

Open innovation: the activities and views of companies in Wales

Final Report



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Open innovation: the activities and views of companies in Wales

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Executive summary

In an increasingly complex and competitive business environment, companies are challenged to look at new ways of commercialising their ideas. ‘Open innovation’ is a collaborative approach in which companies combine internal and external resources to take new products, services and solutions to the market. International research suggests that **open innovation leads to improved firm performance** – in terms of profitability, Research and Development (R&D) performance, customer satisfaction and level of innovativeness of products and services. This report assesses the activities and views of companies in Wales on open innovation. It is informed by global literature and engagement with companies in Wales through several methods, including interviews, a survey and a focus group. This study considers the activities and views of individual companies but also relates these to the innovation ecosystem, which consists of a range of actors. Open innovation depends on a nexus of relationships and resources exchanged between companies, intermediary services, Government and academia.

Main views on open innovation

The vast majority of companies surveyed have a positive view of open innovation: 85 per cent of questionnaire respondents believe that open innovation improves the quality of the work that they do, and 83 per cent believe that it increases their company’s effectiveness.

When it comes to innovation and commercialisation, most companies acknowledge that they don’t have all the answers internally. The main motivations for engaging in open innovation were to access new technology and capability, enter new business areas, reduce risks, solve difficult problems and get to market faster.

Open innovation activities

All the companies interviewed and 85 per cent of companies surveyed through a questionnaire engage in open innovation activities, measured according to a range of inbound and outbound activities. The most common open innovation activities that were used by companies were: collaboration with stakeholders (suppliers, customers, Universities), entering into strategic alliances and external scanning of technologies and markets.

One of the areas explored was the relationship between open innovation and the company’s overall innovation and strategy processes. There was a notable difference in the processes used by companies from different industries. Companies from R&D intensive sectors – such as life sciences and aerospace – have very structured innovation processes, e.g. using Technology Readiness Levels (TRLs), and stage-gate processes. A contrast was found in the service-based businesses studied – where innovation processes were not formalised, but were more organic and fluid.

Barriers and Challenges

Companies reported a number of open innovation barriers and challenges. Company culture was widely regarded as a barrier to open innovation, which is manifested in several ways: the 'not invented here' syndrome – resistance to ideas and knowledge generated outside the company; risk aversion; and the culture of management (e.g. towards Intellectual Property (IP) protection and collaboration). A lack of funding is a barrier frequently cited by companies. A lack of trust is also as a barrier – smaller companies in particular are wary of their IP being misappropriated by large companies.

Companies suggested a number of ways to address these barriers:

- Culture of management: to be more open and more tolerant of risk;
- Early collaboration with Universities;
- Developing trust with collaborators;
- Internal open innovation training;
- Demonstrating and communicating the value of open innovation e.g. Getting 'quick wins'; intangibles; generating unexpected leads; building networks and relationships with SMEs; engaging early with customers;
- Learning from other organisations that have been through the open innovation process successfully.

Developing a more effective open innovation ecosystem

The study discusses Government support measures for open innovation. Those most favoured by companies are:

- Financial support for collaboration
- Increase co-funding schemes for SMEs' R&D
- Improve the institutional framework for collaboration
- Improve access to governmental support
- Foster networks and clusters

Bridging the gap between academia and commercial research: businesses and Universities benefit from effective knowledge exchange; these relationships are very important in creating economic growth, stimulating investment and generating demand for higher skills and knowledge. There are some excellent examples of knowledge exchange between Welsh Universities and companies – some of which were identified by the businesses that contributed to this study. However, it is clear from the findings that companies see scope for improvement in collaborative programmes between academia and the business community. There are many factors that impact upon this situation – including IP and commercialisation procedures, the culture of collaboration, the interface mechanisms, and the incentives for both Universities and businesses to collaborate. The collaboration imperative is likely to become stronger in the future so it is important that

the knowledge assets of our Universities are exploited to their maximum potential for greater economic benefit.

Connecting the main actors in the innovation system: an effective open innovation system consists of multiple actors engaged in exchange of diverse knowledge, ideas and resources. Evidence from the companies that have 'gone open' indicates that many had been unaware of a range of potential partners and suppliers that operated within relative geographical proximity. Companies require further support for networking and communication (especially business-to-business).

Recommendations

The report sets out seven key recommendations for promoting open innovation – and the economic benefits that it can deliver in Wales. These depend on collaboration between business, government and academia. We indicate the organisations that should take these actions forward (business/government/academia/combination).

Responsibility: Business

Recommendation 1: Open portfolios of unused Intellectual Property rights, particularly to partners in the value chain/network.

Recommendation 2: Review the strategic orientation and culture of the company. An open innovation 'fitness check' can identify bottlenecks and barriers that may prevent the company from realising the benefits of more open and collaborative practices.

Responsibility: Government

Recommendation 3: Develop a comprehensive open innovation programme funded by Government. This should build on the momentum of the Open Innovation Development Awards but also bring together existing and planned innovation and commercialisation schemes for industry and academia. Government funds should be used to lever in additional investment in innovation activities. The following initiatives should be considered as part of the larger innovation programme, where openness and collaboration are critical:

- a. Create a 3-year beta programme to sustain activities developed under the existing Open Innovation Development Awards.
- b. Develop a significant Innovation and Technology Seed Fund. This would scale up the Welsh Government's £7.5million Welsh Technology Seed Fund, managed by Finance Wales. The High-Tech Gründerfonds in Germany provides an interesting model in which public investment levers in private investment and industrial collaboration.
- c. Assess the feasibility of sector-based innovation investment funds, similar to the Wales Life Sciences Investment Fund. This would follow Welsh Government's

principles of focused investment in priority sectors. The ICT/digital sector appears to be a strong candidate for a dedicated innovation fund.

- d. Assess the feasibility of a Transfer Fund that can invest (for-profit) in transfer projects between academia and business.
- e. Innovation vouchers that can be used by firms to receive boundary spanner support, technical services, assistance on IPR, etc. This would be a continuation of the type of Innovation Vouchers scheme currently operated by Welsh Government (until 2015)
- f. Innovation through supply chains: building on the success of supply chain development programmes over a number of years, this should focus on developing innovative capability and solutions within the supply chain. Novel approaches such as collaborative business modelling, foresight studies, utilising network analysis and actor-matrices can help to further systematise the building of supply chains in new business fields.

Recommendation 4: Assess how an open innovation programme could be developed and funded within the EU Structural Funding for Wales, 2014-2020. The Welsh Government and its partners should consider whether there should be a specific measure which supports and funds open innovation within the business sector. In addition, the use of Financial Instruments within EU funding is increasing and these should be considered in supporting funding programmes focusing on developing open innovation.

Responsibility: Academia and Business

Recommendation 5: Develop schemes to attract global talent in collaboration with Universities. This would supplement the Sêr Cymru programme through a focus on emerging and early career talent – in addition to established leaders in science, technology and engineering. This would provide continued investment and focus, following some of the successes achieved by similar initiatives in Wales, such as the Prince of Wales Innovation Scholarships (POWIS) and the Knowledge Economy Skills Scholarships (KESS).

Responsibility: Government, Academia and Business

Recommendation 6: The Hauser Report (Hauser, 2010) expresses concern over the lack of infrastructure in the UK that can translate research and technology into commercial gains. The Technology Strategy Board Catapult Centres programme is regarded as a significant development in addressing this gap. However, whilst they can service Welsh companies, none of the Catapult Centres are based in Wales. In consultation with Academia and Business, the Welsh Government should assess options for improving translational innovation infrastructure in Wales, including the establishment of a national technology and innovation centre (such as TNO in the Netherlands and VTT in Finland).

Recommendation 7: Evidence from the companies that have ‘gone open’ indicates that they were hitherto unaware of a range of potential partners and suppliers that operated within relative geographical proximity. This could be addressed by the creation of networks of boundary spanners, such as the privately funded Steinbeis Institutes, which bridge gaps between Academia and Business but also create linkages between business, and support innovation by orchestrating joint research. Government could provide financial support for the development phase.

1. Introduction

This report presents the results of a study on open innovation in Welsh businesses. A little over a decade has elapsed since the publication of the seminal work of Henry Chesbrough on open innovation (Chesbrough, 2003). Since then many companies have been keen to explore how models of acquiring technologies and knowledge externally can enhance sustainable competitive advantage. The concept of open innovation includes the flows of knowledge and resources from the external environment into the company, and from the company to the outside world.

The importance of Open Innovation is highlighted in *Innovation Wales*¹, the Innovation Strategy launched by Welsh Government in July 2013. *Innovation Wales* identifies five key themes: improving collaboration; promoting a culture of innovation; providing flexible support and finance for innovation; innovation in government; and prioritising and creating critical mass. Open innovation is important for the first two of these themes in particular.

Commissioned by Welsh Government, this study accompanies the Open Innovation Pilot Project established to address Action Area 11 of *Innovation Wales*, which states that Wales should seek to develop a culture of open innovation. The Open Innovation Development Award for anchor companies in Wales is underway and will run until 31st March 2015. The awards support these companies to explore business models and identify practical solutions. Further information on the Development Awards and participating companies can be found in Annex 1.

Open innovation has been defined in the following terms (Chesbrough et al., 2006):

“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, respectively. [This paradigm] assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology.”

A simpler definition was offered for the specification of this study: *Open Innovation is widely accepted to be collaborative innovation for the successful commercialisation of new ideas*. Although the case studies cited for open innovation are often technologically intensive industries and products, the paradigm is applicable to a range of business contexts, and include manufacturing and service-based industries. The study considered evidence and examples across business sectors.

Many companies attest to the value of open innovation – for delivering innovations and results that would not have been possible if they had acted alone. The value of open innovation in improving company performance has been identified by international research. Practising open innovation is linked to improved financial performance,

¹<http://wales.gov.uk/topics/businessandconomy/publications/innovation/;jsessionid=7C8627B4DAE1AD21964C56F4EBA3D0A9?lang=en>

innovativeness in new services and products, new product and service success in the marketplace and customer performance (Cheng and Huizingh, 2014).

The study has been guided by the following main questions:

- What are the main incentives and motivations for companies to engage in open innovation (including perceived costs and benefits)?
- How is open innovation perceived by businesses in Wales?
- What kind of barriers to open innovation do businesses in Wales encounter?
- How do companies manage open innovation activities?
- What are the economic and non-economic benefits that those businesses get from open innovation?
- How can open innovation activities be supported by Government?

The study consisted of 3 main phases: (1) review of open innovation literature and concepts; (2) interviews with companies; and (3) an Internet-based survey with a larger sample of businesses in Wales. A focus group was held with the companies that have received the Open Innovation Development Awards to explore some of the key findings that emerged from this study. Further information on the methodology is presented in Section 2.

The review of published literature on open innovation was undertaken to generate an understanding of existing knowledge and the state of the art. This informed the development of our questions and the main methods for the study – the interviews and the survey. The main findings are presented in Sections 3, 4 and 5. For each of the themes and issues explored, we present within these sections a summary of existing knowledge drawn from the literature. We have sought to analyse and measure the activities and views of companies in Wales on open innovation against this global knowledge base. We incorporate findings from the interviews and survey related to these key themes.

Section 3 focuses on practices – and the companies' approach to managing open innovation. It presents the evidence on inbound and outbound open innovation practices, the relationship between open innovation and the companies' strategies, and traces the origins of open innovation activities in companies.

Section 4 presents the views and perceptions of companies on open innovation: incentives and motivations for open innovation – and its advantages; barriers, challenges and disadvantages.

Section 5 discusses the views of companies towards public support for open innovation, particularly in relation to the role of Welsh Government and Universities. Some of these themes link to the broader question of developing an effective open innovation ecosystem. Alongside the views of companies, we present some international cases of different forms of open innovation support. To our knowledge, the Welsh Government Open Innovation Pilot Programme is the first bespoke, explicit open innovation support initiative – certainly conducted in a smaller country (or sub-State) context. We consider the potential learning to be drawn from selected initiatives in Germany, San Diego and the EU.

Section 6 brings together the main conclusions from the study on open innovation in Wales. Section 7 sets out a number of recommendations to strengthen open innovation – and its underlying ecosystem – in Wales. These focus on actions for business, Government and academia.

2. Methodology

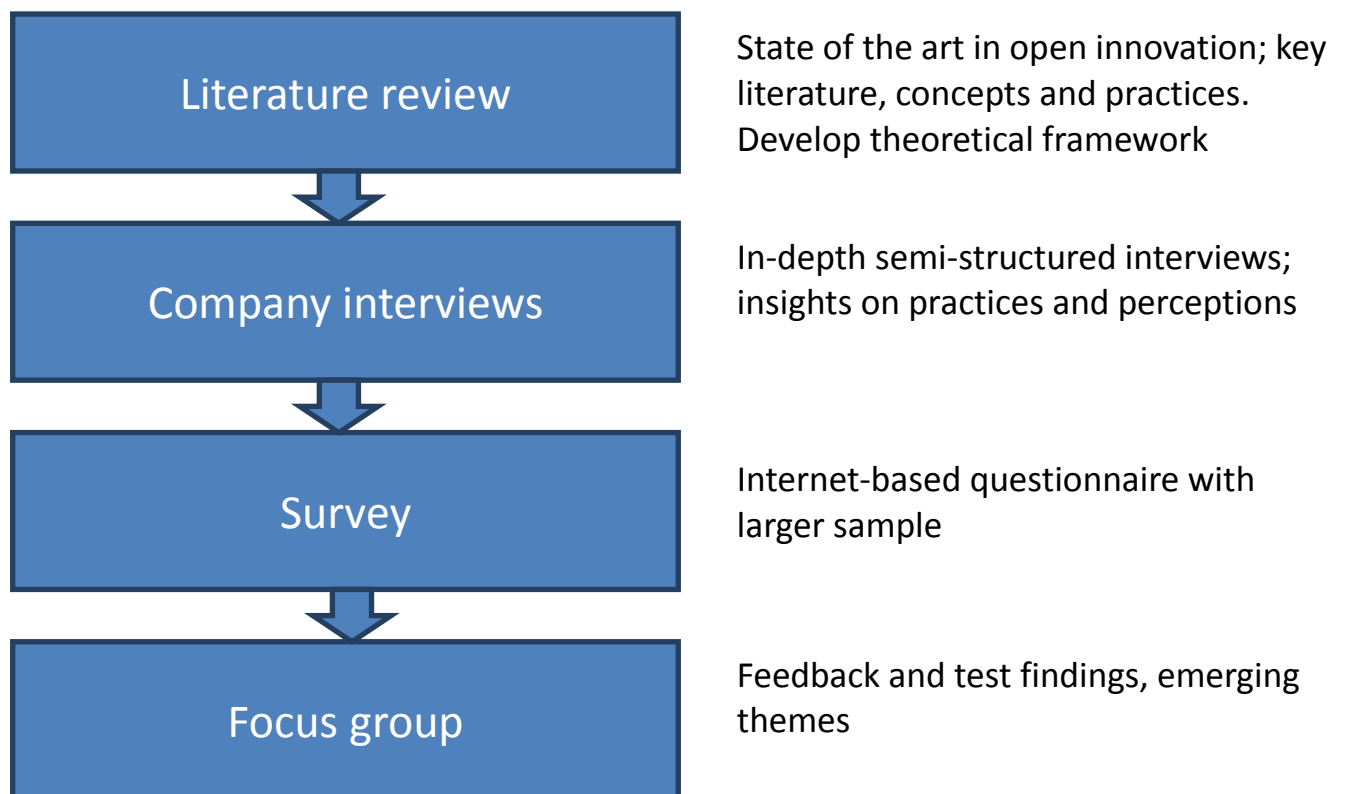
2.1 Introduction

The methodology and the selection of methods were developed around the main aims of the study and the research questions (listed in the Introduction):

- What are the main incentives and motivations for companies to engage in open innovation (including perceived costs and benefits)?
- How is open innovation perceived by businesses in Wales?
- What kind of barriers to open innovation do businesses in Wales encounter?
- How do companies manage open innovation activities?
- What are the economic and non-economic benefits that those businesses get from open innovation?
- How can open innovation activities be supported by Government?

There were four main methods: literature review; interviews; survey; and a focus group.

Figure 2.1 Overview of Methodology and Steps



2.2 Literature Review

A focused literature review was undertaken to identify open innovation practices, the management of open innovation, motivations, costs and benefits. The literature review aimed to identify the state-of-the-art in open innovation, focusing primarily on the following areas

- Main contributions in the field of open innovation and collaborative innovation – concepts, ideas
- Incentives and motivations to engage in open innovation activities
- Methods and approaches for managing open innovation, including search routines and capabilities, engagement of suppliers in process; joint ventures and strategic alliances
- Relationship between open innovation approaches and firms' strategic initiatives and structures, for example, broad innovation strategy, technology strategy, mergers and acquisitions, corporate strategy, relationships between strategic business units
- Sectoral/industry characteristics and trends regarding open innovation, for example, the relationship between product and industry maturity, and open innovation
- Determinants/factors in achieving open innovation success

The sources reviewed included published outputs in scientific or academic journals, and grey literature (which included business case studies, reports by national and international governmental and research organisations etc).

During this process, a desk-based research exercise was carried out to review examples of support for open innovation internationally. This was designed as a rapid assessment of how other countries and regions are supporting activities associated with open innovation.

2.3 Interviews with companies

Based on the literature review, a set of themes and questions was developed into an interview schedule for companies (semi-structured interviews). The schedule consisted of open, text-based questions, supplemented by a small number of numerical questions. As outlined in the specification for the study, the interviews were drawn from a sample of the Anchor companies and Regionally Important Companies identified by Welsh Government (75 in total).

Welsh Government has defined Anchor companies in the following way:

'An anchor company is considered as:

- a company which is a global or international organisation

- have Welsh head quarters or significant corporate presence in Wales'².

It has defined regionally important companies in the following way:

'A regionally important company is considered as:

- a company which is of significant importance to the Region of Wales in which they are located as a result of, for example, number of employees, commitment to a skilled workforce development of the supply chain and investment in the Welsh site'.³

A total 15 companies were interviewed for the study, which were all Anchor companies. Some regionally important companies were contacted but were not available. Interviews lasted approximately 1 hour on average and were conducted face-to-face or by telephone.

2.4 Survey

A theoretical framework developed from the literature review and enriched by the preliminary findings of the in-depth interviews was used as the basis of a structured questionnaire of mainly closed questions.

Companies were invited to complete the survey via intermediary organisations (University of South Wales; South Wales Chamber of Commerce; and the Fast Growth 50 Network). In total 1,600 invitations were sent. The survey was conducted on the Internet using Survey Monkey.

A total of 98 responses were received from companies. 99% were usable for descriptive analysis and 61% were usable for advanced analysis (61% were usable as the rest were incomplete).

Demographic data of respondents

The age of respondents ranged from 22 to over 65 years old. The majority (88%) were aged between 35 and 64 years old. In terms of gender, less than one third of the respondents were female.

