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Innovation Index Working Paper

Proposal for Measures of Firm-Level Innovation Performance in 12 Sectors of UK Industry

Richard Adams (Cranfield University)
Andy Neely (Cranfield University)
Bassil Yaghi (Cranfield University)
John Bessant (Imperial College)

This working paper was published as part of the Innovation Index project that NESTA is running pursuant to Recommendation 18 in the UK Government's 'Innovation Nation' white paper (March, 2008). As a consequence, it is intended to extend and provoke debate on issues related to innovation measurement. The views expressed are those of the author(s) and do not necessarily represent those of NESTA.

Proposal for Measures of Firm-Level Innovation

Performance in 12 Sectors of UK Industry

A working paper prepared for NESTA by:

Dr Richard Adams, Cranfield University
Professor Andy Neely, Cranfield University
Dr Bassil Yaghi, Cranfield University
Professor John Bessant, Imperial College

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1 EXECUTIVE SUMMARY

Innovation, defined here as "change associated with the creation and adoption of ideas that are new-to-world, new-to-nation/region, new-to-industry or new-to-firm" is notoriously difficult to measure.

As part of the process for the development of the UK's new Innovation Index, this working paper addresses the phenomenon of firm-level innovation performance measurement in the following areas of industrial activity: aerospace and defence; business services; construction; creative industries; financial services; high-technology manufacturing; information ad communications technology; pharmaceuticals; the public sector; retail and wholesale distribution; telecommunications, and; transport.

The objectives of this working paper are to:

- Summarise firm-level indicators currently applied to measure innovation performance across 12 sectors of UK industry, informed by the academic and grey literature and contemporary management practice.
- Propose a set of 3-5 metrics per sector reflecting the essence of each sector's innovation performance – where the impacts of its innovation activity are felt.
- Assess whether or not these measures are effective in measuring what needs to be measured.
- Identify areas where further metric development may be required.

Our principal conclusions are highlighted below:

- Despite the best efforts of authors to capture a wider conceptualisation of innovation in national and regional surveys, innovation measurement remains underdeveloped, in two particular respects. First in capturing innovation in non product-centric organisations and, second, in accounting for 'hidden innovation' those innovation activities that are not reflected in traditional indicators such as investments in formal R&D or patents awarded (NESTA, 2007).
- To more adequately represent the innovation output of firms, a suite of measures is required that extend the conceptualisation of innovation performance beyond the traditional financial and patent-counting metrics.
- Across the 12 sectors we propose 60 metrics across 23 categories or measurement themes. Fewer than half of these directly measure financial performance or count intermediate outputs such as patents. The remainder are intended to extend measurement practice beyond these traditional measures (Appendix 1).
- The review demonstrates some commonality of metrics across the different sectors, but also divergences are noted. Furthermore, there appears to be a range of levels of sophistication in use of measures, with some sectors applying conceptually more sophisticated metrics than others. Some sectors appear to be operating with a fairly basic set of measures (e.g. construction) whereas others have a more comprehensive set (e.g. aerospace and defence).
- Frequently, process and output performance perspectives are conflated. *Innovation performance* can relate to how well the R&D, NPD, NSD etc

process works (on time, on budget, efficient etc), or to the immediate or longer term results of those processes (new products, new business models, new markets entered, reputational enhancement etc). However, one result *may* be modified development processes, and so process improvement can be a legitimate output measure of innovation.
- We outline a proposal to take forward the proposed measures into a further round of development, testing and implementation in Appendix 2

2 BACKGROUND

In the UK Government White Paper *Innovation Nation* (DIUS, 2008) NESTA was charged with developing a new Innovation Index to measure the UK's performance as an Innovation Nation with a pilot index to be published in 2009. This working paper on firm-level measures of innovation output performance has been prepared as part of this initiative.

It has been suggested that innovation performance measurement belongs in the "too hard" basket and that to suggest a set of performance measures that would be relevant to all firms, or even a group of firms, would be presumptuous (Chapman, O'Mara, Ronchi and Corso, 2001).

To get a handle on indicators of performance, it is useful, in the first instance, to turn to the literature on key success factors associated with new product development. Whilst these focus on dimensions such as leadership, top-management support, the use of metrics to manage processes etc, they also provide a range of conceptualisations of innovation output performance. Several useful reviews can be identified, including Balachandra and Friar (1997), Barczak (1995), Griffin (1993), Griffin and Page (1993; 1996), Lilien and Yoon (1989), Linton, Walsh and Morabito (2002) and, Montoya-Weiss and Calantone (1994)) (some of which are summarised in Appendix 3). In addition to these, we can include the work of Robert Cooper and colleagues (see Cooper (1988; 1990) and Cooper and Kleinschmidt (1986; 1987a; 1987b; 1987c; 1995b; 1996)) whose studies of the success and failure of development projects develop conceptualisations of output performance, including: *financial, temporal, market and product related factors*.

The axiom "what can be measured gets measured" appears to hold as much for innovation output as it does for other areas of performance measurement, and popular indicators appear to be those for which the appropriate data is relatively easily obtainable. Various studies have looked at measures in use. Cooper and Edgett (2008) found that the most popular metrics to gauge the performance of individual new product projects are sales and profit measures: revenue achieved versus forecasted revenue is used the most followed by profitability. And, the Boston Consulting Group discovered the three metrics that executives consider most valuable are time to market, new product sales, and return on investment in innovation. (Boston Consulting Group, 2006).

But, limitations have been associated with the earliest 'industrial era' measures which, with their emphasis on products, fail adequately to capture the diversity of possible outputs from a broad conceptualisation of innovation embedded in the knowledge economy unfolding around us (Milbergs and Vonortas, undated). For example, process innovations are largely understudied yet, these innovations play an important strategic role within companies by allowing productivity improvement and new product development (Becheikh, Landry and Amara, 2006) and further metric development is required.

In the following, we first briefly describe our method, how we sought to move measurement away from indicators that have proven to be easier to implement to measures that address more long-term or wider outputs and impacts. Following that, we review each sector first by its context for innovation, then reviewing the data from our empirical work and the literature and finally proposing a set of measures. The paper concludes with a SWOT analysis.

3 METHOD

There is a rich history of academic research and a wealth of grey literature that address the practice of innovation measurement. It was not consistent with the objectives of this project, nor within its time and budgetary constraints, to perform an exhaustive review of this work.

Our purpose has been to perform a mapping exercise of metrics found in the literature as well as an indication of those used in practice, with a view to proposing what an ideal set might look like on a sectoral basis. The appropriate selection of metrics is a process governed by purpose and context (Kerssens-van Drongelen, 1999) and so, our review of the literature has been purposefully selective, seeking out those academic papers and contributions from the grey literature that address the phenomenon of interest.

Papers were identified on the basis of database searches, snowballing and the recommendations of industry and academic experts. We include only those papers in our review where we can clearly identify a sector of interest, either as a focus of the research or, as part of a mixed sample. As a consequence we exclude a large number of papers that are theoretical or fail adequately to specify a sector. The studies we have excluded from our review are noted in Appendix 3.

In addition, we have undertaken five interviews (availability of candidates for interview was curtailed by the holiday season, Appendix 4) and run a web-based survey from which we received 40 usable responses (Appendix 5).

In selecting measures for inclusion, our task was a complex one. It was not merely a case of identifying the most popular or frequently used measures. To have done this would have returned us to the start and a proposed set consisting of counts of patents and returns from R&D. Instead our principal criterion for inclusion or exclusion was the extent to which measures reflected important aspects of innovation activity in the sector, whilst continuing to take into account a measure's reported importance to the sector. Measures were evaluated against what we identified (from the literature and our empirical data) as the key areas of innovation activity in each sector.

Broadly, this was a subjective process of comparative synthesis, bringing together data (metrics) from a range of sources, drawing conclusions about their appropriateness based on the sectoral context of innovation and, reducing them to a parsimonious set capable of capturing a broad spectrum of each sector's output performance. Our purpose has been to shift from the pursuit of alternative and sometimes overlapping indicators (e.g. multiple measures of sales growth), to the joint consideration of complementary and even mutually excluding measures that cover a broad spectrum of output and whose advantages may compensate for others' flaws (Beneito, 2006).

4 AEROSPACE AND DEFENCE

4.1 INNOVATION IN THE AEROSPACE AND DEFENCE INDUSTRIES

Fierce global competition, turbulent market dynamics, exploitation of technologies, new materials and novel manufacturing processes and methods, regulatory requirements, public expectations for higher levels of safety, efficiency, affordability, ethical behaviour, environmental awareness and sustainability, the challenge of continuous improvement and demand for environmentally friendly low-cost production and product all set the agenda for innovation in the international Aerospace and Defence Industries. As the Aerospace Industries Association of Canada puts it**, "**the traditional aerospace performance criteria of 'higher, faster, farther,' have been joined by new criteria of 'safer, quieter, cleaner, more affordable'"[1].

So, in the Aerospace and Defence Industries competitive advantage has become defined by innovation. Of particular importance has been the adoption of organisational and process innovations such as *lean manufacturing.* Research has indicated that many UK aerospace companies are in the process of adopting the lean manufacturing philosophy (Crute, Ward, Brown and Graves, 2003). But, that is not to overlook the technological, product and organisational innovation occurring within the sector. To some extent this diversity is represented in our data, but a small sample and a limited literature restricts our ability to make strong recommendations regarding innovation performance measures.

4.2 AN INDUSTRY PERSPECTIVE ON MEASUREMENT

We have received one response to our survey and also undertaken one interview, however it is worth noting that the research team have worked with a number of aerospace companies over the years and clearly these experiences have influenced our comments. Additionally we can supplement our look at measurement in practice by reflecting on the work of trade associations such as the Society of British Aerospace Companies (SBAC)[2] and also the UK Lean Aerospace Initiative (UKLAI)[3], whose websites and activities place tremendous emphasis on process innovation – the adoption of World Class Manufacturing practices such as *Lean*.

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[1] http://innovation.gc.ca

[2] SBAC is the UK's national trade association representing companies supplying civil air transport, defence, homeland security and space.

[3] As an element of SBAC, the UK Lean Aerospace Initiative is a national research programme involving a leading consortium of Universities in the UK and MIT in the USA.

Whilst our survey and interview data reveal the application of what might be called the 'traditional' metrics of counting (innovations, patents and invention notes) and financial performance (income from patents etc), it also confirms process innovation as important (c.f. 'better, faster, cheaper' in Appendix 6).

Our empirical work reveals another dimension to innovation measurement, one that emphasises the exploitation and conversion of knowledge stocks over time and our respondents advocate measures that reflect new business opportunities arising from the exploitation of knowledge stocks (e.g. spinouts, 'intrapreneurialism' and, the development of new applications from existing ideas). Exploitation and return over time appear particularly important in the industry specifically because the timescale between research and implementation of new products can be as long as 20 years. (SBAC, 2007).

Finally, one of our respondents points toward potentially useful future metrics on the theme of collaborative innovation (e.g. measuring open innovation), reflecting the increasingly distributed nature of work in the industry and the complexity and diversity of skills and knowledge to be integrated in new products. It is likely, though, that the output of open innovation can be measured using the same metrics as for traditional innovation.

4.3 AN ACADEMIC PERSPECTIVE ON MEASUREMENT

Surprisingly, few studies were found that focused specifically on firm-level innovation performance in the aerospace and defence sectors (Appendix 7), more often the aerospace and defence industries formed sub-sets of mixed samples (e.g. (Kotabe and Murray, 1990; Balbontin, Yazdani, Cooper and Souder, 2000). Each of the studies adopts a different approach to performance measurement: managers' perceptions of performance (Balbontin et al 2000); lagging financial and growth indicators (Kotabe and Murray 1990), and; metrics development based on literature review (Haque and Moore 2004).

The single Aerospace-specific study (Haque and Moore 2004) focuses largely on process efficiencies as opposed to innovation performance (e.g. Engineering throughput: the number of milestones completed for a given type of project/Project man-hours). However, they present the **NPI[4] Efficiency Index**, as the key overarching or strategic level metric, which sits above the others. It primarily measures value to the business and effectiveness of both the product of NPI and the process.

Overall, the metrics identified in the literature largely tally with those reported from the survey. In the survey response and from interview, counts of patents are reported as the most important metric currently in use as well as the income they generate. But the limitations of this metric are widely recorded in the literature (e.g. Griliches (1990), Coombs, Narandren and Richards (1996), Acs, Anselin and Varga (2002) and, Beneito (2006)) and recognised by our respondents "numbers of patents filed does not measure sustainable value versus cost of generation and maintenance".

[4] NPI = New Product Introduction

The literature identifies process efficiency and effectiveness as important dimensions of performance measurement. In our survey and interview, a slightly different perspective is presented, that measures should capture what is done ‘better’ as embodied in the product or service rather than the process, and this is a view reflected in a comment on the Innovation Index website “…Apple is extremely innovative, but most of their products do not do fundamentally new things; they do things that can already be done, but WAY better. How do you put a number on ‘better’?” (Tom B Jul 17, 2008).

4.4 PROPOSED MEASURES

On the basis of the literature review and empirical data we recognise that both product and process innovations are important to the Aerospace and Defence industries, and consequently recommend measures in three areas: Financial – the outcomes of innovation; Conversion – conversion and exploitation of knowledge stocks over time and process innovation and improvement, and; Input to innovation – technology development measured by patent counts. These are further developed in table 1 and Appendix 8.

Measurement theme	Measure
Financial performance	Profitability from new products and, income generated from patents and licences
Technology development	Number of patents filed, licences etc
Knowledge utilisation	Proportion of new knowledge assets (<3years old) incorporated into new products
Exploitation of knowledge stocks over time	Returns from products incorporating own patents >5years old, not previously having been used
Process improvement	New Product Effectiveness Index[5] = (Total value of engineering output/Cost of engineering department) * 100%

Table 1: Proposed innovation performance measures for aerospace and defence

5 BUSINESS SERVICES

5.1 INNOVATION IN THE BUSINESS SERVICES SECTOR

The measurement of innovation in services presents some specific challenges that makes it a different proposition from innovation measurement in product-focused industries. These challenges include: conceptualising and defining innovation, understanding the organisation and ‘location’ of innovation within service industries and mapping the economic effects of service sector innovation – for both the firm and the wider stakeholder community (Coombs and Miles, 2000). Business services develop and adopt a range of different innovations and, not only do firms find it

[5] After Haque and Moore, 2004.

difficult to measure organisational and process innovations, but identifying innovation performance and linking them with firm performance is also a significant challenge.

Important areas for innovation are the client interface, the service concept, the service delivery system and technology. Indeed, many service innovations are combinatorial, concurrently impacting two or more of these dimensions: for instance, a new IT system (technology dimension) may be used to enable customer self-service using a web site or automatic teller machine (interface dimension), (Miles, 2008). Further distinctiveness of the sector is lent by its tendency not to use patents to protect intellectual property and also a relative absence of clearly demarcated R&D departments, activities or budgets. Consequently, we would expect a set of metrics different from those applicable in manufacturing industries.

