firms must defend their intellectual property against competition.

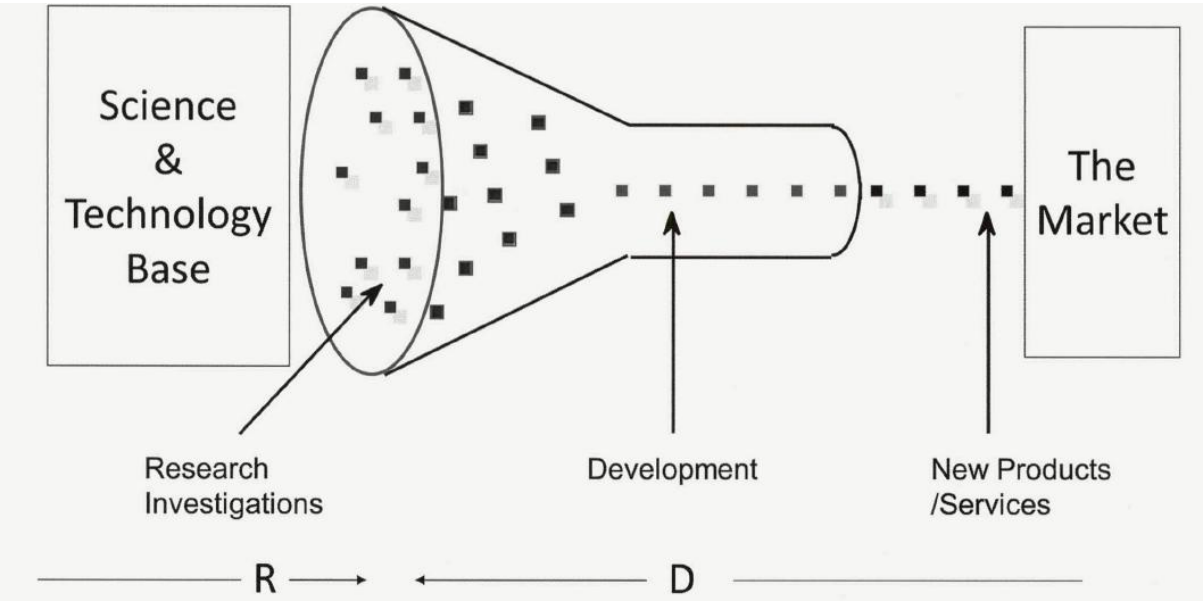

Figure 2: A closed innovation system (Chesbrough 2012 p.22)

It has been argued from the wider evidence base that a paradigm shift is taking place in how companies conceptualise and commercialise knowledge and inventions, resulting the boundaries of the firm to become permeable (Trott & Hartmann, 2009) and also a propensity has been observed to integrate a number of external parties such as universities, research organisations, suppliers, customers and competitors in the innovation process (Wallin & von Krogh, 2010). In addition large amounts of knowledge are a necessary condition for creativity to occur in firms, which it may lead to innovative ideas (Conboy & Morgan, 2011). The transition from the authoritative and individualistic innovation process, reflecting the close innovation model, to a newer model of innovation has highlighted the collaborative and interactive character of building and commercialising products where the point of departure is the interactions with suppliers, users and a number of other institutions inside the innovation system (Abulrub & Lee, 2012; Belussi, Sammarra, & Sedita, 2010; Fichter, 2009; Laursen, K, 2006).

3.3.1 Defining open innovation

Against this background Henry Chesbrough meant to explain this paradigm shift by introducing the notion of 'open innovation' in 2003. Chesbrough defined open innovation as a model in which firms commercialise external ideas by deploying outside (as well as inside) pathways to the market (Chesbrough, 2003b).

More recently, Chesbrough added an extra element to the definition of open innovation related to the firm's explicit intention to contribute to internal innovation through external input but also to help the market's growth by externalising inventions to competitors.

> [Open innovation] is the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation (2006: 1).

The view of open innovation from a business model perspective integrated to certain artefacts is key to Chesbrough's definition as this is clearly reflected in most recent publication:

> Open innovation processes combine internal and external ideas together into platforms, architectures and systems [and] utilise business models to define the requirements for these architectures and systems. These business models access both external and internal ideas to create value while defining internal mechanisms to claim some portion of that value. (2012, p. 21)

Literature suggests that there is mixed and inconclusive evidence in understanding the meaning of open innovation from a business perspective and this has led to scattered use of the term in different domains. For example, there is another definition of open innovation that builds on the concept of open-source software. Chesbrough (2012) argues that open and distributed innovation in open source software is not synonymous with open innovation as a business model. Open innovation has also come to be associated with other similar terms and applied to different contexts such as distributed innovation (Sawhney and Prandelli 2000), co-creation (Franke and Piller 2004) and customer-driven innovation (von Hippel 2005). This tendency to use the term slightly different within a multitude of contexts, while its basic meaning remains almost constant, may denote the increased transfer of the term to other sectors due to its perceived advantages but also it may characterise an evolution towards involving additional features that enhance its effectiveness and applicability. Others suggest (see for example (Giannopoulou, Ystrom, & Ollila, 2011; Lichtenthaler, 2011) that as yet there is not a conceptual framework that will support and guide firms to understand and use open innovation in practice and this results to see more than one way of implementing open innovation in firms.

For the purposes of the OpEx project, our focus in on open innovation from the business model perspective as its distinctive hallmarks are: 'more extensive, more collaborative, and more engaging with a wider variety of participants' (2012, p. 20) in general and in establishing and sustaining university-industry relationships via participatory platforms, tools and services in particular.

Fundamentally, open innovation suggests that the benefits firms gain from internal R&D activities have declined and subsequently firms now spend little on R&D; and knowledge and expertise is drawn from a wide range of external resources. It is perceived that the erosion in the strategic advantage of internal R&D might be related to dynamic markets, short product life cycles, increased mobility of knowledge workers and the role of university research in establishing collaborations with industry may prevent the firms to monitor, control and appropriate their R&D-related investments (Laursen, 2006). This is illuminated in Chesbrough's assertion of firms that are too focused internally are prone to miss a number of opportunities because many will fall out outside the organisations's current business or will need to be combined with external technologies to unlock their potential. Therefore, the central element of the open innovation model is how firms identify, implement and sustain knowledge and ideas of external sources in their innovation processes (Raymond & St-Pierre, 2010).

In contrast to the closed innovation model, knowledge and ideas flows may enter or exit in various ways, from internal research investigations or from partnerships with the public science base and other external players. Technology transfer is achieved through integrating external knowledge with tacit knowledge (technology insourcing) already existing in the firm Firms can make their way to market in many ways through firm's own channels, joint ventures, spin-offs or outlicencing whilst they decide for alternative marketing and sales channels. (Chesbrough, 2012) (see figure 3).

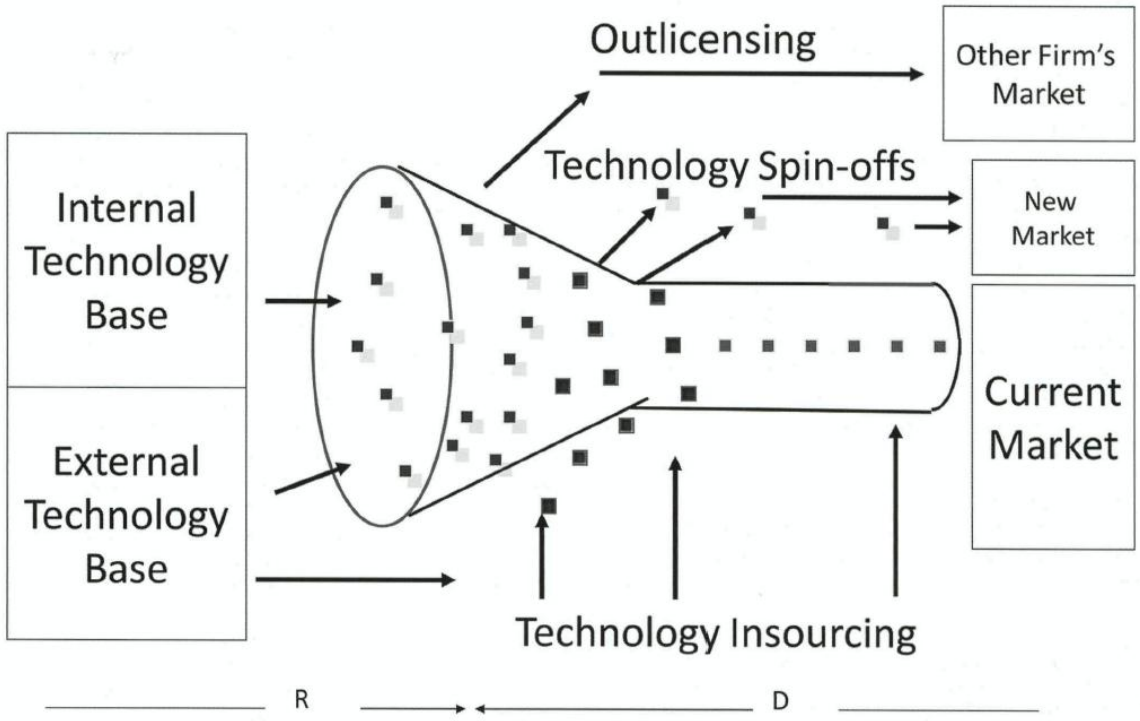

Figure 3: The open innovation model (Chesbrough 2012, p.23)

Reflecting on Chesbrough's model, we can understand open innovation as a form of external orientation for commercializing internal and external ideas that can be realized through transitioning from 'the not invented here' syndrome to 'proud to be found elsewhere' (Tether & Tajar, 2008; van de Vrande, 2009; Talaga 2009). West and Gallagher (2006) argued that for this transition to occur firms should consciously integrate external contribution with firm's capabilities and resources and broadly exploiting these opportunities through known and unknown channels. Laursen and Salter (2006) link this transition with innovative search strategies to shape innovative performance informed by increasing conceptual understandings of innovative search processes.

3.3.2 Open innovation frameworks

A number of open innovation frameworks (sometimes termed open innovation models) are used as the basis for designing and implementing open innovation. In addition, open innovation frameworks can be used as means to examining the applicability and implications of open innovation in firms but also in creating certain kinds of relationships between universities and industry. However, few, if any, of these frameworks provide guidance on the

steps and processes necessary to identify, develop and sustain open innovation as means to value creation and value capture processes (Fabrizio, 2009; Giannopoulou, Yström, Ollila, Fredberg, & Elmquist, 2010; Kolk & Püümann, 2008; Lazzarotti & Manzini, 2009). Many commentators (see for example Chesbrough and Appleyard, 2007; Schweisfurth, Raasch, & Herstatt, 2011) argue that current open innovation frameworks are partly inconclusive, overlapping and encompassing. It has been also coined that these frameworks encapsulate variations in meanings of 'openness' and bring to the fore different features that draw from various theoretical underpinnings resulting in lack of a shared understanding of how these frameworks can be applied in practice. This section illustrates a number of prolific open innovation models for understanding how they can be used as a way of steering methodological considerations to designing open innovation both for firms and universities.