² <http://wales.gov.uk/topics/businessandconomy/sector/anchor/?lang=en>

³ <http://wales.gov.uk/topics/businessandconomy/sector/regionalcomp/?lang=en>

Chart 2.1 Age and sex of survey respondents

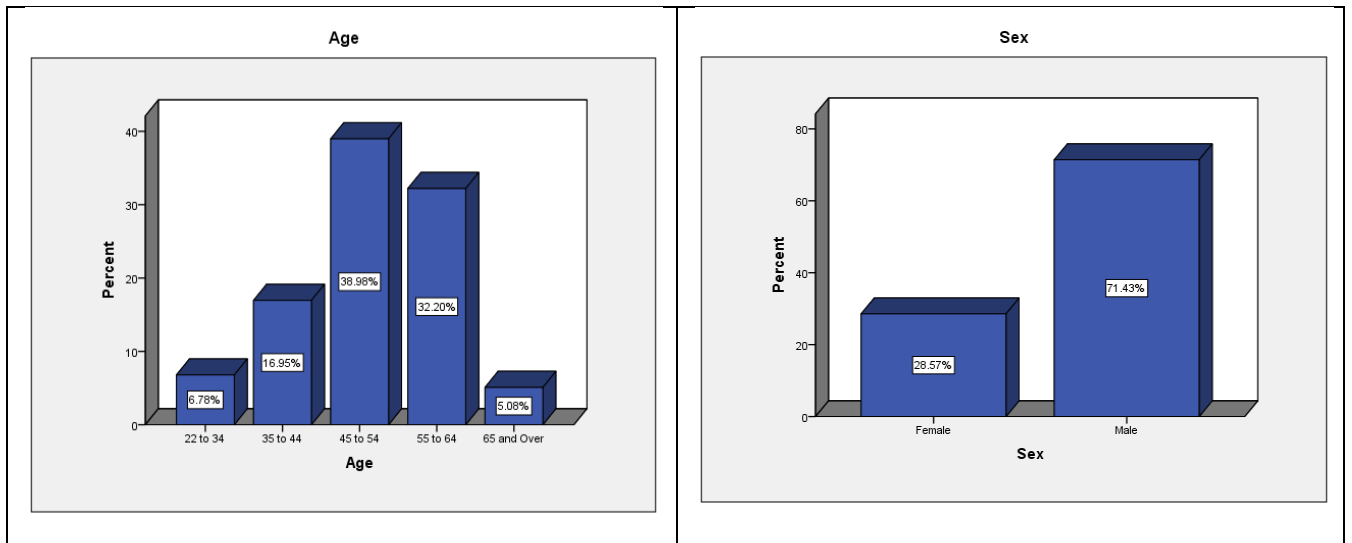


Table 2.1 Survey Descriptive Statistics

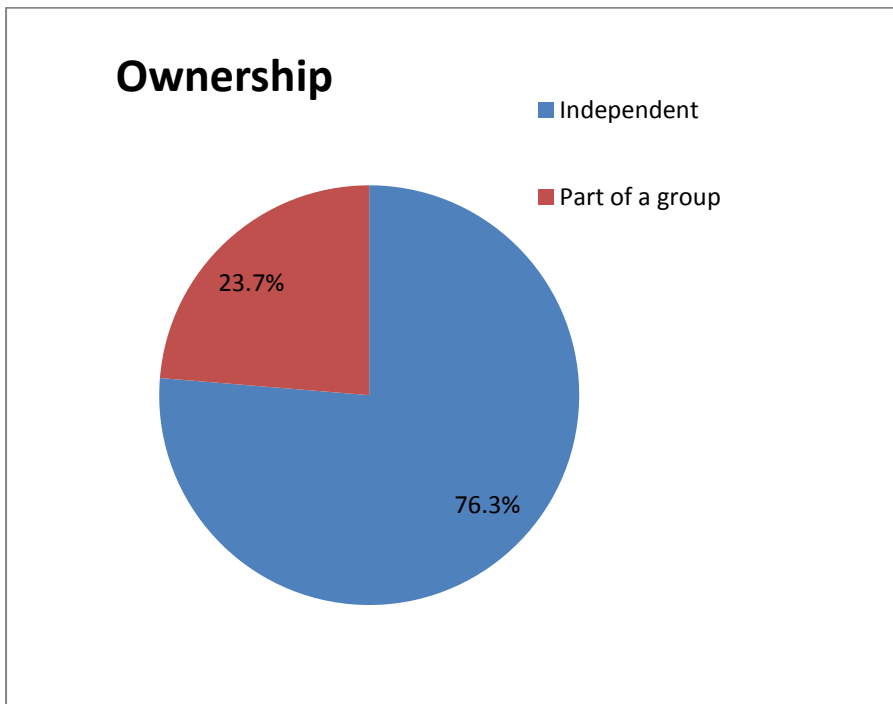
	N	Range	Min	Max	Mean	S.D.
Length of service with the current company (years)	58	38	1	39	13.87	9.405
Experience (Total Number of years)	57	47	5	52	31.56	10.541
Total number of employees	55	1799	1	1800	256.38	425.208
Company age	58	249	2	250	30.13	39.917

N - Number (of companies)

SD – Standard deviation

The majority of respondents were from independently owned companies (76.3 per cent) whilst 23.7 per cent were part of a group.

Chart 2.2 Ownership of respondent companies



2.5 Focus group

A focus group was convened with representatives from 7 companies that have been engaged in Welsh Government's Open Innovation Pilot Programme (all Anchor companies). The main aim of the focus group was to test the emerging findings and themes from the study. This information has been used to enrich the content of the final report.

3. Open innovation practices and management of activities

- Do companies contacted in the study engage in open innovation activities?
- What are the open innovation practices of the companies?
- How did open innovation activities arise?
- How do companies manage their open innovation (including links to strategy)?

3.1 Introduction

This section analyses the practices of companies using a categorisation of inbound and outbound open innovation. By assessing the practices of companies within this framework, a judgement can be reached whether the firms researched for this study are actively involved in open innovation. Alongside individual practices, this section addresses the way in which companies manage their open innovation activities. We also explore the link between open innovation activities and the (innovation) strategy of the company.

3.2 Open innovation: inbound and outbound activities

Open innovation is a paradigm that has been discussed within academic and business/practitioner literature. Some companies will recognise this name and may have an explicit open innovation strategy. Other companies will undertake a range of activities consistent with open innovation but may not use or recognise the term. The study sought to establish whether companies engaged in open innovation through the particular types of activities that they undertake. Following a framework developed and applied in previous research internationally, the companies were asked whether they undertook activities that are associated with inbound (outside-in) and outbound (inside-out) open innovation activities. These are explained in Table 3.1.

All the companies interviewed engaged in one or several of these types of open innovation. They are all active in open innovation – even if (1) they don't describe these activities as open innovation, and (2) they don't have an explicit open innovation strategy.

Table 3.1 Inbound and outbound open innovation types

Inbound open innovation	<p>Sourcing Scanning the environment for new technologies, market changes etc. Dahlander and Gann (2010) describe this scanning activity (non-pecuniary, inbound innovation) as ‘Sourcing’. It is important to leverage external knowledge; many companies undertake scanning activities before initiating their own internal R&D (Chesbrough et al., 2006).</p>
	<p>Acquiring Dahlander and Gann (2010) refer to pecuniary, inbound innovation as ‘acquiring’. This acquisition is through the market, through licensing in and acquiring expertise from outside the firm.</p>
Outbound open innovation	<p>Revealing Henkel (2006), Dahlander and Gann (2010) and others suggest that firms sometimes choose to reveal knowledge without direct, immediate financial gain in order to raise awareness of capabilities in the market, to elicit collaboration. Dahlander and Gann (2010) refer to this as ‘Revealing’ – non-pecuniary, outbound innovation Possible disadvantages: capturing the benefits; other firms with complementary resources may use knowledge to their own advantage.</p>
	<p>Selling Outbound innovation for direct financial advantage – such as licensing out or selling technology/knowledge. This is described by Dahlander and Gann (2010) as ‘Selling’</p>

3.2.1 Scanning and searching externally – ‘sourcing’ (inbound open innovation)

Interview findings

Companies were asked whether they carried out searches for innovation-related purposes (e.g. scanning for emerging technologies, customer needs etc.). All the companies interviewed undertook some form of external search activity, which varied significantly between very structured, on-going processes to informal and *ad hoc* activities. Three companies referred to formal technology watch processes (Companies 3,5 and 7). They referred to broadly similar processes of scanning for new and disruptive technologies, which are shared within the organisation via bulletins, emails and portals (electronic dissemination of intelligence). Company 7 organises ‘Town Hall’ events to gather together relevant staff to discuss particular opportunities that might emerge from these scanning activities. Companies also described **scanning for acquisitions and companies in which**

to invest. Analysis of competition was identified as a parallel stream within scanning activities.

The majority of companies interviewed engaged in more informal scanning activities. Whilst most referred to the need to undertake technology and IP searches for particular projects or development opportunities, several companies also identified market-facing channels and functions in the external search process (e.g. sales teams, using customers). For one company (digital and creative business sector), the market-related searches are generally carried out by the sales function and by staff involved in thematic business areas (where the nature of the search relates to the type of product/business area) whereas technology searches will be carried out by a smaller number of technical staff who have an overview of relevant global developments:

On the technology side it's typically a handful of people we have who'll really understand the technology ... who are charged with making sure there's nothing out there that we aren't up to speed on.

Two utilities companies referred to industry fora or bodies that provided technology, IP and market watch services. These were regarded as cost-effective mechanisms for sourcing the latest developments on technological innovations.

One manufacturing company referred to project-based initiatives by individual engineers – with subsequent ‘aggregation’:

It is driven by individual engineers and primarily project based. Chief Engineers act as boundary spanners/technology gatekeepers.

One pharmaceutical company focuses on later stage research – with an internal process to identify and assess potential opportunities:

Yes, particularly aimed at later stage research where the innovation is closer to market. Dedicated business development group used to identify opportunities early with monthly meeting to discuss/ assess potential.

Survey findings

The survey results indicate that the majority of companies engage in inbound open innovation: 84.61 per cent of companies cooperate externally to develop new products

Chart 3.1 'Our company cooperates externally to create new innovative processes or develop new products'

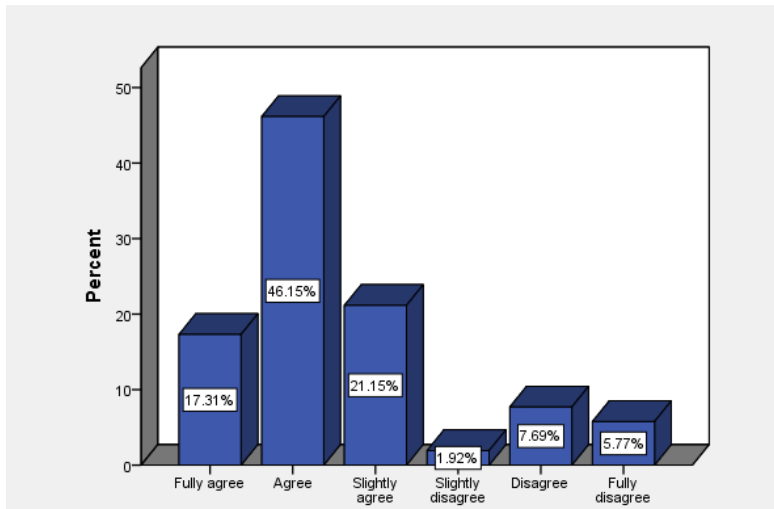
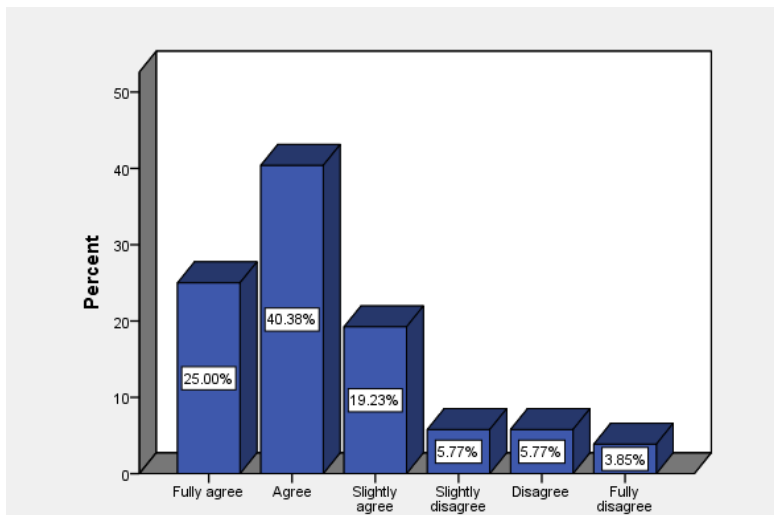


Chart 3.2 'Our company encourages utilisation of external knowledge'



The graph above depicts the results of a question on whether companies encourage the use of external knowledge. The results show that the majority (85%) of companies encourage the utilisation of external knowledge, indicating a relatively positive attitude towards more open activities.

3.2.2 Acquiring and licensing in technologies and knowledge – ‘acquiring’ (inbound open innovation)

Interview findings

Companies were asked whether they acquire or license in technologies or knowledge from outside the firm. The majority of companies reported that they licensed in technologies

Yes, whenever and wherever possible – a “virtual” approach (pharmaceutical company).

Several companies noted the importance of acquiring knowledge through collaborations with Universities.

Yes, this is the “go to” procedure. A variety of input is acquired from academic research; Cranfield; Lancaster, Leeds, Imperial, Sheffield etc). New technologies are often bought (Utilities company).

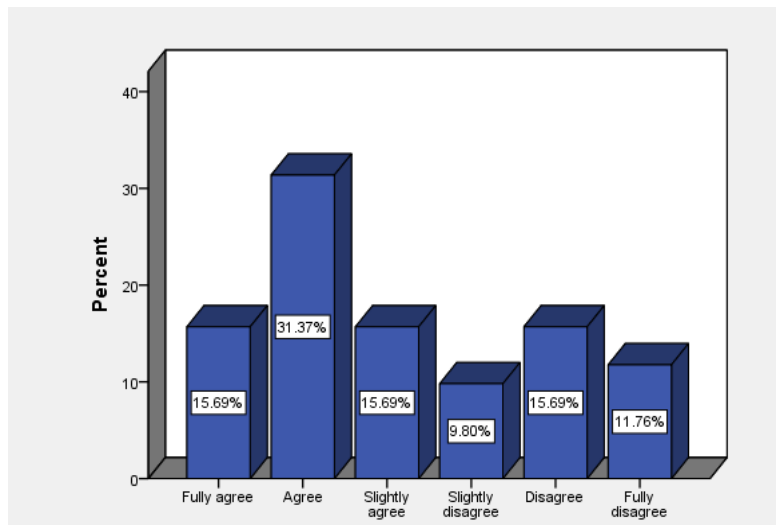
The company has relationships with 7 Strategic Universities – based on previous delivery, quality, and critical mass. This makes Universities more comfortable in sharing ideas, especially in early stage R&D. We fund a total of 10 CASE Awards per year. We have an embedded IP framework with terms and conditions. The relationships (including PhD placements) are predominantly bipartite (Aerospace company).

Two companies referred to the use of strategic acquisitions – to acquire ‘particular skills and technologies, as well as market share and scale’. Two other companies stated that they were currently assessing licensing in technologies.

Survey findings

Within our survey, around 63 % believe that externally licensed technology contributes to their services and sale of their products – whilst 37% do not believe that they make this contribution (Chart 3.3).

Chart 3.3 Externally licensed technology contributes to our services and sale of product



3.2.3 Selectively revealing knowledge to seek potential opportunities – ‘revealing’ (outbound open innovation)

Henkel (2006), Dahlander and Gann (2010) and others suggest that firms sometimes choose to reveal knowledge without direct, immediate financial gain in order to raise awareness of capabilities in the market, to elicit collaboration.

Interview findings

Companies were asked whether they selectively reveal technologies and knowledge without expecting immediate financial gain, e.g. to signal capabilities, elicit interest from partners. The majority of companies interviewed (11/15) engaged in ‘revealing’ activities. These companies referred to several mechanisms through which selective revealing occurs. In some cases, this is an explicit strategy:

Yes, explicitly through the “technology romance” strategy, which sends signals to the supply chain. New customer collaborations will be developed through the supply chain (Photonics company).

Several referred to ‘revealing’ workshops and events that were convened to explore the development of complementary capabilities and resources with prospective suppliers or collaborators, and to signal capabilities to a customer. One company identified the benefits of a ‘show and tell’ workshop that was flexibly structured around a particular technological theme that they wanted to develop.

One Internet-based company selectively revealed technologies and knowledge to enter a new geographical market – where the level of maturity in the product/service area was

relatively low. For a pharmaceutical company, 'revealing' 'is successful in identifying useful innovation'.

Several respondents cited links with Universities in selectively revealing knowledge and capabilities. One manufacturing firm (company 10) commented:

To limited extent this approach has worked. [The company] is keen on working with Universities in their R+D centres and is keen on exposing their staff to new innovations from outside markets

Two respondents commented positively on the role of the Technology Strategy Board's activities in facilitating revealing outbound open innovation, including the open, collaborative approach of the Catapult Centres.

A respondent in a life sciences company commented that they could derive benefit from opening up their IP portfolio as a way of delivering more significant levels of innovation and commercialisation. They are exploring models of delivering this, including co-location and incubation arrangements with SMEs.

An example of opening IP portfolios is offered by Tesla Motors. Recently the company has opened its US patent portfolio to its rivals in the hope that this will boost acceptance for electric cars. Such open innovation activities are particularly important in new market segments that might compete with established markets. Past examples such as the open source mobile operating system Android show the potential power of disclosing in good faith.

Deep concern over intellectual property means that the selective revealing of technologies and knowledge is out of the question for some companies. One company (media) commented that they wouldn't reveal any knowledge:

We don't tell [them] anything. Don't forget a lot of what we do day in, day out and as a form of innovation is a form of art really, rather than IP. It's the way we do things that are different.

Companies interviewed that choose to reveal certain technological capability or knowledge without the prospect of immediate financial return also referred to IP issues. For one company (aerospace), all projects are collaborative but they go self-funded if the IP is very sensitive

[we] have to be clever with resources and what you're exposing...we have to keep the 'Crown Jewels'.

Even those that do reveal their knowledge refer to a '**guarded approach**' and being '**very selective**'.

This question was not explicitly addressed in the survey.

3.2.4 Licensing or selling technologies or knowledge (outbound open innovation)

Licensing can be an attractive option for companies to access new markets. Possible disadvantages of this approach are cited in the literature as follows: it is difficult to anticipate the potential value of out-licensing (Chesbrough and Rosenbloom, 2002); fear of diffusing relevant knowledge (Rivette and Kline, 2000); fear of having innovation stolen when selling firms have to reveal some information before contracts are agreed (Dahlander and Gann, 2010)

Interview findings

Companies were asked whether they licensed or sold their technology/ knowledge resources. Of the four types of inbound and outbound open innovation, 'selling' is the one where the companies surveyed are least active.

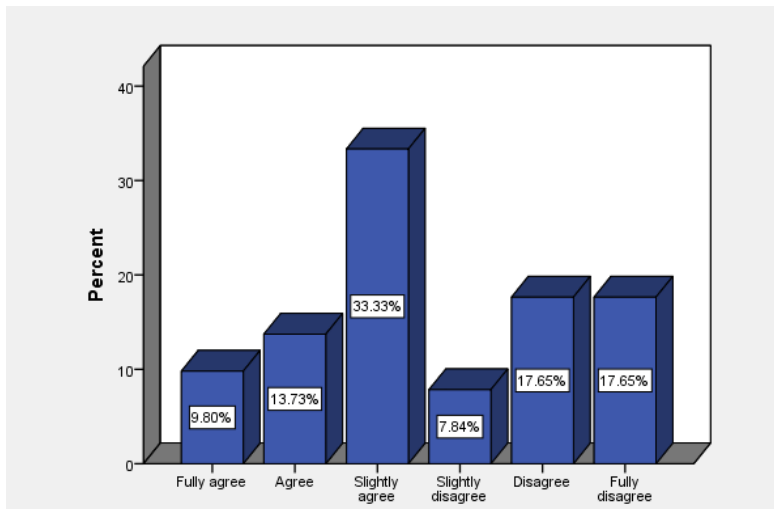
Only three companies had licensed or sold technologies. Two of the companies (in the high technology engineering and pharmaceutical sectors) both cited the same **advantage of accessing geographical markets** (which can be difficult or closed) **and distribution channels**. 'Royalties generated' and 'improvement in manufacturing capabilities' were identified as further benefits of this 'selling' activity. One company used joint ventures to license its technologies in difficult or closed markets. For these companies, the **disadvantages cited were a loss of control and – in some cases – value**.

Three other companies stated that they'd either already considered the option of licensing out – or would consider it in future.

Survey findings

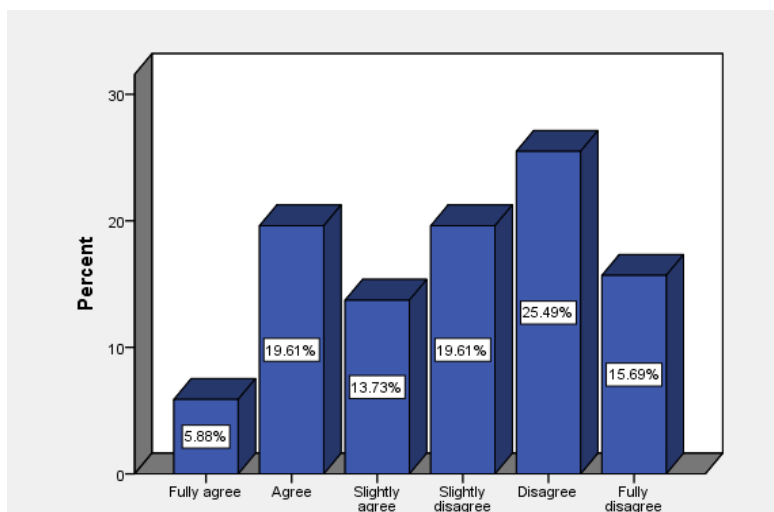
In our survey, 57 per cent of respondents indicated that externally licensed technologies contribute to their company's profits (Chart 3.4) whilst only 39 per cent agreed that efforts are made by the company to commercialise its technology through selling or licensing out (Chart 3.5).