5.2 AN INDUSTRY PERSPECTIVE ON MEASUREMENT

We received 11 responses to our survey (see Appendix 9) and our respondents suggested a great diversity of measures to keep track of innovation performance in the sector. Metrics relating to Business Performance, Financial Indicators and Counts appear to be the most commonly recommended. Other metrics include those that we would not ordinarily think of relating to innovation performance, such as cultural openness to innovation or some of the input indicators mentioned.

Where we might have expected to see a different set of metrics, it is interesting to note that the apparently most common indicators are similar to those used in product-oriented sectors (e.g. revenue from new services). Perhaps this is a reflection of the under-developed field of service innovation measurement and/or the difficulty of isolating precisely the acts and outcomes of innovation in the services sector. Perhaps, also, the more esoteric measures (e.g. cultural openness to innovation) our respondents have suggested, is evidence of efforts in the sector to grapple with this problem.

Contrasting with manufacturing firms, it appears that some business services firms have difficulty breaking down their sales by innovative and non-innovative ‘products’, or identify the extent to which innovations contribute to the sales performance of the firm. Whilst it remains important to try and get some sense of the financial contribution of innovation, a set of more rounded measures would broaden our understanding of the value of innovation in the sector: for example, relating to process efficiencies through back-office automation and improved customer loyalty.

5.3 AN ACADEMIC PERSPECTIVE ON MEASUREMENT

The literature (see Appendix 10) demonstrates that much innovation performance measurement in the services sector in general, draws its inspiration from established instruments such as the Community Innovation Survey. Most of the available innovation indicators from such sources (e.g. R&D, patents, total innovation expenditures, and innovation sales shares) were primarily designed to cover technical innovation in the manufacturing sector, and, as such, are only partially adequate measures of innovation performance in the services sector (Kanerva, Hollanders and Arundel, 2006). Similarly, the categorisation of innovations inherited from the techno-centric tradition and the conventional dichotomisation between radical and incremental (and variants) is not easy to apply in the service industries (Hipp and Grupp, 2005).

Temporal factors appear to be of greater concern in the services sector than for product-oriented firms, particularly with regard to process innovations. In Evangelista and Sirilli's (Evangelista and Sirilli, 1998; Evangelista, Sirilli and Smith, 1998) studies, their respondents noted the difficulty in quantifying the impact of innovation on sales, partly because of the time lags between the introduction of the innovation and the reaping of the corresponding benefits. It is likely, though, that the same difficulty pertains in other sectors. Nevertheless, they emphasise that, in services, sales are often not an appropriate output indicator and do not work as an indicator of economic impact of innovative activities. This is because, in services, the concept of output attributability is hard to define and measure and that a more appropriate measure might be based on cost reductions due to service innovations: a view that was echoed by one of our respondents. Contrary to this academic perspective, a number of respondents identified financial measures (including sales) as important metrics for business services.

Whilst the metrics reported in several of the studies in Appendix 10 betray their techno-centric origins (e.g. Evangelista and Sirilli (1998), Evangelista, Sirilli et al (1998) and, Lopes and Dodinho (2008)), those of van Riel, Lemmink et al (2004) and Kanerva, Hollanders et al (2006) illustrate some of the recent, but limited, conceptual development in addressing service sector innovation performance measurement. Kanerva et al's (2006) **Service Sector Innovation Index** comprises of three important dimensions: technological knowledge, non-technological changes and, commercialisation. On the other hand, van Riel et al's (2004) factor analysis identifies short- and long-term success as important temporal dimensions but also the spin-out benefits of the innovation, more widely felt through the organisation.

5.4 PROPOSED MEASURES

On the basis of the literature review and empirical data we recommend measures in the following areas: Timeliness – how rapidly the firm is able to get new products/services to market; Business performance – new customers and markets reached by the innovation; Financial performance – profitability etc from innovation; Commercialisation – the extent to which other organisations license products and services developed by the innovating firm, and; Innovativeness - new products and services launched. These are further developed in table 2 and Appendix 11.

Measurement theme	Measure
Timeliness	Proportion of innovations that were first to market/early followers in last *n* years
Business performance	Numbers and value of new customers reached by the innovation and, new market niches entered
Financial performance	Profitability, sales, savings, % of income generated by innovation
Commercialisation	Number of other organisations licensing products/services developed by us
Innovativeness	New products/services introduced in last *n* years relative to market leader

Table 2: Proposed innovation performance measures for business services

6 CONSTRUCTION

6.1 INNOVATION IN THE CONSTRUCTION INDUSTRY

In the UK, since Sir John Egan's report *Rethinking Construction* (Egan, 1998), several initiatives have been implemented to encourage, amongst other things, greater innovation in the construction industry. The thrust of the Egan report was that industry should create an integrated project process around the four key elements of *product development, project implementation, partnering the supply chain and production of components.* Sustained improvement should then be delivered through use of techniques for eliminating waste and increasing value for the customer.

The Movement for Innovation (M4I) was formed in November 1998 to implement, across the whole of the industry, the recommendations contained in The Egan Report[6]. M4I aims to lead radical improvement in construction through demonstration of best practice and innovation, particularly in pursuit of performance efficiencies. Seven Key Performance Indicators have been identified for the sector (KPI Working Group, 2000), mostly related to business processes. Whilst these KPIs appear not to have been designed to measure innovation performance, arguably movement of the KPIs is unlikely to be achieved without innovative changes to working practices.

Ten years on, these priorities still set the agenda for innovation, and have been supplemented by the addition of environmental and sustainability concerns. The major drivers of innovation are, therefore toward technological/product innovation that is oriented toward the 'hardware' of the construction industry and, process innovation, more about business processes, *lean principles* and working practices. As the NESTA report *Hidden Innovation* (2007) notes, improved performance in the construction industry often comes from new-to-the-firm practices rather than new-to-the-world technologies.

6.2 AN INDUSTRY PERSPECTIVE ON MEASUREMENT

The evidence from our two survey (Appendix 12) responses provides only limited insights. The focus of their gaze is toward reputational factors, such as customer satisfaction and quality and design features of the construction project. As well as traditional financial and enquiry generation, also important is the process and new skills acquisition within the firm. The focus on process is commensurate with the context of innovation in the construction industry described above, but, notable by its absence, is any consideration of technological innovation – say, the use of new materials or modern methods of construction

6.3 AN ACADEMIC PERSPECTIVE ON MEASUREMENT

As with Aerospace and Defence, there appears not to be an extensive body of sector specific studies relating to innovation performance measurement in the construction

[6] See http://www.constructingexcellence.org.uk

industry. Consequently, our analysis is based on seven papers (Appendix 13), two of which consist of mixed samples.

Den Hertog and Brouwer (2001) suggest an explanation for the thin literature base, that researchers' tend to adopt a technological and product orientation to innovation yet most of the innovation in the sector is organisational and market. It is difficult to know whether or not this is the case. Certainly, for some years the industry has had an anecdotal reputation for not being innovative, perhaps constrained by strictures of procurement processes or operating on low margins. However, industry responses to the sustainability agenda, policy initiatives and innovative activity in sectors that feed the construction industry (e.g. in architectural and engineering practices), may give lie to the popular perception. In fact, it may be more accurate to suggest that different organisational types deliver a range of different innovation outputs within the construction industry.

Some evidence points toward a variety of types of innovation emanating from the construction sector, including managerial, organisational and relational (Barrett and Sexton, 2006) and between specialist materials supplier and suppliers of standard materials, and between bigger and smaller firms (den Hertog and Brouwer 2001).

6.4 PROPOSED MEASURES

On the basis of the literature review and empirical data it appears that the construction sector operationalises a limited number of relatively unsophisticated innovation performance measures. These relate principally to process efficiencies gained from the adoption of innovative philosophies, techniques and practices associated with *Lean* thinking and, new sales and revenues generated.

This raises a question about the sectors' readiness or capability to provide data for a wider suite of measures, however we recommend measures in the following areas: Process improvement – the new skills that the firm has a acquired as a result of the innovation; Future business value – an assessment of the likely future value to be derived; Financial performance – financial value resulting from the innovation: Technological application – to assess whether or not the firm makes use of new materials, methods of construction etc, and; Innovation collaborations. These are further developed in table 3 and Appendix 14.

Measurement theme	Measure
Process improvement	What new skills have been acquired by (and retained within) the firm as a result of the innovation?
Future business value	To what extent has the innovation enhanced the sales of firm's other products or lead to future opportunities?
Financial performance	Sales, profitability improvement due to innovation and/or costs saved
Technological application	What proportion of the service offer comprises new products, materials, technologies etc?

Innovation collaborations	Number of innovation outputs infeasible without the collaborative relationship

Table 3: Proposed innovation performance measures for construction industries

7 CREATIVE INDUSTRIES

7.1 INNOVATION IN THE CREATIVE INDUSTRIES

The Department for Culture Media and Sports has identified 13 industries, from Arts and Antiques to Advertising and Designer Fashion to Video, Film and Photography, as the *Creative Industries.* Collectively, the Creative Industries have in common the origination of expressive value which they commercialise (The Work Foundation, 2007). For this sector, finding and developing new ways of working has become a critical factor. Currently, the processes of origination and commercialisation are subject to the influence of digital technologies. From the perspective of innovation, new technologies have profoundly impacted on the ways in which content[7] is developed (disintermediation, user-involvement, digitisation etc…), on the channels through which they are distributed and consumed (for example digital distribution of music) and on the business models of new and incumbent organisations as a response also to a new generation of consumers that does not appear to respect traditional IP.

7.2 AN INDUSTRY PERSPECTIVE ON MEASUREMENT

Nine responses to our survey were received (Appendix 15), providing a diverse range of important measures. Some of these are immediately recognisable in the tradition of innovation performance measurement including financial measures such as increased sales due to innovation and also counts of innovative projects and new products and services. However, our respondents also identified a number of sector-specific areas for measurement. Specifically, they identified *Business Models* and *Organisational Reputation for Innovation/Creativity* as important outputs of innovation activity.

In terms of Business Models, two factors were seen as important: first, that organisations were sufficiently flexible to be able to change their processes and practices to respond to turbulence in their environments. Second, that they maintained productive collaborative relationships along the value chain and also with users. As one respondent put it, there are "…no measures are in place to systematically or officially measure innovation (or enterprise) in the creative industries...By enterprising we mean those creatives who are willing and able to invest their own time and skills in developing new products, services, processes and propositions in view to bringing them to market directly, in collaborative shared risk and reward deals or via license to manufacture/marketing deals".

With regard to Organisational Reputation for Innovation/Creativity, creativity and innovation are at the heart of these organisations' activities and it is important that their reputations for performance in these areas is recognised by peers and customers.

[7] Or, more familiarly, 'products'

7.3 AN ACADEMIC PERSPECTIVE ON MEASUREMENT

As is reported in the recent Work Foundation report *Staying ahead: the economic performance of the UK's creative industries* (The Work Foundation, 2007), few studies of metrics relating specifically to the Creative Industries have been published. Our review identified only four studies (Appendix 16) in which innovation output metrics for the Creative Industries were specifically addressed, and it is notable that these are very recent – indicating researchers are only now turning their attention to this sector. Two of these studies were critical of the traditional survey approach to innovation measurement as it is currently applied to the creative industries and suggest the need for further development of metrics for the sector.

Classical measurement concepts used for the manufacturing sector provide little informative value, "As a rule, it makes no more sense to ask a typical record company or publisher how many patents they filed than it makes sense to ask a pharmaceuticals company how many copyrighted works they have released" (Handke, 2007).
The techno-centric perspective has proven especially disadvantageous for the services sector in general and Creative Industries in particular: many of the traditional innovation measures drawn from the techno-centric perspective do not adequately capture its distinctiveness. So, although a *counting* approach is evident, it is counts of copyrights, brands, trademarks etc as opposed to patents that are operationalised (Hipp and Grupp, 2005; Alcaide-Marzal and Tortajada-Esparza, 2007).

7.4 PROPOSED MEASURES

On the basis of the literature review and empirical data we recommend measures in the following areas: Content creation – an alternative to patent counts, a measure of trademarks etc to capture content creation and IP; Financial performance – profitability etc from innovation; Business model innovation – two measures, is the firm finding new ways of working and new collaborations; Reputational enhancement – creative industries place great store by their reputations for innovativeness and creativity, how are they perceived? These are further developed in table 4 and Appendix 17.

Measurement theme	**Measure**
Content creation (IP Counting)	Number of copyrights, trademarks etc in last *n* years
Financial performance	Percentage revenue from offerings that did not exist *n* years ago
Business model innovation (i)	Number and scale of significant business model changes in last *n* years
Business model innovation (ii)	Number and diversity of productive collaborations in last *n* years
Reputational enhancement	Customer and peer perceptions of us as an innovative organisation

Table 4: Proposed innovation performance measures for creative industries

8 FINANCIAL SERVICES

8.1 INNOVATION IN THE FINANCIAL SERVICES SECTOR

In recent years, the financial services sector has changed from being fairly closed, with conservative and slowly-operating companies to an extremely dynamic one. Inside these dynamically growing companies innovation, generally, has acquired the status as an important activity (Vermeulen, 2004). The sector is fiercely competitive and this drives the need for product innovation, however, product innovations in the financial services tend to be very rapidly copied (Drew, 1995). Consequently, it has little to offer by way of sustainable competitive advantage, making timing critical (first to market or rapid follower) and also the need for continuous innovation. Furthermore, the failure rate of innovation in Financial Services industries has been recorded as unusually high, up to 50% (Cooper and Edgett, 1996). So, in addition to product innovation, the sector emphasises innovation in terms of process (particularly 'back-office') and in terms of customer relations and service delivery, particularly facilitated by information technology.

8.2 AN INDUSTRY PERSPECTIVE ON MEASUREMENT

We received three responses to our survey (Appendix 18) which reveal counting as the most popular approach to measuring innovation performance (new product launches, products in pipeline, customers etc). Next most popular metrics relate to organisational innovation, such as improvement in processes and responsiveness to customers. Of course, there are financial and market performance measures included, but these were less frequently referred to by our respondents. This profile of measurement approaches seems quite congruent with the industry drivers we have noted above.

8.3 AN ACADEMIC PERSPECTIVE ON MEASUREMENT

As with other service sector innovations, their very intangibility can make it difficult to develop valid performance measures, and the techno-centric legacy is clearly evident in the literature. Our analysis is based on 15 papers (Appendix 19).

Typically, new product and new service success has been thought of in terms of financial performance (profitability and revenue generation), but the studies show that other factors are also important, including non-financial factors, or indirect benefits. For example, Easingwood and Percival (1990) illustrate, in order of importance, a number of non-direct benefits derived through the introduction of successful new financial services. These include improved company reputation, increased likelihood that existing customers will purchase more existing products, better company new product development skills, purchase of existing products by the new users of the product, improved loyalty and helping redirect the company in a new direction. The aggregate value of these non-direct benefits was found to be nearly equivalent to the value of direct benefits, with important implications for the new service development process.

Edgett and Snow (1996) review approaches to measurement of new product performance according to three criteria: customer satisfaction, product quality and new product success. In the case of customer satisfaction and product quality, they found that the measures most often used differed from those which respondents reported most helpful. This suggests that financial institutions are not satisfied that the traditional accounting-type measures are presenting the full performance picture for new products or there are difficulties in applying some of the measures. In terms of new product success, respondents were concerned to establish benchmarks for comparison, for more effective and timely costing measures, for better integration of systems (IT), and to develop clearer criteria against which to measure product performance.