Outside-in, inside-out and the coupled process

Chesbrough described two important approaches to open innovation. The *outside-in* and the *inside-out*. The *outside-in* (also termed *inbound open innovation*) approach to open innovation involves "opening up a firm's certain processes of open innovation to many kinds of external inputs and contributions." (Chesbrough, 2012: 21). This means firms that choose the outside-in approach are determined to collaborate with universities and other public research organisations, suppliers, customers, competitors etc. for creating new knowledge and ideas that can then be integrated into firm's knowledge (see figure 3). Chesbrough (2012) supports that this aspect of open innovation gained greater attention both in practice and in academic research. For successfully implementing the outside-in process firms need to possess and maintain the necessary capabilities and skills for integrating internal resources with external input of other members (e.g. universities, researchers, inventors etc.) Integrating external knowledge contributors and especially customers in internal innovation processes has been described in several literature streams and empirical studies (see for example (Harison & Koski, 2010; Kim et al., 2012; Kolk & Püümann, 2008; Spaeth, Stuermer, & Von Krogh, 2010) but not as much in collaborating with universities, other public research organisations and network partners outside the boundaries of the firm.

This overarching difference has been recognized by Dahlander & Gann, (2010) in terms of introducing two types of inbound innovation: acquiring and sourcing. Dahlander and Gann (2010) argue that there are qualitatively different ways in understanding openness and therefore it needs to be placed in a continuum, ranging from closed to open; thus presenting and identifying dimensions of variation in practicing inbound open innovation processes. More generally research evidence in open innovation has recognised that some aspects of open innovation may be closed and some other aspects may be open as the importance of identifying variation in conceptions of, and approaches to, open innovation among different empirical studies is increasing (Lazarrotti and Manzini 2009; Dahlander and Gann 2010; (Lameras, et al., Forthcoming). For example, Knudsen and Mortensen (2011) identified four types of openness: (1) *completely closed* (i.e. no utilization of internal sources besides members of the R&D team and no utilization of external sources), (2) *only internal resources* (i.e. no utilization of external sources, but utilization of internal resources) (3) *only external resources* (no utilization of internal sources but utilization of external resources) and (4) *completely open* (i.e. utilization of both internal and external resources). Pisano and Verganti (2008) focused on the outside-in innovation model from the perspective of identifying the degree to which 'membership' is open within and outside the boundaries of the firm. Different aspects of open innovation have been revealed from completely open innovation where the focus is on creating collaborations and links with actors and resources outside

firm's existing network, to closed innovation (e.g. within firm's known network) for maintaining trust and loyalty to firm's processes and practices. Lazzarotti & Manzini, (2009) identified four progressive variations of openness as the drivers of collaborative activities for open innovation. These ranged from: low partner variety and few phases (closed innovators), high partner variety and many phases (open innovators), high partner variety and small phase variety (specialized innovators), and low partner variety and large phase variety (integrated innovators). Dahlander and Gann (2010) identified three types of openness based on different degrees of formal and informal protection, the number of sources of external innovation and the degree to which firms are collaborating with external actors for shaping formal and informal relationships.

The outside-in model for the purposes of the OpEx project is characterized as the process of externalizing ideas and innovative processes through the use of intermediary technologies and platforms to interested contributors (i.e. researchers, academics and graduates) as a way of supporting internal capabilities, creativity and value creation.

Pisano and Verganti (2008) clarified that the term closed innovation implies an aspect of the open innovation model and it is not related with the traditional closed innovation approach proliferated by Chesbrough. (Praest Knudsen & Bøtker Mortensen, 2011) in a recent study focused on the closed aspect of open innovation in terms of allowing access to external collaborations only from those partners selected by the firm (i.e. private clubs as termed by Lazzarotti and Manzini, 2009). The results showed that firms could perform better by following a closed project model by outlining some (perceived) negative effects of openness to innovation whilst stressing that caution should be given when characterizing openness as effective or ineffective.

The *inside-out open innovation* (also referred to as *outbound open innovation*) "requires organisations to allow unused and underutilized ideas to go outside the organization for others to use in their businesses and business models" (Chesbrough 2012: 21). The essence of the inside-out model is the process of externalizing firm's knowledge and innovation as a way of contributing ideas and innovative products to the market (see figure 3). The inside-out process can contribute to increasing assets and revenues through commercializing inventions to a number of different industries and markets as shown in Figure 2.

Outsourcing or partnering may be characterized as a possible approach in penetrating new markets as fully-fledged innovations can be produced externally whilst gaining internal leverage. Outsourcing as means to promote and better understand the inside-out process can benefit also in other ways: by creating social networks for collaborative knowledge creation and dissemination, by providing access to emerging technologies and state-of-the-art scientific discoveries; re-invigorating certain organizational capabilities as well as gaining access to new areas of knowledge construction and assimilation (Kleyn, Kitney, & Atun, 2007). Outsourcing has also helped R&D firms to improve the communication and interaction with technical specialists from different sectors for accelerating the creation of links and relationships with diverse groups and the transferring of technology and ideas from other industries. However, outsourcing activities may sometimes substitute internal R&D activities as more radical innovations are being developed by outside partners that would be partially developed by the firm (Tether & Tajar, 2008).

It has been found the companies that choose to adopt the inside-out process are research-based firms for reducing R&D costs by outsourcing the risks of their supply chain while keeping some parts of the development process internally. However, it has been argued (see Chesbrough 2012) that this model is less utilised and understood both in industry practice and

academic research in comparison to the outside-in model. Subsequently, an increasingly important research strand to be investigated more widely with a diverse range of organisations is how the inside-out model is being practiced in congruence to designing, managing and promoting innovative products and the perceived benefits and outcomes for firms, the outside partners and the market.

In the context of the OpEx project, the inside-out process refers to creating partnerships and collaborations between firms and academia for technology and knowledge transfer as means of gaining certain advantages closely related to technology commercialization purposes. (Giannopoulou et al., 2010) stresses the importance of balancing the two approaches (i.e. outside-in and inside-out) to the firm's attempt to better structure its open innovation strategy.

In line with the need of balancing the two frameworks, Gassman and Enkel (2004) proposed the combination of the outside-in (absorbing external knowledge) with the inside-out process (externalizing innovations to the market) as the *coupled process* (see figure 4). For both to occur simultaneously, firms are open to form certain kind of partnerships such as spin-offs, joint ventures and strategic alliances as well as with universities and research institutes for coping with technology intensity, technology fusion and knowledge leveraging (Gassmann, 2006). Therefore, co-creation with complementary partnerships is fundamental for jointly develop and commercialise innovation. Benefits of adopting the coupled approach may include: collaborating knowledge construction and the creation of communities of practice as means of situative learning in authentic contexts (Su and Lee, 2012). For the purposes of the OpEx project, the coupled process will be used as the overarching framework for modelling the conceptual design and architecture of the OpEx marketplace in terms of obtaining purposeful knowledge flows between industry and academia and vise versa to shaping inter-organisational networks.

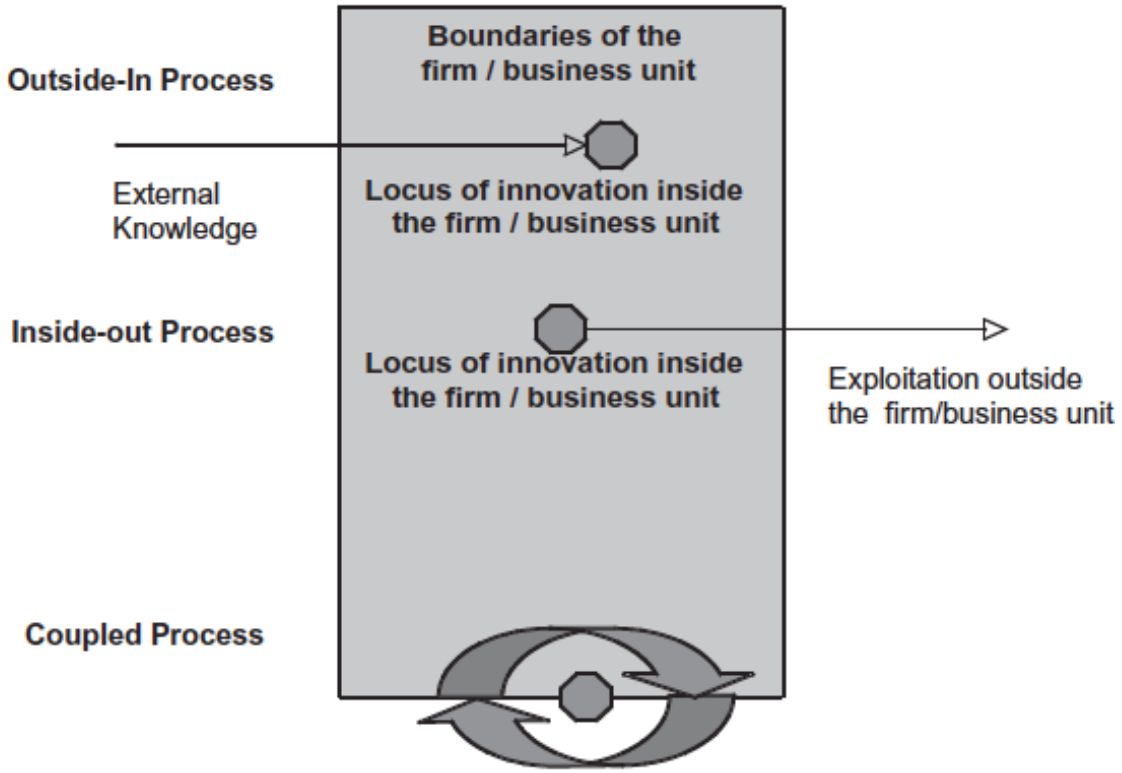

Figure 4: The outside-in, inside-out and coupled process (Conboy and Morgan 2011, p.539)

Absorptive capacity

The main contribution of the OpEx project is to offer an online market place that would act as driver for establishing and sustaining competitive advantage by utilizing external knowledge, and knowledge to generate certain innovations proposed by the users (i.e. company managers, academics, researchers and students) of the platform. This contribution is drawn from an extensive body of literature suggesting that innovation must be regarded as resulting from distributed inter-organisational networks, rather than from single firms (Chesbrough, 2011; Dreyfuss, 2011; Malik, Georghiou, & Grieve, 2011; Sørensen, Mattsson, & Sundbo, 2010; Spaeth et al., 2010; Westergren & Holmström, 2012). Nevertheless, knowledge creation and ideas generation within the OpEx online marketplace platform might be potentially benefitted from localised knowledge spillovers and collaborations with firms in the same industry. Especially, if the firm is active in the area of science and technology, the ability to identify, assimilate and exploit relevant knowledge that exists on the online marketplace may be related to the firm's use of that knowledge for creating innovation. This is especially relevant to the outside-in model of open innovation (Fabrizio, 2009; Mortara & Minshall, 2011; Spithoven, Clarysse, & Knockaert, 2010) and relates to the conceptualization of absorptive capacity as put forth by Cohen and Levinthal (1989, 1990). Absorptive capacity focuses on the increasing ability of a firm to identify and use external knowledge but also it highlights that external knowledge is useful only to those firms that have developed the necessary processes and strategies to make use of that knowledge. Lane et al., (2006) argued that there are three sequential processes in order for external knowledge to be identified, utilized and exploited: (1) identifying and consolidating relevant knowledge outside the firm via exploratory learning; (2) assimilating new knowledge through transformative learning and (3) creating new knowledge from the assimilated knowledge and commercializing it through assimilative learning.