Chart 3.4 'Our externally licensed technology contributes to company profits'



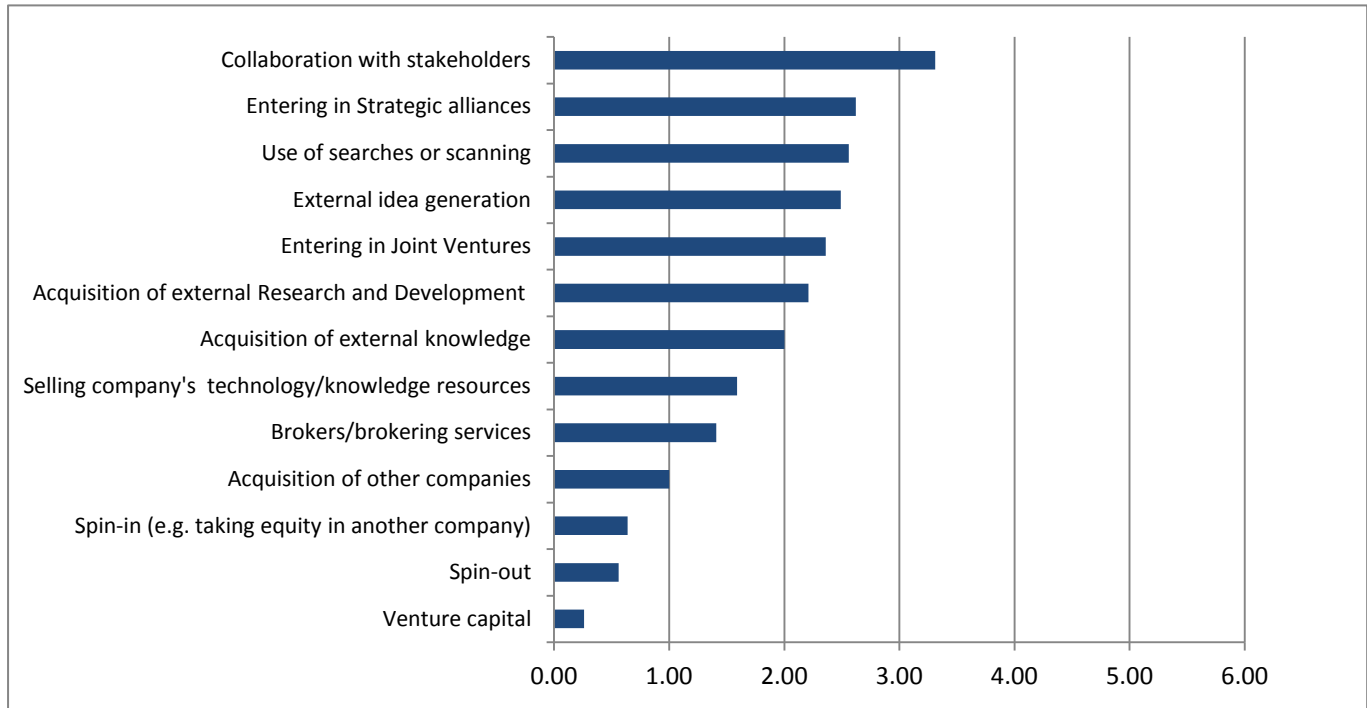
Not many companies in our sample are very active in commercialising their technologies through selling or licensing. The bar chart below (Chart 3.5) shows that only one quarter do so actively with around 14% slightly doing this while more than 60% do not do so. This may be explained by the difficulties in generating revenues from licensing.

Chart 3.5 Efforts are made by our company to commercialise our technology through selling or licensing



In our survey, companies were asked whether they invested in a range of activities or instruments associated with open innovation. The activities that were used most by companies were: collaboration with stakeholders, entering into strategic alliances and external scanning of technologies and markets. The least used activities were venture capital and spin outs (Chart 3.6).

Chart 3.6 Activities used by companies over last 3 years for the purposes of current or future innovation



Note: higher scores denote more important activities. Further information on activities:

- Collaboration with stakeholders (e.g. suppliers, competitors, end-users, universities, etc.)
- Use of searches or scanning (technologies, markets)
- External idea generation (using external parties to generate ideas)
- Acquisition of external Research and Development (including other businesses within your group, or by public or private research organisations and purchased)
- Acquisition of external knowledge (Purchase or licensing of patents and non-patented inventions, know-how and other types of knowledge from others)

Chart 3.7

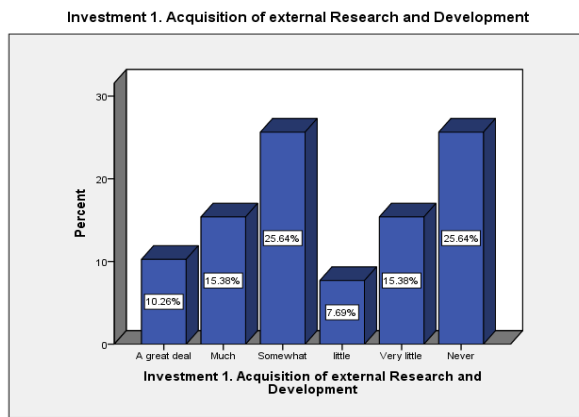


Chart 3.8

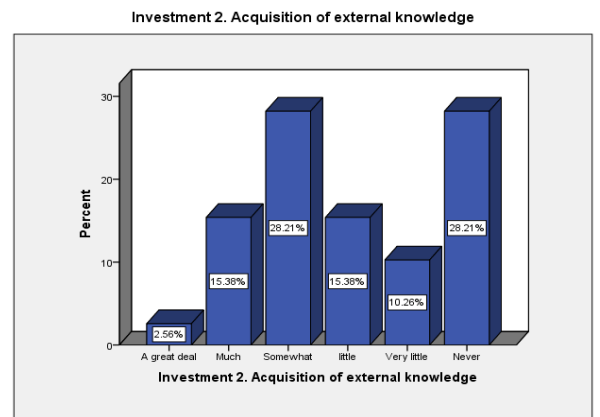


Chart 3.9

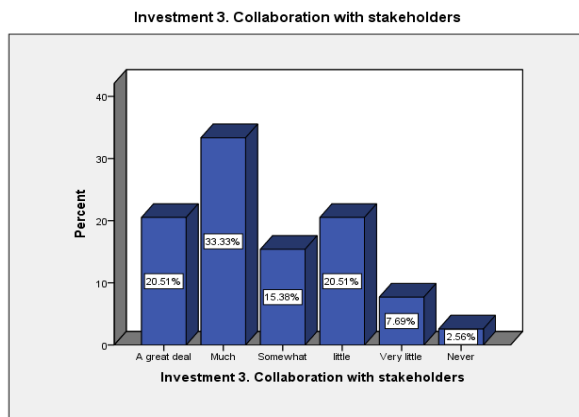


Chart 3.10

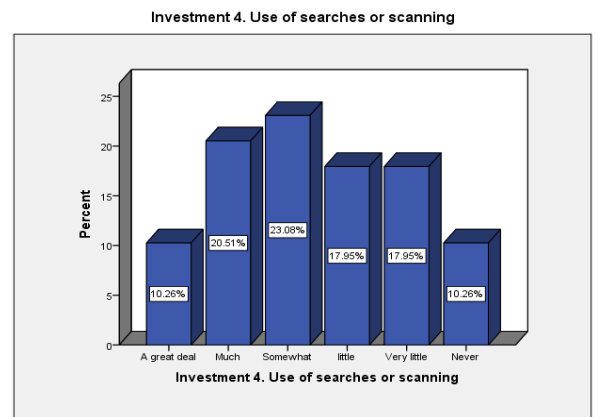


Chart 3.11

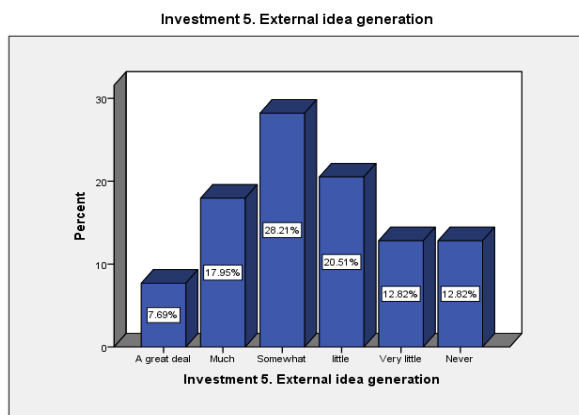


Chart 3.12

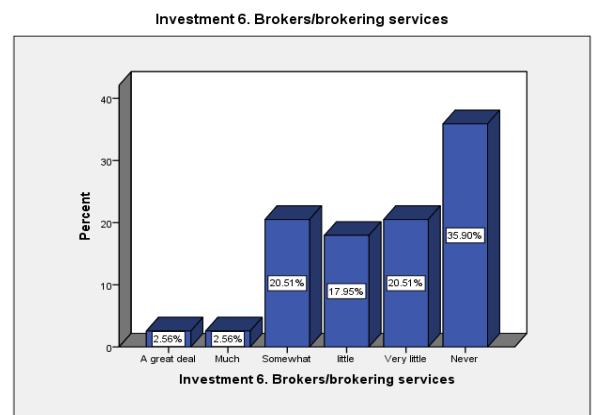


Chart 3.13

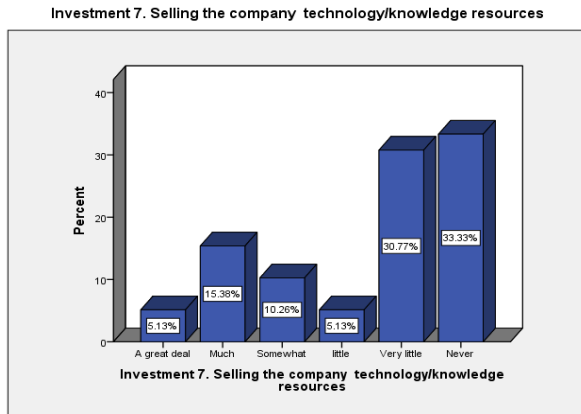


Chart 3.14

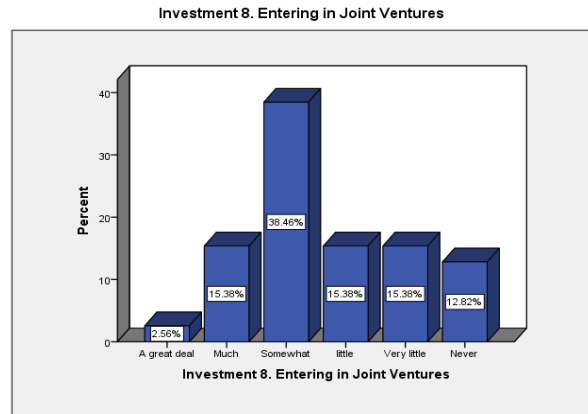


Chart 3.15

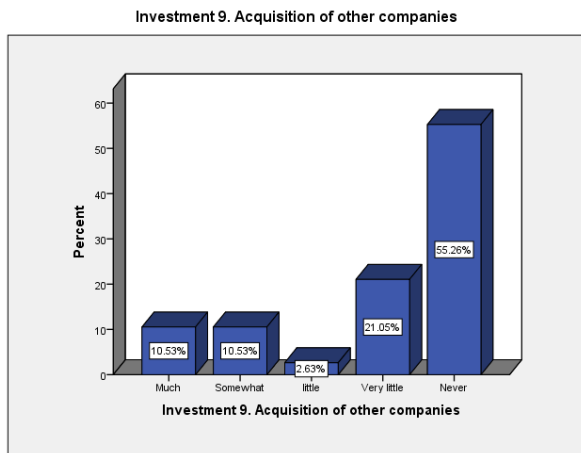


Chart 3.16

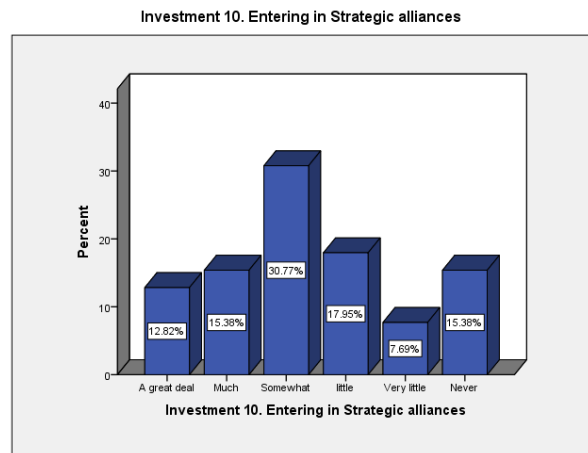


Chart 3.17

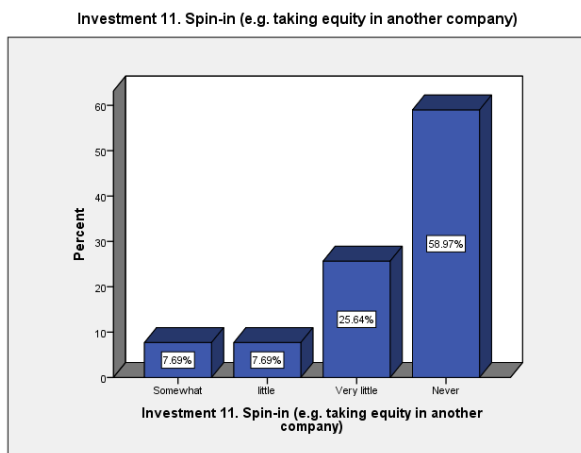


Chart 3.18

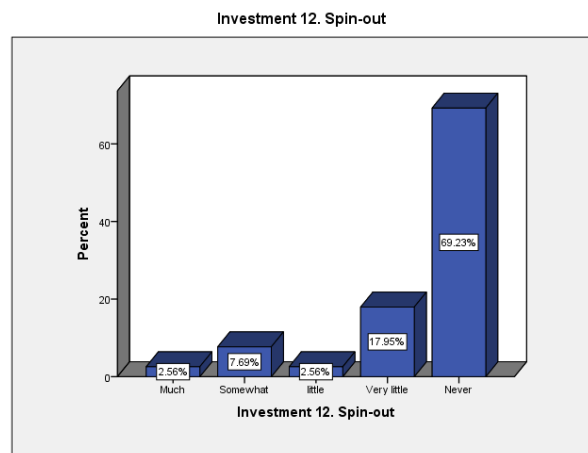
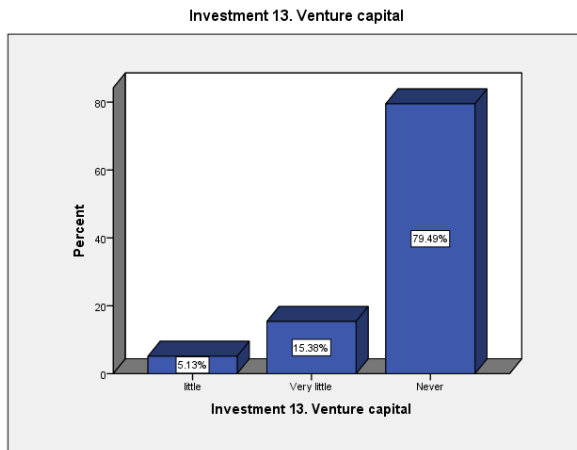


Chart 3.19



3.3 Innovation approach and strategy

Companies that were interviewed were asked to describe their innovation approach or strategy – and whether this was explicit. Companies engaged in technology-intensive product development tended to have an innovation approach that was grounded in their technology strategy. These companies were part of large groups. Most respondents reported structured approaches to innovation – although these varied in levels of formality. Stage-gate and the R&D pipelines were referenced in the innovation approaches of these companies.

Some companies that had formal, explicit innovation approaches and strategies referred to the use of Technology Readiness Level (TRL) processes. In some sectors, such as aerospace, this is regarded as the standard approach. One company within that sector used a formalised gate approach – with links to readiness and maturity gates (there is one for the product and one for the technology). Another company cited the use of roadmaps to guide the innovation process:

The core business is a roadmap that we follow and part of that is really the constant refinement of the product and the specifications that it has to meet.

For two of the companies (Insurance and media sectors), there was significant innovation happening (both companies considered successful and leaders in their industries) but this in an organic, less-structured way.

We certainly don't have innovation pipelines, we tend not to have innovation teams... I think innovation tends to come [from] the departments, within departments, and it probably is a conscious decision not to have a standalone innovation function. We don't have a process, we don't have gateway processes like a lot of companies might have. When we do establish a piece of innovation which requires a capital investment, or requires a substantial amount of someone's time or a team's time, we

then ring-fence a project team with a project lead, and they pull in resource from other departments. No, we don't have some sort of cerebral thing carrying out new innovation.

One respondent described the innovation culture of the company, where groups would work autonomously and come together every 3-4 months to share ideas.

I would argue...we always have [had an innovation approach]. If I look at our profit margins now they are at roughly the same level as they were 20 years ago when our prices were twice as high. Now you can't sustain that sort of position in the marketplace unless you're constantly innovating and innovating isn't about cutting costs, it's about finding different ways of doing things.

3.4 The origins of open innovation approaches in the company

The global literature on open innovation points to some interesting factors that may induce companies to become more open. A related issue is whether the propensity of a company to become more open is linked to their particular context or industrial setting. Gassmann (2006) states that OI is more appropriate in contexts characterised by globalisation, technology intensity, technology fusion, new business models, and knowledge leveraging. These characteristics may belong to several economic sectors. On the other hand, other research suggests that OI is linked more to business strategy than industry factors (internal environment more significant than external environment) (Keupp and Gassmann, 2009).

Interview findings

As noted above, **all companies interviewed engaged in open innovation in some facet** (using the inbound/outbound innovation framework) but this varied significantly in terms of the scale of openness. Companies were asked whether they could identify how the open innovation process arose (for example, industry-level factors, part of strategy, new top management etc.)

Four companies stated that the open approach was inherent in their strategy and culture – that this had been an ever-present characteristic. Several respondents linked industry or market competition with a change in strategy – to adopt a more open approach. For example:

Conscious decision by senior management to win more business, so utilising more resources became very important...market driven.

Another company in the life sciences sector identified the move towards more open innovation as part of **changes in the innovation and commercialising process** – with new technology portfolio teams – again as a response to competitive market forces.

One company, that had set up a specific open innovation programme, stated that ‘there was a need for collaboration with SMEs’. Although the decision to set up the programme was taken independently, the prior development of the same type of programme in one of their other global sites had demonstrated some of the benefits to them.

The improvement in the UK innovation environment for collaboration – with the TSB Catapult Centres and research centres – was cited as a key factor by one aerospace company. The respondent stated that the company had become more collaborative because of these institutions.

Three companies cited the Welsh Government’s Open Innovation Development Awards as a key factor.

3.5 Types and numbers of external sources/collaborators for innovation

One measure of a company’s level of openness is the number of external sources that it uses in its innovation activities (Laursen and Salter, 2004). Related to this is the scale of external search breadth – the different types of search channels that the company uses for its innovation activities, such as suppliers, users, competitors, research organisations and universities (Laursen and Salter, 2006).

Interview findings

Companies were asked to identify the types of organisations with whom they collaborated. The three types cited most often were **Universities** (or research organisations), **suppliers** and **customers**. Three of the companies referred to relatively large networks of external sources – with 100+ organisations. In one case (aerospace sector), the company has 1,200 partners on R&D projects. Two companies (advanced manufacturing and defence sectors) identified competitors as collaborators in their innovation activities.

Table 3.2 Numbers and Types of external sources of innovation cited by interviewees

Company ID	Types of external sources (external search breadth)
1	Suppliers, Universities, Customers
2	Mainly customers and universities. Some from the Supply Chain
3	SMEs, Universities, competitors (100s)
4	Customers, universities, competitors, customers
5	Universities, SMEs, suppliers
6	Customers, Universities, starting to do more with suppliers
7	Research organisations, Universities, suppliers. 1,200 partners on research projects around the world
8	Mainly suppliers. Universities (a dozen or so)
9	Technology suppliers
10	Suppliers, Universities
11	Not answered due to confidentiality.
12	Academia (120 universities); suppliers; Contract Research Organisations
13	Universities, suppliers (10-15 partners regularly used)
14	Mostly regulators, industry, professional institutions, NGOs and academia.
15	Research organisations/universities; engineering and technology providers (suppliers)

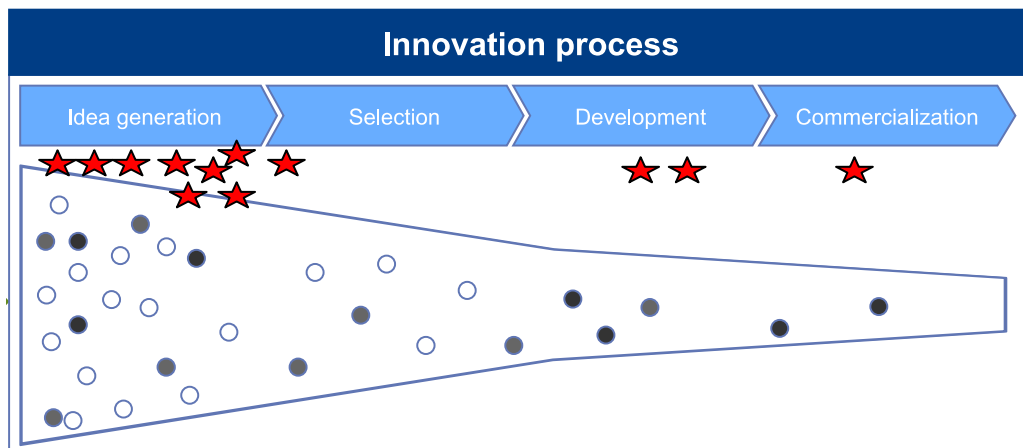
3.6 Collaboration and openness in different stages of the innovation process

Fetterhoff and Voelkel (2006) propose a model including five stages of open innovation: (1) seeking opportunities, (2) evaluating their market potential and inventiveness, (3) recruiting potential development partners, (4) capturing value through commercialisation, and (5) extending the innovation offering. This model can be aligned with a more generic innovation process, starting with idea generation and then moving through the stages of selection, development and commercialisation.