Avlonitis et al's (2001) study of the relationships between innovativeness and financial and non-financial performance strongly suggests that a portfolio of measures is necessary for a balanced and inclusive approach to the measurement of innovation activity in the Financial Services. So, although financial concerns appear to remain critical for most managers, the fact that innovations may result in enhanced relationships, boost the sales of related products or, enhance the firm's reputation in customers' perceptions are also important evaluative criteria.

8.4 PROPOSED MEASURES

On the basis of the literature review and empirical data we recommend measures in the following areas: Financial performance – profitability etc from innovation; Business performance – new customers and markets reached by the innovation; Reputational enhancement – company reputation is an important indirect benefit of innovation; Innovativeness – product launches and products in the pipeline, and; Timeliness – how rapidly the firm is able to get new products/services to market; Process improvement – the new skills that the firm has a acquired as a result of the innovation. These are further developed in table 5 and Appendix 20.

Measurement theme	Measure
Financial performance	Profitability, sales, savings, percentage of income generated by innovation
Business performance	Number and value of new customers reached by the innovation and, new market niches entered
Reputational enhancement	Customer and peer perceptions of us as an innovative organisation
Innovativeness	Number of NP launches and pipeline content
Timeliness	Proportion of innovations that were first to market/early followers
Process improvement	What new skills have been acquired by (and retained within) the firm as a result of the innovation

Table 5: Proposed innovation performance measures for financial services

9 <u>HIGH TECH MANUFACTURING</u>

9.1 INNOVATION IN HIGH-TECH MANUFACTURING

Product, process and technological innovations are important to the high-tec manufacturing industries. From the 1950s, performance in the sector has frequently been described in terms of expenditure on R&D activities and/or numbers and value of patents awarded. More recently, the limitations of these approaches have been identified and other metrics suggested that more accurately reflect the nature and performance of innovation in the sector. Nevertheless, in surveys, manufacturing firms tend to be the most likely to report innovation activities (though this may reflect inadequacies in the data collection instruments, such as the extent to which these privilege product and technological innovations over other innovation types (Bakhshi, McVittie and Simmie, 2008)).

Contemporary innovation is now driven by, escalating research and development (R&D) costs, rapid and radical technological developments, short product life cycles, intense competition, and high new product failure rates (Droge, Calantone and Harmancioglu, 2008). The most successful firms generate around 60% of their sales from new products (Hustad, 1996) and much research effort has been expended on uncovering the factors and practices associated with such success. However, success or performance continues to remain ill-defined, and the legacy of the R&D cost and patent counting approaches remains evident.

9.2 AN INDUSTRY PERSPECTIVE ON MEASUREMENT

We received two survey returns (Appendix 21) from High-Tec Manufacturing industries sector. According to our categorisation of approaches, Business and financial performance metrics are the most frequently cited. These are followed by process performance and the counting of patents awarded. Notwithstanding the small sample (n=2), this is an interesting set of metrics because it demonstrates apparently little advancement since the 1950s.

Famously, 3M use percentage of sales generated from new products as a benchmark of innovative performance (Krogh, Prager, Sorensen and Tomlinson, 1988; Figueroa and Conceiçâo, 2000; Coyne, 2001), and it is no surprise to have found the use of similar metrics diffused through the industry. But, as we illustrate below, a range of other metrics has been developed and evidence of wider use of some of these might have been expected. Tellis et al (2007) report one Vice President of Research at a US Fortune 500 company saying "We have many technologies and patents sitting on the shelf. Our problem is getting them out into the market". Perhaps application of metrics relating to exploitation or conversion could help focus efforts to addressing such issues.

9.3 AN ACADEMIC PERSPECTIVE ON MEASUREMENT

For this section, we have reviewed 23 studies (Appendix 22). In addition to the inevitable counts of patents and R&D expenditure, several other approaches to performance measurement can be identified.

More so than in the other sectors reviewed, researchers frequently conflate, or at least do not distinguish between, innovation process performance and innovation performance. So, for example, Song et al (Song, Montoya-Weiss and Schmidt, 1997) operationalise *New Product Performance* with indicators of process quality and time alongside measures of meeting objectives and programme success. Intel's Innovation Index (Westerman and Curley, 2008) is an interesting portrayal of this conflation from measurement in practice, as it combines leading and lagging process and output measures to produce an indication of the current state of IT innovation in the firm.

Amongst the measures, there appears to be quite a strong strategic perspective – either from the position of the product or the firm. Song and Parry's (1996) notion of product advantage (a product's perceived superiority relative to competitive products) finds echoes in other studies such as Oke et al's (2007) *Innovation Performance.* Similarly, measures of the strategic importance of innovation can be found in Thamain (1990), Kleinschmidt and Cooper (1991), Oerlemans et al (2001).

Finally, assessing the popularity of measures-in-use, Driva et al (2001) find a set of process-related cost measures to be the most frequently used performance measures. More interestingly, perhaps, amongst their informants they report a unanimous desire to improve on their use of performance measures and the authors conclude that managers are not satisfied with current performance measurement…but don't know how to improve without incurring major costs and spending time setting up a system'.

9.4 PROPOSED MEASURES

On the basis of the literature review and empirical data we recommend measures in the following areas: Product advantage – degree of quality or technological improvement relative to competitors; Strategic importance of innovation – what is the contribution of the innovation to meeting firm's strategic objectives; Innovativeness – a count of the numbers of innovations from the pipeline; Financial performance - profitability etc from innovation, and; Business performance – new customers and markets reached by the innovation. These are further developed in table 6 and Appendix 23.

Measurement theme	**Measure**
Product advantage	Extent to which the product/service is superior to competing products in terms of meeting customers' needs
Strategic importance of innovation	Extent to which strategic objectives have been met by the innovation
Innovativeness	Number of patents, new product ideas, new product launches
Financial performance	Proportion of sales and profits from new products less than *n* years old
Business performance	Number and value of new customers reached by the innovation and, new market niches entered

Table 6: Proposed innovation performance measures for high-tech manufacturing

10 ICT

10.1 INNOVATION IN ICT

Rapid technological development, innovation and diffusion have accounted for much of the recent growth in the highly competitive global ICT industry. Competition continues to be fierce, markets becoming increasingly globalised and the pace of technological development shows no sign of abating. Layered over these drivers of innovation is the recognition of the sector, at least at a regional (European[8]) level, as strategically significant for its contribution to economic prosperity, the modernisation of public sector institutions and social well-being.

The advance of ICT technologies has facilitated the development of new ways of working, allowing businesses to move away from traditional means of the conducting their operations, and new ways of living. Commensurately, the public is placing ever greater demands on the technologies: for more capacity in the infrastructure and for smarter, better, faster, cleaner more secure and efficient machines.

The seven future challenges identified by the European Commission's ICT Work Programme under FP7[9] are technologically oriented, but technology is not the sole driver for innovation in the industry. As well as taking the form of new products, innovation also occurs in new processes and forms of organisation in order to remain competitive.

10.2 AN INDUSTRY PERSPECTIVE ON MEASUREMENT

We received four responses to our survey from the ICT sector (Appendix 24), identifying a range of measures. These appear, primarily, to focus around business growth, strategic considerations and counts. However, there appears to be a strong theme running across many of the measures our respondents have reported, and that is the acquisition, integration and exploitation of technological knowledge. For example, the reported financial performance measure is, more realistically, an indicator of input and not of returns from innovation but, taken together with the *counts* and *resource exploitation* measures the important part for the conversion of knowledge for organisational growth/advantage is evident.

[8] See http://cordis.europa.eu/fp7/ict/

[9] Pervasive and trusted network and service infrastructures; Cognitive systems, interaction and robotics; Components, systems and engineering; Digital libraries and content; Sustainable and personalised healthcare; Mobility, environmental sustainability and energy efficiency; Independent living and inclusion.

10.3 AN ACADEMIC PERSPECTIVE ON MEASUREMENT

Our analysis of innovation performance measurement in ICT is based on seven papers (Appendix 25). We have been surprised to find only very few papers addressing Innovation performance in ICT, and have included several papers in our review in which the ICT sector comprises only a small element of the studies' samples. The measures we observe are not dissimilar to those found in High-Tec Manufacturing.

The origins of a number of the indicators can be traced back to earlier studies of factors associated with successful new product development (e.g Voss, 1985), and level of patenting output appears to remain an important indicator. However, for the majority of firms, the ultimate purpose is the launch of new products (Aaboen, Lindelof, Von Koch and Lofsten, 2006), and so a number of growth-oriented and knowledge exploitation/commercialisation indicators are evident. There are several measures of the performance of the R&D process, such as McGrath and Romeri's (1994) R&D Effectiveness Index which measures effectiveness by comparing the profit from new products to the investment in new product development– but this is a measure of the development process rather than output performance.

The important measurement dimensions that emerge from the literature (Financial performance, Patent counts, Innovativeness and Market factors) only partially match with those suggested by our survey respondents. Whilst both share an interest in financial measures and counts of knowledge products such as patents, our respondents also include measures addressing the exploitation of innovation, such as the use of all patents in product development (similar to an observation in Aerospace and Defence) and investment in new start ups.

10.4 PROPOSED MEASURES

On the basis of the literature review and empirical data we recommend measures in the following areas: Financial performance – sales and profitability arising from the innovation; Business performance – new customers and markets reached by the innovation; Innovativeness – new products and services launched; Knowledge conversion – reflecting new businesses created as a result of technological/knowledge development, and; Knowledge utilisation – how effectively is the firm incorporating its knowledge assets into its product/service development. These are further developed in table 7 and Appendix 26.

Measurement theme	Measure
Financial performance	Sales, profitability and savings arising from innovations in last *n* years
Business performance	Number and value of new customers reached by the innovation, and new market niches entered
Innovativeness	Number of new (degrees of newness apply) products, goods or services in last *n* years
Knowledge conversion	Number of new business start-ups/commercial opportunities/collaborations etc arising from technological and knowledge development
Knowledge utilisation	Proportion of new knowledge assets (<3years old) incorporated into new products

Table 7: Proposed innovation performance measures for ICT

11 <u>PHARMACEUTICALS</u>

11.1 INNOVATION IN THE PHARMACEUTICAL INDUSTRY

The pharmaceutical industry is research-based and knowledge-based and innovation in the sector is strongly driven by product pipeline requirements. Within the context of pipeline, there are two critical areas of innovation. First, developing efficacious products and second continuously improving the development process. It can take as many as 15 years to bring products to market and so associated costs can be startling but, more importantly, being first-to-market with new drugs brings considerable financial rewards – being third means negative returns (Gassmann and Von Zedtwitz, 2003). Consequently, knowledge, in the form of patents, is jealously guarded. However, on the expiry of patent protection generic forms of the drug enter the marketplace to provide further competition. In recent years the processes of development have changed and continue to change, one-dimensional, linear single-actor type processes have been replaced by multi-dimensional, complex, multi-actor schemes. As a consequence, new players, collaborations and ways of working are becoming more important, with biotechnology firms playing a key role (Jungmittag, Reger, and Reiss, 2000).

Finally, a combination of demographic and ethical factors is also exerting pressure on pharmaceutical companies for innovation in business models and corporate social responsibility. Particularly with respect to conditions such as AIDS and malaria, which disproportionately afflict the less-developed economies, pharmaceutical companies are being pressured to address first the cost of proprietary treatments and second devote greater resources to finding solutions to these conditions. One response is business model innovation, for example pharmaceutical company Roche has developed policies to remove both patents and profit as barriers to their two HIV medicines used in least developed countries and sub-Saharan Africa.

11.2 AN INDUSTRY PERSPECTIVE ON MEASUREMENT

No survey responses

11.3 AN ACADEMIC PERSPECTIVE ON MEASUREMENT

Our analysis is based on a review of 12 papers (Appendix 27), some of which relate to the chemicals industry and others of which incorporate the pharmaceuticals sector as part of a mixed-sample study.

Unsurprisingly, patent counts are strongly evident as a measure of output – reflecting the importance of proprietary knowledge in the sector – as are measures of financial performance, particularly relating to sales. Notably absent are measures relating to internal benefits (such as improvements to the processes of innovation). The focus of the literature is strongly oriented toward product innovation.

For Deeds (2001), the outputs from the technical development process of a pharmaceutical biotechnology company are patent applications, patents, products in pre-clinical trials, products in clinical trials and products which have reached the market. And these outputs are important because they weigh heavily in the financial community's evaluation of a pharmaceutical biotechnology company. Calantone et al (2006), incorporate novelty into the perspective as, they contend, the primary means of achieving new product success is through gaining product advantage, and the primary means of improving product advantage is through producing an innovative product.

Jones and Austin's (2002) "Innovation index™" maintains a product-centric perspective but incorporates and reflects a firm's relative ability to generate innovation assets. The index takes into account company size, revenue, R&D investment and patent output and the authors argue that it allows for smaller companies to be considered on a level field with larger ones. Consequently, the measures we recommend reflect the product-centric view.

11.4 PROPOSED MEASURES

Our recommended measures are made on the basis of the literature review: ; Financial performance - profitability etc from innovation; Innovation index™ -an input/output ratio taking into account company size, revenue, R&D investment and patent output; Innovativeness; Market performance – positioning the firm's innovativeness against important competitors, and: Product advantage – degree of quality or technological improvement relative to competitors. These are further developed in table 8 and Appendix 28.

Measurement theme	Measure
Financial performance	Percentage of current sales due to radically and incrementally innovative products introduced in the past *n* years
Innovation index™[10]	Number of patents per employee/R&D as % of sales
Innovativeness	Degree of change represented by the innovation (major technological advance over existing technologies, or outputs which made prevailing technologies obsolete)
Market performance	Relative market share growth from the innovation (relative to important competitors)
Product advantage	Extent to which the product/service is superior to competing products in terms of meeting customers' needs

Table 8: Proposed innovation performance measures for pharmaceuticals

12 PUBLIC SECTOR

12.1 INNOVATION IN THE PUBLIC SECTOR

The public sector has some parallel motivations but value in the public sector is different from value in the private sector, and can be more complex and more difficult

[10] Jones and Austin (2002)

to measure. It includes some readily quantifiable outcomes (such as less crime, poverty or violence), and some 'softer' outcomes such as the quality of services and trust between service providers and users (Mulgan and Albury, 2003).

Although some public sector organisations may not expire for lack of innovation, strong drivers to innovate are felt throughout the sector. Mulgan and Albury (2003) argue that innovation should be a core activity of the public sector: it helps public services to improve performance and increase public value; respond to the expectations of citizens and adapt to the needs of users; increase service efficiency and minimise costs. Others, such as Donahue (2005) regard failure to innovate in the public sector as a derogation of the obligations owed to society in fulfilment of socially important tasks. Such innovation includes developing efficient and effective government and public services for better ways of meeting needs, reaching out to all potential client groups, solving problems, and using resources and technologies. Finally, one factor that is increasingly present in policy and practice innovation is the desire on the part of policy makers to capitalise on the full potential of ICTs, in terms of both efficiency gains and improved service provision and delivery (IDEA, 2005).