Focusing on the firm's ability to access sources of external knowledge does not necessarily limits the activities that are taking place within the firm. This is consistent with the notion of 'connectedness' to outside experts (especially specialist knowledge providers such as researchers and academics) for gaining access to emerging technologies and innovative ideas that have not reached the market yet. Therefore the firm's 'network' of collaborations and connections with universities and associated researchers may increase sources of knowledge and thereby the outcomes of inventive performance. However, according to (Camisón & Forés, 2011) the analysis of the knowledge development process must also consider two sub processes: *internal knowledge creation* and *external knowledge absorption*. *Internal knowledge creation capacity* can be understood as the skills and competencies associated with the creation of collaborative processes within the firm as means of continuous learning. Firm's internal knowledge is normally created through R&D investment and internal problem solving as well as through employees' abilities, experience, education, and the skills they acquire during their employment from their interaction with other employees with different experience and knowledge bases (Camisón & Forés, 2011). A firm's *external knowledge capacity,* which does not substitute but it supplements the outside-in model involves the usage of mechanisms through which knowledge outside the firm is identified, acquired, assimilated transformed and applied.

We suggest therefore that the level of absorptive capacity generated by firms and their internal research processes may influence the ability of the firm to identify and make use of connections to external knowledge sources. The use of the OpEx online marketplace is likely to be of benefit to firms with superior internal research knowledge in terms of identifying,

acquiring, assimilating and transforming knowledge and ideas generated from university scientists and researchers.

Innovation communities

The role of communities in discovering, creating and disseminating innovations has been increasingly emphasized in open innovation research (see for example special issues in industry and innovation 2008; R&D Management 2009; Research Policy 2003; Organisation Studies 2007). It has been argued that "communities and their role in the innovation process both fit within and offer an opportunity to extend the company-centric concept of open innovation" (West & Lakhani, 2008). However, open innovation research presents mixed, inconclusive or overlapping results on the role of collaboration and networking across organizational boundaries. The existence of *innovation communities* can contribute to a source of innovation that is communally designed and implemented. Individuals in these communities may be able to create innovations into the firm but also they can come up with new perspectives on and ways of framing the problems (Dahlander, Frederiksen, & Rullani, 2008). Against this background firms are beginning to perceive innovation communities as strategic assets that provide external expertise, develop ideas and support innovation development. (West & Lakhani, 2008) defined a community as a voluntary association of actors not working in the same firm but united by a shared instrumental goal. In particular to creating communities for open innovation, Fichter defines innovation communities as:

> […] an informal network of likeminded individuals, acting as universal or specialized promotors, often from more than one company and different organisations that team up in a project and commonly promote a specific innovation either on one or across different levels of an innovation system (2009: 360)

Innovation communities are distinct from other types of communities such as from scientific communities, and technical communities (Stam, 2009) or other communities that follow specific professional interests aiming to support specific scientific topics of innovation. To this line innovation communities are not a synonym with communities of practice (see for example Lave and Wenger (1991)) but are a specific type of communities that are related to the design, use and sharing of innovation projects. Innovation communities are not also related to user innovation networks that encompass the user generated model as the basic distinction is the cultural and social identity imparted in communities (Schweisfurth et al., 2011) More specifically, Fichther (2009) differentiated innovation communities in terms of: (1) a specific innovation idea or project; (2) the promotor's role of each community member; and (3) the informal nature of collaborations and the feeling of group identity (see figure 5).

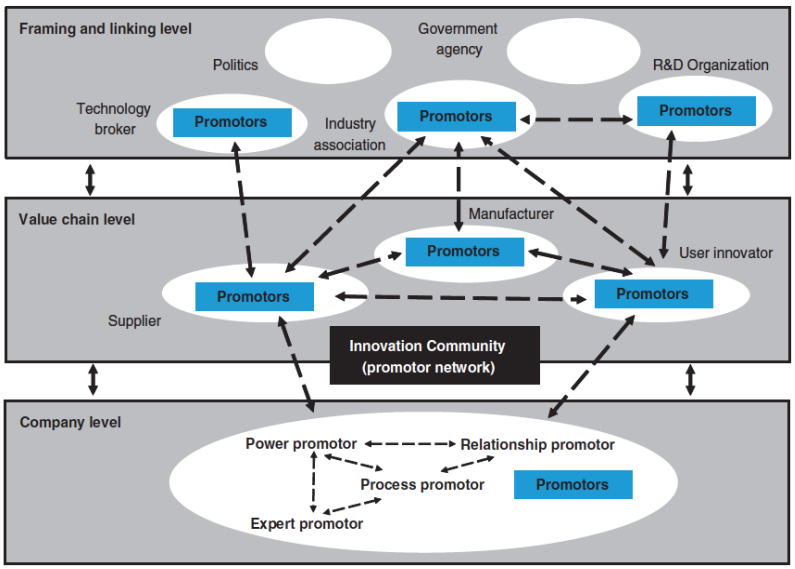

Figure 5: Innovation Community as a network of promotors (Fichther 2009, p. 361)

Research evidence has identified a number of ways that innovation communities can be formulated and promoted for the purpose of collaboratively creating an innovation product. For example, the creation of *change agents* can positively influence the adoption of an innovation community and thereby the creation and dissemination of an innovative product. In the context of an innovation community a change agent could be end-users helping in adopting an innovation by convincing the hosting organization of the innovation community, to adopt the innovation (Di Gangi & Wasko, 2009).

Despite the perceived benefits of innovation communities, there are also a number of challenges for managing innovation communities. (Dahlander et al., 2008) identified such challenges in relation to: managing online communities and the participating individuals who may sometimes be beyond the firms' hierarchical realms as work processes are more flexible, making difficult for firms to steer direction of development. This may increase the resources that firms have to invest in such communities and may increase the risk of such investments. In addition a vast number of individuals with different goals and misaligned skills and with diverse degrees of involvement may raise issues of governance of online innovation communities.

Crowdsourcing

Inter-organisational relationships have always been the hallmark for external use of innovation and for co-creating value. Inter-organisational relationships frequently involve the collaboration of people and teams with expertise in different domains. These relationships however can be viewed as different stages of open innovation. Exchange of knowledge and collaborative engagement with external entities that are already known to the firm's network can be perceived as only an initial stage in the developmental process of open innovation. Such relationships for example may rely on existing connections and interactions that may prevent new collaborations within a wider range of networks. More developed forms of open innovation may encompass the use of different networks with specific expertise in certain fields that would necessitate for firms to re-think collaboration models and intellectual

property strategies as part of an overall cultural change (see figure 5). This would have an immediate feedback on firm's absorptive capacity in terms of exploiting knowledge flows between external sources with which the firm does not have a pre-existing relationship. These more developed collaborative processes and strategies are in line with the creation and nurturing of online innovation communities as means to access specialized knowledge and expertise that may not be available through hierarchical and traditional business innovation relationships. Research evidence from the literature has strengthened the need for retrieving and incorporating knowledge from unknown networks and individuals for the acquisition of innovation capability beyond a firm's known connections and networks.

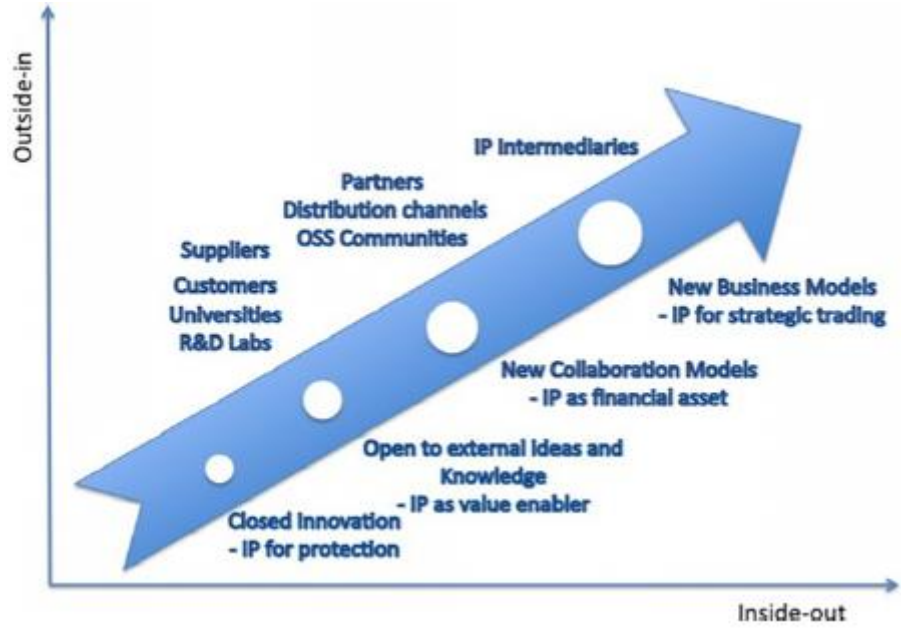

Figure 5: The evolution of open innovation (Feller et al., 2011, p. 2)

These kind of collaborations, through direct or mediated means describe a form of collective intelligence that is enabled by new technologies; particularly Internet connectivity and they represent a form of *crowdsourcing*. Crowdsourcing is the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in the form of an open call (Howe, 2010). It is clear from this definition that crowdsourcing refers to the involvement of different actors outside a firm's boundaries into concrete steps of the firm's innovation process. A common example of crowdsourcing in peer-production settings as means of harnessing collective knowledge toward creating innovative solutions is presented by Lakhani et al., (2007). Crowdsourcing can be regarded as a strategy with great potential for creating open innovation strategies and is particularly useful for the design of *innovation intermediaries* (see for example Lakhani et al., 2007; Feller et al., 2011). Innovation intermediaries help firms to use external information and knowledge and external actors (inventors, public research organisations etc.) to find a market to market their ideas. Such intermediaries (e.g. Fellowforce[2]; InnoCentive[3],

[2] http://www.crunchbase.com/company/fellowforce

[3] http://www.innocentive.com/

YouEncore[4], NineSigma[5]; Innovation Exchange[6] etc.) can help firms to find external actors with specific skills for taking over specific innovation tasks and can also support a large demand of external innovators to offer their experiences and skills. However, although there is evidence on effective brokerage by using such kind of online intermediaries, little is known about specific aspects of operation or the types of searching processes for knowledge and people that prevails in online crowdsourcing processes supported by such systems.

The crowdsourcing principle could be adopted for the design and implementation of the OpEx marketplace as means for creating a pool of ideas, resources and skills from a large undefined group of people (academics and business people) collaborating together for creating innovative solutions.

Search principles through crowdsourcing for technology transfer

The role of search in helping organisations to find sources and people through crowdsourcing mediators is highlighted in innovation literature because it may provide opportunities for firms to choose among different people with diverse skills according to desired technological paths. Search strategies can be influenced by the richness of innovation opportunities and investments in searching mechanisms for searching more widely and deeply for accessing critical knowledge and skills. Searching processes have also become key element in explaining innovative performance from the firm's external innovative search efforts (see for example Laursen, 2006).