Interview findings

Companies were asked at what stage in the process they collaborated with others. The innovation process figure (Figure 3.1) was used as a prompt to facilitate the discussions. The red stars in Figure 3.1 indicate specific points in the innovation process where companies collaborate with others – and engage in more open innovation. The cluster within idea generation indicates that companies engage in open, collaborative activities often in the front end of the innovation process. However, several companies responded that collaboration was a feature along the innovation process – and not confined to a single point.

Figure 3.1 Collaboration and openness at points in the innovation process



Note: Red stars denote specific points in the innovation process where collaboration happens – cited by interviewees

One company differentiating between the motivations in two stages:

Early – for demonstrating capability...later – when there is a specification.

Another company signalled a slight shift in focus:

Mainly in Development and Commercialisation phases – but starting to do more in earlier phases as well

Finally, the context was a contingent factor that guided the timing of collaboration in the process:

At the earliest possible point, however this is dependent upon geographical region, stage of clinical trials, and resources.

This finding seems to point to the crucial issue of how to support joint commercialisation. The figure illustrates the challenge of utilising open innovation approaches in the development and commercialisation phase. However this is where the economic value is being created. While in mature industries we can expect that companies will drive these phases individually, examples such as the Apple iPod show how an open approach can enable high innovation speed and scaling quickly to the global market.

3.7 Relative importance of internal R&D vs. external/open innovation

The literature and existing evidence generally indicate that internal R&D and openness/OI are complementary, and it is less likely that openness (external sourcing alone) can substitute internal R&D (Dahlander and Gann, 2010). One explanation (cited in Dahlander and Gann, 2010) is that R&D has a dual role to develop products/ services internally but

also develops absorptive capacity to track developments outside the firm (Cohen and Levinthal, 1989). Also, firms with high levels of investment in R&D are able to benefit from 'spill-overs' (Cohen and Levinthal, 1990).

Interview findings

Companies interviewed were asked to comment on: the relative importance of internal R&D innovation activities vs. external/open innovation; the relationship between them in the company (Co-development?); and the percentage of their R&D projects that have an OI element.

Table 3.3 Relative importance of internal R&D vs. external/open innovation

Company ID	Relative importance of internal vs. external
2 (high technology engineering)	Internal R&D first due to ownership of IP issues. An "ageing" workforce may prompt a review of this approach. Percentage of OI not known.
3 (Defence)	More on internal R&D vs. external OI activity (approximately 80:20) Not all R&D has an open element but most does.
4 (advanced manufacturing)	Most R&D collaborative – embedded in the company. All R&D projects have open element
5 (life sciences)	Roughly half have an open element but mostly on the periphery
12 (life sciences/ pharma)	The exact split is not known, however it is a balance between internal and external forces, with the strategy to lower internal R&D and increase external R&D
13	Cannot be quantified, but seen to be equal...50/50. NPD looking to change this to 35/65.
14 (utilities)	Almost all innovation is external through collaboration with partners

All companies reported an element of openness within their R&D activities. With the exception of company 14, all the companies listed in Table 3.3 are relatively R&D intensive. Broadly, a group of companies (2,3,5,12,13) identified a strong internal R&D focus – with in-house capability. One of the most interesting insights to emerge from discussions around this question was the strategic intent of three companies to alter the relative share of internal vs. external R&D and innovation activities (i.e. more external), while another company indicated that this might be a consideration in future.

3.8 Capturing value from open innovation: formal and informal protection measures

The ability to capture profits generated by innovation has been described as the ‘appropriability regime’ (Teece, 1986) or ‘appropriability strategy’ (Cohen et al 2000: 8). Formal and informal methods can be used by companies as part of their appropriability strategy:

- Formal methods: patent, trademark, copyright protection
- Informal methods: lead time, first mover advantage, lock-ins, product complexity

Interview findings

Companies’ innovation strategies are linked to acquisition and different forms of appropriability – even though protection mechanisms (formal and informal) still provide limited protection (Arora and Gambardella, 2010).

Table 3.4 Methods used by interviewed companies to capture the value of innovations

Company ID	Methods
1 (Insurance)	Formal methods – legal; trademarks [example given] – as much protection as possible
2 (high technology engineering)	Formal methods are the preferred route, once the exploratory moves have been agreed.
3 (Defence/security)	NDA’s with SMEs for OI programme First mover advantage, teaming agreements
4 (advanced manufacturing)	Both formal and informal.
5 (life sciences)	Formal – few from collaboration
7 (aerospace)	Formal and informal. The company has sold patents to suppliers – more important that supply chain benefits
11 (defence/security)	Both formal and informal methods
13 (photonics)	Formal methods used, however most deals use the informal networks, especially when complexity is a factor.

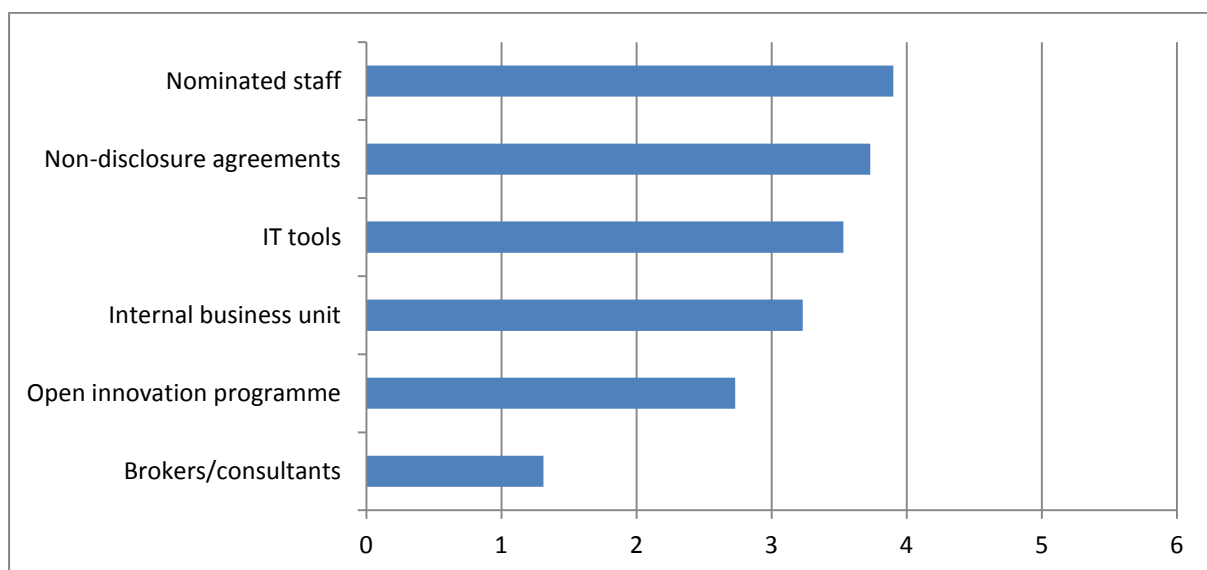
The R&D and technology-intensive companies interviewed pursue formal methods to protect their IP and appropriate the value from the innovations that result. However, several noted their reluctance to use formal methods – preferring informal methods to guard sensitive IP and know-how:

it's more informal than formal... I think we probably have maybe 20 or 30 patents. We tend not to patent anything, partly because not all of the IP is our own because we're sharing it with someone else, but also it is actually very difficult... First of all we don't have any single competitor across our whole product range, but we have individual pockets of competitors across different products, and because it's [specialist engineering area] it's very difficult to police because if we were to publish how we do something we're telling the competitor exactly how to do it, so we tend not to publish. We have cases where we know, it does lead to a minefield, so we tend not to patent the detail for that reason.

Survey findings

Companies that were surveyed were asked whether they used the following tools or mechanisms in managing their open innovation processes. The three most used approaches were the use of nominated staff in the organisation; non-disclosure agreements; and IT tools.

Chart 3.20 Tools and approaches used by companies to manage open innovation activities



Note: higher scores denote more important activities.

Few companies cite the use of brokers and consultants in their open innovation activities. Whilst this would require further investigation, there may be several reasons for not engaging with brokers or consultants, e.g. a belief that internal staff resources are sufficient; previous, negative experiences with consultants; lack of familiarity with consultants in the field. Other research has suggested that firms that provide specialist business services (including consulting firms) are important carriers and facilitators of innovation (Miles et al, 1995; Muller and Zenker, 2001). Therefore, having higher levels of

engagement with brokers and consultants may yield benefits for companies and for the economy in Wales as a whole.

In the Steinbeis Model in Germany (described in Section 5.4), the dedicated boundary spanners – that perform an important function – are located outside the firms, but have ways to reach inside them. In the model, firms share the costs for boundary spanners that link to research organisations but are equally capable of linking their client organisations together and orchestrate joint innovation projects. These schemes are particularly relevant in the case of SMEs as they are typically unable to pay full-time employees to perform open innovation activities. That is probably also why the Steinbeis Model is particularly successful in the South-West of Germany, which is dominated by SMEs.

Chart 3.20

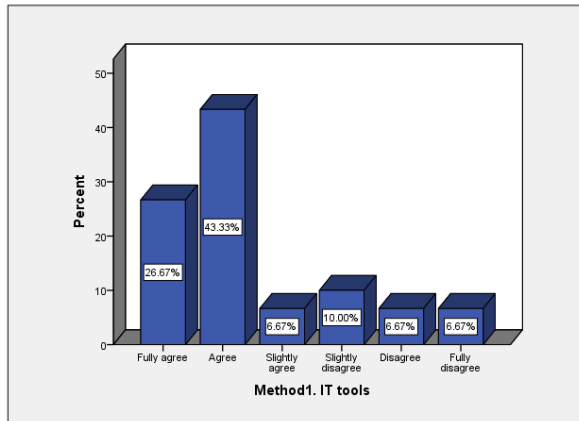


Chart 3.21

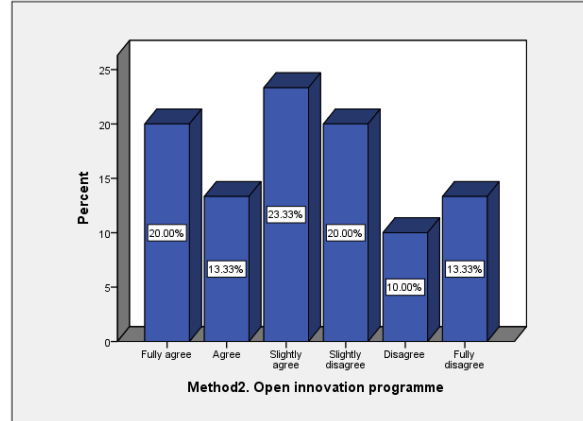


Chart 3.22

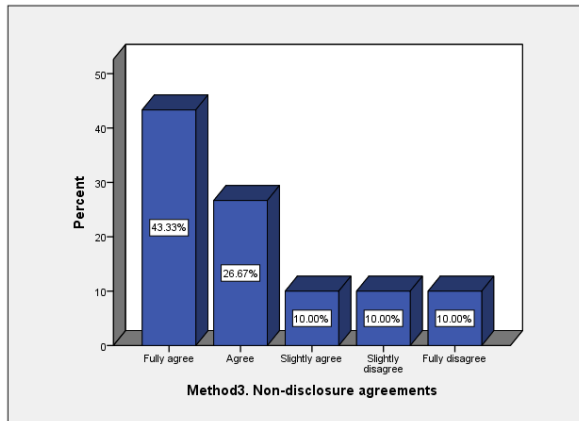


Chart 3.23

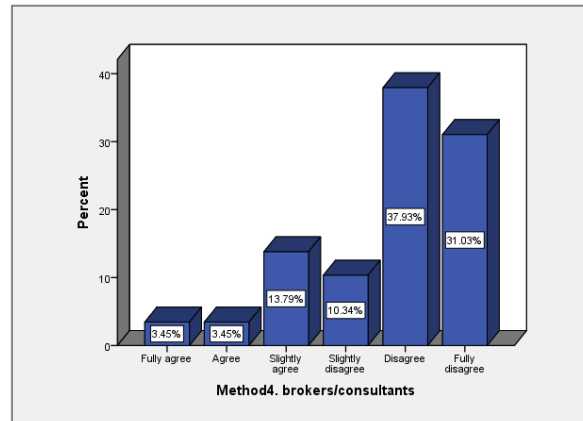


Chart 3.24

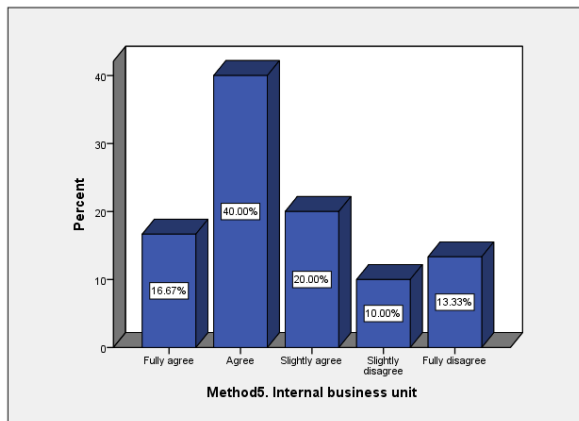
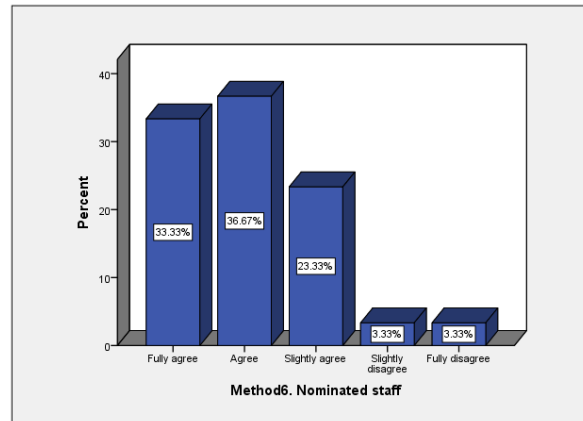


Chart 3.25



3.9 Summary of results: practices and management of open innovation

It is evident that a high proportion of the companies contacted for the research engage in some form of open innovation. All of the companies interviewed and 85 per cent of those that responded to the questionnaire said that they collaborate with others externally to develop new products and services. They use a range of tools and approaches for both inbound and outbound open innovation activities; protect their IP through formal and informal measures. The approach cited most frequently was the use of nominated or dedicated staff for open innovation. Whilst R&D, product-based industries tend to have

open innovation as part of a formal innovation process (using stage-gates, TRL maturity levels etc), service-based industries tend to have more informal and less structured innovation processes. In the case of the former, open innovation activities are usually linked to the company's technology strategy.

Table 3.5 Practices and management of open innovation: summary of main findings

Questions	Findings
Do companies contacted in the study engage in open innovation activities?	<p>All the companies interviewed and the majority of companies surveyed through a questionnaire engage in open innovation activities.</p> <p>This was measured according to inbound and outbound open innovation activities.</p> <p>85 per cent of surveyed companies cooperate externally to develop new products and processes.</p>
What are the open innovation practices of the companies?	<p>Variety of practices</p> <p>Inbound (sourcing): Technology watch; monitoring disruptive technologies; IP searches; market intelligence; scanning for acquisitions and companies in which to invest; boundary spanners – aggregation across projects and areas. Sharing and dissemination via email, portals, Town Hall events</p> <p>Inbound (acquiring knowledge, licensing): strategic acquisitions; in-licensing</p> <p>Outbound ('revealing' capabilities etc): 'technology romance strategy'; show and tell workshops; caution in being very selective and guarded.</p> <p>Outbound (licensing out or selling knowledge/technology) to access geographical markets and distributions channels</p> <p>Survey: The open innovation activities that were used most by companies were (in order, most first): collaboration with stakeholders, entering into strategic alliances and external scanning of technologies and markets.</p> <p>Tools used (in order, most first): nominated staff; NDAs; IT tools; internal business unit; open innovation programme; and brokers/consultants</p> <p>Protecting knowledge/IP: NDAs, patents, trademarks; also informal – first mover advantage, complexity</p>
How did open innovation activities arise?	<p>Formal company strategy; restructuring of innovation activities; Welsh Government open innovation programme; changes in UK innovation environment (more open, supportive)</p>
How do companies manage their open innovation (including links to strategy)?	<p>As part of/with: Technology roadmaps; technology strategy; stage-gate and innovation pipelines; bottom up processes in service companies (without formal stage-gates)</p>

4. Companies' views on open innovation: motivations and barriers

- What are the main incentives and motivations for companies to engage in open innovation? (including costs and benefits)
- How is open innovation perceived by firms in Wales?
- What kind of barriers to open innovation do Welsh businesses perceive?

4.1 Incentives and motivations for engaging in open innovation

Companies were asked to outline their incentives and motivations for collaboration and openness/ open innovation. Previous research suggests that firms collaborate and engage in open innovation for the following reasons (often a combination of these):

- Reducing technology development costs or market entry costs
- Reducing risk in developing technologies or entering new markets
- Achieving economies of scale, especially in production
- Accelerating the process of commercialisation – taking new products to the market (Rohrbeck et al., 2009).
- Shared learning
- Accessing complementary capabilities and knowledge; complementary assets (Teece, 1996)

A distinction has been made between offensive reasons (stimulating growth) versus defensive reasons (reducing costs and risks) in becoming more oriented towards open innovation (Huizingh, 2011). In their review of empirical studies, Chesbrough and Crowther (2006) and Van de Vrande et al. (2009) indicate that offensive reasons were more important.

The responses of the companies (Table 4.1) are closely aligned with the global literature on incentives for motivation.

Table 4.1 Respondent motivations for open innovation (interviews)

Co. ID	Incentives identified
1	Where we can't build the capability internally – where it's too expensive
2	To supplement internal R&D and develop new products for existing markets, and critically to create innovation during traditional [specific named] industry cyclical downturns.
3	Access to new technology and capability Solving difficult problems
4	Increase business Work with other partners to attract other services
5	Faster, cheaper; de-risk – allowing others to take risks; Capability in disruptive areas Future proof R&D [in Welsh site]
6	Short cuts, faster, more efficient, get into markets where barriers to entry are high, need other skillsets
7	[The company] doesn't know everything – supply chain, universities have solutions and capabilities
8	Regulatory push
10	Shared knowledge, shared resource, reduced / shared risk, greater productivity
12	Opportunities to develop and access new ideas to ...increase market reach. Maintaining and growing market share, and identifying opportunities that will enhance the standing of [the company].
13	It is about achieving more than is currently delivered, and to find extra resource from the supply chain. Finding specialist skills not existing within the organisation. Winning more work.
14	To improve the quality of services delivered to customers, and at a reduced cost

Research has shown that adopting new innovations is affected by managers' perception of whether the new innovation will have a positive impact on performance (Performance Expectancy) or not and whether they are discouraged if too much effort is to be put into the adoption of the new innovation (Effort Expectancy).

The vast majority of respondents (85%) believe that open innovation improves the quality of work they do, and increases their companies' effectiveness (83%). Also, 84% of the respondents reported that they find open innovation advantageous to their companies.