12.2 AN INDUSTRY PERSPECTIVE ON MEASUREMENT

From public sector organisations, we received five responses to our survey (Appendix 29), one of whom noted:

> "Very little emphasis is placed on measuring innovation. Projects are not thought of, in the first place, as innovative, but rather as introducing new services. So, measuring innovation is not something which we do. Admittedly we should, but I have little idea as to how such measurements could be made..."

Mulgan and Albury (2003) articulate some of the differences between drivers for and output of innovation in the public and private sectors. Some of this difference is apparent in the spread of reported measures, with our respondents suggesting a greater consideration of public impacts than the other sectors we have considered. These public impacts include assessment of customer satisfaction and evaluations of benefit to the public, both of which are well-established approaches with associated methods and processes. A less-easily measured public impact is also presented, *How has the innovation influenced change.*

The reported counts of innovation performance mix inputs with outputs, but give the impression of institutions actively working toward a more innovative orientation: for example, counting teams and hours set aside for innovation. The financial measures can also be interpreted this way, as indicative of organisations moving towards becoming more innovative, so a reputation for innovativeness is, perhaps, reflected in the amount of funding attracted for research. For example, the NHS Beacon programme was launched in 1999 to identify services that make significant contributions to modernising the NHS. Services that received Beacon status subsequently have found themselves a focus for dissemination of good practice to other parts of the NHS and accrued reputational enhancement as a result (see also (Hartley and Downe, 2007)for a similar initiative for local authorities)

Finally, the measure *What is the potential for your innovation to be adopted or adapted elsewhere in the organisation,* appears to confirm the view that the sector is particularly concerned about becoming more innovative and, in the fashion of a virtuous cycle one of the outcomes of successful innovation is that the organisational culture and practice of innovation is reinforced.

12.3 AN ACADEMIC PERSPECTIVE ON MEASUREMENT

There is quite an extensive literature on innovation in the public sector, but little of it directly addresses the phenomenon of innovation performance. As we have elaborated in the preceding two sub-sections, the literature tends to focus on how public sector organisations might be supported in becoming more innovative (e.g. Mulgan and Albury (2003), Albury (2005), Bessant (2005) and, Moore (2005)). So, whilst there is advocacy for improved performance in the literature, there is little that actually describes what this improvement might look like. Consequently, our analysis is based on three papers identified in our search (Appendix 30).

As we have implied, the range of measures of innovation performance in the public sector is especially underdeveloped. In the three papers reviewed, one simply counts the innovations (Walker, Jeanes and Rowlands, 2002), the second identifies different types of innovation (Walker, 2004) and the third speculates that "One is forced, we think, to evaluate the innovations not only in terms of efficiency and cost effectiveness, but also in terms of what might be considered right relationships in the society – some notion of justice and fairness" (Moore and Hartley, 2008).

Whereas a number of the other sectors considered in this report have drawn their measurement inspiration from manufacturing practice, many of the innovations which concern the public sector are not of a similar type. They are, instead, innovations designed to re-shape a broader social system that not only produces public goods and services (and in doing so, to transform aggregate social conditions in socially desirable ways), but also provides the financing and material to produce these results (Moore and Hartley, 2008).

Consequently, metrics specific to the public sector are particularly required that can capture the complex multidimensionality of public organisations. To this end they need to include equity, accountability and impact alongside more traditional measures of economy, efficiency and effectiveness (Walker, 2004).

12.4 PROPOSED MEASURES

On the basis of the literature review and empirical data, we recommend measures in the following areas: Innovativeness – a count of innovations; Technology application – how much use is the organisation making of new technologies to facilitate service delivery; Reinforcement of innovation orientation – does the culture increasingly facilitate innovation; Public perceptions – does the stakeholder/user group think the organisation is innovative, and; Outreach – the service reaching out to new user groups. These are further developed in table 9 and Appendix 31.

Measurement theme	Measure
Innovativeness	Number of ideas generated and number of new (degrees of newness apply) products, goods or services in last *n* years
Technology application	Number of non-person interactions between service provider and citizen (online interactivity) as proportion of all contacts
Reinforcement of innovation orientation	Employees are more incentivised and managers more tolerant of risk/failure as a result of the innovation
Public impacts	Customer/user perceptions of us as an innovative organisation
Outreach	New and hard to reach customer/user/stakeholder groups reached by innovation

Table 9: Proposed innovation performance measures for the public sector

13 RETAIL AND WHOLESALE DISTRIBUTION

13.1 INNOVATION IN RETAIL AND WHOLESALE DISTRIBUTION

Innovation in retail is driven by intense pressures that militate against any consideration of not being responsive to market demands or competitors' activities. Within these general themes exist a number of specific challenges including: consumer lifestyle changes, changing buyer behaviour patterns, reducing product cycle times, pressures for ethical sourcing and clear articulations of Corporate Socially Responsibly behaviour and, particularly currently, a slowdown in consumer spending.

A recent study commissioned by the Economic and Social Research Council (Wood, Lowe, Adams and Neely, 2008) identified a set of fundamental questions relating to innovation that the sector required answers to. These included *What differentiates innovative and non-innovative retailers? What is, and what drives retail innovation?* And, *Innovation in retail is intangible and difficult to measure, what would an appropriate set of metrics look like?* These questions strongly suggest an industry that is struggling to come to terms with the concept of innovation and precisely what it might mean in practice. This conclusion is lent some weight by the findings of our empirical work and literature review.

13.2 AN INDUSTRY PERSPECTIVE ON MEASUREMENT

From retail and wholesale distribution organisations, we received one response to our survey, we also undertook one interview (Appendix 32).

Although the retail and wholesale distribution industries operate in intensely competitive environments which are fast moving, complex and constantly changing, in which, it has been argued, innovation is necessary for survival it was interesting to discover from our interviewee that, in retail, innovation is wholly about product. This is a narrow conceptualisation of innovation in which products are either new to the world (and there are different ways in which products can be new to the world) or a copy of some competitor's novelty. Our informant recognised that there might be several ways in which a product is new to the world: both the first mobile telephone and a third generation mobile telephone with additional functionality can be new to the world. *Degree of novelty* is a long-established approach to measurement in the academic literature but, for our informant, it is not specifically targeted for measurement, though the performance of products is assessed against corporate objectives.

Our survey response suggests an eclectic set of measures around reflecting, most likely, our respondent's organisational orientation, but which can be categorised under a more generic set of headings: Customer related; Technological exploitation, and; Counting. These additional areas for measurement suggest that the views expressed by our interviewee probably do not hold throughout the sector, but our limited data does not allow us to draw that conclusion.

13.3 AN ACADEMIC PERSPECTIVE ON MEASUREMENT

From the perspective of the literature, where innovation is considered in the retail/wholesale distribution context, it tends to focus on factors relating to customer adoptions of retail innovations, say internet banking or online grocery buying. As Reynolds et al (2007) report, there is very little that specifically deals with innovation performance. In our search of the literature, we found only one paper that detailed innovation performance measures in the retail and wholesale distribution industries (Appendix 33). The focus of these measures is on novelty in different areas of important activity: products, methods of production, markets opened, supply sources and organisational forms.

13.4 PROPOSED MEASURES

Based on the limited evidence available, our recommendations of candidate measures can only tentatively be made. Clearly product innovation and the extent to which it meets objectives set are important metrics. Our empirical data points us toward measures of novelty as important, but this is an assumption on our part as it is not directly stated.

In spite of our failure to uncover strong evidence of innovation in relation to eliminating inefficiencies in supply chains, improving relationships with customers and suppliers or, the exploitation of new technologies (for our interviewee, these were *Business Processes* and not the subject of innovation), we believe they are important areas of innovation in the retail and wholesale distribution industries. Consequently, we tentatively suggest that they be further investigated as potential areas for measurement.

On the basis of the literature review and empirical data we recommend measures in the following areas: Innovativeness – a count of new products and services launched; Strategic importance of innovation – what is the contribution of the innovation to meeting firm's strategic objectives; Technological application – to assess whether or not the firm makes use of new materials, technologies etc in its service offer, and; and; Reinforcement of innovation orientation – does the culture increasingly facilitate innovation. These are further developed in table 10 and Appendix 34.

Measurement theme	Measure
Innovativeness	Number of new (degrees of newness apply) products, goods or services in last *n* years
Strategic importance of innovation	Extent to which strategic objectives have been met by the innovation
Technological application	What proportion of the service offer comprises new products, materials, technologies etc?
Reinforcement of innovation orientation	Employees are more incentivised and managers more tolerant of risk/failure as a result of the innovation

Table 10: Proposed innovation performance measures for retail and wholesale distribution

14 <u>TELECOMS</u>

14.1 INNOVATION IN TELECOMMUNICATIONS

The structure of the telecoms industry has changed almost beyond recognition in the last 15. Telecom firms have exploited the products of fundamental research and development to deliver a range of product and service innovations. The large, incumbent operators have had their pre-eminence challenged by smaller, more nimble competitors and many real innovation challenges remain. According to consultancy firm Innovaro, there are four significant innovation challenges currently confronting the telecoms industry: Product Innovation – for example, which devices can shake up the market (e.g. the Apple iPhone); Service Innovation – for example, developing and exploiting new services that integrate key elements to provide step changes in the consumer experience; Platform Innovation – for example, new technology platforms that will provide end-users with greater choice, control and flexibility, and; Business Model Innovation - for example, creating new business models to take advantage of ubiquitous connectivity (Innovaro, 2007).

14.2 AN INDUSTRY PERSPECTIVE ON MEASUREMENT

From telecom organisations, we received one response to our survey and we undertook one interview (Appendix 35). Our interviewee emphasised measures currently in use: New products introductions and Number of spin-offs (counting approach) and, new business models. From our survey, service variety and technological exploitation measures are reported. These measures tally with the challenges identified by Innovaro (above).

14.3 AN ACADEMIC PERSPECTIVE ON MEASUREMENT

To an extent, the measures we have found in our review of four papers (Appendix 36) echo those identified in our empirical work. However, notably absent is any measure of Business Model innovation or Service innovation.

Three of the papers in our review are 10 or more years old, the fourth paper was published in 2005 (Cho and Lee, 2005) (it is surprising that there is little contemporary work). Cho and Lee's conceptualisation of performance or, as they call it, the *Project Effect*, covers a range of dimensions – more than can be identified in the three earlier papers. This may reflect the increasing variety of ways in which innovation is important to the sector as identified in the Innovaro report.

14.4 PROPOSED MEASURES

On the basis of the literature review and empirical data we recommend measures in the following areas: Innovativeness - a count of new products and services launched; Financial - contribution of new products/services to profitability and cost saving; Technological application – to assess whether or not the firm makes use of new materials, technologies etc in its service offer; Business model innovation – to capture number and nature of changes in business processes and services, and; Reputational enhancement – company reputation is an important indirect benefit of innovation. These are further developed in table 11 and Appendix 37.

Measurement theme	Measure
Innovativeness	Number of new (degrees of newness apply) products, goods or services in last *n* years
Financial performance	Percentage of sales and profits accounted for by products/services which were introduced in the last *n* years
Technological application	What proportion of the service offer comprises new products, materials, technologies etc?
Business model innovation	Number and scale of significant business model developments/conceptual initiatives in last *n* years
Reputational enhancement	Customer and peer perceptions of us as an innovative organisation

Table 11: Proposed innovation performance measures for telecoms sector

15 TRANSPORT

15.1 INNOVATION IN TRANSPORTATION

The transportation industry is ferociously competitive and, generally speaking, operates on tight margins – particularly in current times following a period of steep inflation in fuel prices. For the industry, both product and process innovation are critical. There are significant negative aspects associated with transportation industries which require innovative solutions. Amongst these are the problems of global warming, congestion, pollution, noise, safety, sustainability and waste. As Governments and other influential bodies exert pressures on manufacturers and service delivery organisations to address these challenges, new technologies are being mobilised and social or behavioural innovation encouraged. Global warming and energy security are the main drivers for innovation towards alternative and sustainable energy solutions. The prevailing notion is that eventually technological innovations will solve the problem (Vergragt and Brown, 2006).

In terms of process innovation, consider the case of Atlanta-based United Parcel Service who utilise technology to optimise vehicle delivery runs by minimising the number of left-hand turns the vehicles make. As ABC News reported[11], "UPS trucks drove 2.5 billion miles last year, but the company says its package flow technology combined with right-turn routes saved 28,541,472 million miles, and three million gallons of fuel. The company puts almost 92,000 trucks on the road every day. But without its efficiency and right-turn routes, it would have to send out an additional 1,100 trucks". In fact, in a survey of innovation in the Canadian transportation industry (Lonmo, 2005), it was found that in six of the seven transportation industries studied, innovators were more likely to develop process innovations than product innovations.

15.2 AN INDUSTRY PERSPECTIVE ON MEASUREMENT

From transport organisations, we received one response to our survey (Appendix 38). This response indicated an organisational and process focus to the measurement of innovation performance, perhaps a reflection of the pattern identified in the Lonmo (2005) study – i.e. an emphasis on process over product innovation. This, however, is a rather vague metric addressing "the way things are done in the company". This, at least, recognises that innovation is about more than simply new products.

Lonmo's study also identifies that, at least for the respondents to her survey, transportation firms' preferred indicators of impact relate to productivity, competing with and keeping up with competitors and, improvements in the quality of goods and services. Productivity improvements might be attributed to process innovations, so there appears to be some congruence between preferred measures and the principal area of innovation activity.

Finally, given the competitive intensity and tight margins, an important indicator for innovation performance might be its impact on market share and organisational performance relative to competitor activity. However, we do not have empirical support for this assumption.

15.3 AN ACADEMIC PERSPECTIVE ON MEASUREMENT

Our experience of searching the literature suggests that studies specifically relating to innovation in the transportation industry and which report measures of output or performance are rare. Consequently, our analysis of the literature is based on those studies that include transport as part of a mixed-sample. From the notes accompanying our summary of measures in Appendix 39, it can be seen that, in most instances, the transportation industry forms only a small proportion of any of the samples and it has not been possible to disentangle these studies to allow us to say anything with confidence about sector-specific appropriateness.

Predominantly, the literature proposes measures of market and project performance. That is, what market opportunities were opened up by the innovation and to what extent did revenues, sales or customers increase. Project performance measures are more inward looking, such as did the new product or service result in process efficiencies or cost savings for the firm.

[11] http://abcnews.go.com

15.4 PROPOSED MEASURES

On the basis of the literature review and empirical data we recommend measures in the following areas: Market factors – impact of innovation on market share; Financial performance- contribution of new products/services to profitability and cost saving; Innovativeness – new products and services launched, and: Two process improvement measures – process improvements are particularly important for the sector. These are further developed in table 12 and Appendix 40.

Measurement theme	Measure
Market performance	Relative market share growth from the innovation (relative to important competitors)
Financial performance	Percentage of sales, profits and savings due to innovative (radical and incremental) products/services introduced in last *n* years
Innovativeness	Number of new (degrees of newness apply) products, goods or services in last *n* years
Process improvement (i)	The innovation has allowed the firm to improve the quality of its products/services
Process improvement (ii)	What new skills have been acquired by (and retained within) the firm as a result of the innovation

Table 12: Proposed innovation performance measures for transport sector

16 SWOT ANALYSIS

16.1 STRENGTHS

Our review has been informed by social science research, the grey literature and an exploratory investigation of the metrics managers actually use to measure their firm's innovation output. We have attempted to synthesise these sometimes diverse perspectives to arrive at a set of measures that reflects the essence of innovation in each specific sector. Rather than proposing a set of metrics to be aggregated, we have proposed sets of multiple metrics that capture sectors' diversity.