As described in previous sections the fundamental element of open innovation is based on opening up the innovation and development process, while searching and retrieving knowledge to a diversified extent. The process of searching information through unknown external actors is termed by (Lakhani et al., 2007) as the principle of *broadcast search'.* Lakhani et al claim that for the broadcast of search to be effectively applied an innovation challenge or problem is tendered to wide range of interested innovators and specialists by means of an 'open request for collaboration' in order to contact unknown actors for negotiating the possibility of conducting relevant work by offering appropriate incentives. Employees inside the company are expected to contribute to the task solution by searching for information and knowledge through networks that already known to them.

Against this background, broadcast search is applicable to technology transfer and technical knowledge (i.e. knowledge that is derived from R&D work). For example a firm assigns a research problem, which has been (partially) addressed internally, to an innovation community network that consists of high-skilled individuals through publishing an open request for collaboration. An open request is related to the publishing of the problem or issue to a wide range of people who decide according to their own skills, experiences and knowledge how to address the problem as well as if they intend to come to an agreement for resolving the problem with the firm.

The broadcast search principle contradicts with the traditional form of knowledge transfer in a way that the latter implies the storage of knowledge in databases which require traditional

[4] http://www.yourencore.com/

[5] http://www.ninesigma.com/

[6] http://www.innovationexchange.com/

searching methods (e.g. through keywords or Boolean proximity operators for advanced searches) which require data to be retrieved from a mass of data resulting in information overload and time-consuming processes. In addition knowledge in databases is not updated constantly and are not informed by the state-of-the-art information already available on the Web. This may create problems in terms of using knowledge in databases in different contexts, as it may not be applicable outside its primary origin. On the other hand the objective of open innovation which complements the principles of broadcast search is to transform external contributors to problem-solvers for tackling complex and ill-defined problems that emerge from industries.

Collaboration, motivation and negotiation of knowledge and ideas are central components in broadcast search (see figure 6). As Hilgers, (2011) points out the objective of the firm is not only to resolve the problem but also to formulate the appropriate questions and bids as to attract as many problem-solvers as possible.

The OpEx online marketplace therefore could be designed in such a way as to encourage its members to adopt a broadcast search approach in order to discover and retrieve information but also to bring together motivated problem-solvers from academia and industry for working collaboratively on resolving a complex problem.

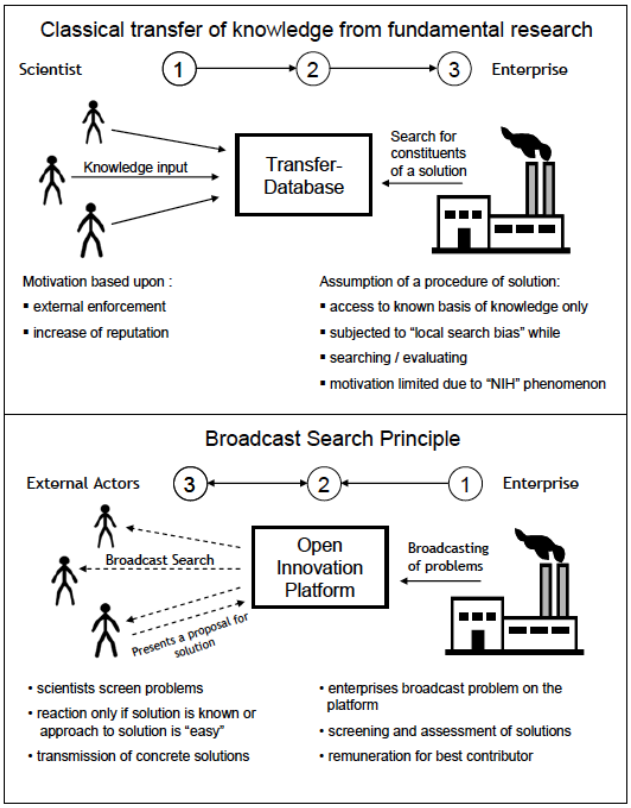

Figure 6: Traditional knowledge and broadcast search principle (Hilgers 2011, p. 114)

3.4 Best practices in open innovation

Open innovation practices involve actual implementation of specific strategies, and processes that firms deploy for creating value through internal and external collaborations. This requires firms to make informed decisions about: internal and external collaborations, type of external actors (i.e. universities, suppliers, customers, competitors etc.) which may have the

competencies and skills for contributing to a firm's innovation requirements or to further improve innovations that the firm has already developed. The complexity of the nature of these collaborations includes: aspects of time (e.g. temporary periods of developing a project), different groups of organizations that have different roles within the project from different departments (from R&D to logistics, production, human resources etc).

Our approach for identifying effective open innovation processes is through case studies identified from the literature for providing suggestions in terms of how other firms can conceptualise and deploy open innovation. In this section therefore we present a limited number of open innovation best practice examples from different types of industries identified in the literature that would shed light in understanding the use of open innovation and thereby the necessary changes that need to be made in a company's business model than merely adopting a few innovation practices.

Procter and Gamble (P&G) in 1999 initiated a new strategy to increase growth and capital investment by using an open innovation approach called *organization 2005*. The aim of '*organization 2005'* as described by (Dodgson etal., 2006) was to introduce, implement and sustain the open innovation paradigm by transforming P&G's internal isolative communicating processes to cohesive practices that would involve the engagement of external actors in conjunction to internal resources and practices. Several P&G commentators argued that by launching 'organisation 2005' a culture of sharing ideas and resources amongst people would emerge. Therefore, R&D processes would be transformed to *C&D – Connect and Develop*. The Connect and Develop concept was a key element for organization 2005. Business executives from P&G stated that 'innovation is all about making new connections and combining new knowledge in new ways or bringing ideas from one context to another. Recognising that many of P&G's solutions to innovation problems were solved from external contributors was a fundamental step to the creation of C&D. P&G realized that for its 7,500 R&D staff there were approximately 1.5 million individuals with specialist knowledge and skills around the world working in science and technology. The challenge was to create the appropriate search processes in order to find those individuals as well as to change the current internal culture so as to encourage collaboration with external sources for accomplishing a common goal. P&G implemented a strategy for growth through open innovation and open innovation through building connections with external people and resources. Dodgson et al., (2006) argue that P&G had to change its entire business model in order to enact open innovation. Changes in organizational practices and technological media were necessary for implementing open innovation. For example P&G was protective about its IP and patents and always concerned about outlicensing. As a result of its C&D strategy, P&G aims to create innovation through collaborative knowledge creation with external partners in at least 50% of cases. P&G has also created a Technology Acquisition Group (TAG), which explores and applies new complimentary technologies from external sources as well as licensing P&G's ideas as means to increase its return on investment. P&G has instantiated other initiatives including the acquisition of entrepreneurial companies and the development of internal seed funds. These strategies reveal P&G's intentions to change its organization and culture and its determination to bring ideas from outside sources exploiting the entrepreneurial advantages of small firms. As part of the C&D project, P&G used a number of technologies for facilitating the creation, utilization and transfer of ideas and information across organizational boundaries. The technologies range from data searching and mining, simulation and modeling, and virtual and rapid prototyping. Dodgson et al., (2006) termed this type of technologies "*Innovation Technologies"* used for creating innovation.

Another example of practicing open innovation comes from the automotive industry. Kuschel, et al. (2011) describes the case of VOLVO and its interpretation of open innovation. The authors summarise VOLVO's efforts to externalize its R&D outside of the organizational borders as follows: In 1999 the company decided to spin-off its ideas on vehicle development in collaboration with other companies. The objective was to create a company that would strengthen the development of vehicle services such as the *Wireless Car*. As the spin-off company takes form, it aligns with Chesbrough definition of open innovation presented previously. The setting facilitated ideas and knowledge between internal and external actors, although is has been regarded as having a rather strict business model based on control over all revenue streams. However, the spin-off created a shared communication platform where new services and processes were added. The authors mapped the WirelessCar case in congruence to open and closed innovation principles (see table 2).

Closed innovation principles	*L*	*Volvo case with WCar*	*R*	*Open innovation principles*
The smart people in our field work for us.		The triad did assume that by opening and forming Wcar synergies would be greater than if they only would have formed and controlled a strategic alliance.	XX	Not all the smart people work for us. We need to work with smart people inside and outside our company.
To profit from R&D, we must discover it, develop it, and ship it ourselves.		Wcar should be the driver for R&D, backed up by the external R&D from the triad participants.	XXX	External R&D can create significant value: internal R&D need to claim some proportion of that value.
If we discover it ourselves, we will get it to the market first.		Even though Volvo had great experiences in vehicle services, it was obvious that additional knowledge would strengthen the development.	XX	We don't have to originate the research to profit from it.
The company that gets an innovation to the market first will win.	X	Wcar was set-up with an assumed business model and had no intent to change that business model.		Building a better business model is better than getting to market first.
If we create the most and the best ideas in the industry, we will win.		Wcar were merging ideas from the triad organisations, however, less from other organisations.	X	If we make the best use of internal and external ideas, we will win.
We should control our IP, so that our competitors don't profit from our ideas.		Wcar has opened up for other players to contribute to usage and improvements of next generation telematics protocol.	X	We should profit from others' use of our IP, and we should buy others' IP whenever it advances our own business model.

Table 2: Open and closed innovation principles in relation to the WirelessCar Case (Kuschel et al 2011, p. 134)

Chesbrough & Garman, (2009) provided a series of best practices examples to demonstrate how firms apply the inside-out approach as it may provide certain advantages for companies, although as noted previously it is the less-utilised approach. The authors refer to the example of BT (formerly British Telecom) to describe how the firm nurtured new supply and partnership relationships. Since 2003, BT has formed partnerships and relationships with venture capital investors for launching spin-off companies that produce key parts of larger offerings from BT to its customers. BT needed to be top provider of network services and not building hardware or software products. Becoming a customer or supplier of internal projects may reduce costs or risks as advocated by Chesbrough and Garman. As an example, the

authors describe how Eli Lilly with the project Bounty Chem could improve sourcing of external ideas for developing new drugs. This contributed to the development of InnoCentive and became Lilly's first customer. The costs and services of InnoCentive were distributed and shared by a number of customers and outside inventors. As a way of letting others to develop a firm's initiatives, Chesbrough and Garman described the case of Lucent Digital Video. The company spun-off a separate venture that demonstrated that Asian countries such as China are willing to accommodate the development of technological products. Lucent was able to profit by identifying another market that was willing to fund and manage the project. As part of making a company's IP available to others, Chessbrough and Garman brings to the fore the example of Philips that has spun-off its semiconductor business and now focuses on healthcare and wellness markets. This shift allowed the company to use some of its ideas and IP assets for strategically integrating open innovation and to extract some more value from R&D. As a way to grow firm's ecosystem even if the firm is not growing, the authors present the case of Unilever. Unilever as a global consumer products and health care company has developed a wide range of eco-system related open innovation processes. Incubators are used for identifying and nurturing projects that have commercial potential but are not ready for one of its business. Unilever either adopts the offspring of its incubators or from any of its spin-offs that search for funding for possible commercialization. This benefits the people who work in R&D as they see their products to enter in new markets and capitalize profits thus; the company adds new partners to its ecosystem. An example of an incubation project is MiLife, which aims to future market collaborations between MiLife and centralised Unilever brands. Chesbrough and Garman argue that firms need to create open domains to reduce costs and expand participation. As an example of this, the authors present the Merck Gene Index Project. The company realised that many new biotech companies wanted to patent central parts of the genome. Such patents would prevent Merck and other pharmaceutical companies to develop and commercialize new drugs for genetically related issues. To overcome this problem, Merck has funded a number of university-based human genome projects for publishing related findings. This strategic move allowed the Merck Gene Index to be a key part in the public domain where all companies can use it but no one can patent specific gene sequences and impede drug development.