Chart 4.1 Open innovation improves the quality of the work we do

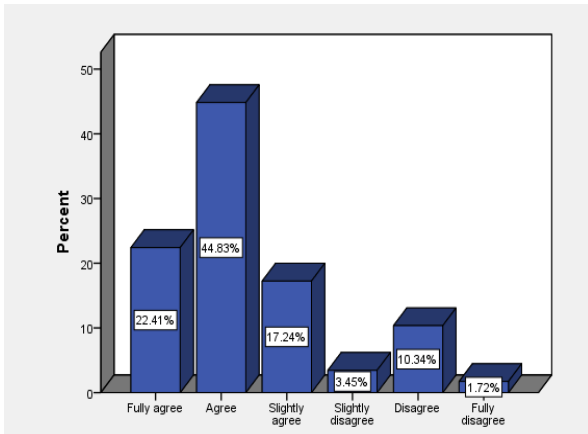


Chart 4.2 Using open innovation increases our effectiveness

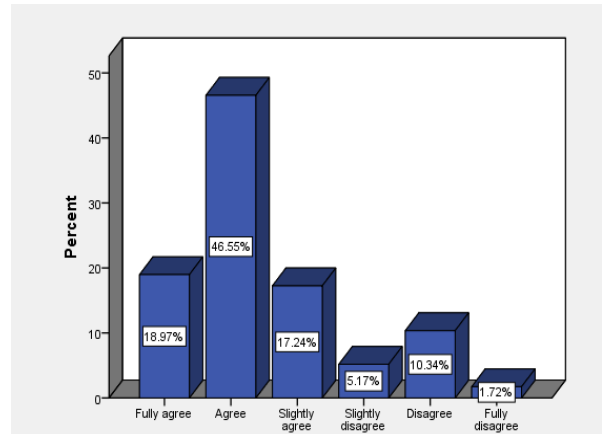
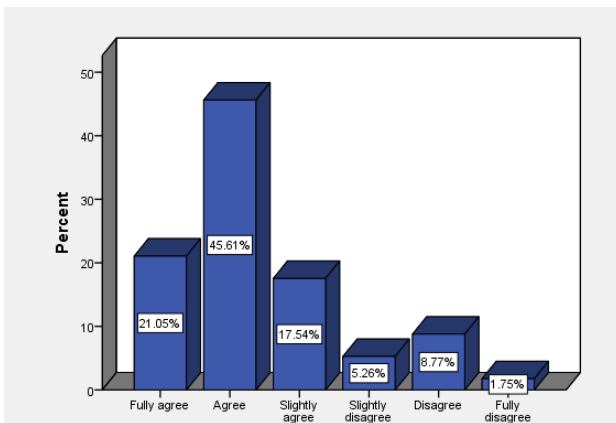
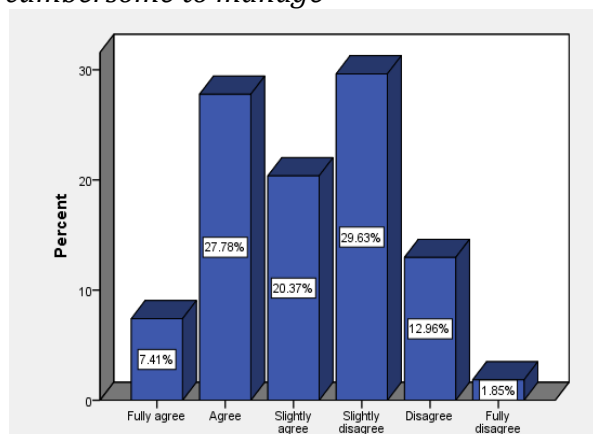


Chart 4.3 Overall, we find using open innovation advantageous to our company



Approximately two thirds of respondents believed that open innovation was cumbersome to manage (Chart 4.4).

Chart 4.4 We believe that Open innovation is cumbersome to manage



4.2 Open innovation barriers and challenges

A range of barriers and challenges to open innovation has been in the literature, including

- Costs of coordination and competition (Grant, 1996)
- Not invented here syndrome – internal resistance in the company to externally developed knowledge (Katz and Allen, 1982)
- Not sold here syndrome – concern over licensing technologies externally for fear of losing the ‘Crown Jewels’ (Kline, 2003)
- Evaluating external ideas can be more difficult than evaluating internal ideas - less first hand information (Menon and Pfeffer, 2003)
- Different capabilities required – external-facing broker (OI) vs. internal R&D (Huizingh, 2011)
- Maintenance of relations with external actors

Companies were asked to comment on the barriers and challenges to open innovation that faced them. The responses of these companies are provided in Table 4.2. The main themes that emerged in the responses were:

- **Culture:** overcoming the not invented here syndrome, and the slow or risk averse approach of the company towards risk; culture of management
- **Seeking and maintaining relationships with external actors,** identifying the right partners

- **Costs of external search coordination**
- **IP: ownership and ceding of IP; funding**
- **Lack of resource (inc. funding)**

Table 4.2 Barriers and challenges to OI identified by interviewed companies

Company and code	Barriers and challenges identified
(1)	<ul style="list-style-type: none"> ▪ Intellectual property sensitivities ▪ Right partners/fit
(2)	<ul style="list-style-type: none"> ▪ Ownership of IP based on value of inputs and outputs when VCs involved
(3)	<ul style="list-style-type: none"> ▪ Getting agility in own Commercial Department – creating trust in the commercial department – risk, regulation ▪ Finding SMEs – networking is key ▪ Maintaining personal relationships
(4)	<ul style="list-style-type: none"> ▪ Not invented here – knowledge is power. Sharing between companies ▪ IP – particularly where they are seen as a bigger company
(5)	<ul style="list-style-type: none"> ▪ Culture – legal and IP protection. Old culture of company was risk averse (IP, legal) ▪ Shrinking funding and headcount ▪ Ownership of IP ▪ Funding OI ▪ Showing value – royalties/acquisition
(6)	<ul style="list-style-type: none"> ▪ Getting people to do it without realising – low key internally (internal, company). ▪ Costs of external search coordination.
(7)	<ul style="list-style-type: none"> ▪ Collaborators in early stage of process more informally...then there is a problem of procurement and price – competition (procurement people aren't happy) ▪ Mixed experiences of collaborative research projects – some hanging on the company's coat tails
(8)	<ul style="list-style-type: none"> ▪ Cultural barriers – whether it's seen as useful to the business. On a learning curve, a lot of convincing to be done that it's worth resourcing.
(9)	<ul style="list-style-type: none"> ▪ Not a great believer in sharing ideas outside the company – loss of competitive advantage
(10)	<ul style="list-style-type: none"> ▪ Main disadvantage is the sharing of IPR and technology – we are a market leader so sharing has the potential to help competitors. ▪ Mindsets need changing at all levels in the company
(11)	<ul style="list-style-type: none"> ▪ Sharing of IP and technology –the potential to help competitors.
(12)	<ul style="list-style-type: none"> ▪ Securing the appropriate funding is seen as the greatest barrier. ▪ IP ownership; costs; managing expectations; fully funded resources. ▪ Management resource and time, particularly when dealing with academia.
(13)	<ul style="list-style-type: none"> ▪ Taking knowledge outside the company, therefore sharing know-how is an issue. ▪ Diverting funding to external partnerships creates tensions. ▪ Job security has become a factor. ▪ Management burden of controlling OI projects. ▪ Procedure, process and data security, but this should improve over time.
(14)	<ul style="list-style-type: none"> ▪ Time and lack of funding for both internal and external projects.
(15)	<ul style="list-style-type: none"> ▪ Competition – certainly in the industry that we're in. Cannot be seen to be involved with competitors ▪ Financial disclosure and confidentiality. One project had a NDA.

Companies were asked to identify ways in which those barriers and challenges identified above could be overcome. Some of the main themes that emerged include:

- **Changing the culture of the company**, including management culture
- **Demonstrating and communicating the value of open innovation**, particularly internally
- **Training and development staff in OI processes**

‘Not invented here’ and ‘not sold here’ barriers

Companies that were surveyed were asked a number of related questions on the ‘not invented here’ and ‘not sold here’ barriers.

‘Not invented here’

More than half of the respondents (61.5%) believe that it is better to develop a technology internally rather than buying from outside and even more (67.3%) believe that their companies can achieve market success without recourse to external technology.

Chart 4.5 We’d rather develop a technology on our own than buy from outside

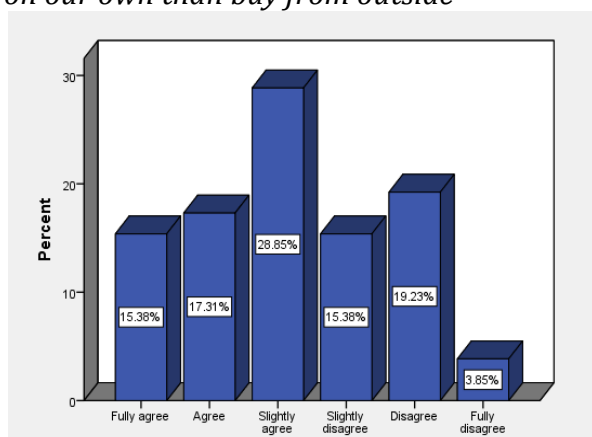
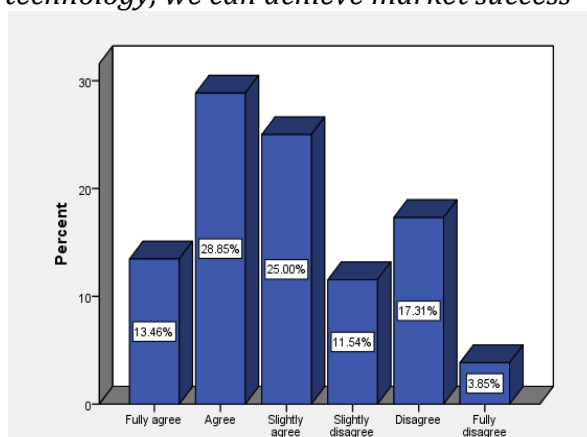


Chart 4.6 Even without using external technology, we can achieve market success



In relation to sourcing of external technologies, more than one third of the respondents believe that in order to sustain their companies’ competitive position, relevant technologies for their companies must NOT be sourced externally – although the majority appear to have a more open position. The same percentage also believe that sourcing technologies externally will weaken their companies’ competitive position. Moreover, more than one third believe that technologies relevant to their companies cannot be developed in an effective and efficient way by any other company.

Chart 4.7 In order to sustain our competitive position, relevant technologies for our company must not be sourced externally

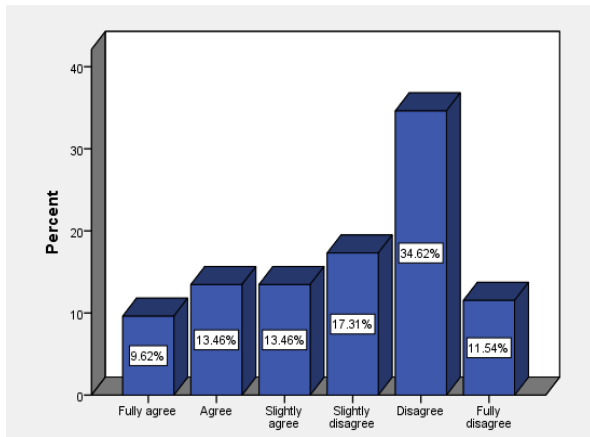
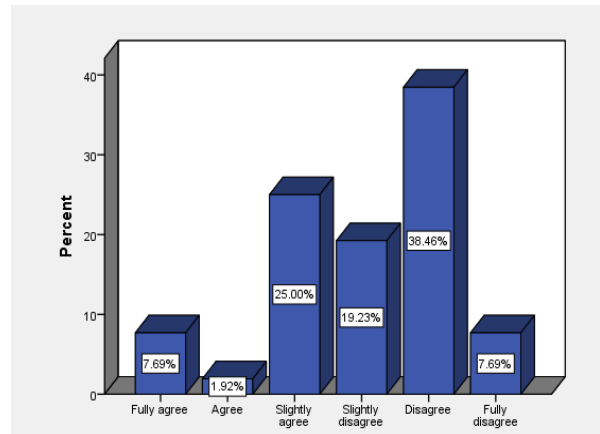


Chart 4.8 Technologies that are relevant for our company, cannot be developed in a similarly effective and efficient way by any other company.



‘Not Sold Here Syndrome’

More than one third (36.5%) believe that they would run the risk to lose control over their technology, if they licensed it to a third party; and more than half (51%) believe that their companies’ innovations should be brought to market through their business unit rather than through licensing or alliances.

Chart 4. We would run the risk to lose control over our technology if we licensed it to third parties

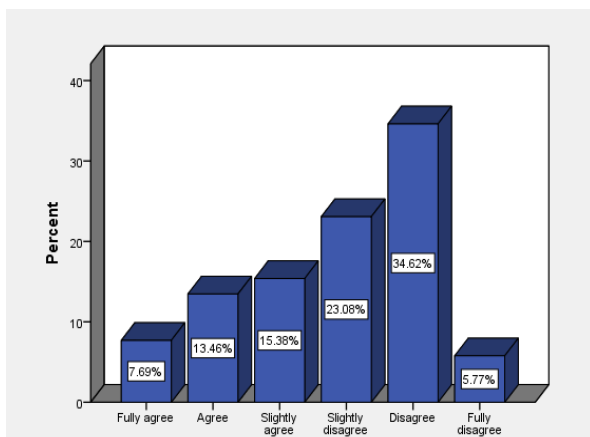
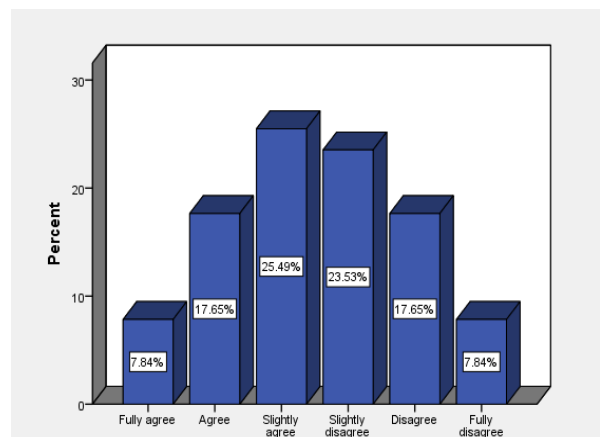


Chart 4.10 Our innovation should be brought to market through our business unit rather than through licensing, alliances etc.



Almost 40% of the respondents think that their companies' technologies should be marketed exclusively via their existing distribution channels, while one third agreed with the statement that using external pathways to market is an important alternative for technology commercialisation within this business unit.

One third of the respondents reported that top management insists on the internal use of technologies, and more than 40% believe that if they decide not to use a technology internally, top management will urge them to search for pathways to market outside of their business unit.

Chart 4.11 Our technologies should be marketed exclusively via our distribution channels

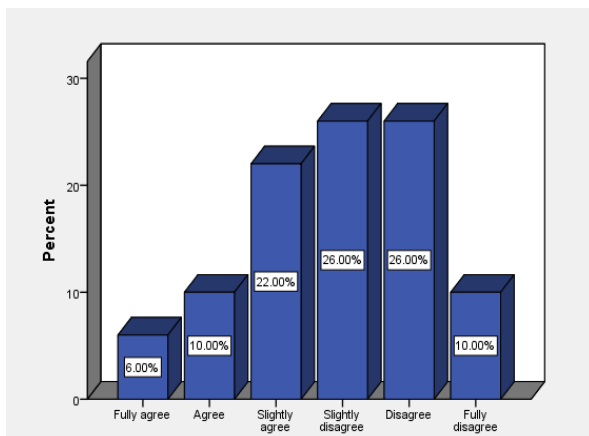
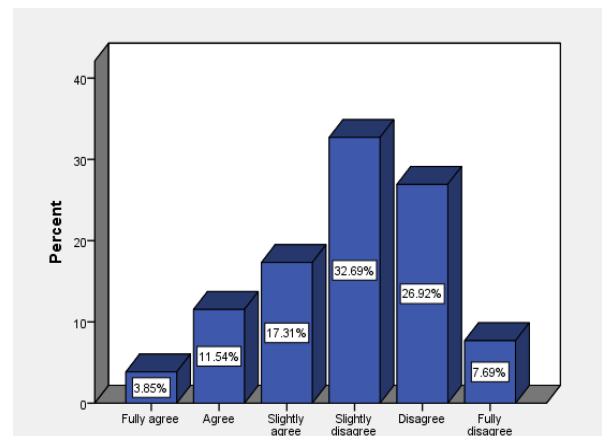


Chart 4.12 Using external pathways to market is an important alternative for technology commercialization within our business unit



Senior Management support is fundamental for the success of open innovation implementation. In this research, more than 70 per cent of respondents reported that their CEO strongly recognises that open innovation enhances the company profitability and that their senior management strongly recognises that that it can enhance competitiveness.

Chart 4.13 The CEO strongly recognises that open innovation enhances the company profitability

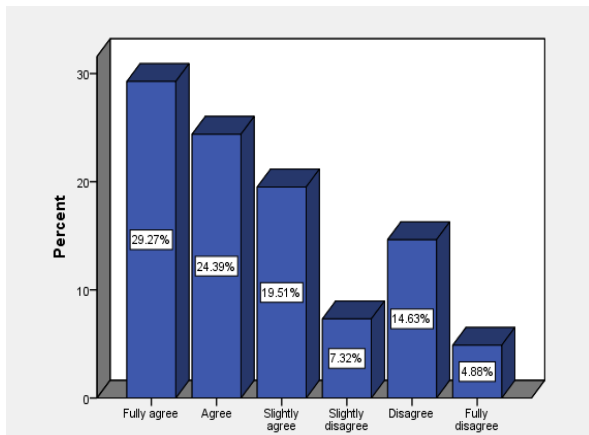
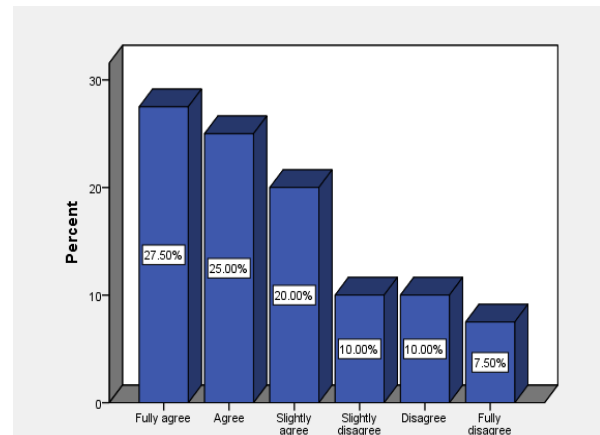


Chart 4.14 Senior management strongly recognises that open innovation can enhance company competitiveness



4.3 Companies' views on motivations and barriers: summary of findings

There was generally a **positive view of open innovation** amongst the companies in the study sample: 85 per cent of questionnaire respondents believe that open innovation improves the quality of the work that they do, and 83 per cent believe that it increases their company's effectiveness.

The main **motivations** were to access capability that didn't exist internally; to commercialise faster; to grow the business; to access new markets (where barriers are high); and to reduce risk.

The main **barriers** identified by companies were culture (especially overcoming the not invented here syndrome and low tolerance to risk), and issues around the practical management of open innovation (costs of external searching and managing relationships).

Table 4.3 Companies' views on motivations and barriers: summary of findings

Questions	Findings
<ul style="list-style-type: none"> ▪ What are the main incentives and motivations for companies to engage in open innovation? (including costs and benefits) 	<ul style="list-style-type: none"> ▪ Access to new technology and capability, including in disruptive areas ▪ Generate new business and increased market reach ▪ Faster innovation and commercialisation ▪ Reducing risk in developing technologies ▪ Entering new markets where barriers are high or require different skillsets ▪ Solving difficult problems
<ul style="list-style-type: none"> ▪ What kind of barriers do non-OI active Welsh businesses perceive? 	<ul style="list-style-type: none"> ▪ Culture: overcoming the not invented here syndrome; risk averse approach of the company; culture of management ▪ Seeking and maintaining relationships with external actors, identifying the right partners ▪ Costs of external search coordination ▪ IP: ownership and ceding of IP; funding ▪ Lack of resources, including funding

5. Overcoming barriers and supporting open innovation

- How can some of the identified barriers be overcome?
- What type of open innovation support do companies want?
- Which international practices can we learn from?