However, the process of review and synthesis has revealed the somewhat limited extent of knowledge relating to output performance measurement on a sectoral basis. It is clear that some sectors have received greater attention than others suggesting that further investigative work and metric development is required in certain areas, particularly: Retail and wholesale distribution, transport, construction and the public sector.

The metrics proposed in this working paper help move measurement of innovation output beyond the traditional approaches based on inputs (e.g. percentage of revenue spent on R&D), interim measures (e.g. patent counting) and, output measures that rely on a product/artefact conceptualisation of innovation (e.g. number of new products, percentage of sales/profits originating from new products).

We have proposed a wider range of measures that exhibits sectoral variety. This variation reflects the relative innovation sophistication of the different sectors. For example, a respondent in the aerospace and defence sector expressed interest in a future measure of open innovation which reflects the increasingly collaborative nature of innovation in that sector. This contrasts with some of the fundamental questions about innovation that the retail and wholesale distribution sector, at least on the basis of our investigation, is asking. The variety of measures we propose also reflects the different innovation priorities across the sectors.

The individual content of a set of metrics will change over time as firm and sector priorities change, and so we would recommend that the measures that emerge from this process be reviewed on a frequent basis. The content also will always be contestable, particularly as one objective is to maintain as parsimonious a set of measures as is possible.

16.1.1 Comparability

We have presented quite a broad range of measures data for which will necessarily be collected from a number of different sources and by a range of methods. Internationally, there are a number of databases on which researchers could draw in order to collate data on the measures we have described as *Counting* (typically patents or trademarks) and *Financial performance* (typically sales or profit related) (see, for example, OECD (2005), Diewert (2006) and, OECD (2007).

In truth, though, the measures we propose, or something similar to them in their attempt at generating a more rounded picture of sectoral innovation output at the level of the firm, will not be internationally comparable without international efforts to promote the generation and collection of such data from firms across the globe. The extent to which the measures we propose will resonate more widely with managers in the sectors of interest is unclear.

Obtaining the data will always be a major barrier to applying the metrics. In the literature reviewed, researchers have enjoyed response rates of between about 15% and 80%. The data for some of the metrics we propose is already available in national or regional level surveys and should therefore not impose any further collection obligations on busy managers. Some, however, are not collected. Where a metric is common to all sectors, negotiations could be undertaken to have it included in a future survey instrument. Other, more qualitative indicators that interrogate managers' perceptions will require more sensitive treatment.

16.1.2 Accounting for 'hidden innovation'

In the proposed measures, we recognise and account for hidden innovation – those innovation activities that are not reflected in traditional indicators such as investments in formal R&D or patents awarded (NESTA, 2007). Across the 12 sectors we propose 60 metrics across 21 categories or measurement themes. Fewer than half of these directly measure financial performance or count intermediate outputs such as patents. The remainder are intended to extend measurement practice beyond these traditional measures (Appendix 1).

The proposed measures do not address 'open innovation', 'user-led innovation' or, 'absorptive capacity'. We regard these as processes of innovation or, as von Hippel recently noted on the Innovation Index website as *methods* of performing or diffusing innovation or as *organizational attributes* that can affect an organization's ability to innovate or to adopt innovations. Hence, they are not direct measures of innovation.

Thus, our measures whilst continuing to incorporate the traditional perspective, attempt to move measurement practice in line with current thinking about innovation, not as linear phenomenon that begins with R&D, but as something that is increasingly performed collaboratively, has longer-term and wider impacts amongst a greater group of stakeholders than has been previously recognised and, also, incorporates a broader conceptualisation of innovation including management, process and social innovations.

Criticism has been levelled at individual approaches to innovation measurement: at indirect approaches such as patents because not all innovations are patented and different sectors have different patenting activity; at object-oriented approaches such as patent counts because they tend to privilege product innovations, and; at subject-oriented approaches such as surveys of managers because, although they access important managerial perceptions, the researcher is hostage to response rates, of lagging measures. By combining different approaches in our set of measures, it is hoped that the deficiencies of one approach are compensated for by the advantages of others.

16.2 WEAKNESSES

Of course, the empirical data we have gathered results from a skewed sample. Our respondents reflect those with an interest in innovation management and we can assume that amongst those who did not respond there is a proportion (perhaps significant) who may think innovation and/or its measurement is not important. Further work to validate the proposed measures in those sectors that are particularly under-represented in this report will be required.

Although we have reviewed in excess of 100 articles and items from the grey literature, for reasons of time, cost, availability, relevance and contribution there remain a large number of sources we have not included in our review. Listed in the Innovation Index website[12] is listed a set of links to other innovator indicator website. As these are already known to the community we have not included them in our review, preferring instead to focus on what the community seemed not to have access to. Also, there are several commercially available measurement instruments at the firm level and other national initiatives which we have excluded from our review[13].

Another gap in our metrics relates to wider social impacts of innovation such as spillovers and the development of social capital which were beyond the scope and resources of this project. These impacts with wider socio-economic implications are not necessarily the outputs that firms are interested in.

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[12] http://www.innovationindex.org.uk/

[13] For instance: The *Advanced guide: how to set innovation metrics* Futurethink 2008; The *index of Corporate Innovation* Conference Board of Canada 2008; Innovations Balanced Scorecard Metrics (http://www.strategy2act.com); Construction Industry Key Performance indicators)http://www.kpizone.com/), (Schramm, 2008) and so forth…

Finally, there remains a level of imprecision regarding some metrics and it is uncertain whether or not companies routinely collect data relating to others. Further work is necessary to refine these measures and establish their formulae and assess the extent to which the data are available in firms.

16.3 OPPORTUNITIES

The Innovation Index in general and the measurement of firm-level output in particular represent an opportunity for the UK to head international development of the assessment of a more complete conceptualisation of innovation. Whilst there are many instruments available, they are constrained by a tendency to a limited conceptualisation of output which is often conflated with process.

16.4 THREATS

The principal threat is that, whilst the measures we propose attempt to capture a sense of the hidden innovation that goes on, this may hold some conceptual difficulties for potential informants. By way of example, the Government of New Zealand undertakes regular innovation surveys. Most recently, they reported that the most common reasons for innovating were to increase revenue (87% of all innovating firms) and reduce costs (71%). These reasons were followed by increasing market share, improving productivity, and increasing responsiveness to customers – reasons given by over half of all innovating businesses (Statistics New Zealand, 2008).

The point is, that, generally speaking, many organisations and managers think about the output of innovation in financial terms and it may take time to move away from this position. The good news is that, as the respondents to our survey and interviewees show, there are managers who think more widely about the output and ramifications of innovation, and this is echoed in the New Zealand survey with a small number of respondents citing, for instance, reduced environmental impact as an output. But, our sample was small and skewed and the New Zealand sample consisted of self-selected respondents.

17 LAST WORD

We have proposed a limited set of performance measures to measure a diverse range of outputs. Innovation measurement is always likely to be a contested area and, in pursuit of developing an appropriate and manageable set, we subscribe to the BCG view that “More important than finding exactly the ‘right measures’ …is to use measures that are not too wrong” (Boston Consulting Group, 2003). Following discussion at the workshop and wider consultation, no doubt the list will be refined. After that, the challenge will be to apply the measures to firms and discover more about the state of innovation in the UK.

18 APPENDICES

18.1 APPENDIX 1: MEASUREMENT CATEGORIES AND INDUSTRY SECTORS

	Aero/Def	Bus Serv	Constr	Creative	Fin Serv	HT Manuf	ICT	Pharma	Pub Sect	Ret & Wholesale	Telecom	Transport
Financial performance	■	■	■	■	■	■	■	■			■	■
Innovativeness		■			■	■	■	■	■	■	■	■
Technological application			■						■	■	■	
Business performance		■			■	■	■					
Process improvement	■		■		■							■
Reputational enhancement				■	■						■	
Knowledge utilisation	■						■					
Market performance								■				■
Product advantage						■		■				
Business model innovation				■							■	

Contd/…

Contd/…

	Aero/Def	Bus Serv	Constr	Creative	Fin Serv	HT Manuf	ICT	Pharma	Pub Sect	Ret & Wholesale	Telecom	Transport
Reinforcement of innovation orientation									■	■		
Strategic importance of innovation						■				■		
Timeliness		■			■							
Commercialisation		■										
Content creation				■								
Exploitation of knowledge stocks over time	■											
Future business value			■									
Innovation collaborations			■									
Innovation index								■				
Knowledge conversion							■					
Outreach									■			
Public impacts									■			
Technology development	■											

18.2 APPENDIX 2: PHASE 2 – OPERATIONALISING THE INNOVATION INDEX

As the previous sections have shown it is possible to identify a broad set of innovation metrics for each of the 12 sectors studied. While some data might be available in existing surveys, see for example the Community Innovation Survey, it is highly likely that new primary data will have to be collected if the Innovation Index is to capture hidden innovation at the level of the firm. This section of the report outlines an initial project plan for capturing the necessary data. It consists of three sub-sections: (i) development and piloting of data collection instruments, (ii) full scale data collection and (iii) analysis and interpretation.

18.2.1 Development and Piloting of Data Collection Instruments

This first phase will involve confirming which of the proposed measures will require primary data collection and establishing appropriate methods for capturing such data. In some cases it may be possible to harvest data from existing sources, hence reducing the need to capture new primary data. In this first phase we would therefore recommend:

- Identifying specific scales that are going to be used to capture the data (based on the measures proposed in this report).
- Establishing whether any existing data sources exist – e.g. the Community Innovation Survey.
- Developing and piloting a postal and/or telephone survey to capture additional data as required.

We would anticipate this phase of the work taking six person months (but would suggest two researchers work on the project for three months each). The researchers would be supported by an administrator.

The estimated cost for this phase would be £96K.

18.2.2 Full Scale Data Collection

We have already undertaken a preliminary scoping study to establish the size of the task. Table 13 shows the number of UK organisations in each of the 12 sectors covered in this report. In total 1,447,497 UK organisations are listed in the FAME database. Assuming a survey were carried out covering 25% of these organisations and the cost per organisation was £2.50, the cost of data collection would be £900K. We would anticipate this phase would take 12 person months (but would suggest two researchers work on the project for six months each).

The total cost for this phase (including data collection) would be approximately £1 million.

Sector	UK Firms	Search
Aerospace and Defence	1,207	Search on aerospace or defence

Business Services (e.g., Legal, Consulting, Accounting, Architecture)	669,857	UK SIC 74 - Other business activities
Construction	179,522	UK SIC 45 - Construction
Creative Industries	46,779	UK SIC 921, 922, 923 and 924; 921=Motion picture and video activities, 922=Radio and television activities, 923=Other entertainment activities, 924=News agency activities, 925 - Library, archives, museums and other cultural activities...
Financial Services (e.g., Banking, Insurance)	43,376	UK SIC 65-67; 65=Financial intermediation, except insurance and pension funding, 66=Insurance and pension funding, except compulsory social security, 67=Activities auxiliary to financial intermediation
High-tech Manufacturing	17,921	UK SIC 29, 31, 32 and 33; 29=Manufacture of machinery and equipment not elsewhere clasified, 31=Manufacture of electrical machinery and apparatus not elsewhere classified, 32=Manufacture of radio, television and communication equipment and apparatus, 33=Manufacture of medical, precision and optical instruments, watches and clocks
ICT	141,796	UK SIC 30 and 72; 30=Manufacture of office machinery and computers, 72=Computer and related activities
Pharmaceuticals	903	UK SIC 244 - Manufacture of pharmaceuticals, medicinal chemicals and botanical products
Public Sector	69,663	UK SIC 75, 80 and 85; 75=Public administration and defence; compulsory social security, 80=Education, 85=Health and social work
Retail and Wholesale Distribution	208,626	UK SIC 50, 51, 52; 50=Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel, 51=Wholesale trade and commission trade, except of motor vehicles and motorcycles, 52=Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods
Telecoms	10,316	UK 642 - Telecommunications
Transport	57,531	UK SIC 60, 61, 62 and 63; 60=Land transport; transport via pipelines, 61=Water transport, 62=Air transport, 63=Supporting and auxiliary transport activities; activities of travel agencies
Total	1,447,497	

Table 13: Number of organisations in each sector (source FAME atabase)

18.2.3 Analysis and Interpretation

The final phase of the work would involve analysis and interpretation of the data. We would suggest that two researchers work on this phase for three months each. In addition to data analysis we would propose a series of sectoral workshops (to be hosted by NESTA) where the results of the survey could be discussed and debated. The cost of organising these workshops, producing 12 sectoral reports and an integrated report would be £176K.

Table 14 summarises the total budget that we think would be required for this project. Clearly these figures are estimates at this stage and detailed costings have yet to be developed.