Thomke & von Hippel, (2002) analysed and presented the case of International Flavors and Fragrances (IFF) in the context of the food industry sector. The company supplies flavors to the food industry and it managed to outsource part of its new product design to customers. IFF developed a customer innovation web-based tool-kit including a vast database of flavor profiles where customers can access in order to design and change flavor samples and customize the flavor according to their own needs. This allowed IFF to produce customizable products as well as minimizing costly research activities that would result to accelerate the trial-and-error cycles at the product development phase. IFF increased its knowledge base through understanding and applying customers' designs while decreasing costs and risks. Similarly, van Haverbeke & Cloodt, (2006) described how Calgene, a biotechnology R&D firm, created a network of interrelationships with farmers, legislators, consumers and packers to access assets and provide guidance and support for the development of a genetically modified tomato for the food market. Calgene as a small company cooperated with other companies that were able to develop and commercialize a wide range of foods despite of the uncertainties inherent to the launch of genetically modified foods. Company's participation to a wider innovation community with larger and more experienced companies enabled Calgene to understand better the process of product innovation through gene-modification technology and to leverage the initial low levels of public acceptance and profit margins.

Hilgers (2011) provides an overview that depicts a number of successful open innovation approaches from different companies with a special focus on externalizing parts of their business processes to external sources emphasizing the need for collaboration and value co-creation (see Table 3). Hilgers notes that the table provides insight to business managers and general practitioners alike in terms of understanding how openness towards external contributions has been proven to offer unprecedented benefits and growth. The approaches illustrated in the table are different from each other in terms of using different tools and resources for initiating open innovation.

Phase of value creation	Company	Issue	Mechanism	Result
Idea generation	Ideacrossing.org	Ideacrossing has specialized on the organisation of major ideas competition for other companies (open innovation intermediary)	Ideas competition to gain ideas for technical but also social and market innovations.	e.g. Development of a concept of "green" hotel rooms for Hilton, development of a sales strategy for the Chinese market for the software company RedHat.
Concept and product development	3M	Development of a new formula for an adhesive.	Use of the intermediary NineSigma to transfer a description of a problem by means of a so-called request fro proposal (RFP) on the Nine-Sigma platform to a wide network of experts.	Reception of five different proposals for solution on the Nine-Sigma platform resulting in radical product innovation at 3M in the form of an oil- and water-resistant adhesive.
Concept and product development	Open Street Map-Project	Creation of a free of charge world map (creative common licence) from data of mobile GPS devices provided or traced on the basis of satellite images by users.	Commons-based-peer Production / collaborative project	Development of new maps including city maps and world maps, amongst others as an alternative to Google Maps.
(Scientific) product development	Nasa Clickworkers	Mars Clickworkers is a pilot project initiated by the NASA Ames' Research Center which intends to confide scientific routine work to interested laypersons. The purpose of the project is to mark and classify craters on exposures of the Mars. Similarly; stardust@Home which is aimed at the identification of interstellar dust clouds or foldit and at the identification of the folding of proteins.	Commons-based-peer production: release of high-resolution photographs of the Mars sensor "Mars Reconnaissance Orbitor" classified and identified by 200.000 individuals (the automation of this task was not feasible due to missing algorithms).	Development of a new map of Mars within less than 15 months; the pre-estimated investment amounted to 1000 man years.

Market test/ product development	Threadless	A highly successful company in the USA in 2000 imprinting and selling T-shirts.	The particularity of the business strategy is the crowd sourcing of all substantial value creating tasks to customers, i.e. customer design the T-shirts and generate ideas for improvement for the draft of other customers: they screen and assess all drafts and select those ones out of the conception which are supposed to be produced.	With a workforce of only 25 employees Threadless realized a revenue of 30 million US$ and a profit of 9 million US$ in 2007. Sales volume is more than 50.000 T-shirts a month with hundreds of accepted designs.
Market phase	Netflix	Netflix is the largest DVD rental agency in the USA / 7 million subscribers). Search for an improved algorithm for the generation of recommendations for DVDs within the database of the company (films, etc).	Open tender of problem (including a remuneration of 1 million US$) (Crowdsourcing): The first person to improve the algorithm by 10 percent receives 1 million US$.	Improved algorithm significantly reducing the probability of error of a wrong recommendation. Fundamentally new method to gain recommendations on basis of psychological factors.

Table 3: Successful examples of implementing open innovation (Hilgers 2011, p.111-112)

Hilgers argues that intermediaries such as InnoCentive or Ideacrossing [7]initiated the process of opening up the innovation process for the companies illustrated by the table. These ideas have been published at their early stages and they have been based on the *broadcast search principle* described previously. Another best practice example as means of strengthening and extending networks with known and (possibly) unknown contacts in LinkedIn[8]. LinkedIn is a business oriented social network that it is used for professional networking. Individuals are able to search and create professional relationships with people whom their skills match with an associated project or innovation. After users create a profile that briefly summarises academic and professional experience, they can create connections by inviting different people. The different types of connections can be realized in different ways: Meeting unknown people through a mutual friend; Finding jobs and business opportunities directly through employers and/or through recommendations made from an individual's network.

[7] https://www.ideacrossing.org/default.aspx

[8] http://www.linkedin.com/home?trk=hb_home

3.5 Benefits, challenges and enabling conditions

Published research on the effectiveness of open innovation approaches includes inconclusive, mixed, or negative results. Nevertheless the overarching conclusion is that there is a sufficient body of evidence to demonstrate significant gains in comparison with traditional innovation approaches.

For example Chesbrough & Crowther, (2006) conducted an interview-based study for exploring firms' motives in adopting open innovation. The authors found that firms were positive to adopt open innovation strategies for external technology acquisition as means to develop and maintain growth. It was perceived that important entrepreneurial values such as revenues and growth are the most essential motives of enterprises to practice open innovation. Wang et al., (2012) investigated the impact of open innovation on national systems of innovation and concluded that a number of benefits can be derived from applying open innovation on national systems including: increase of effectiveness; network diversification and reinforcing the importance of co-creating value. Westergren & Holmström, (2012) argue that the adoption of the open innovation model can benefit the firms to develop a culture for knowledge sharing, building a trustful environment, and a constructive use of technology.

Giannopoulou et al., (2011) explored how managerial implications for open innovation such as 'organising for openness', 'co-creating value', 'leadership for diversity' and 'intellectual property management' may influence the adoption of open innovation in firms. It has been argued that the fundamental challenge of successfully implementing open innovation is of convincing managers and practitioners to achieve a conceptual change by allowing and maintaining a culture of openness through open science and free revealing processes:

> '[…] The day organizations from the bottom all the way to the top believe in the open paradigm, instead of protecting and preserving their intellectual assets with every mean they have, we have truly established a new business model' Giannopoulou et al (2011: 519).

Nevertheless, Gassmann, (2006) notes that there is a need for a contingency approach regarding the management of open innovation. This is mainly because the internal processes by which companies manage open innovation is still trial and error than a professionally and sustained managed process. There is a need therefore to provide guidance and support to open innovation practitioners for making informed decisions in terms of how to use open innovation and the different aspects that defines it. Huisingh refers to this as:

> 'What is missing is a decent cookbook, an integrated framework that helps managers to decide when and how to deploy which open innovation practices. In what stage of the innovation process is collaboration most effective? With which parties to collaborate, and how to find and select them? What is the best way to capture value in collaborative networks especially when formal protection methods are less feasible e.g. with service innovations or small firms?' (2011: 7)

To incorporate these questions to designing an integrated framework for open innovation may require managerial practices to be aligned and focused with overall business objectives. Two main challenges are connected to this: The not invented here syndrome which can be addressed by realizing that internal efforts are not sufficient to meet objectives and thereby building organizational commitment to an open innovation approach (Chesbrough and Crowther, 2006). The second adoption challenge for open innovation is to develop and sustain internal commitment to realize the benefits of open innovation principles (ibid.).

Some other important challenges are identified from Talaga (2009) which are closely connected to: (a) setting-up an open innovation strategy (b) requirements definition (c) internal business engagement (d) aligned internal view of how to manage IP (e) explore all kind of open innovation providers (f) partners meeting firm's expectations (g) partners share same business philosophy (h) and respect the needs of partners. Mortara & Minshall, (2011) investigated how companies are currently adopting open innovation across several industries through a qualitative inductive method with forty-three multinational firms. The challenges that were found depend on the firm's *innovation needs, the timing of the implementation and the organizational culture.* Chesbrough and Crowther (2006) also found that early adopters of open innovation do not create new processes and metrics rather they tend to add open innovation instances onto existing processes and this might have a negative influence in terms of losing its distinctiveness.

Pera, (2009) on behalf of the Joint Information Systems Committee (JISC) conducted a feasibility study on open innovation and identified twenty-six key conditions, which enable the widespread use of open innovation for co-developing value. The conditions inform our analysis and synthesis of the relevant open innovation themes, models and principles described in this document. These can be summarized as follows:

- Developing intrinsic innovation among staff
- Value creation
- Effective systems for accessing information
- Absorptive capacity
- Ambidexterity (i.e. ability to balance managing operations and R&D)
- Marketing capabilities
- Financial incentives
- High Quality IP systems and organized diffusion of business results
- User innovation
- Customer relationships
- Human capital
- Support for interaction
- Alignment of agendas
- Technology markets
- Use of intermediaries
- Regional clusters
- Access to private finance
- Public procurement of R&D and its outcomes
- Implementation routes for commercial and non-commercial application
- Appropriate funding levels
- Focus on quality
- General stimulation
- Entrepreneurship education
- Flexibility, expertise and commercial roles
- Global connections

3.6 Open innovation through university-industry collaborations

The basic focus of the OpEx project is to create an online marketplace that will work as an intermediate platform that will allow connections to be created and maintained between firms and universities for the purpose of commonly pursuing an innovation project. This section presents and synthesizes relevant issues surrounding the creation of university-industry relations as well as the tools that may be used to foster such relationships for open innovation. It is clear that technology transfer is a key driver for innovation and socio-economic development. It is realized mainly through a firm's R&D as a result of the development of new products and services. However, in order for a firm to have access to state-of-the-art technological innovations that are informed through scientific research, firms need to establish collaborations with public research institutions and universities. The process of approaching scientific outcomes as means of acquiring technological innovation is known as university-industry collaborations (Bruneel et al., 2010; Dalmarco et al., 2011; Kafouros & Forsans, 2012; Perkmann & Walsh, 2007; Pinheiro & Teixeira, 2009; Teixeira & Pinheiro, 2010).