5.1 Overcoming barriers to open innovation

Companies that were interviewed were asked how some of the barriers that they identified could be overcome. Seven key themes were identified:

- **Culture of management:** to be more open and more tolerant of risk
- **Collaboration with Universities:** more could be done at lower TRL by Universities to accelerate development. This should be aligned more with the later TRL innovation landscape. Also, having earlier engagement with University collaborators could be beneficial. For example, one company has a template agreement with academia that has helped this process considerably.
- **Developing trust:** trust is a crucial element for effective collaboration. Where large companies are dealing with smaller companies, trust has to be cultivated in the relationship (for SMEs to be convinced that their IP won't be misappropriated).
- **Internal training and development** for open innovation: support for developing new practices and routines.
- **NDA and other forms of collaborative agreements:** these are important in protecting the parties involved. However, the timing and type of NDAs (e.g. where they are onerous) can be key issues.
- **Demonstrating and communicating the value of open innovation:** quick wins can help demonstrate the value to the company. The tangible and intangible benefits need to be demonstrated and communicated across the company.
- **Learning from other organisations that have been through the OI process successfully.**

5.2 Demand for open innovation support

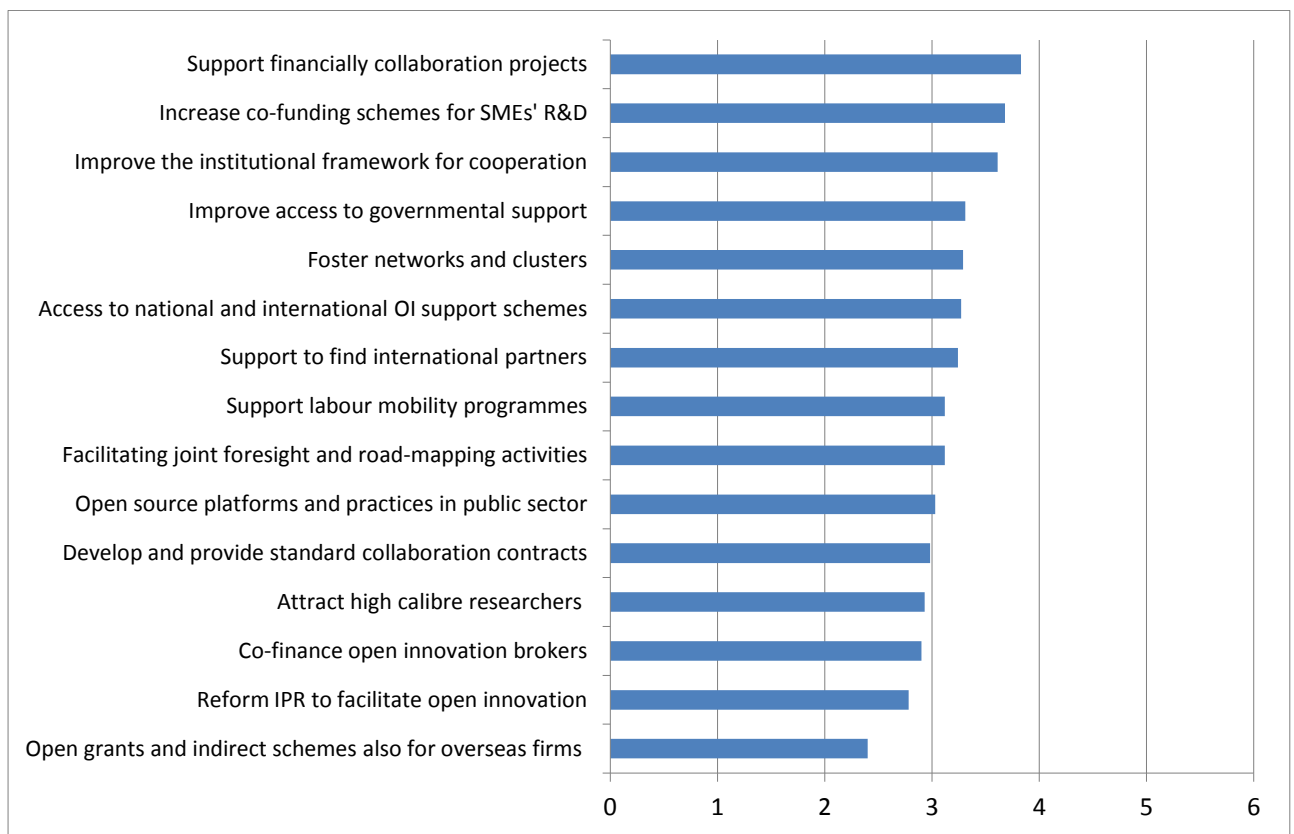
Companies that were interviewed were asked whether they saw a role for public bodies as a facilitator of open innovation. Most companies believed that there was an important role for Welsh Government and other public bodies in facilitating open innovation. The main roles identified were

- Support the development of clusters and innovation ecosystems (see EIT ICT Labs example, 5.4.3)

- Connecting the main actors in the innovation system; support for networking and communication with other companies
- Infrastructure investment and support
- Developing supply chains
- Bridging the gap between academia and commercial research
- Funding, including specific open innovation activities

The interview findings are consistent with the responses received from the companies surveyed (Chart 5.1). The two types of support and **instruments most favoured by companies were financial** in nature (financial support for collaboration projects and increase co-funding schemes for SMEs' R&D). The third most favoured type of support was the **improvement of the institutional framework for cooperation between Universities and companies.**

Chart 5.1 Types of Government support favoured by companies



Detailed responses on the types of government support for open innovation are provided in Charts 5.2 to 5.16 below.

Chart 5.2 Attract high calibre researchers

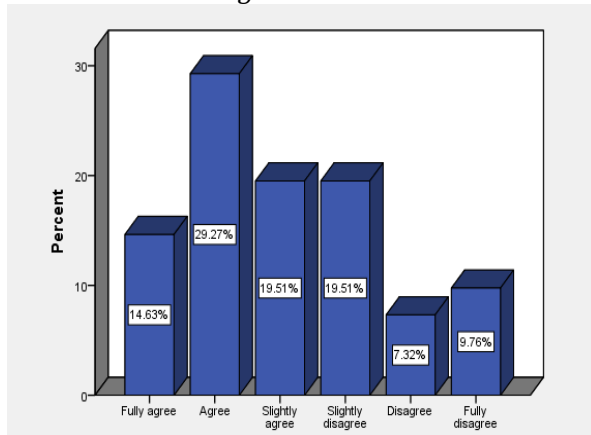


Chart 5.3 Co-finance innovation brokers

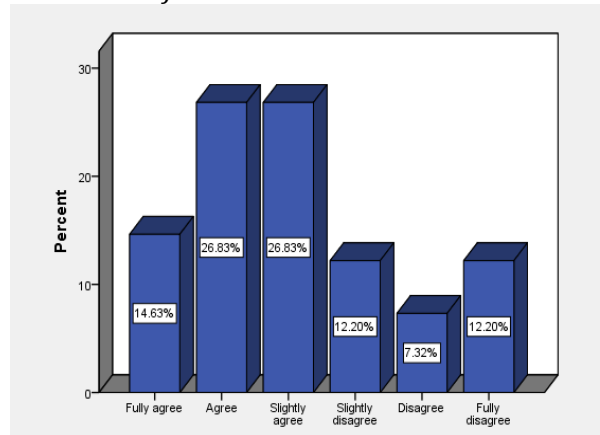


Chart 5.4 Improve access to governmental support

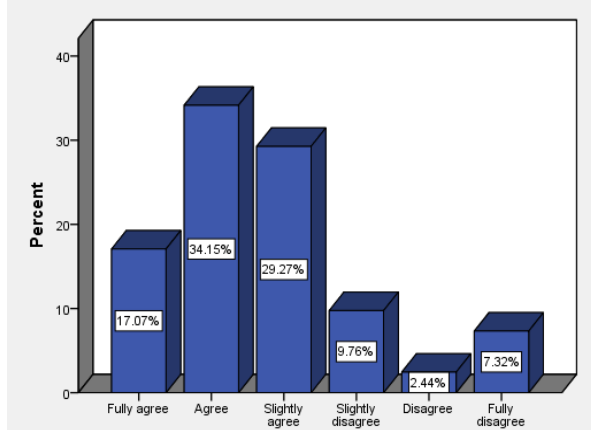


Chart 5.5 Improve the institutional framework for collaboration

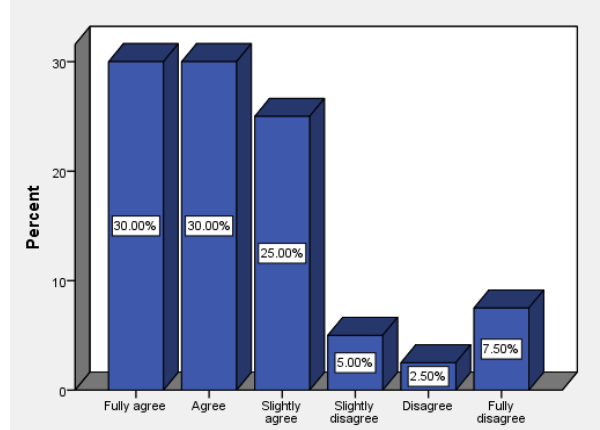


Chart 5.6 Support financially collaboration projects

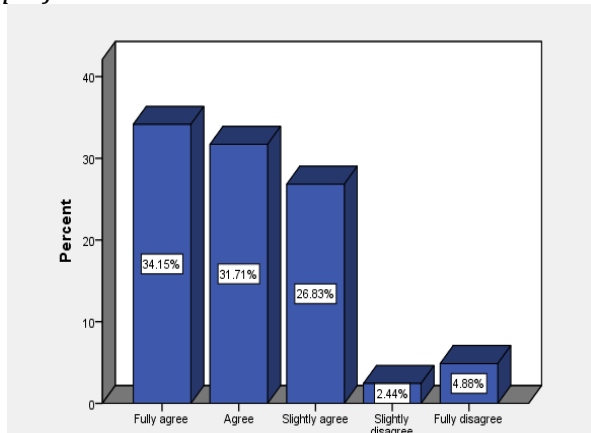


Chart 5.7 Support to find international partners

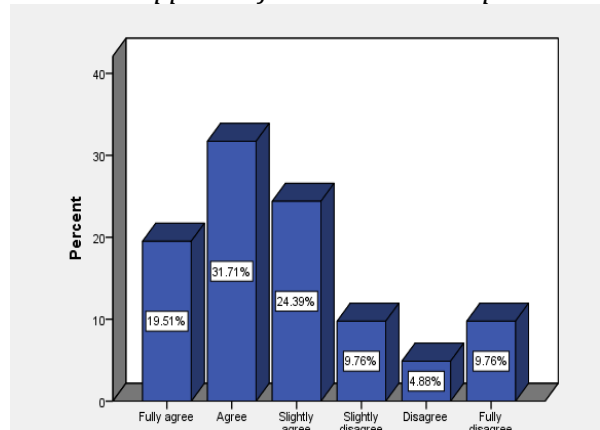


Chart 5.8 Increase co-funding schemes for SMEs' R&D

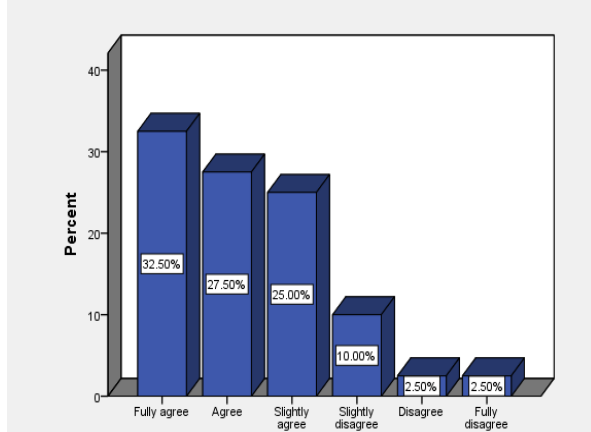


Chart 5.9 Support labour mobility programmes

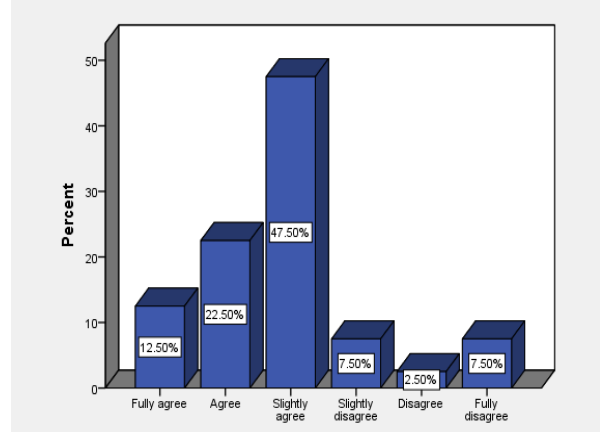


Chart 5.10 Develop and provide standard collaboration contracts

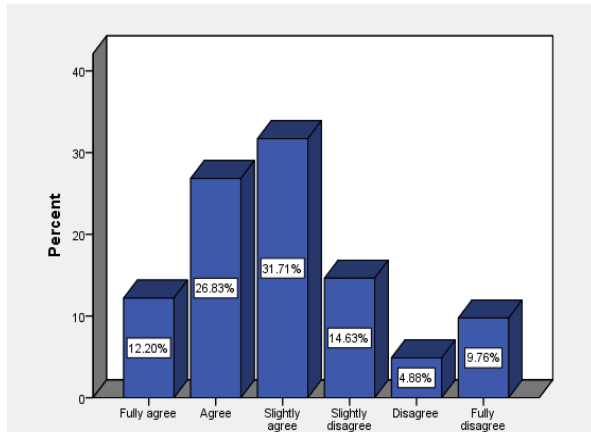


Chart 5.11 Reform IPR to facilitate open innovation

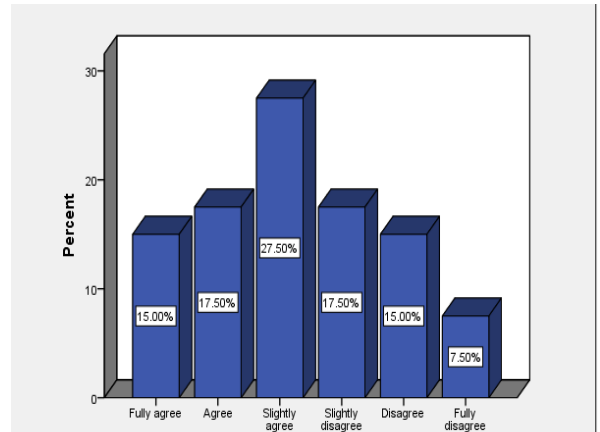


Chart 5.12 Open grants and indirect schemes for overseas firms

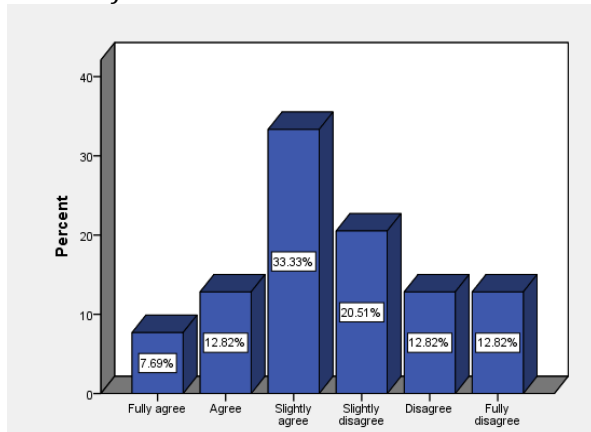


Chart 5.13 Open source platforms and practices in the public sector

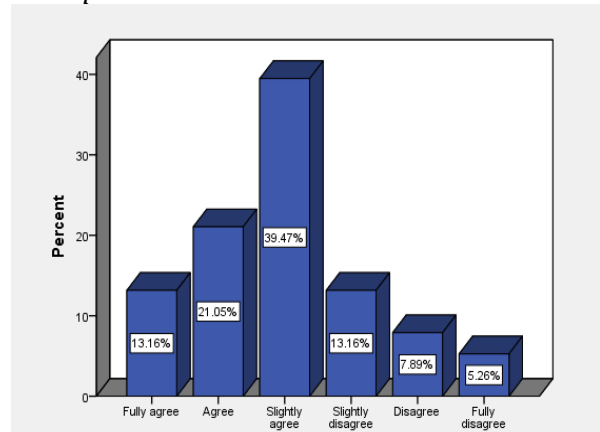


Chart 5.14 Facilitating joint foresight and road-mapping activities

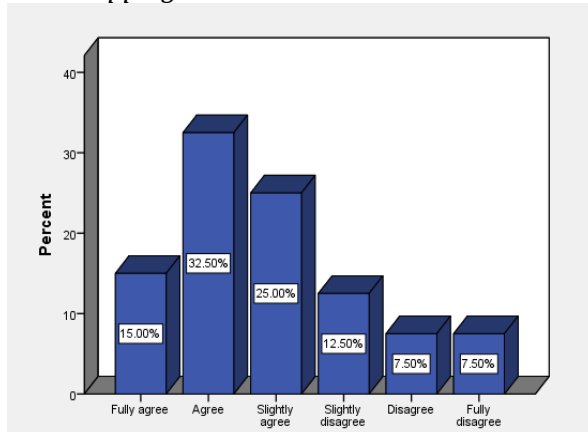


Chart 5.15 Foster networks and clusters

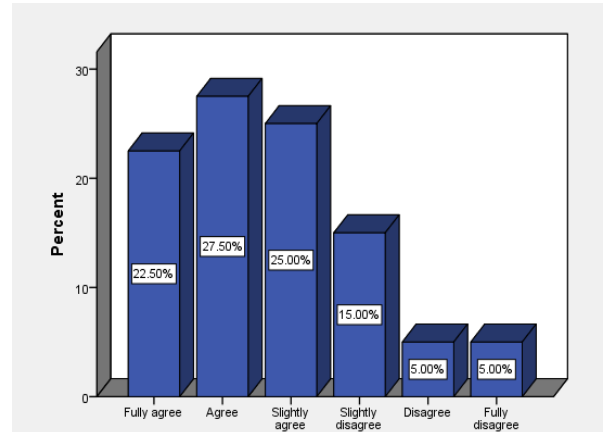
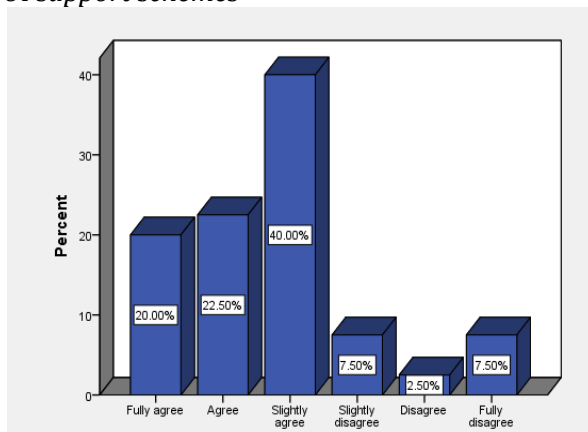


Chart 5.16 Access to national and international OI support schemes



5.3 Focus Group Results

A focus group was held with the companies participating in Welsh Government's Open Innovation Pilot Programme. Participants were asked to comment on questions related to six key themes that had emerged from the study:

- Strategic orientation, performance and effectiveness
- Culture – not invented here; risk and organisational culture
- IP and the right internal/external balance
- Measuring and demonstrating the value of open innovation
- Key practical issues
- Developing the OI ecosystem in Wales

5.3.1 Strategic orientation, performance and effectiveness

With reference to the evidence that strategic orientation of companies makes a difference to open innovation performance and effectiveness (Cheng and Huizingh, 2014), participants were asked to comment on two (opposing) statements:

Individual OI initiatives won't be effective without clear strategic orientation – a shift in company strategy

OI pilot/initiative as a pathfinder to change strategic orientation

In some cases there is an explicit and significant shift in the company strategy towards a strategy based on open innovation (as happened with Procter and Gamble). Whilst the specific direction of the CEO clearly helps in mobilising the whole organisation, it is considered relatively rare to have such an unequivocal shift in the firm's strategic orientation.

My ambition is to generate some quick successes which shows this is what you can do through open innovation by working more collaboratively, and then hopefully you'll change direction of the ship that way (participant 4).

If you look at a typical organisation you've got pockets of well-motivated, well-meaning staff that get it, and those are the ones that will drive from the bottom these pathfinders, these easy wins ... They need a champion or some frame somewhere on the board to stick up for these guys (participant 6).

Although strategic orientation does matter, the comments from the participants – exemplified by the two cited above – suggest that pathfinder initiatives that demonstrate success can be effective in open innovation. Clearly, there needs to be a minimum level of licence or permission from the organisation to engage in these activities. Learning and demonstration can support emergent open innovation strategy.

5.3.2 Culture (not invented here syndrome; risk and organisational culture)

Culture is a major theme that affects open innovation in firms in a number of ways. Based on the literature and our findings, participants were asked to comment on two important aspects of culture: the not invented here syndrome, and risk and organisational culture.

Question posed: Who suffers most from the not invented here syndrome?

- Staff, CEO, Senior Management, R&D team?
- Role of investors?
- Types of business/sectors?

The experiences of the companies indicate that the not invented here syndrome is an issue for R&D and technical teams in particular, as noted by two participants as follows:

[recounting an experience from a previous company] you were getting very strong strategic direction right from the top of the organisation saying that we need to source products from anywhere and everywhere, and we were charged with being part of that process but then the due diligence that we would then do on things naturally involved our internal expertise to really stress test these things. And it was the prejudice and the nature of the internal technical groups was really the brake on things ... they saw the glass half empty on every issue, forgetting, I think...they're not going to have every brick in the wall that we would have if it was an internal project... it's a cultural shift in all these different parts of the business in order to get these things through.

Not invented here means that it automatically will not meet our standards. And I've seen it happen where we work with companies for a period of time until it's got to that point of real transfer of IP and then it gets even harder because it definitely hasn't been invented yet. And it's a very technical response, people think and work probably in different ways and think a big broad-brush statement but I think some of our technical people can be extraordinarily defensive.

Tolerance of risk and organisational culture

Participants recounted different experiences of risk appetites and organisational cultures – and how they can prevent more open innovation. In several cases, the propensity towards risk aversion emanated from commercial departments. On the other hand, this seemed to be a general issue rather than one which was specific to open innovation. From the point of view of sales and profits, the 'commercial people didn't care where the development came from' (i.e. from outside the company).