Phase	Rationale	Resources
Development and piloting of data collection instruments	Data for some of proposed indicators may already available from existing instruments. Careful (sectorally based) piloting of the survey would be required.	2 researchers for 3 months = £30K Administrative support = £10K Project management = £20K Pilot survey (12 sectors) = £36K
Full scale data collection	Table 13 summarises the size of the task – assuming 25% of UK organisations were targeted the cost of data collection would be significant.	2 researchers for 6 months = £60K Administrative support = £20K Project management = £40K Data collection (12 sectors) = £900K
Analysis and interpretation	Analysis of the data, sectoral discussion fora to explore and interpret the results, sectoral publications and integrated report.	2 researchers for 3 months = £30K Administrative support = £20K Project management = £20K Sectoral fora (12 sectors) = £36K Sectoral reports (12 sectors) = £60K Integrated report = £10K
Total		**£1,292K**

Table 14: Estimated budget for phase 2

18.3 APPENDIX 3: LITERATURE REVIEW – EXCLUDED STUDIES

Measure(s)	Reference	Notes
Indirect measures • Customer satisfaction • Total sales • Market share • EBIT **Direct measures** • Sales/results of new products • Number of new products • Impact on sales, EBIT, and/or costs • Number of patents • Time to market • Project management measures • Innovation rate	(AD Little, 2005)	Global survey n=850
Speed to Market • This product was developed much faster than other comparable products developed by our organization • This product was developed much faster than similar products developed by our nearest competitors • This product could have been developed in a shorter time (R) • The product concept formation (i.e., opportunity identification and product design) took longer than expected (R) • The product development phase took longer than expected for this product.(R) • The product commercialization (i.e., market testing,	(Barczak, Sultan and Hultink, 2007)	Survey of 212 PDMA practitioner members - 36% of respondents referred to development of a consumer product, 52% to development of an industrial product NEW PRODUCT PERFORMANCE (pp613)

production, distribution, promotion, sales) took longer than expected (R) **Market Performance** • Level of sales achieved • Customer satisfaction with the product • Market performance of the product relative to its competition • Chances of the product being a success in the market • Level of initial market penetration (i.e. market share) • Projected financial profits on this product		
• Export sales from incrementally changed products • Export sales from new products • Export sales from radically changed products • Sales from innovative products new to the firm • Sales from innovative products new to the industry • Sales from new products • Sales of radically changed products	(Calvert, Ibarra, Patel and Pavitt, 2002)	
Technical performance • Percent of new processes/process innovations considered successful • Percent sales and profits from products introduced within the last 3 or 5 years • Percent sales and profits from products with significant enhancements in the last 3 or 5 years • Percentage improvement over 1 or 3 years **Quality** • Percentage improvement over 1 or 3 years • Manufacturing cost • Market share • Product cost • Return on sales • Market share	(CBI/DTI, 1993)	Generic frameworks

• Cost of development projects compared to budget	(Cebon and Newton, 1999)	
Impact on firm's competitiveness of an individual innovation (to be compared against competitor's and/or expected results) • Sales – domestic market • Sales – regional market • Sales – global market • Market share – domestic market • Market share – regional market • Market share – global market **Impact on firm's portfolio of an individual innovation** • Profit • Sales of the portfolio before an dafter the innovation • Profits of the portfolio before and after innovation **Impact on firm's competitiveness of a series of innovations** • Sales, market share and profits of a series of innovations to which the innovation belongs **Impact of the innovation process on competitiveness over time** • % sales or profits from products introduced in the last *n* years • % sales or profits from products with significant enhancements in the last *n* years	(Chiesa, Coughlan and Voss, 1996)	Generic framework . Development of an audit model to assess performance of the process, but also makes consideration of impact of innovation on competitiveness
Technical success • Difference between past performance of the item and current performance of the item • Customer satisfaction • Number of duplications • Number of project parts jointly carried out with other projects • Percent sales and profits from new products introduced in the last 3 or 5 years • Customer satisfaction audit – customer may be internal or external	(Chiesa and Masella, 1994)	Generic framework

All things considered, how successful the business unit's total new product efforts are when compared to competitors Strength of impact the total new product effort has on the business unit's sales revenue or turnover. Met sales objectives; met profit objectives; per cent successful; impact on business's sales; impact on business's profits; profitability vs competition; overall success	(Cooper, 1998)	161 Business units in a variety of industries in the US, Germany, Denmark and Canada
Organisational innovation • Rate of adoption of innovations • Numbers of awards won • Number of patents acquired by companies • Number of innovations adopted within a given period	(Damanpour, 1991)	Meta analysis of 23 empirical studies, 21 articles & 2 books
• Percent revenue from products less than x years old Percent projects terminated before the development stage Cycle time from start to a commercialisation point, such as first significant sales Percent earnings after Y years of commercialisation vs prediction at last gate	(Davidson, Clamen and Karol, 1999)	Aim to identify best practices, from an R&D point of view, for achieving both effectiveness and efficiency of innovation processes. Survey and interviews with QDN (Quality Directors' Network of the Industrial Research Institute) member companies (n not specified)
• Attains margin goals • Attains profitability goals • Break-even time (from start of project) • Customer acceptance • Customer acceptance • Customer satisfaction level • Internal rate of return or return on investment • Number of months till breakeven after release • Number of months till breakeven after release • Percent of sales provided by products less than 5 years old • Ratios Number of years till breakeven after release	(Griffin and Page, 1993)	The authors compared the measures used in over seventy-five published studies of new product development to those surveyed companies say they use...A total of seventy-five measures of product development success and failure were generated across the two questions in the survey and the literature review. As Figure 1 indicates, only sixteen, or 21% of the measures are common across all three sources. These sixteen measures can be thought of as the ones that everyone is using and wants to use--they are the core S/F measures...The S/F measures actually used by companies were obtained through surveys of practitioners attending two PDMA conferences, the 1991 International Conference in Boston, MA, and a local one-day conference the next month in Chicago, IL. The questions used in the predominantly open-ended survey can be found in Table 3. A total of 50

• Total cost to develop the product • Degree to which the product met unit sales goals • Met revenue goals • Revenue growth • Profitability • Relative market share = share ratio relative to next largest • Competitor • Sales growth rate • Sales growth rate • Relative market share = share ratio relative to next largest competitor		responses were obtained, generating thirty-four different S/F measures which are currently used by firms...Firms generally use about four measures from two different categories in determining product development success.
• Attainment of profitability goals • Degree to which the product met market share goals • Success/failure rate • NPV of a project or programme • Percent of profits or gross margin due to products • introduced in the last X (usually 3 or 5) years • Percent profits under patent protection • Percent sales from new products • Percent sales under patent protection • Percent profits from new products • Programme hit 5 year objectives • Degree to which product met revenue goals • Development programme ROI • Overall programme success (composite measure) • Revenue growth due to new products • Success/failure rate of new products • Goal attainment (market share, revenue, revenue growth, • volume, customer numbers etc) • Customer satisfaction audit – customer may be internal or • external • Project lead to future opportunities • Objective financial assessments (e.g. IRR, ROI, ROA, cash flow payback, benefit-to-cost ratio etc)	(Griffin and Page, 1996)	Mixed sample n=80. Physical goods 76%; mixture of goods and services 19%; services 5%. Purposive sample of individuals active in product development: members of either the Product Development and Management Association or the American Productivity and Quality Centre International Benchmarking Clearinghouse New Product Development Common Interest Group

• Competitive advantage • Customer satisfaction audit – customer may be internal or external • Profitability	(Griffin, 1994)
• Overall success • Relative success • Market success • Financial success	(Griffin, 1997)
• Service quality • Anticipativeness of customer needs = percent of customer • driven projects • Customer rating of technology benefits = numerical ranking • of a firm's product by a customer/customer's ranking of the • best competitive product • Number of customers who found faults • Percent of sales from new products • Profit due to R&D • PV of R&D accomplishments • Customer rating of technology benefits = numerical ranking of a firm's product by a customer/customer's ranking of the best competitive product • Number of customers who found faults • Market share gained due to R&D • Customer satisfaction audit – customer may be internal or external • Objective financial assessments (e.g. IRR, ROI, ROA, cash flow payback, benefit-to-cost ratio etc)	(Kerssens-van Drongelen and Bilderbeek, 1999)

• Patent counts • R&D expenditure • Total innovation expenditure **New indicators include:** • Total innovation expenditures • Shares of imitative and innovative products in a firm's total sales • New product announcements in trade and technical journals • Significant or basic innovations.	(Kleinknecht, van Montfort and Brouwer, 2002)	Conceptual
Innovation performance metrics (measuring growth) • **R**eturn on innovation investment (cumulative net profits generated from new products launched • Research costs+development costs+incremental production costs+initial commercialisation pre-launch costs) • New product success rate (number of new products exceeding 3 year original forecasts • Total number of new products commercialised in the last 3 years) • New product survival rate (number of new products remaining in the market [time period x] • Total number of new products launched in time period x) • Cumulative new product revenue (cumulative [3-5 years] revenues from new products) • Cumulative new product profit (cumulative [3-5 years] profits from new products) • Growth impact (revenues from new products over 3-5 years; 3 year revenue growth) **Innovation performance metrics (measuring programme management and control)** • R&D innovation emphasis ratio (Cumulative [3-5 year] • R&D expenditure allocated solely to new products • Cumulative [3-5 year] R&D expenditure) • New product portfolio mix - three types of new product : new to world, new to company, product line extensions	(Kuczmarski, 2000)	Product oriented, but not sector specific. Set of isolated indicators, no attempt at cumulation

(Number new products of type X, Total number of new products, Revenues from new products of type X, Total revenues from new products, Expenditures for products of type X, Total expenditures on new products) • Process pipeline flow (Number ot new product concepts in each stage of development, e.g. at: 1. Concept analysis, 2. Prototype development, 3. Market testing, 4. First year ot launch) • Innovation revenues per employee (Total annual revenues from commercialized new products; Total number of tull-time equivalent employees devoted solely to innovation initiatives) speed to market (Σ[Time from idea generation to market launch for new products]; Total number of new products)	
Innovation performance metrics measuring growth: • Associated costs • Revenues • Numbers of innovations • Innovation survival rates **Innovation performance metrics measuring programme management and control:** • Speed of process • Amount expended • Innovation types developed (newness) • Success	(Kuczmarski, 2000)
• Benefit ÷ cost ratio • Objective financial assessments (e.g. IRR, ROI, ROA, cash flow payback, benefit-to-cost ratio etc)	(Merrill and McGeary, 2002)

Financial Criteria Used to Measure the Performance of New Products • Return on investment • Various profit margin measures • Sales and sales growth • Various profit measures • Payback and payback period • Internal rate of return • ROA, ROE, and ROCE • Breakeven and breakeven point • Share and market share • Return on sales • Net present value • Other financial measures **Nonfinancial Criteria Used to Measure the Performance of New Products** • Sales performance of new products • Market share achieved • Satisfy customer needs • Other marketing-related benefits • Strategic issues/fit/synergy • Technical aspects/performance • Uniqueness of the new products • Other nonfinancial factors	(Page, 1993)	North America, goods and services, high and low tech
• Share of sales allocated to R&D (an indicator of input into the • innovation process) • Firm's patent applications • Share of sales due to innovative products or processes (incremental or radical)	(Peeters and van Pottelsberghe de la Potterie, 2003)	

Goals, and category of goal from Innovation • Increase in overall efficiency- Productivity/efficiency • Increase production efficiency - Productivity/efficiency • Reduction in material costs- Cost reduction • Creation of successor products - Customer value • Reduction of labour costs - Cost reduction • Restructuring of product mix - Product-market • Rounding out of product mix - Customer value • Inducing internal entrepreneurship - Human resources • Response to regulatory pressures (other than environmental • standards) - Regulatory compliance • Compliance with environmental standards - Regulatory compliance • Energy cost savings - Cost reduction • Improvement of working conditions - Human resources	(Ramanujam and Mensch, 1985)	
Outcome measure Commercial success: the net acquisition of a worthwhile net monetary gain and/or market share - measured 3 factors: net direct monetary gain, market share - number of units sold and average sales price per unit, Alignment with company strategy	(Rothwell, Freeman, Horseley, Jervis, Robertson and Townsend, 1974)	Forty- three pairs of innovations, twenty- two in chemical processes and twenty-one in scientific instruments.

Innovation Value Index = (outputs/inputs)=([problem x solution x implementation]/[capital x labour x time]) • Problem = Problem Size (people, organizations, dollars) x Need Priority (Importance, urgency) • Solution = Novelty x Sophistication (technology, type, advancement source, quality) • Implementation = Intellectual Property (patents, industrial designs, trademarks) x Sales Market Scope (export countries) x Success Factors (and barriers) • Capital = (sources, amounts) • Labour = Team (members, type, location) x Partners • Time (project status and duration)	Spectrum Innovation Group 2007	"The Innovation Value Index is different from productivity and efficiency measures because it focuses on a specific project for a new or improved product. Productivity and efficiency apply to ongoing activities, although innovative improvements often increase productivity. The outputs can be used for end-user consumption (consumer) or as inputs for other commercial projects (business)" www.spectruminnovation.com

• Total cost of all commercially successful projects ÷ number of commercially successful projects • Direct market share • Economic value of a new product feature = (price premium • due to the feature – extra cost)*sales volume • Estimated future sales due to projects in the R&D pipeline • probability of attaining the project objectives • Percent of sales protected by patents owned by the company • NPV of future cash flows in the R&D pipeline probability of • attaining the project objectives • Percent of sales protected by patents, trade secrets and/or • other exclusive company know-how or arrangements • Savings in the cost of goods sold due to process • developments of product changes introduced in the past X • years • Total R&D budget ÷ number of projects with commercial • output • Differential share gain at a constant price for product • containing the quality feature • Profits due to product and process improvements introduced • in the last X years/R&D costs • R&D yield = gross profit contribution from sales of new • products and cost savings due to R&D • Direct market share • Percent of sales protected by patents owned by the company • Percent of sales protected by patents, trade secrets and/or • other exclusive company know-how or arrangements • Market share growth • Manufacturing costs compared to relevant competition • Actual cost savings ÷ reductions in products or processes • Customer satisfaction audit – customer may be internal or • external • Revenue growth due to new products	(Tipping and Zeffren, 1995)

Overall Assessment of the Value of R&D = A + [(C x B) x D] • **(A)** Effectiveness Index = Present Value of Revenue Generated from Products Introduced in the Last 5 Years/Present Value of Last 5 Years' Cumulative R&D Costs • **(B)** Timeliness Index = (Number of Projects Completed On Time during Some Representative Period/Number of Projects Started in That Period) x100% • **(C)** Future Potential Index = Present Value of Expected Future Revenues from Technologies Currently Under Development/Present Value of All Costs to Develop These Technologies • **(D)** Peer Rating Audit of Unfilled Future Needs That Will Inhibit the Achievement of Future Greatness, Expressed on a Scale from 0 to 100%	(Werner and Souder, 1997)	This article analyzes the state of the art in R&D performance measurement, based on extensive literature searches.
New sales ratio • Ratio of the current annual sales of new products to total annual sales	(Whiteley, Parish, Dressler and Nicholson, 1998)	For generic use in R&D

18.4 APPENDIX 4: INTERVIEWEES

Aerospace and Defence:
Senior Manager Innovation and Business Ventures international defence technology company.
Senior Manager, international aircraft manufacture and assembly

Business Services:
Partner, big 4 management consulting company.

Retail and Wholesale Distribution:
Senior Merchandiser, international luxury branded products.