For understanding better the nature of this relationship, scarce research evidence concentrates not only in exploring the conditions for creating such relationships (e.g. Westergren & Holmström, 2012) but also investigating the different characteristics and dimensions of knowledge and its implications for the success of cooperative R&D projects (e.g. Niedergassel & Leker, 2011). However, according to a meta-analysis in various themes of open innovation, there are very few, if any, studies that explore the theme of university-industry partnerships omitting to analyse the benefits of such relationships as well as the mechanisms through which companies could obtain competitive advantage from utilizing open innovation based on relationships with universities (Pinheiro & Teixeira, 2009). From an empirical point of view, evidence with regards to the development, sustainability and evolution of university-industry relationships and the way by which they obtain and exploit benefits from such relations is missing (Perkmann & Walsh, 2007; Teixeira & Pinheiro, 2010).

For helping researchers and practitioners alike to focus more on university-industry relationships for open innovation, Perkmann and Walsh (2007) proposed a framework that distinguishes university-industry relationships from other processes such as technology transfer or human mobility. The importance of the role of practices such as collaborative research, university-industry research centres, contract research and academic consulting are also described as different forms of collaborations. Furthermore, Perkmann and Walsh make a distinction between university-industry *links* and university-industry *relationships*. The former focuses on transfer of technology and IP as channels through which information and other resources are co-produced and shared across university and industry. The latter focuses on interactive innovation processes as for example through sponsoring studentships or internships. The OpEx project focuses on both processes, as through establishing links, technology transfer and IP issues will remain to practitioners' awareness when creating links with the academia or industry. By creating relationships, we believe that both parties (i.e. managers, teachers, researchers, students etc.) will aim to create intrinsic relationships by transferring generic skills and competencies, such university graduates searching for employment in industry. It has been argued that the inclusion of university graduates to interested firms for employment purposes may have a positive impact in creating university-industry relationships. For example, Tether & Tajar, (2008) presented a number of advantages for firms in terms of forging relationships with university graduates: firstly university

graduates tend to occupy the same social worlds as scientists and researchers working in firms; secondly graduates have the ability to span boundaries and engage with different communities and therefore can be valuable in accessing knowledge and information being generated in universities.

To support and guide entrepreneurs, managers and academics to create partnerships and collaborations that will result in co-developing ideas, projects and innovations, de Freitas et al., (forthcoming) developed the Innovation Diffusion Model (IDM) which aims to bring together some overarching open innovation models (inside-out, outside-in, crowdsourcing etc) to accelerate innovation between industry sectors and academia. The IDM aims to accelerate the processes of open innovation through the proximity of academia and industry, by giving special emphasis to creating synergies through national and international funded projects, summer schools, conferences, international collaborations and the use of pervasive technologies for creating rich-mediated interactions (see Figure 7).

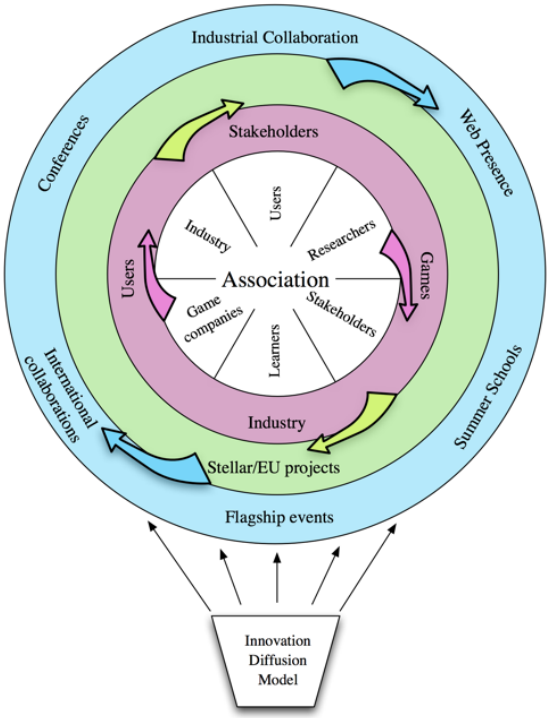

Figure 7: Innovation Diffusion Model pushing up the three-step approach (de Freitas et al., forthcoming)

3.6.1 Factors that influence collaborations between universities and industry

An important parameter for creating university-industry partnerships is collaboration. By initiating such relationships, both parties aim to enhance their value creation processes through aligning their value chain with scientific and research-oriented innovations. Researchers and scientists working in universities are becoming more-interested in field testing and translating their prototypes into products ready for commercialization (Minshall et al., 2007). In addition there is prevailing interest from governments in Europe and beyond in supporting and fostering university-industry interactions as key input to innovation by transforming research outputs to tangible products. On the other hand, industry is interested in relationships with academia for gaining expertise and knowledge that can be applied for the development of innovative products.

Certain types of strategic partnerships and alliances are being formed for university-industry collaborations. For example in the pharmaceutical sector, outsourcing or sponsorship is no longer seen as the appropriate types for open innovation collaborations (Lessl, 2010). The objective is seen as not only to transfer results from academic to industry but also to establish innovation and multidimensional networks that foster the creation of complementary skills, collaborative knowledge creation and learning integration (Bruneel et al., 2010). Rewards and novel risk models are currently implemented for achieving a conceptual and practical change from individual cookbook approaches to resolving a problem to collaborative support through a dialogic process between university staff and industry managers (Vehmas, 2010). An example of a risk sharing approach is the development of consortia between industry and academia supported by public funding (e.g. EU and/or national funds). One example is the current 7th Research Framework Program of the European Union (FP7) which aims to promote and encourage the creation of links between industry and academia as part of collaborating towards a common goal by solving research tasks and sharing a budget to particular research programs. From a national perspective, the US National Research Council recommended that the National Science Foundation, responsible for supporting scientific research, offers funds in diverse scientific areas as a key step to motivate research organisations and industry to collaborate for developing complex innovations that will resolve major scientific, social and economic challenges (NRC, 2007).

From a firm's perspective, university research appears to offer a potential to enhance national competitiveness in terms of translating university staff knowledge and expertise into new products and services. Laursen and Sattler, (2004) explored the role of universities in shaping industrial practice. The authors found that only a limited number of firms draw directly from universities as a source of information for their innovative activities. The results imply that only a limited number of UK firms from specific industrial sectors (e.g. science, technology and medicine), who have certain capabilities in R&D and who have adopted an open innovation approach are keen on developing links with universities. According to Laursen and Sattler, (2004) R&D intensity, firm size and the industrial environment are important factors in explaining the propensity of the firms to use universities in their open innovation activities.

Other studies have found that the interactions between universities and industrial firms remain largely complex, indirect and subtle due to certain challenges. For example, Sam Saguy, (2011) in the context of studying relationships between academia and the food industry supported that the pertaining conflicts in university-industry relations span around confidentiality, publishing, IPs rights and ownership. In addition, organization, culture and funding have been identified as major constraints that may have a substantial influence on the partnership negotiations, which sometimes may affect the primary purpose of the collaborative relationship. Cultural differences are also an influential factor that may determine the main focus of the research and/or project. The main focus of universities is on student education and on conducting research and publishing its outcomes to journals and conferences for contributing to knowledge and for informing the wider research community. On the other hand, industry's focus is on using research outcomes for informing the product design and development as means of producing innovative products that would generate profit. This characterizes a major difference between academia's and industry's value chain (Heap, 2010; Kolk & Püümann, 2008; Spaeth et al., 2010; Tyler, 2009; van Geenhuizen & Nijkamp, 2012). Furthermore Lessl, (2010) found that know-how and expertise provided by

academic institutions is often not structured or presented in a tailored manner to industry. In addition operational barriers may influence the creation of collaborations such as hierarchical structures in large companies may result in time-consuming decision making, whilst universities may have to improve management capabilities (e.g. contract negotiations). Table 4 provides an overview of the barriers for university-industry relationships.

Differences	Challenges	Academia	Industry
Cultural differences	-Different value chains -Different types of people attracted	Driven by pursuing basic science and knowledge dissemination	Driven mainly by maximizing a profit, market share and consumer acceptance
Strategic tensions	Different goals and drivers	-Originality of knowledge and research -Educating students -Contributing to the world of work -Publish data	-Transforming knowledge to products -Generate profit -Explopen innovationt scientific knowledge -Create competitive advantage
Operational tensions	Goals, objectives and timelines are different	-Flexible organizational structure -Long-term orientation -Retain IP rights	-Focused on product -Strict deadlines -Wishes to hold IP rights – proprietary position
Learning challenges	Learning may be viewed differently	Using old knowledge and background to develop new knowledge and understandings	Outsourcing complex scientific problems to external companies for creating innovations
Communication challenges	Meaning of words differ and are not clearly defined	Research as producing knowledge for contributing to the wider society	Research as transferring outcomes to products and services for direct profit
Commitment	-Commitment to different stakeholders	Commitment to society, to colleagues and to students	Committed to society, customers and investors to create and share value.

Table 4: Barriers for university-industry relationships (adapted from Lessl 2010)

Lessl (2010) provided some suggestions for overcoming these barriers. For example universities should make an effort to professionalise their approach to finding appropriate partners as well as to strengthen their ability to manage academic-industrial alliances. Industries, on the other hand, need to accelerate their decision-making processes and be more inclined towards collaborating with academia for enhancing products but also for contributing to the development of scientific knowledge base by disseminating findings and product outcomes to academic journals and conferences. Furthermore, providing access to information may form the basis of exchanging know-how for spurring innovation (see Table 5)

Universities • Enhance the process of creating collaborations with industry as well as proffesionalise the process of finding relevant partners through using technological tools and resources. • Proffesionalise contract and collaboration management by efficient operational structures • Set appropriate motives and incentives (funding) for transforming research into products. • Support industry's engagement in the process of publishing outcomes to academic journals and conferences
Industry • Improve communication and define its requirements and interests clearly • Improve transparency (access to information, generation of online platforms for ideas generation) and acceleration of decision making • Set up operational structures to promote collaboration and support and provide guidance and support in publishing research findings to wider research community

Table 5: Measures to overcome barriers between universities and industries (adapted from Lessl 2010)

Pera (2009) identified a number of identical critical factors for creating university-industry collaborations as well as a number of strategies for strengthening the realization of open innovation. These are:

- **Trust within online tools and platforms:** Ranking individuals, means of validating personal data; third party analysis of personality; usage of tag clouds to collate information about an individual; feedback provision to increase user's confidence.
- **Cultural differences: mediating the different languages of academics and individuals:** re-think ways information is communicated – use of intermediaries could facilitate effective communication of information.
- **Define the problem:** facilitation of online workshops to help define the topic; tagging of terms generated for alternative solutions
- **Identification of the most relevant individuals:** development of databases to access relevant skills and competencies; online skill database with third party generated content; visual representations for showing graphically the suitability of a person to join the project.

3.6.2 Intellectual property

It is clear that the process of co-creating and sharing information and ideas for transferring and commercializing technology creates the need to consider intellectual assets. Some basic Intellectual Property (IP) rules need to be established for enabling open innovation (Chesbrough, 2012) particularly for creating and sustaining collaborations between industry and universities. Slowinski & Zerby, (2008) define proprietary IP as:

> "[…] intangible IP assets for which various types of legal protection or ownership types are given" p.58.

These protection or ownership types may refer to patents, copyrights, trademarks, domain names, trade secrets and tacit knowledge which represent specific skills and competencies that differentiate one firm from another.