One company, that had witnessed a period of significant growth, seemed to have experienced a cultural change, which made it less entrepreneurial and have less appetite for risk. The stage of the innovation process was identified as an important factor in organisational attitudes towards risk. There tends to be a greater risk aversion at higher technology readiness levels where the costs of development are that much higher. One suggested a solution of educating SMEs:

using the innovation environment to educate the SMEs such that they then remove some of that risk as part of the earlier development, because there's nothing worse than getting, I don't know, pick an example, a pilot code or a pharmaceutical product that you know has been hacked together for whatever reason and you've just got to

take it apart and put it all back together again, and you think well that's where the not invented here comes in because you've got a...great big bill at the side of it.

The other key point raised in relation to organisational culture was the **system of incentives**. Unless open innovation appeared in the formal and informal incentive systems within the company, the people and behaviours of the organisation are less likely to become more geared towards open innovation. Examples include:

- Pay and rewards;
- Performance management systems (personal scorecards), and
- Allocation of time for more innovative activity (such as the 80:20 system used by 3M, Google and others to encourage staff to work on their own initiatives).

5.3.3 When and how to share IP and knowledge

Participants were asked about how and when to share IP and knowledge. As part of the discussion, they were also asked to what extent this came back to questions of strategic orientation and culture. Many useful points were raised on the use of NDAs – and the way in which they are changing. When large companies (represented at the focus group) deal with SMEs, **trust** is a critical issue. In essence, SMEs tend to mistrust large companies, and assume that their knowledge will be stolen by the larger actor. Several companies have tried to overcome this by building relationships with SMEs and by setting up early NDAs. The type of NDAs used varies significantly and one participant recounted recent experiences of how onerous some of them had become. Formal IP arrangements can be problematic when the technology develops very quickly. In general formal protection needs to be applied in the more mature levels of the development process:

At the lower TRL maturity level, the process and IP protection perhaps around it needs to be less than when you actually get to something where the money is.

In the pharmaceutical industry, 'where IP is actually critical, the shift has been to collaborate where you can collaborate'. An example of this has been the setting up of pre-competitive consortia. One interesting distinction was made in another industry between significant collaboration over process but not over product.

5.3.4 Measuring and demonstrating the value of open innovation

The evidence indicates that OI enhances company performance (Cheng and Huizingh, 2014). Companies were asked to comment on how they measure and demonstrate the value of open innovation, and over what period. Related to this, they were also asked to reflect on the following question: '(How) do you take people with you when the results haven't materialised yet?'

Getting 'quick wins' is an important way of building momentum and support within the organisation for open innovation.

Demonstrating value through **intangibles, generating unexpected leads, building networks and relationships with SMEs, engaging early with customers** are also important:

Intangibles

I think you need to focus in the short-term on the intangibles...by actually doing this, look at what else is going on in the organisation and what the benefits are, because you're enriching your competitive analysis position of what's going on out there, you're getting more awareness of potentially disruptive technology, you're training your staff and you've got a lot more engagement in the workplace.

*I agree with that totally and that's the way I've kind of sold it internally. I have a couple of examples through the work that we've been doing in this project where we've posted some technology challenges on a site and we've had responses from two quite big companies that almost certainly will not be able to use a special technology challenge but it's given us a foot in the door to go and talk to them about commercial opportunities. And it's almost tangible that, to us... **And that wouldn't have happened had we not had this kind of innovation or kind of challenge out there to respond to.***

Building networks and relationships with SMEs

*You develop **some great relationships with the SMEs** and you think actually, some things that come through, and the knowledge and experience that you gain mutually. Each of you learn a lot about each other's business and that leads to stuff.*

I think ours has been mainly through relationships. One, there's an awareness but there's actually a lot more going on in Wales than we were aware of in our sector and we've built up a lot more networks. And interestingly, we're aware of some connections that have been made that actually won't benefit [the company] directly but then they may ultimately, but networks that have been built up with people with the networks that we've established. But also some profile raising exercises as well, because that's definitely been an outcome from that.

Engaging with the customer

*Actually **engaging with the customer early is very, very powerful** because actually you hear what they want, what they really, really want, and that can influence you back in doing other things, not only what you're dealing with there. So you'd get a better understanding of your customer's needs when sometimes that customer isn't very good at elaborating.*

5.3.5 Practices

Participants were asked to identify some of the key practical issues that they have encountered and what's worked well.

Some of the examples found in the literature were given as prompts - costs of external search coordination (seeking and maintaining relationships with external actors, identifying the right partners etc).

The challenges: maintaining relationships, coping with volume and managing SMEs expectations; aligning opportunities with company's own priorities

there's an acknowledgement that finding those people and those relationships is...hard work, it takes a lot of effort and time and commitment, and it has to be done continuously because otherwise you've got a reputation, you've got to keep this fire fed, you can't leave it.

just coping with the volume and manage them to the SMEs' expectations. And ... speed of response and I think that's a struggle for us.

making sure that we don't just take innovations that come along, and we have a view of what our priorities are across a range of various widgets to solve more customer facing innovations which we're struggling on.

Dealing with a large number of external partners may be more familiar experience in R&D-intensive and high-tech industries – whereas for other sectors the coordination of a wide range of actors outside the company may be a more novel situation:

to some extent this is industry driven too. So if you take the high-tech industry, they're well used to dealing with 40/50/60 potential partners because they have to converge technology into a solution.

What's worked well: bringing people together – the power of the network, with enough face-to-face time

there are smart ways of doing it and I think we've come up with a few that have worked for us and it's building those relationships, face-to-face time in an environment that you can get to the solution of the problem and explain it and elucidate it and capture it, it works for us...

5.3.6 Developing the open innovation ecosystem

Companies were asked to identify the main issues in improving the open innovation ecosystem (between companies, Universities, Government, intermediaries etc.)

- **Simplifying and streamlining the different public support offerings for (open) innovation.** Participants referred to the range of innovation and R&D initiatives available (including Horizon 2020, Technology Strategy Board, UK Research Councils, Welsh Government programmes etc). The plethora of initiatives can overload companies to the point where it's difficult to 'see the wood from the trees'. For Universities, the simplification and streamlining process could take the form, for example, of more integrated support where technical expertise and funding support are packaged together more effectively for companies.

- **Providing support for potentially game changing innovation**

Government intervention could focus more on high potential innovation activities where greater development work, investment and patience is needed:

whilst the easy, low-hanging fruit gets picked up and taken, we might be missing the next big thing. So for me, it's that hammock, how do you put that intelligent hammock, safety net or whatever you want to call it, underneath that captures and nurtures those and spits them back?

- **3-year beta programme for open innovation** – to bridge the way through to seeing full commercialisation benefits

- **Developing innovation through the supply chain**– over and above supporting companies to source products or widgets from supplier environment in Wales, supply chain development programmes could focus more on developing innovative solutions and capabilities.

5.4 Open innovation support measures: selected cases from other countries

Our review indicates that the Welsh Government Open Innovation Pilot Programme is the first dedicated open innovation support initiative of its type– certainly conducted in a smaller country (or sub-State) context. Whilst this study did not aim to carry out a comprehensive analysis of all open innovation support activities around the world, we suggest that potential learning can be drawn from the initiatives that we outline below. These are selected initiatives from Germany, San Diego and the EU (EIT ICT Labs and European Lead Factory).

5.4.1 Connect San Diego

In the mid-1980s, the University of California San Diego (UCSD) created a collaboration programme called UCSD CONNECT that was intended to connect institutions and business with academic research. It was hoped that this would produce new technology-based companies that would become the economic future of the region. In the 1990s, the region suffered a decade of deep recession when federal spending on defence was severely cut, however this period of adversity also forced the rapid expansion of UCSD CONNECT, as the collaboration process had already started to transform technology transfer, and create new businesses and wealth.

The concept of Open Innovation was a key part of this transformation, since it enabled strategic collaboration to produce valuable IP and business development, and to become a possible role model for future innovation development in the region. In 2000, Michael Porter selected San Diego as a pilot region for his national cluster analysis (Porter, 2000). The region was selected because it had already achieved some success in developing active biotechnology and pharmaceutical, and communications industry clusters (reducing its economic dependence on traditional clusters), and was fast emerging from the 1990s recession to become one of the nations fastest growing and diverse economic regions. This analysis by Porter, which also drew on the success factors of the nearby Silicon Valley region, provided the route map for assessing the opportunities and challenges facing the San Diego region in the future.

Several factors prompted the change towards more collaboration: the Bayh-Dole Act in the early 1980s encouraged universities to take a more aggressive approach to technology transfer; a new UCSD chancellor from Stanford brought a pro-commercialization approach; UCSD CONNECT made it easier for academics to start businesses; early wins created a culture of success; and the region was able to attract significant funding for viable business opportunities.

In 2005 UCSD CONNECT converted to CONNECT⁴ in order to widen its focus on developing innovation programs for the whole research community. Since 1985 CONNECT has helped the formation of more than three thousand companies, and attracted over \$2 billion of investment capital as well as establishing its unique culture of collaboration⁵. Despite its strong performance and growing global presence, the region suffered from the financial crises of 2008, and it is only just returning to these levels today.

Open innovation: institutions

For the San Diego region, this meant the formation and influence of UCSD, UCSD CONNECT and CONNECT; the military legacy of telecommunications, transportation, logistics, aerospace, analytical instruments, IT, and power generation; and the research legacy that underpins current innovation in biotechnology, pharmaceutical, and medical devices. In the research community the establishment of the Scripps Institute and Salk Institute, and then from the business community SAIC, formed a powerful attraction for many other institutions. When established these institutions formed powerful networks that fostered and grew innovation and enterprise.

There can be a tendency for economic clusters to operate vertically, so the institutions developed multiple opportunities through horizontal and multi-discipline innovation, for example biotechnology. UCSD CONNECT quickly recognized that addressing these issues strengthened open innovation, and helped to overcome the slow pace of technology transfer and universities over-valuing their IP. As a result, the institutional communities have heavily shaped the contemporary economy, enabling the region to perform well in most national economic indicators, except interestingly average wage levels.

Open innovation: ecosystem and cluster development

Today, the region is a vibrant economic community with a worldwide reputation for innovation in the pharmaceutical, biotechnology and communications research industries, and ranks in the top five US clusters for these industries, and in the top three US clusters for attraction of funding and patent applications. In addition, the more traditional clusters of tourism and defence still perform relatively strongly.

The availability of over twenty-five years of strong funding, interesting jobs and quality of life has attracted talent to the region, which it has been able to retain during difficult periods, allowing a positive attitude to develop between these critical resources and the

⁴ <http://connect.org>

⁵ <http://connect.org/programs/innovation-report/Innovation-Report-2013.pdf>

institutions. This collaborative community helped the region to survive the defence cutbacks of the 1990s, and develop a diverse industry profile to maintain and grow economic possibilities. Interestingly, the initial attempts to innovate within the defence sector failed, and it was only when entrepreneurial pursuits began (mainly by redundant workers) that real momentum was finally created.

The key drivers of the region's economic performance have been significant investment in R&D; connecting institutions with academia and government; and encouraging an entrepreneurial spirit and vision from its business leaders and communities. University leaders have produced institutions for collaboration that facilitate the flow of research and ideas, bringing scarce local business resources to university-based entrepreneurs that has enabled them to build many successful companies.

The region's economy is composed of several different types of activities, and development has benefited from Porter's in-depth analysis of the pharmaceutical and biotechnology, and communications sectors, and the process by which clusters develop. This enabled a time-based and resource-based route map to be created that framed the economic direction and the present and future challenges. This was a key strategic plan for regional business and political leaders that helped to form companies like QUALCOMM, which came out of the defence research community.

It is significant that these initiatives took over twenty years to develop, for example the defence cluster; another twenty years to realise the significant development of ecosystems and economic clusters; and another twelve years to create a self-sustaining growth and investment pattern (fifty-two years in total!) This timeline confirms that sustainable innovation is not a quick process, requiring long-term policy commitment.

Porter considered that cluster depth, and interaction between firms to be vital to the creation of innovation. In many cases this means collaboration and open innovation, as firms use each other to extract value from multiple networks and integrated value chains. Porter's report also pointed out that the San Diego infrastructure had to support all clusters, not just the newly established ones, for example leveraging the military presence and infrastructure. Since new industries and clusters tend to emerge from existing ones, and form independently from government, cross-cluster activity needs to be actively encouraged by policy-makers. Porter concluded that most government organizations were perceived by the business community to be performing ineffectively, except for the San Diego Regional Economic Development Corporation (SDREDC).

Open innovation: model

The traditional model has firms and institutions operating separately in resource-specific and research-specific modes, with the result that the silo effect counteracts collaborative

innovation. Today, the region relies on firms accessing resources in their value chain and applied research programmes. As a result, collaboration has increased significantly, built on firm-university interchange of ideas, and developing these into tangible business opportunities.

The close proximity of research institutions is felt to be a significant factor in the growth of innovation, however when collaboration fails this usually translates to business failure. This factor was not lost on Porter as he sought to encourage the regions institutions to collaborate more in innovation, attraction of funding, and the growth of traded and local clusters.

Most institutions and businesses in San Diego believe that the creation of UCSD CONNECT provided the role model for future innovation development.

Porter (2001) also identified a number of key innovation objectives for the region, most of which have been incorporated in the emerging business model, and some of which are still relevant today.

Many pharmaceutical industry watchers have reached the conclusion that strategic partnerships may be the key to rescuing early-stage innovation, since large pharma needs a constant flow of new ideas and innovation from academics, research institutions, and emerging biotechnology and medical device and diagnostics firms, in order to be able to deliver shareholder value⁶.

Open innovation: funding

The region still continues to attract significant funding, for example over \$700 million in digital health, even though since 2008 the total amount of venture capital investment has fallen (PwC, 2014), and US government funding for basic biomedical research has decreased. This has impacted early-stage innovation, and together with the patent cliff has forced large companies to develop different strategies that involve more collaborative relationships with institutions meaning that open innovation is back on the strategic agenda.

As a result, some large pharmaceutical companies have established new translational research programmes with academia, for example Bayer's CoLaborator in San Francisco; Merck's California Institute for Biomedical Research (Calibr); GSK's committed \$50 million support to Sanderling Ventures' early-stage healthcare fund; and Johnson & Johnson's Innovation Centers (especially its subsidiary Janssen Labs, San Diego that operates a global open innovation business model).

⁶ Scientific American: a Global Biotechnology Perspective, 2014

The important role played by federally funded research continues to generate new technologies and spinout companies, helping to drive the regional economy, and UCSD is still instrumental in initiating this essential part of economic growth. A report⁷ highlights the importance of collaboration in the region's economy through the creation of regional innovation hubs, growth and jobs; and university research-based companies unique contribution to nurturing the ecosystem of research universities, technology transfer offices, business incubators, business schools and workforce talent.

The CONNECT 2014 conference in August, sponsored by one of the region's founded firms Qualcomm, which is still headquartered in San Diego, emphasized the importance of open innovation to the region's economic performance by pointing out the regions continuing success of access to capital (rated A); access to talent (rated B); the public policy agenda (rated C); and sustainable returns on investment (rated C).

5.4.2 Steinbeis Institutes

The Steinbeis Institutes are a network of privately funded knowledge and technology transfer companies (Steinbeis Companies, SC). The basis for the network is a foundation that has the objective of supporting SMEs in Baden-Württemberg, Germany (Bundesland with the capital Stuttgart). Today the network consists of 912 independent for-profit organizations. They follow an entrepreneurial and market-oriented approach to link new technological knowledge to market opportunities. Through their investment fund, they can even become co-investors into innovation opportunities, investing in projects alongside technology owners and the companies, which aims to exploit the market opportunity.

In 2013 the SC generated revenues of 145 M EUR and employed in their organisations a total of 1,708 employees among which 730 are professors. The geographical reach in which SCs exist goes well beyond the region and extends today to all main global R&D regions.

⁷ Science Coalition "Sparkling Economic Growth", November 2013

Geographical reach of Steinbeis Institutes (Source: <http://www.steinbeis.de/de/experten/steinbeis-weltweit.html>)



The key to success seems to have been the traditional role of privately funded transfer units in the region and the market-oriented approach. As the transfer units work for-profit they have created a rich set of technology transfer mechanisms that can be applied in a tailored fashion. As a result, they are highly adaptable to the different needs of firms and framework conditions that might govern the behaviour of the public and private partners of the transfer activities.

5.4.3 EIT ICT Labs

Background: In 2009 the European Commission (EC) launched an open call for the creation of integrated Knowledge and Innovation Communities (KICs). At the same time the EC created the European Institute of Innovation and Technology (EIT) as the body that would select and govern the KICs. Each of the three selected KICs was awarded European funding of about 270 M EUR for the first five years after the launch. This funding was granted under the condition that at least three times this amount would be contributed from other sources, including national and regional governmental support and in-kind and in-cash contributions from the partner organisations.

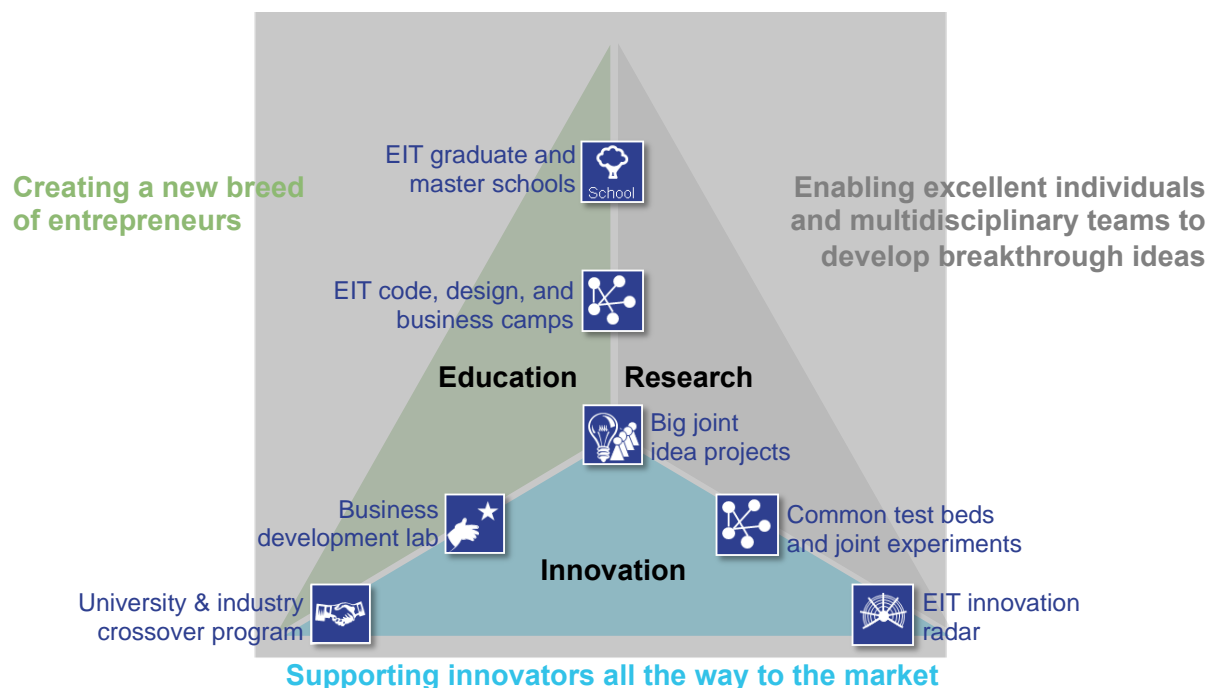
Practice: The central design idea of the KICs is to form an integrated organisation that behaves similar to a private firm. Consequently the KICs were asked to create a business plan that demonstrates in particular its ability to

- Deliver innovation, particularly aimed at solutions that help to overcome societal grand challenges

- Create an innovation system that is self-reinforcing and self-sustaining, including the goal to eventually become independent of EU funding
- Leverage the capabilities of the partner organizations
- Create a high-level of collaboration between the public and private partner organizations

The EIT KIC on Information and Communication Technology innovations (EIT ICT Labs) created a set of open innovation catalysts (the blue icons in the figure below) that address specific open innovation barriers and support the development of a self-sustaining open innovation ecosystem. Furthermore the catalysts are designed to bridge the traditional chasms between Education, Research and Innovation.

Open Innovation Activities (Catalysts) of the EIT ICT Labs. Source: Internal Document; publicly available version: <http://ictlabs.elte.hu/old/index.php?id=business-partnership>



Focusing on specific catalysts also justifies the use of public funding for innovation activities. This allows the public sector to overcome the paradox that on the one hand public funding is designed to be used to create economic wealth, but on the other hand should not distort competition, resulting in funding of only pre-competitive innovation activities. In the case of EIT ICT Labs it was primarily the catalysts, which were supported through the EU funding, and these were also partly open to organisations outside the EIT ICT Labs partner organisation network.

5.4.4 European Lead Factory

An open innovation flagship facility: Launched in 2013, the European Lead Factory (ELF) is a pan-European 5-year public-private drug discovery project, and a flagship open innovation resource for academia, public organisations, large pharmaceutical companies and SMEs⁸.

The ELF is managed by an international consortium of thirty partners, and funded under the European Innovative Medicines Initiative (IMI). The programme office is run by Top Institute Pharma (TIP), which gives academics and SMEs access to an ‘industry-like’ discovery platform that encourages active participation, and is also open to non-contractual partners.