Telecoms:
Partner, big 4 management consulting, Telecoms focus

18.5 APPENDIX 5: DESCRIPTIVE STATISTICS FOR SURVEY RESPONSES

	Aero/Def	Bus Serv	Const	Creative	Fin Servs	HT Manuf	ICT	Pharma	Pub Sect	Ret & Wholesale	Transport	Telecom	Total
Number of respondents	1	11	2	9	3	2	4	0	5	1	1	1	40
Employees													
<49	-	8	2	5	-	1	2	-	2	-	-	-	20
50-99	-	2	-	-	-	1	-	-	-	-	-	-	3
100-500	-	-	-	1	-	-	-	-	-	-	-	-	1
500-999	-	-	-	2	1	-	-	-	-	1	-	-	4
1000-1999	-	1	-	-	-	-	-	-	1	-	-	-	2
2000-2999	-	-	-	-	-	-	-	-	-	-	-	-	-
>3000	1	-	-	1	2	-	2	-	2	-	1	1	10
Firm age													
< 5 years	-	5	1	2	-	-	-	-	2	-	-	-	10
6-10 years	-	2	-	1	-	-	2	-	-	1	1	1	8
11-25 years	-	1	-	4	1	1	-	-	-	-	-	-	7
26-50 years	-	2	1	1	-	-	-	-	1	-	-	-	5
>50 years	1	1	-	1	2	1	2	-	2	-	-	-	10
How frequently is the performance of innovation-related activities reviewed?													
Never	-	-	-	1	-	-	-	-	-	-	-	-	1
Weekly	-	1	-	3	-	1	2	-	-	-	-	-	8
Monthly	-	3	2	1	1	1	1	-	1	-	-	-	10
Yearly	1	-	-	-	-	-	-	-	3	-	-	-	4
Sporadically	-	7	-	4	2	-	1	-	-	-	1	-	15
Do you routinely use more than 5 measures to monitor innovation related performance?													
Yes	1	1	-	3	-	-	-	-	1	-	-	-	6
No	-	11	1	5	3	2	3	-	4	1	1	1	32

18.6 APPENDIX 6: AEROSPACE AND DEFENCE – SURVEY AND INTERVIEW RESPONSES

Measures of innovation output performance
Exploitation/Conversion • Conversion rates from ideas to exploitation • Stock take of legacy innovations and traceability to new innovations • Spin outs, JVs, 'intrapreneurialism' • Development of new applications from existing ideas • Tracking of activities of capability development programmes **Technology development** • Number of patents filed • Number of invention notes raised internally • Number of 'Fellow' grade scientific staff • Number of internal awards and nominations • Internal awards for business or technical ideas raised **Innovation with partners** • Measuring innovation with supply chain. • Measuring 3rd party product/research acquisitions. • Measuring open innovation **Process performance** • Scientist satisfaction of innovation freedom vs fee earning time • Better, faster, cheaper **Financial** • Income generated from patents and licences • Operational business sales arising from innovations **Vis a vis competition** • Comparison of similar and dis-similar R&D organisations

18.7 APPENDIX 7: AEROSPACE AND DEFENCE - LITERATURE

Measure(s)	Reference	Notes
Overall success • The overall commercial average success rate of new products launched **Count** • Number of new product ideas partially developed and the number of new products launched per year.	(Balbontin, Yazdani et al, 2000)	Survey of UK & US firms representing high technology business from key industrial sectors: computers (13 UK, 13 US), electronics (16 UK, 12 US), chemicals, pharmaceuticals, food and fibres (14 UK, 9 US) and transportation, aerospace, materials, industrial products (20 UK, 3 US).
New Product Introduction effectiveness index • (Total value of engineering output/cost of engineering department)*100%. • Total value of output = gross margin*sales volumes (new products) + delta gross margin * sales volume (re-engineered products) + engineering sales in the period.	(Haque and Moore, 2004)	Metrics development based on reviewing the existing body of knowledge on performance measurement for NPD/NPI processes and applying a lean filter. NPI effectiveness index is the key overarching or strategic level metric, which sits above the other proposed (process) measures including, Compliance to customer requirements, Schedule performance, Cost performance, Inappropriate design changes, Engineering throughput and, Information inventory efficiency. It primarily measures value to the business and effectiveness of both the product and the process.
Financial • Profitability Sales growth rate **Vis a vis competition** • Relative market share = share ratio relative to next largest competitor	(Kotabe and Murray, 1990)	71 usable responses of Japanese/European subsidiaries of US firms. Metal products 11.6%; Electronics 11.6%; Transportation equipment 7%; Motor vehicles and parts 2.3%; Aerospace 2.3%; Scientific and photo equipment 7%; Computers and office equipment 11.6%; Industrial and farm equipment 27.9%; Not specified 18.6%

18.8 APPENDIX 8: PROPOSED MEASURES FOR AEROSPACE AND DEFENCE

<table>
<tr><th>Measurement theme</th><th>Measure</th><th>Supporting evidence</th><th>Significance</th><th>Feasibility</th></tr>
<tr><td>Financial performance</td><td>Profitability from new products and, income generated from patents and licences</td><td>Widespread across many sectors in literature and practice</td><td rowspan="4">Moderate. Fails to capture process and management innovations</td><td rowspan="2">Data typically readily available</td></tr>
<tr><td>Technology development</td><td>Number of patents filed, licences etc</td><td>Extensive</td></tr>
<tr><td>Knowledge utilisation</td><td>Proportion of new knowledge assets (<3years old) incorporated into new products</td><td rowspan="2">Limited. New measure, untested. Supported by empirical data, not the literature</td><td rowspan="2">Interview feedback suggests these data may not be routinely collected due to short term reporting perspectives.</td></tr>
<tr><td>Exploitation of knowledge stocks over time</td><td>Returns from products incorporating own patents >5years old, not previously having been used</td></tr>
<tr><td>Process improvement</td><td>New Product Effectiveness Index[14] = (Total value of engineering output/Cost of engineering department) * 100%</td><td>Important area of innovation for A&D industries, with large supporting literature</td><td>Moderate. Fails to capture product innovation and knowledge exploitation</td><td>If data not readily available, unlikely to be difficult for firms to capture</td></tr>
</table>

[14] After Haque and Moore, 2004

18.9 APPENDIX 9: BUSINESS SERVICES – SURVEY AND INTERVIEW RESPONSES

Measures of innovation output performance
Business performance • New business logged • Market share changes (innovation driving share growth) • Size/growth of educational software/technology market • Use of new technologies • Usefulness to business purpose • Impact on business - sales etc. • New business won **Financial** • Revenue from new services as % of total • Spending on innovation activities • Sales of new products • Revenue from products less then 3 years old • Average margin on new product/service divided by average margin of old product/service • IP revenue • Spending on innovation activities **Innovativeness** • Number of professional research papers published • Number of other organisations licensing products/services developed by us • Number of new ideas generated • Number of references to product/service offerings in peer reviewed journals • Pass rates of key qualifications • # students learning online • Number of other organisations licensing products/services developed by us **Inputs** • Number of FTEs as % staff working on service innovation • Budgets (time/people/funds) relating to innovation • % of turnover invested in research & development **Organisational characteristics** • Cultural openness to innovation • Thought leadership factors **Comparative** • % students learning online vs US • Benchmarking with other countries and continents **Quality** • Client satisfaction • Staff satisfaction **Effectiveness** • % of projects successful **Organisational processes** • Updating on best practice

18.10 APPENDIX 10: BUSINESS SERVICES – LITERATURE REVIEW

Measure(s)	Reference	Notes
Degree of innovativeness • **T**echnological newness • Service newness to the market, etc.) **Project performance** • **S**ales/revenue • Profitability • Market expansion etc • And, an overall, or “global”, measure: perceived overall degree of project success/failure— which ranged from “overriding success, exceeding all expectations” to “totally unsuccessful, below all expectations”.	(de Brentani, 2001)	Survey of 276 successful/unsuccessful projects. Comparison of highly innovative and incremental new business services to discover impact on: Product-related dimensions; Market-related dimensions; Company-related dimensions, and New Service Development-related dimensions.
• Type of innovation (service, process/delivery) • Impact of innovation on sales and on employment • Future programs for innovation	(Evangelista and Sirilli, 1998)	Survey structured along Oslo Manual guidelines
• R&D (software development should be included)	(Evangelista, Sirilli et al, 1998)	Survey structured along Oslo Manual guidelines
New products/services introduced • Introduction to the market of any service or service production/supplying method technologically new or improved, during the period of interest	(Lopes and Dodinho, 2008)	Portuguese data from CIS 2 Dichotomous measure. Unsatisfactory because it gives neither indication of magnitude or frequency nor any indication of the value or benefits that accrued to the firm

Service Sector Innovation Index (SSII) • Technological knowledge • Non-technological changes (such as organisational innovation) • Commercialisation	(Kanerva, Hollanders et al, 2006)	24 indicators assigned to seven themes of which only Technological change, Non-technological change and Commercialisation are firm-level indicators of performance. Indicators drawn from previous (mostly product-oriented) survey work. SSII is a composite of these indicators
Short term success • The new service is an overall success • Success exceeds expectations • The new service adds substantial value to other products and services • The new service was a good idea to invest in • The new service contributed to financial success **Long term success** • The new service contributed to commercial success • The new service improved our competitive position • The new service improved brand equity and reputation • The new service enabled expansion into new markets • The new service increased customer satisfaction and loyalty **Indirect success** • The new service increased in-house technological knowledge • The new service increased employee satisfaction • The new service created innovation opportunities	(van Riel, Lemmink et al, 2004)	Factor analysis of 13 items produced the 3 dimensions of product success.

18.11 APPENDIX 11: PROPOSED MEASURES FOR BUSINESS SERVICES

Measurement theme	Measure	Supporting evidence	Significance	Feasibility
Timeliness	Proportion of innovations that were first to market/early followers in last *n* years	None found in literature. Recommended on basis of nature of innovation in the sector	High	Literature-based research should offer a way into this data.
Business performance	Numbers and value of new customers reached by the innovation and, new market niches entered	Supported by empirical evidence and literature review	Moderate	Connection between the exploitation and the innovation may not always be clear
Financial performance	Profitability, sales, savings, % of income generated by innovation	Provenance well-established in techno-centric sectors but argued to be insufficient on its own for service sectors		Connection between the innovation and the numbers may not always be clear, but typically financial data are collected
Commercialisation	Number of other organisations licensing products/services developed by us	Based on empirical responses. No evidence found in literature	High. Commercialisation, exploitation, licensing, etc are important indicators for the sector	Data exist but not routinely collected
Innovativeness	New products/services introduced in last *n* years relative to market leader	Counting is a well-established approach (including literature-based counting), also applicable to services	Moderate. In some sub-sectors (e.g. consulting services) it can be difficult to separate new products. Also, may fail to capture organisational innovations	Uncertain as to whether or not data exist due to problem of isolating innovation. Literature-based indicators may be an aid.

18.12 APPENDIX 12: CONSTRUCTION – SURVEY AND INTERVIEW RESPONSES

Measures of innovation output performance
Reputational • Quality • Design • Customer satisfaction **Innovation processes** • Amount of brainstorming activity undertaken • Sustainability of processes **Enquiries generated** • Amount of R&D enquiries undertaken **Financial** • Bottom line **Internal factors** • New skills acquisition

18.13 APPENDIX 13: CONSTRUCTION – LITERATURE REVIEW

Measure(s)	Reference	Notes
Project performance • Did the new product/service achieve important cost efficiencies for the firm **Market performance** • Did the new product/service enhance the sales and customer use of the firm's other products and services **Goal attainment** • Market share, revenue, revenue growth, volume, customer numbers etc) • Did the new product/service substantially lower costs for the firm • Project lead to future opportunities	(Atuahene-Gima, 1995)	Cross sectional survey of 275 Australian firms. Sample comprised 13% chemical, pharmaceutical and biotechnology; 11% food and beverage; 13% electrical, electronic, scientific equipment firms; 12% metal and industrial equipment; 6% computer software firms; 3% communication and information technology; 16% banking and trusts; 8% insurance and superannuation and the rest from industries such as transport equipment, wood products, engineering , architectural and construction services.
Outcomes of innovation activity • Improving effectiveness - making sure the firm is doing the right activities • Improving efficiency - making sure the firm's activities are well done	(Barrett and Sexton, 2006)	Qualitative study of SME and project based firms to clarify important outcomes of innovation in project-based working.
New processes • New ecological design practices and new ecological construction practices **New products** • New ecological designs and new ecological objects areas	(Bossink, 2004)	Investigates the effects of innovation leadership styles on innovation outcomes.
Sales performance • Sales improvement due to innovation	(den Hertog and Brouwer, 2001)	Country level innovation evaluation of the Dutch Construction sector using the ClusterMonitor database.

Key Performance Indicators • 30 KPIs identified but not specified, to cover a range of factors including innovation output	(Jones and Kaluarachchi, 2008)	Case studies.
Time • Time for Construction - Headline • Time Predictability – Design - Headline • Time Predictability – Construction - Headline • Time Predictability – Design & Construction – Operational • Time Predictability – Construction - Diagnostic • (Client Change Orders) • Time Predictability – Construction - Diagnostic • (Project Leader Change Orders) • Time to Rectify Defects - Operational **Cost** • Cost for Construction – Headline • Cost Predictability (Design) – Headline • Cost Predictability (Construction) – Headline • Cost Predictability (Design and Construction) – Operational • Cost Predictability (Construction - Client Change Orders) - Diagnostic • Cost Predictability (Construction - Project Leader Change Orders) – Diagnostic • Cost of Rectifying Defects – Operational • Cost In Use - Operational **Quality** • Defects – Headline • Quality Issues at Available for Use – Operational • Quality Issues at End of Defect Rectification Period - Operational **Client Satisfaction** • Client Satisfaction Product (Standard Criteria) – Headline • Client Satisfaction Service (Standard Criteria) – Headline • Client Satisfaction (Client-Specified Criteria) - Operational	(KPI Working Group, 2000)	

Change Orders • Change Orders (Client) – Diagnostic • Change Orders (Project Manager) - Diagnostic **Business Performance** • Profitability (company) – Headline • Productivity (company) – Headline • Return on Capital employed (company) – Operational • Return on Value Added (company) – Operational • Interest Cover (company) – Operational • Return on Investment (client) – Operational • Profit Predictability (project) – Operational • Ratio of Value Added (company) – Diagnostic • Repeat Business (company) – Diagnostic • Outstanding Money (project) – Diagnostic • Time taken to reach Final Account (project) - Diagnostic **Health and Safety** • Reportable Accidents (inc fatalities) – Headline • Reportable Accidents (non-fatal) – Operational • Lost Time Accidents – Operational • **F**atalities - Operational		
Financial • Expected profit increment due to application of the R&D results	(Lee, Son and Lee, 1996)	28 Korean industrial companies from: agriculture, mining and quarrying, chemical products and refining, food and beverage products, basic metals, nonmetallic mineral products, paper products and publishing, textiles and apparel, machinery and equipment, gas and electricity, construction and communications. Actual profile of respondents not recorded.