The literature suggests that companies who engage in open innovation should share their IP with external actors in an attempt to capture the value and capitalize investments (Ghauri & Rao, 2009). To steer firms' efforts to acknowledge the importance of sharing IPs and to further explore IP issues in collaborative research agreements, Slowinski & Zerby, (2008) propose the *'Want, Find, Get, Manage' Model*. The model has 4 sections and each one has its own IP issues and challenges. IP decisions vary between sections and may impact IP decisions in other sections affecting the overall value of the collaboration. For example, in the *'Want'* section senior level managers determine the IP, assets and skills possessed by an external collaborator. In the *'find'* section, a systematic search is implemented for discovering a number of solver providers with the necessary competencies and skills. The *"Get"* section includes the acquisition of the necessary rights to carry out the desired processes. The "*Manage"* section includes the organization and management of the collaborative relationships for achieving the best possible results. The authors claim that these processes may lessen the chances that IPs will be used in inappropriate ways outside the field of use or in projects not covered in the agreement whilst they will enable firms to collaborate and coordinate confidently for enjoying some protection from direct imitation. Slowinski and Zerby (2008) propose two options for a firm to exploit their invention in the marketplace: the *sole* option where only the firm that invents the IP can exploit the IP; and the *Joint* option where rights to use the invention are independent of inventorship. In other words, each firm will have the right to use the IP no matter which firm made the invention.

Henkel, (2006) argues that adopting principles within the *open science* context or *free revealing* would encourage firms to rethink their processes and practices on IP in order to exploit collaboratively the benefits of sharing and co-creating value. Ghauri and Rao (2009) explore IP issues in pharmaceutical research combined with the trends toward open innovation and economic development. Dalmarco et al., (2011) use a multiple case study approach to investigate IP processes in relation to technology transfer processes in Universities in Brazil. Caution should be given to the collaboration with universities as sometimes universities have unrealistic expectations about the commercial potential of academic research which may cause to overvaluing IP (Bruneel, et al., 2010). This mainly occurs because universities do not share the same mentality with most of the firms with regards to sharing and publishing intellectual assets. Similarly Kleyn et al., (2007) found that IP issues may prevent firms to collaborate with universities because of inefficient management of IP issues.

Giannopoulou et al., (2010) support that appropriability of IP resulting from collaborative activity may create implications especially in innovation communities and from the relationship with intermediaries.

It is clear that the process of co-creating and sharing information and ideas for transferring and commercializing technology creates the need to consider intellectual assets. Some basic IP rules need to be established for enabling open innovation particularly for creating and sustaining collaborations between industry and universities. For the purposes of the OpEx project, the term IP will be used to refer to all technology-based intangible assets of a firm including a project that encompasses an idea which will eventually be materialized to a new product or process. To facilitate the process of IP management, we propose the inclusion of **disclosure mechanisms in the OpEx online marketplace for the user/proposer to decide how IP will be shared and managed in the context of the proposed project.**

3.6.3 Tools and applications for promoting university-industry collaborations for open innovation

As the Internet offers unprecedented possibilities for communication and interaction between innovation contributors for a relatively low cost, it has become the key driver for introducing new forms of collaboration and community participation as a way of creating, utilizing and disseminating innovation. Digital tools and applications specifically developed for supporting innovation purposes are referred to as Computer Aided Innovation (CAI) tools (Hüsig & Kohn, 2011). Typical tools for creating collaborations for open innovation are online open innovation communities, innovation contests, online toolkits, and virtual worlds.

As discussed previously, an interesting and viable approach for enacting open innovation is to disclose university-industry collaborations via open innovation platforms on the Web. In these online platforms, online communities may be created where external experts can contribute in resolving predefined innovation problems or challenges. Firms seeking external solutions for their own products create and maintain some of these platforms (e.g. Global Innovation Jams by IBM or Unilever's[9] open innovation submission portal, while others such as InnoCentive, the European Open Innovation[10], NineSigma etc. act as innovation intermediaries and virtual brokers for firms. However, innovation communities in such platforms such as InnoCentive may not be created since there is not intrinsic interaction between the users or the members in terms of collaborating together to provide a solution. Rather such platforms broadcast problems or innovation challenges and each member disclose individual solutions, which are not shared with the rest of the registered members. In the context of aiding university-industry relations open innovation platforms (i.e. online marketplace for the transfer of inventions) can act as intermediaries between researchers and scientists working in universities and firms's R&D organisations – that seeking experts to solve technical or scientific problems. A statement of the problem is formulated and it is available to a vast numbers of researchers and scientists around the world. Depending on the availability and interest a limited number of these specialists will provide a solution. Then the organization will examine the provided solutions already available on the online platform to decide if the solution meets its requirements. If it is, the organization will make an effort to acquire the intellectual property from the scientist or researcher by providing a monetary reward. Through an open innovation platform therefore, firms and universities can be brought together for co-creating ideas and projects. For realizing the design and actual implementation of open innovation platforms, Hilgers (2011) provided a number of conceptual characteristics of innovation platforms for fostering university-industry collaborations, which **could inform the conceptual design of the OpEx online marketplace. These are:**

- **Framing the broadcast search principle:** Broadcasting an open tender within an online innovation community in which academics, scientists and researchers are taking part in innovation contests for taking over projects and problems.
- **Articulation of problem:** Formulating the project or problem may be perceived as a challenge to the firm as it needs to describe as simple and as accurate as possible the corresponding problem taking into consideration the technical and scientific nature of the language that needs to be used in such a way that will be able to reach a large number of experts whose language is not aligned with the language of the problem.

[9] https://open innovationportal.yet2.com/

[10] www.openinnovation.eu

- **Granularity of the problem:** Projects or problems should be openly designed and for which knowledge is required to address sub-tasks and deliverables towards completion. Problems need to be defined including all the complexity of an ill-defined project but also need to be placed into a general context for achieving greater understanding.
- **Mechanism of coordination:** Self-selection and self-integration is central for constituting co-operations in online platforms. Therefore, all individual coordination processes within the community serves as the backbone for creating projects as well as for participating in other peoples' projects.
- **Scaling motivation:** Intrinsic motivation is key for participating in open innovation projects through online platforms. Monetary remunerations and incentives act as catalysts for creating motivational incentives to collaborate. As universities are being funded by public and third party funds for offering their services an alternative form of funding acquisition is through online innovation contests and problem-solving competitions.

Other general tools that can provide access to scientists, researchers and the general public to improve a product or service are online toolkits. These toolkits are Internet based instruments, which support users in transferring and applying their needs into new products concepts (Hüsig & Kohn, 2011). The aim of these toolkits is to enable non-specialist users to design customizable products, which match the firm's requirements. Therefore, to aid such non-specialist users, toolkits contain user-friendly features that can facilitate the design of the product. The most common way to use a toolkit is for preliminary designs and prototypes as means to assess a product's functionality within the user's environment for further improving it until the design satisfies the overarching product's requirements (Franke & Hippel, 2003). An illustrative example of a toolkit is the case of *Toyota Scion*. To customize and personalize their cars, the company added an additional display to their web-site where users can choose from different colors enabling mass customization but also more experienced users can modify the whole vehicle from the available option.

A less frequent tool for creating university-industry interactions for open innovation is virtual worlds. The integration of scientists and managers into virtual worlds as virtual characters, may allow capitalizing on their innovative potential and knowledge. Kohler et al., (2009) introduced the concept of *avatar-based innovation* to represent a first attempt to take advantage of virtual worlds for open innovation. Virtual worlds such as Second Life are computer-generated physical spaces that can be experienced by many users. A rich mediated virtual environment can be provided to universities and firms that may facilitate direct and rich interactions with each other. Virtual worlds contain built-in tools for users to create their own products and services and they could provide the means for innovation-based activities to take place. Kohler et al., (2009) describe an avatar as the graphic representation of the self within a virtual environment where collaboration occurs between different avatars to generate value for their innovation activities. Based on virtual worlds, therefore, collaborations and interactions between universities and industry can emerge for participating in projects; partner matching and co-developing innovations. According to Kohler et al (2009) the goal of using virtual worlds for open innovation is to: (a) to create value for the real world, (b) integration of different types of users, especially scientists and researchers, throughout the whole new product development process, (c) encouraging users to have an active role during the innovation process and (d) to facilitate avatar-mediated communication through three dimensional virtual worlds. Virtual worlds are also characterized by anonymity as users can

choose pseudonyms and adapt their virtual personality. Furthermore, the level of realism and the levels of media-richness are important factors that differentiate virtual worlds from open innovation platforms. Interactivity and *telepresence* influence the directness of experience, which allow users to interact with *produ*cts instead of only seeing them. This experience with different objects and products emulates a feeling of ownership of brand, service or product (Kohler et al., 2009). Among the most famous companies that utilize virtual words for innovation purposes is the *Coca-Cola Company*. The *'Cole Virtual Thirst'* initiative in Second Life is available to all types of residents and to general public where are invited to submit ideas for the next generation of Coke machines. Another example is with the light manufacturer *Osram*. Interested avatars are invited to design and create their ideas around issues and topics of lighting as part of a virtual competition in Second Life.

Since virtual worlds are still not widely used for open innovation processes (Kohler et al. 2009) and because of the simplicity and user-friendliness of web-based innovation platforms, **we propose that the OpEx overarching architecture to be web-based encompassing different tools and resources for searching partners and collaborating for developing ideas and projects.**

3.6.4 Best practices of creating university-industry collaborations for open innovation

University Innovation Centres (UIC) is one way for managing university-industry relationships. UICs can be understood as instruments for mobilizing researchers to build innovative products and enable the corporate partner to build new business opportunities (Malik et al., 2011). An efficient example that draws on UIC is the partnership between agribusiness Syngenta AG and the University of Manchester. Malik et al., (2011) offer an analysis of the UIC model and its advantages for industry and business. The first Syngenta UIC opened at the University of Manchester in 2007 in the School of Electrical and Electronic Engineering. The centre is equipped with researching sensing systems and digital technologies for agriculture and farming, with central focus on sensors and knowledge-based approaches to support agriculture. The process of the UIC model is explained as: once a technology is identified and before major technical work is done, the UIC works with the company's business development team to identify markets that can be opened up by new technologies. Once the market and business model is fully developed, the UIC researchers work to deliver first-generation prototypes, using company funding for supporting the commercial and scientific viability of the conceptual model. According to Malik et al., the UIC model has its own benefits and limitations. Benefits include the development of novel technologies and business model combinations that do not currently exist as well as for industry scientists to establish long-term relationships with academics and researchers. One of the main challenges is IP in terms of restricting publications of research undertaken at the UIC. Other open innovation R&D establishments in UK similar to the UIC model include the Hitachi Research Laboratory at Cambridge; the Rolls Royce network of University Technology Centres (UTC) located in a number of universities across UK where each UTC is concentrated in a particular part of engine technology; and the Systems Engineering Innovation Centre at Loughborough University funded by BAE systems.