The ELF is the first pharmaceutical and life sciences partnership of its kind, and connects academics and SMEs to opportunities for the discovery of new drug lead molecules with the ultimate goal is to address neglected diseases and provide opportunities for collaboration. The project is designed to deliver substantial cost savings, and a realizable exchange of ideas.

The European Federation of Pharmaceutical Industries and Associations (EFPIA) has contributed its 300,000 compound collection, so that new chemistry scaffolds can be developed. A key project goal is to add a further 200,000 innovative compounds from academia and SMEs. This collaboration will result in a Joint European Compound Collection (JECC)⁹ that will be used to screen against future biology targets.

Open innovation: Innovative Medicines Initiative

The ELF research has received support from the IMI Joint Undertaking, which provides financial resources from the European Union's Framework Programmes FP7, Horizons 2020, and also EFPIA's in-kind contribution. The IMI is another unique public-private partnership set to enhance drug discovery via open innovation, with the JECC at its core.

The IMI strategy is to promote cutting-edge research, and to transform this quickly into high-quality drug lead molecules on a previously unprecedented scale. Those submitting promising targets can also choose to partner with EFPIA companies, therefore accessing the resources and support needed to progress to drug trials.

The total project budget is around €196 million (€80 million from the European Commission, €91 million of ‘in kind’ contributions from participating members of the EFPIA, and €25 million from non-EFPIA participants).

⁸ <https://www.europeanleadfactory.eu/>

⁹ <https://www.europeanleadfactory.eu/assets/joint-european-compound-library/>

Open innovation: stakeholder participation

All stakeholders, including patient organisations and global health initiatives, are actively invited to support and promote the consortium, and to help explore the new drug lead molecules that emerge from the ELF programmes.

Open innovation: the European Screening Centre, Scotland

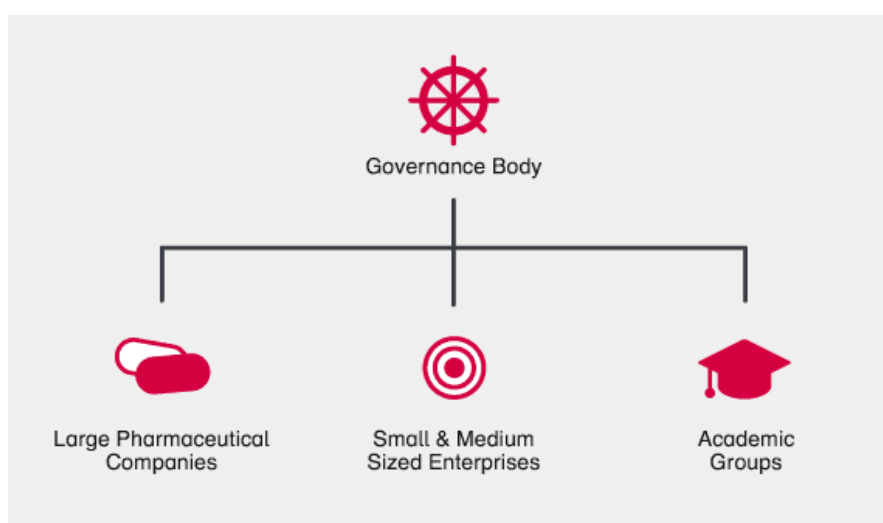
The European Screening Centre (ESC) based at Newhouse is an integrated drug discovery and chemical biology group staffed by the University of Dundee, providing an array of compound screening and medicinal chemistry capabilities. The ESC is organized into three groups to deliver its services: a biology group responsible for compound characterisation and hit triaging to elucidate primary and off target activity of compounds, and conduct in-depth mechanism of action studies; a chemistry group to carry out expert analysis of the progressibility of selected chemotypes with the aim of delivering the most tractable and attractive structures for further development; and a technologies group that provides a comprehensive cheminformatics and modeling capability to enable compound design.

The establishment of the ESC in Scotland was made possible by the strong support of the Scottish Government that also created the necessary infrastructure for it to operate quickly and efficiently. The structure of the ESC enables early validation of potential drug candidates that can effectively reduce the later trial costs, enabling pharmaceutical and biotechnology firms to make cost and time savings when taking new drugs to market.

Open innovation: a unique collaboration

The ELF is a new kind of partnership that capitalizes on the innovation of academia, the agility of SMEs, and the experience and resources of EFPIA members.

A brief description of each partner organisation is as follows:



Governance: part of the IM

The ELF is governed by the Project Management Board and the Project General Assembly¹⁰.

The Programme Office at TIP¹¹ is responsible for scientific management, and all project management services are provided by GABO:mi¹².

TIP - is a not-for-profit organisation and independent research enabler based in the Netherlands that catalyzes medicine development by founding partnerships between academia and industry, and actively managing research programmes. It sets up and runs multidisciplinary partnerships linking precompetitive, pharmaceutical research and expertise - from science to industry - in open innovation. It also provides third-party governance to build and safeguard the trust necessary in strategic pharmaceutical partnerships, and has to-date helped to found 80 partnerships of 3 to 30 partners, managed the programmes and supported these with funding, finance, IT, education & training, intellectual property, communications and secretarial services. The active portfolio is dedicated to the priority medicines identified by the World Health Organization reports of 2004¹³ and 2013¹⁴. Priority medicines R&D is often difficult, or impossible for a single group to perform alone, so partnership using TIP takes R&D to the next level - making the development of critical medicines better, faster and more affordable.

GABO:mi - provides free-of-charge help and advice to contact organizations that are applying for European research funding (FP7; Horizon 2020; IMI and IMI2), and is based in Germany. The services provided are mainly in contract negotiations, financial management, reporting to the EC and meeting organization.

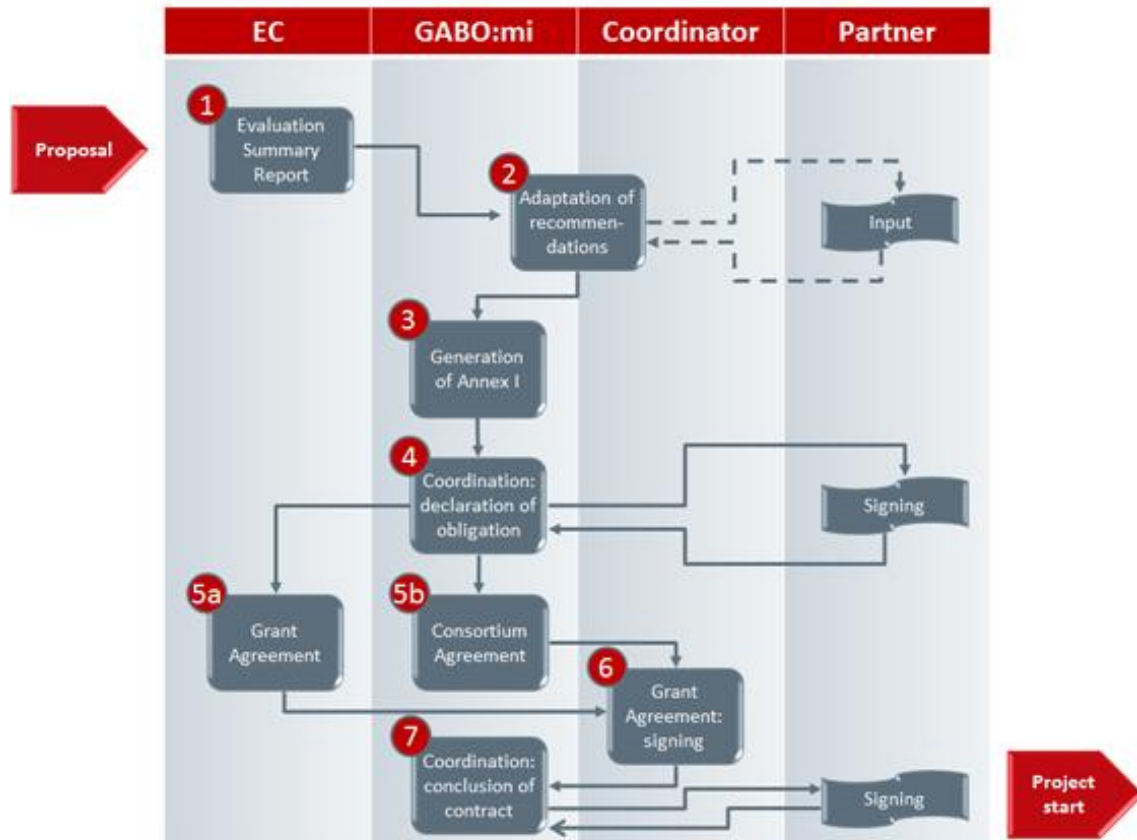
¹⁰ <https://www.europeanleadfactory.eu/about/governance/>

¹¹ www.tipharma.com

¹² www.gabo-mi.com

¹³ <http://www.who.int/whr/2004/en/>

¹⁴ <http://www.who.int/whr/en/>



5.5 Overcoming barriers and supporting open innovation: summary of findings

Table 5.1 Overcoming barriers and supporting open innovation

Questions	Findings
How can some of the identified barriers be overcome?	<ul style="list-style-type: none"> ▪ Culture of management: to be more open and more tolerant of risk ▪ Early collaboration with Universities ▪ Developing trust with collaborators ▪ Internal training and NDAs ▪ Demonstrating and communicating the value of open innovation e.g. Getting 'quick wins'; intangibles; generating unexpected leads; building networks and relationships with SMEs; engaging early with customers ▪ Learning from other organisations that have been through the OI process successfully.
What type of open innovation support do companies want? (developing the open innovation ecosystem)	<ul style="list-style-type: none"> ▪ Connecting the main actors in the innovation system; support for networking and communication with other companies ▪ Developing supply chains – focus on innovative capability and solutions ▪ Bridging the gap between academia and commercial research ▪ Funding, including specific open innovation activities ▪ Simplifying and streamlining the different public support offerings for (open) innovation. ▪ Providing support for potentially game changing innovation ▪ 3-year beta programme for open innovation ▪ Infrastructure investment and support
Which international practices can we learn from? (interesting examples)	<ul style="list-style-type: none"> ▪ Steinbeis Institutes, a German network of privately funded knowledge and technology transfer companies with a strong focus on supporting SMEs ▪ San Diego – UCSD Connect Programme: an integrated technology transfer and funding programme for academia and businesses

6. Conclusion

6.1 Engagement in open innovation activities

The majority of companies studied engage in open innovation activities. This was measured by the specific types of activities that they carry out – inbound and outbound open innovation activities. Rather than asking the companies whether ‘they did open innovation’, we were able to conclude that a range of open innovation activities are undertaken by companies in Wales. All the companies interviewed and 85 per cent of companies that responded to the questionnaire cooperate externally to develop new products and processes. For most, this was ‘the way of doing things’ rather than an explicit ‘open innovation strategy’.

The most frequently cited activities are collaboration with stakeholders (especially suppliers) and inbound (sourcing) open innovation, which include the following: Technology watch; monitoring disruptive technologies; IP searches; market intelligence; scanning for acquisitions. Strategic acquisitions and in-licensing were reported as important forms of inbound open innovation (‘acquiring’). However, scanning and sourcing activities are more common.

6.2 Motivations and benefits

The companies studied cited the motivations and benefits of open innovation that are often reported in the literature, including:

- Access to new technology and capability, including in disruptive areas
- Generate new business and increased market reach
- Faster innovation and commercialisation
- Reducing risk in developing technologies
- Entering new markets where barriers are high or require different skillsets
- Solving difficult problems

Several of the companies interviewed explicitly acknowledged that they did not have all of the knowledge or answers themselves.

6.3 The importance of strategic orientation

The study examined the origins of open innovation in companies. Changes in strategy or leadership are often the main driver for adopting more open innovation approaches. Companies were aware of broader changes and trends within their industries – and in other industries – towards more collaborative forms of innovation. Recent evidence suggests that companies with an entrepreneurial strategic orientation in particular gain greater benefits (performance and effectiveness) from their open innovation activities. **A**

clear, strategic orientation greatly facilitates the development of an open innovation approach within companies. However, in many cases – provided that there is broad permission from the top of the company – ‘pathfinder’ open innovation initiatives can offer a mechanism for gaining momentum (provided that benefits are demonstrated through this process).

The evidence from this study indicates that the way of managing open innovation varies significantly according to the nature of the industry in which the business operates. We explored how open innovation ‘fits’ with the strategy and innovation process of the companies. For companies involved in high-technology engineering and manufacturing, open innovation fits into very formal and structured innovation processes, using pipelines, TRLs and stage-gate processes. This is contrasted with some of the highly innovative service-based company cases examined (e.g. Insurance, media), where there is no formal innovation process, and where the development of innovation tends to be more fluid and organic. The service industry companies also used open innovation activities but with frameworks and processes that were in keeping with the nature of the company and industry. Open innovation is applicable across industries. It is **important to consider and support open innovation in service-based companies**, where there is a less standardised or structured way of generating innovation. This reinforces the key messages of previous research – that acknowledges the different needs of service-based innovation (DTI, 2007).

6.4 Barriers and challenges – and potential solutions

Culture: this is a major theme that affects companies in many ways. The ‘**not invented here syndrome**’ and the ‘not sold here syndrome’ are often cited by the literature on open innovation. Resistance to ideas generated outside the organisation can be a problem across the company but tend to be prevalent in technical/R&D functions. However, this resistance can often be exacerbated by negative experiences e.g. where small, external suppliers don’t have the norms and standards of larger companies in their innovation processes. Part of the solution here is to ‘educate’ SMEs on the requirements and criteria that need to be satisfied to contribute to the larger company’s innovation process (e.g. TRLs). **Risk aversion** and the **culture of management** (e.g. towards IP protection and collaboration) are also challenges to more open forms of innovation.

External search coordination, identifying the right partners, maintaining relationships with external actors, and managing the expectations of external organisations are all important **practical challenges** of open innovation. Here, companies need to strike a balance between focusing on external knowledge that meets their explicit priority and being open to ideas and opportunities that it may not have considered.

Demonstrating and communicating the value of open innovation: companies need a way of identifying value from open innovation activities. Getting ‘quick wins’ will provide a

major boost but some of the benefits will be (initially) intangibles, for example in building networks and relationships with SMEs and engaging early with customers.

Trust and collaboration: mistrust of large companies by SMEs is often a barrier. Smaller companies often perceive larger companies as IP predators, ready to steal their knowledge. Formal mechanisms such as NDAs provide protection although engendering trust and developing a positive reputation probably requires the cultivation of relationships with other companies over a period of time.

7. Recommendations

Here we focus on the options and solutions for developing a more effective open innovation ecosystem in Wales – and who should be responsible for delivering them (business, academia and government).

Responsibility: Business

Recommendation 1: Open portfolios of unused Intellectual Property rights, particularly to partners in the value chain/network. It might even be beneficial to open them to competitors in cases where emerging markets need to be sustained by a number of companies to ensure that it matures, e.g. Tesla opening up all its patents on electric mobility.

Recommendation 2: Review the strategic orientation and culture of the company. An open innovation ‘fitness check’ can identify bottlenecks and barriers that may prevent the company from realising the benefits of more open and collaborative practices.

Responsibility: Government

Recommendation 3: Develop a **comprehensive open innovation programme** funded by Government. This should build on the momentum of the Open Innovation Development Awards but also bring together existing and planned innovation and commercialisation schemes for industry and academia. Government funds should be used to lever in additional investment in innovation activities. The following initiatives should be considered as part of the larger innovation programme, where openness and collaboration are critical:

- a. Create a 3-year beta programme to sustain activities developed under the existing Open Innovation Development Awards.
- b. Develop a significant **Innovation and Technology Seed Fund**. This would scale up the Welsh Government’s £7.5million Welsh Technology Seed Fund, managed by Finance Wales. The High-Tech Gründerfonds in Germany provides an interesting model in which public investment levers in private investment and industrial collaboration¹⁵.
- c. Assess the feasibility of sector-based innovation investment funds, similar to the Wales Life Sciences Investment Fund. This would follow Welsh Government’s

¹⁵ Initiated by the state owned development bank (KfW) and 6 of the largest firms in Germany (<http://www.en.high-tech-gruenderfonds.de>; http://en.wikipedia.org/wiki/High-Tech_Grunderfonds)

principles of focused investment in priority sectors. The ICT/digital sector appears to be a strong candidate for a dedicated innovation fund.

- d. Assess the feasibility of a **Transfer Fund** that can invest (for-profit) in transfer projects between academia and business¹⁶.
- e. Innovation **vouchers** that can be used by firms to receive boundary spanner support, technical services, assistance on IPR, etc. This would be a continuation of the type of Innovation Vouchers scheme currently operated by Welsh Government (until 2015).
- f. Innovation through **supply chains**: building on the success of supply chain development programmes over a number of years, this should focus on developing innovative capability and solutions within the supply chain. Novel approaches such as collaborative business modelling, foresight studies, utilising network analysis and actor-matrices can help to further systematise the building of supply chains in new business fields.

Recommendation 4: Assess how an open innovation programme could be developed and funded within the EU Structural Funding for Wales, 2014-2020. The Welsh Government and its partners should consider whether there should be a specific measure which supports and funds open innovation within the business sector. In addition, the use of Financial Instruments within EU funding is increasing and these should be considered in supporting funding programmes focusing on developing open innovation.

Responsibility: Academia and Business

Recommendation 5: Develop schemes to attract global talent in collaboration with Universities. This would supplement the Sêr Cymru programme through a focus on emerging and early career talent – in addition to established leaders in science, technology and engineering¹⁷. This would provide continued investment and focus, following some of the successes achieved by similar initiatives in Wales, such as the Prince of Wales Innovation Scholarships (POWIS) and the Knowledge Economy Skills Scholarships (KESS).

¹⁶ The Karlsruhe Institute of Technology has been operating such a fund for 4 years. It started with fund size of 1 Million EUR

¹⁷ For example the German “Software Campus” Initiative attracts PhD talent by providing them with a project and a mentor from one of the business partners - in addition to a grant for tuition and living costs. <http://www.softwarecampus.de/en/home/>

Responsibility: Government, Academia and Business

Recommendation 6: The Hauser Report (Hauser, 2010) expresses concern over the lack of infrastructure in the UK that can translate research and technology into commercial gains. The Technology Strategy Board Catapult Centres programme is regarded as a significant development in addressing this gap. However, whilst they can service Welsh companies, none of the Catapult Centres are based in Wales. In consultation with Academia and Business, the Welsh Government should assess options for **improving translational innovation infrastructure** in Wales, including the establishment of a national technology and innovation centre (such as TNO in the Netherlands and VTT in Finland).

Recommendation 7: Evidence from the companies that have ‘gone open’ indicates that they were hitherto unaware of a range of potential partners and suppliers that operated within relative geographical proximity. This could be addressed by the **creation of networks of boundary spanners**, such as the privately funded Steinbeis Institutes, which bridge gaps between Academia and Business but also create linkages between business, and support innovation by orchestrating joint research. Government could provide financial support for the development phase.

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Annex 1 Welsh Government's Open Innovation Development Awards

The Development Award for Anchor Companies is one phase of the larger Open Innovation Pilot Project being undertaken by the Welsh Government.

The Development Awards have been designed to fund the implementation or extension of internal frameworks to enable open/collaborative innovation with multiple collaborating partners, supported optionally by academia. The framework should nurture and support the relationship to maximise the impact of working with smaller businesses. This will provide them with a better understanding of the markets they operate in, the technical solutions required, and access new routes to market by allowing them to commercialise new products by utilising the experience of the larger companies for the benefit of the Welsh economy.

To satisfy the aims of the project, Anchor companies are expected to:

- Nominate an 'O.I Champion'
- Develop external collaborative links
- Develop commercially exploitable solutions to the benefit of all parties.
- Share best practice amongst other Anchors/SMEs/Academia – including case study publication.
- Nurture and develop SMEs they engage with e.g. access to facilities/expertise.
- Provide input to shaping any future delivery of Welsh Government support.

Following a competition, the following Anchor Companies have received Open Innovation Development Awards:

- Airbus Defence (was Cassidian)
- General Dynamics
- IQE
- Wales & West Utilities
- Norgine
- Pure Wafer
- Tata Steel

The Open Innovation Development Awards run until March 2015.

Annex 2 Study Participants

We are very grateful for the contributions of companies that participated in the study. To preserve their anonymity, only the main business sectors of interviewed companies are provided.

Interviews

Company ID	Main business sector
1	Insurance
2	High-technology engineering
3	Defence and Security
4	Advanced manufacturing
5	Life sciences
6	Advanced manufacturing
7	Aerospace
8	Utilities
9	Media
10	Advanced manufacturing
11	Defence and Security
12	Life Sciences
13	Photonics
14	Utilities
15	Advanced manufacturing

Focus Group

1. Airbus Defence (was Cassidian)
2. General Dynamics
3. IQE
4. Wales & West Utilities
5. Norgine
6. Pure Wafer
7. Tata Steel