The 'Innovation Commons[11]' is a UK initiative that provides a commercial 'space in common' where UK universities, SMEs and individual innovators can create, share and

[11] http://www.theinnovationcommons.co.uk/index.html

negotiate ideas and resources for technological innovations and IP as means of enhancing user integration and new business opportunities. Currently 6 UK Universities are members of the Innovation Commons community and another 11 are in the pipeline. By using Innovation Commons, Universities have access to knowledge and expertise of a wide range of entrepreneurs and consultants who can assist with the commercialization of an idea or project. Crowdsourcing techniques are applied to test early ideas for validating the commercial value for ensuring that perceived ideas and projects can be further considered as innovative and worth investing for. Universities can also register to the Global Innovation Network[12](GIN), which represents a virtual community that facilitates innovation, and business development processes by creating relations between academics, researchers, investors and businesses. Consultants can also share their professional expertise and opinions, secure business opportunities and discover interesting projects. Different kind of investors can get access to research and industry-focused projects that currently run in UK Universities and benefit from IP, innovation analysis and early testing of business models as dedicated services provided by the system. Another similar initiative is the 'iBridge Network[13]' in US which provides an additional pathway for industry to access university innovations. It is a centralized online source of scientific information, inventions and early stage technologies. The aim is to drive access to early stage university innovations as well as to field experts and research specialists. Through the platform those who are interested in innovations can search for and obtain resources through an intuitive user interface. Projects, ideas and innovation already stored in the database range from computer science and informatics to biological cell lines and animal models. The network also provides some tools to its members such as personalized emails and newsfeed on topics and innovations that are of interest to individuals.

Another exemplar practice represents a public-private partnership between academia, SMEs and pharmaceutical companies under a European funded project. The objective of the Open PHACTS (Open Pharmacological Concept Triple Store) project is to design an open pharmacological space using state-of-the-art web standards and technologies in order to address specific questions in drug discovery research; thus to facilitate improvements in drug discovery in academia and industry (Williams et al., 2012). The Open PHACTS platform will store interoperable data accessed by user-friendly interfaces for enhancing and accelerating the research process for its users. Another European-funded project that is based on initiating and strengthening collaborations between pharmaceutical companies and academia is PharmaTrek[14]. The project develops an interactive web explorer designed for academics and researchers in the field of multitarget pharmacology to address complex queries in an intuitive manner. The researcher can visualize the outcomes of the queries in an interactive way for taking informed decisions for the multi-target queries.

To combine ideas from both academia and industry on drug discovery Bayer Healthcare has implemented an online platform called 'Grants4Targets[15]'. After reviewing all grant applications, funds are provided to conduct certain experiments to further validate the proposed targets. The grants are provided for one year and all IP remains with the applicant within the funding period. 60% of the target ideas were novel and proposed (mostly) by academic institutions (94%) and from start-up companies (6%) (Lessl et al., 2011). Other

[12] http://gin.cloud9network.com/

[13] http://ibridgenetwork.org/

[14] http://cgl.imim.es/pharmatrek

[15] http://www.grants4targets.com

programs following this general trend in creating collaborations between the pharmaceutical industry and academia are 'the call for targets[16]' program in UK, Eli Lilly's 'Phenotypic Drug Discovery Scheme[17]', the 'Pharma in Partnership Program[18]'and the Innovative Medicine Initiative (FP7) for acquiring skills in drug development through an EU education and training program[19]. Since 2004 Creative Commons[20] started to explore the future of science at Creative Commons with the goal of bringing collaboration and openness to the world of research and science. There are a number of scientific projects which their content and services are licensed as a Creative Commons Attribution[21].

[16] http://www.callfortargets.org

[17] http://www.pd2.lilly.com

[18] http://www.pharmainpartnership.gsk.com

[19] http://www.imi.europa.eu

[20] http://creativecommons.org/

[21] http://creativecommons.org/science

4 Summary of research and recommendations

4.1 Summary of review and future research

The 'Best Practices in Open Innovation' report has discussed key concepts and themes in research literature on open innovation with particular reference to the creation of university-industry relationships for communally creating innovation partnerships and projects. The discussion also offered an outline of open innovation frameworks including the outside-in, inside-out and coupled approaches, absorptive capacity, innovation communities and crowdsourcing. In addition, the document highlighted IP issues and how these could be exploited collaboratively for the benefit of sharing and co-creating value. This review has provided a wide range of considerations that should inform the practical implementation of the OpEx through exemplar practices that focus on the enhancement of user integration and the generation of rich-mediated interactions via digital technologies and media as well as ways and processes of creating and maintaining links between university and industry. Drawing on the literature review, we understand that more research is needed towards investigating processes and practices on open innovation. In particular:

- Future research is needed in terms of understanding **practitioners' conceptions of, and approaches to, open innovation as means of experiencing variation in using open innovation among different stakeholders.** This will shed light in conceptualizing qualitatively different ways of experiencing aspects within the open innovation paradigm.
- Future research should **study the motives and challenges related to open innovation in more detail**. We found from the review that there is limited awareness of the motivations for capitalizing on knowledge and finding alternative pathways to markets from industry and especially SMEs.
- Future research should broaden the scope **by studying open innovation particularly in the context of creating links and relationships between universities and academia as means of capturing best practice examples from empirically-based approaches**. Such research should explore key open innovation aspects such as the **use of technology and media (e.g. online platforms, virtual worlds, toolkits etc.), IP licensing, benefits and barriers, enabling factors, alternative forms of partnerships, institutional and organisational conditions and their impact for making academia more responsive to technological or industry needs.**

4.2 Recommendations for the OpEx system

Drawing on the literature review, we attempt to inform the development of the OpEx system and to provide a number of recommendations upon which the system may be best designed, deployed and evaluated.

- The use of technology-mediated open innovation platforms plays an essential role in opening up the innovation process and creates value through communicating and collaborating with instruments, resources and people. The use of open search principles in web-based open innovation platforms aids seekers to find a vast amount of (unknown) solvers with different skill sets to contribute to the solution of the

problem whilst it helps solvers to search and participate into a project or in solving a problem that is of a particular interest and thus can be easily resolved. We **recommend** in particular for the **OpEx system to be a web-based platform where the principle of broadcast search is incorporated into the overarching architecture of the project's online marketplace as an effective mechanism for discovering, accessing and retrieving ideas, projects, information and resources.**

- It is evident from the literature that the coupled approach (i.e. both the outside-in and inside-out) to open innovation is fundamental for absorbing external knowledge as well as for externalisng innovations to the market. **We recommend that the OpEx online marketplace offer the tools and services for users to be able to externalize both their own innovation to interested parties and also to be able to find expertise and skills from partners through an online matching tool that will twin academic staff with industry.**
- The role of communities in discovering, creating and disseminating innovations has been increasingly emphasized in open innovation research. **We recommend that the OpEx online marketplace offer the tools and services (e.g. crowdsourcing and crowd assessment) for creating, exploiting and sustaining innovation communities that will benefit the development of projects and innovations between academics and industry managers.**
- It is clear that the process of co-creating and sharing information and ideas for transferring and commercializing technology creates the need to consider intellectual assets. Some basic IP rules need to be established for enabling open innovation particularly for creating and sustaining collaborations between industry and universities. **We recommend that the OpEx online marketplace to create IP disclosure mechanisms (e.g. a dropdown box or a simple online form) for the user/proposer to decide how IP will be dealt with;** and also to develop **a database within the OpEx system that will track, manage and assess projects and activities, provide certain levels of user disclosure as well as accurate reporting that could be used for both internal purposes and the marketing of patents to generate income.**
- As a key strategy for enabling openness, collaboration and user-generated feedback, **we recommend that the OpEx system will allow open access to new ideas emerging from different research communities, to be able to rate ideas and annotate their feedback.**

5 Conclusions

The purpose of this report is to provide a review of current literature on open innovation in the frame of the Open Innovation Exchange Programme (OpEx) for the purpose of informing the development and implementation of the OpEx online marketplace. The aim of the OpEx project is to produce a sustainable and scalable online marketplace for fostering innovation between academia and industry. The report explicitly focuses on explaining issues surrounding the creation of university-industry relations as well as the tools that may be used to foster such relationships for open innovation. We present the factors that influence collaborations between universities and industry and we elaborate on certain strategies for strengthening the realization of open innovation. Drawing on the literature review, we understand that more research is needed towards investigating processes and practices on open innovation. More specifically, future research should be based on understanding practitioners' conceptions of, and approaches to, open innovation, motives and challenges related to open innovation, studying open innovation particularly in the context of creating links and relationships between universities and academia as means of capturing best practice examples from empirically-based approaches.

The report is part of scoping work undertaken to inform the development of the OpEx system and to provide evidence-based work upon which the system may be best designed, deployed and evaluated. We found from the research review that the use of web-based open innovation platforms with appropriate search mechanisms plays an essential role in opening up the innovation process and creates value through communicating and collaborating with instruments, resources and people. We also found that the provision of certain tools and services are of key importance for users to be able to externalize both their own innovation to interested parties and also to be able to find expertise and skills from partners through an online matching tool that will twin academic staff with industry. The development of innovation communities (through crowdsourcing) for communally creating projects and ideas is an interesting approach for strengthening collaborations within the OpEx system. Moreover, we found that IP disclosure mechanisms are important for the user/proposer to decide how IP will be dealt with for a particular project. Finally, we found that for enabling openness, collaboration and user-generated feedback should be prevalent and therefore, we recommended for the OpEx system to allow open access to new ideas emerging from different research communities, to be able to rate ideas and annotate their feedback. These elements will be used to inform the design of the OpEx online marketplace.

Glossary

Term	Meaning
Open innovation	A model in which firms commercialise external ideas by deploying outside (as well as inside) pathways to the market.
Closed innovation	A business process where the essence of value creation and growth depended on the internal capacity of certain individuals and small groups within the firm.
Outside-in	Opening up a firm's certain processes of open innovation to many kinds of external inputs and contributions.
Inside-out	Requires organisations to allow unused and underutilized ideas to go outside the organization for others to use in their businesses and business models.
Coupled process	the combination of the outside-in (absorbing external knowledge) with the inside-out process (externalizing innovations to the market)
Outsourcing	Penetrating new markets as fully-fledged innovations can be produced externally whilst gaining internal leverage.
Absorptive capacity	the increasing ability of a firm to identify and use external knowledge but also it highlights that external knowledge is useful only to those firms that have developed the necessary processes and strategies to make use of that knowledge.
Innovation communities	An informal network of likeminded individuals, acting as universal or specialized promoters that team up in a project for commonly promote a specific innovation.
Crowdsourcing	Is the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in the form of an open call.
Intellectual property	Intangible IP assets for which various types of legal protection or ownership types are given.
Broadcast search principle	Broadcasting an open tender within an online innovation community in which academics,

	scientists and researchers are taking part in innovation contests for taking over projects and problems.
Computer Aided Innovation	Digital tools and applications specifically developed for supporting innovation purposes.
Open innovation platforms	Platforms broadcast problems or innovation challenges and each member disclose individual solutions, which are or not shared with the rest of the registered members.
Online toolkits	Internet based instruments, which support users in transferring and applying their needs into new products concepts.
Avatar-based innovation	The integration of scientists and managers into virtual worlds as virtual characters for capitalizing on their innovative potential and knowledge.
Avatars	The graphic representation of the self within a virtual environment where collaboration occurs between different avatars to generate value for their innovation activities.
University Innovation Centre	Instrument for mobilizing researchers to build innovative products and enable the corporate partner to build new business opportunities.

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