18.14 APPENDIX 14: PROPOSED MEASURES FOR CONSTRUCTION INDUSTRIES

Measurement theme	Measure	Supporting evidence	Significance	Feasibility
Process improvement	What new skills have been acquired by (and retained within) the firm as a result of the innovation?	Has been applied in literature to construction industry and to other areas of industrial activity	Moderate to high. Currently strongly supported by Government policy as area for innovative activity.	It is not clear how routinely such data are gathered in the construction industry
Future business value	To what extent has the innovation enhanced the sales of firm's other products or lead to future opportunities?	Has been applied in literature to construction industry and to other areas of industrial activity	Moderate	It is not clear how routinely such data are gathered in the construction industry
Financial performance	Sales, profitability improvement due to innovation and/or costs saved	Provenance well-established in literature		Financial data available, but can it be linked to innovation?
Technological application	What proportion of the service offer comprises new products, materials, technologies etc?	Supported in the literature	Moderate. But one of the two key areas of innovation activity for the construction industries	It is not clear how routinely such data are gathered in the construction industry
Innovation collaborations	Number of innovation outputs infeasible without the collaborative relationship	Proposed on basis of nature of innovation in sector. No evidence found in literature	Moderate. But one of the two key areas of innovation activity for the construction industries	It is not clear how routinely such data are gathered in the construction industry

18.15 APPENDIX 15: CREATIVE INDUSTRIES – SURVEY AND INTERVIEW RESPONSES

Measures of innovation output performance
Reputational • Peer response • Generation of word of mouth • Artist engagement • Media perception • Critics' response • Qualitative audience response data • Peer review measuring campaign results • Word of Mouth (WOM) • Recognise the above firms stimulation of the UK manufacturing base via product design creation 'manufactured under license • Celebrate innovation: awards, prizes… • Pubic appeal • Longevity of appeal **Business performance** • Increased sales • Likelihood of innovation to succeed (risk) • Time to market advantage • Does it stretch the organisation and its staff abilities? • Skills gaps and vulnerability • Measuring business transformation thro' campaigns (net promoter) • New opportunities for income • New products and services brought to market under-license both via UK and non-UK deals with industry **Financial** • Cost • Cost of innovation versus potential size of opportunity • Funder support • % revenue from offerings that didn't exist 5 years ago • 20% of subsidy to innovation • Traditional R&D spend measure • Measuring business results of the campaigns/increased sales **Innovativeness** • New products and services and businesses launched by creative industry firms • Citations of thought-leadership in press • Number of innovative projects (containing genuine risk) per financial year • Numbers-is the sector attracting new audiences and participants • Does this represent a new approach to an existing problem? • New service offerings -- new to world, new to category, new to firm • Change in process-led products ie. activity programmes, education **Business models** • New distribution methods • New payment models • Enable a collaborative initiative between each MAS to support designed in One region manufactured in another • Recognise enterprise and start-ups paired with creative industries (particularly design) as an effective job creation opportunity by seed funding collaborative partnerships for viable propositions • Recognise product development firms and designer-makers as semi-manufacturers • Number of collaborations to develop innovative products or services **Innovation process performance**

- Within the Creative Industries as a whole enterprising idea generation
- Failed innovation
- Innovation/Proposition failure
- Percentage of staff / contractor time spent on innovation / R&D / projects containing genuine risk
- Change in processes ie. ways of looking at a problem

Learning
- Failure (without failure there cannot be real innovation)
- Learning - how is the organization learning from failed (or successful)innovation

Consumer behaviour
- Change in consumer attitude ie. take up in arts activities
- Audience/customer response

Behavioural
- Have attitudes/behaviours/ within the sector changed

Quality metrics
- Internal artistic assessment
- Innovation template - Holistic Proposition Development

Benchmarking
- Comparison to related industries

18.16 APPENDIX 16: CREATIVE INDUSTRIES – LITERATURE REVIEW

Measure(s)	Reference	Notes
Intellectual property • Number of design patents (number of designs protected by the firm as an indicator of its aesthetic production) • Product renewal rate (number of new products / total number of products offered).	(Alcaide-Marzal and Tortajada-Esparza, 2007)	The concept of *aesthetic innovation* proposed to aid measurement of innovation in these industries whose main competitive strength lies in product appearance as many firms would be considered innovative if aesthetic considerations were included in the definition of a new product.
Innovation outputs • Product innovation • Novel products • Process innovations **Innovation impacts** • Improved quality • Increased range • Expanded markets	(Bakhshi, McVittie et al, 2008)	Beyond the types of output and impact, no specific measures reported.
Content creation • Number of (copyrighted) first publications of new media content **Humdrum innovation** • A variation on 'introduction and sales of innovative products and processes', e.g. how many publications were made available online, or share of sales of downloads.	(Handke, 2007)	Copyright as the applicable form of intellectual property applies automatically to most new publications. Humdrum innovation spans the entire range of technological and service innovations that concern the reproduction, distribution and promotion of cultural products – i.e. not the creative content.
Intellectual property • Trademarks	Hipp and Grupp 2005	Argues that trademarks more accurately reflect creative activity than patents

18.17 APPENDIX 17: PROPOSED MEASURES FOR CREATIVE INDUSTRIES

<table>
<tr><th>Measurement theme</th><th>Measure</th><th>Supporting evidence</th><th>Significance</th><th>Feasibility</th></tr>
<tr><td>Content creation (IP Counting)</td><td>Number of copyrights, trademarks etc in last n years</td><td rowspan="2">Supported in both the literature and by respondent feedback</td><td rowspan="2">Moderate to high. Overlooks business models, reputational and collaborative innovation</td><td>Data accessible in public records, by firm survey and literature-based methods</td></tr>
<tr><td>Financial performance</td><td>Percentage revenue from offerings that did not exist n years ago</td><td>Data accessible from firm survey and public records (CIS type data)</td></tr>
<tr><td>Business model innovation (i)</td><td>Number and scale of significant business model changes in last n years</td><td rowspan="3">Metric proposed on basis of innovation drivers in the industry and of respondent feedback. Little supporting evidence found in the literature.</td><td rowspan="2">Moderate to high. Sector currently strongly driven by need to identify new business models, but overlooks content creation</td><td>Firm contact required – likely requiring interview</td></tr>
<tr><td>Business model innovation (ii)</td><td>Number and diversity of productive collaborations in last n years</td><td>Firm contact required</td></tr>
<tr><td>Reputational enhancement</td><td>Customer and peer perceptions of us as an innovative organisation</td><td>High. Customer and peer perceptions will reflect on each of the above factors.</td><td>Straightforward on a company basis. But more difficult to generate an industry-level picture.</td></tr>
</table>

18.18 APPENDIX 18: FINANCIAL SERVICES – SURVEY AND INTERVIEW RESPONSES

Measures of innovation output performance
Innovativeness • Number of new product launches • Stock of new products under consideration • Number of marketing initiatives based on Stream 1* innovations (*Stream 1= new product or service which cost >£1m to bring to market) • Number of product launches • Number of new clients **Organisational innovation** • Speed of response and agility • Improvements to customer processes • Degree of organisational change **Financial** • % of revenue generated from *type of* innovation • % of annual reported income generated via new product innovation **Market performance** • New product market response

18.19 APPENDIX 19: FINANCIAL SERVICES – LITERATURE REVIEW

Measure(s) of innovation performance/activity	Reference	Notes
Degree of innovativeness • New to market services • New to the company services • New delivery processes • Service modifications • Service line extensions • Service repositioning **Financial performance** • The service was profitable • Total sales of the service were high • The service had a large market share • The profitability of the service exceeded its objectives • The service exceeded its sales objectives • The service exceeded its market share objectives **Non-financial performance** • The service had a positive impact on the company's perceived image • The service improved the loyalty of the company's existing customers • The introduction of the service enhanced the profitability of other company products • The service attracted a significant number of new customers to the company • The service gave to the company an important competitive advantage	(Avlonitis, Papastathopoulou and Gounaris, 2001)	Postal survey
Product/market fit **Superior product** **Market growth and size**	(Cooper and de Brentani, 1991)	

New Product Performance • Financial measures such as profitability, sales, sales growth, and market share. • Relationship Enhancement:: increased customer loyalty and enhanced image with the customer, and impact on other company products • Market Development: degree to which the new product opened up windows of opportunity in terms of new customers and new markets to the company **Product Advantage** • Superiority • Uniqueness • Quality	(Cooper, Easingwood, Edgett, Kleinschmidt and Storey, 1994)	Postal survey
New service performance • Sales and market share performance • Competitive superiority (perceptual measures e.g. Superior service “experience” to competitors, Unique benefits in comparison to competitors) • Boosting sales and profit of other services • Cost performance	(de Brentani, 1989)	Postal survey
• Success/failure • Profitability • Market share • Market growth • Company image and reputation	(Drew, 1995)	Interview
Non direct benefits • Corporate reputation • Market penetration • Improved loyalty of existing customers • Provide window of opportunities	(Easingwood and Percival, 1990)	Interviews

• Overall quality, • Differentiated product • Product fit and internal marketing • Use of technology	(Easingwood and Storey, 1991)	
Customer satisfaction measures for new products • Increase in the number of customers; Increase in portfolio dollars; Complaint measurements; Market share ; Direct personal interview ; Employee attitude measures; Measure of customer expectations and perceptions ; Reasons why customers discontinue with product or service; Focus groups; Repeat customer rates; Customer survey – mail; Comparison of customer attitudes with other companies; Number of new customer referrals; Customer survey – telephone; Refunding of service charges or fee adjustments ; Customer comment cards; Customer audits; Frequency of customer interaction; Customer hotline tracking; Quality circles **Product quality measures for new products** • Increase in customer satisfaction ; Increase in sales ; Increase in market share; Delivery performance; Improvements in employee attitudes; Performance against established standards; Measure of delivery to standards; Lower error rates; Use of mystery shoppers; Increase in income; Lower cost of delivery; Reduced operating costs; Per employee output; Decrease in employee turnover; Capacity increase; Profit from higher premiums; Overhead trends; Reduction in audit/inspection costs; Employee absenteeism; Reduced sales effort; Higher prices. **New product performance measures for new products** • Increase in sales; Increase in income; Reduced operating costs; Increase in market share; Improvement in employee attitudes; Increase in customer satisfaction; Performance against established standards; Lower error rates; Delivery performance; Lower costs of delivery; Higher prices; Per employee output; Decrease in employee turnover; Profit from higher premiums; Overhead trends; Measure of delivery to standards; Reduced sales effort; Capacity increase; Employee absenteeism; Reduction in audit/inspection time cost; Use of mystery shoppers.	(Edgett and Snow, 1996)	Postal survey. Some of what they identify are not measures, rather they are tools and techniques for eliciting feedback or data - e.g. quality circles **Customer Satisfaction:** The most common measures reported were: measuring the increase in the number of customers and measuring the increase in portfolio dollars. **Product quality:** The most common measures reported were: increase in sales, increase in income and a reduction in operating costs. **New product success:** The most common measures reported were: sales growth against objectives, total sales (either units or revenue), number of new customers and profitability.

Organisational • Effectiveness in meeting organisational goals and objectives	(Gopalakrishnan and Bierly, 2001)	Postal survey
Commercial outcome of the service innovation • Failure versus success: based on a broad group of performance measures including financial measures (such as profit, cost performance, sales and market share) and non-financial measures (such as competitive performance, cross selling and increasing service delivery capabilities).	(Lievens, Moenaert and Jegers, 1999)	Case study
New service development performance • Customer requirements met • Marketplace success (proportion of products launched in last x years) • Met organisational financial and strategic objectives • Degree to which new service offerings lead to future opportunities • Success/failure rate (# offerings launched/total projects started) • Performance relative to competition	(Menor and Roth, 2007)	Scale development and validation. Postal survey.
Innovation Performance • One of the first to market with innovative new product and services • More effective than competitors at taking existing ideas and making them into something better • Better than competitors at developing products and services to meet customer needs • Perceived by customers to be more innovative than our competitors • At the leading edge of innovation	(Oke, 2007)	Interviews and postal survey. Innovation Performance was evaluated using perceptual, non-financial indicators.
Financial • Sales revenue and profitability **Exploitation** • Project led to future opportunities	(Storey and Easingwood, 1998)	Literature review augmented by postal survey

Financial • Return on assets	(Subramanian and Nilakanta, 1996)	Postal survey
Market share • Share of new business **Financial** • Objective financial assessments (e.g. IRR, ROI, ROA, cash flow payback, benefit-to-cost ratio etc)	(Subramanian, 1996)	Postal survey

18.20 APPENDIX 20: PROPOSED MEASURES FOR FINANCIAL SERVICES

Measurement theme	Measure	Supporting evidence	Significance	Feasibility
Financial performance	Profitability, sales, savings, percentage of income generated by innovation	Financial measurement well established in the literature, less history for 'benefit' type measures	Moderate. Externally focused, misses organisational, managerial and process innovations	Income-related measures may be easier to access (and attribute to innovation) than savings-related measures
Business performance	Number and value of new customers reached by the innovation and, new market niches entered	Supported in the literature and by survey responses	Moderate. Externally focused, misses organisational, managerial and process innovations	It is not clear how routinely such data are gathered in the financial services industry
Reputational enhancement	Customer and peer perceptions of us as an innovative organisation	Support from the literature and some support from survey responses	High. Reputational enhancements likely to reflect wider perceptions relating to firm innovativeness	Straightforward on a company basis. But more difficult to generate an industry-level picture
Innovativeness	Number of NP launches and pipeline content	Not strongly evident in the literature, but widely cited by our respondents	Moderate. May miss organisational, managerial and process innovations	It is not clear whether or not pipeline data are gathered in the financial services industry
Timeliness	Proportion of innovations that were first to market/early followers	None found. Recommended on basis of nature of innovation and competition in the sector	High	Literature-based research should offer a way into this data
Process improvement	What new skills have been acquired by (and retained within) the firm as a result of the innovation	Support from the literature and some support from survey responses	Moderate to high. Significant area for innovation activity in the sector	It is not clear how routinely such data are gathered in the industry

18.21 APPENDIX 21: HIGH TECH MANUFACTURING – SURVEY AND INTERVIEW RESPONSES

Measures of innovation output performance
Business performance • Sales performance following launch • What competitive advantage has it delivered? • What value does it add to our business? **Financial performance** • Profitability against sector average • R&D tax relief claimed • Level of grants awarded **Innovation process performance** • Post project evaluation • Project management for the development stage **Counting** • Patents issued **Organisational impact** • Are we energised by the innovation?

18.22 APPENDIX 22: HIGH TECH MANUFACTURING – LITERATURE REVIEW

Measure(s)	Reference	Notes
Counts • Patents	(Acs, Anselin et al, 2002)	4476 Manufacturing innovations identified from a database consisting of 8074 innovations introduced into the United States in 1982.
Market • The overall commercial average success rate of new products launched **Counts** • Number of new product ideas partially developed and the number of new products launched per year.	(Balbontin, Yazdani et al, 2000)	Survey of UK & US firms representing high technology business from key industrial sectors. NPD performance was investigated in the participating firms, based on the perception of top management with relation to their main competitors.
Direct measures • R&D • Patent counts **Indirect measures** • Innovation counts • Firm-level surveys	(Becheikh, Landry et al, 2006).	Systematic review of important factors in manufacturing innovation
Realization of product innovations • 1: realization of product innovations (1990–1992), 0: otherwise	(Becker and Dietz, 2004)	Dichotomous measure. Data from the *first wave of the Mannheim Innovation Panel* (MIP-93) conducted in the German manufacturing industry are used. A total of 2048 firms were included in the questionnaire.
Counts • Patent and utility patent data	(Beneito, 2006)	The data set from the Survey of Entrepreneurial Strategies from the ‘Public Enterprise Foundation’ (Fundaci´on Empresa P´ublica) and the Spanish Ministry of Industry & Energy from 1990 to 1994.
Sales • Sales from new products over the last 3 years	(Coyne, 2001)	Case study of 3M

Cost • Total project cost against budget (4 users) • Profitability analysis-performance against objectives (2 users) • Product cost (1 user) • Actual to predicted profit on products (1 user) • Product development cost as percentage of turnover (1 user) • Margin analysis (1 user) **General** • Percentage sales from new products vs total sales (1 user) • Number of new products released per annum (3 users) • Number of successful development projects vs total number of projects (2 users) • Money generated by new products over first two years vs total sales value (1 user) • Number of products taken up (from portfolio) vs total number available (1 user)	(Driva, Pawar et al, 2001)	Case studies of 10 companies. Assessed popularity amongst managers of measures under four headings: Time, quality and customer, cost and, general. Of which only the latter two relate to performance.
New product success • Product profitability • NP programme profitability over 5 years **Innovativeness** • Numbers of new products or services introduced over last 5 years • Minor changes in product and service lines	(Droge, Calantone et al, 2008)	Postal questionnaire to 346 manufacturers drawn from the Fortune 500
Project outcomes • Profitability level • Sales • Opportunity window	(Dwyer and Mellor, 1991)	95 new product projects in Australia

Sales • Sales from new products over the last 3 years	(Figueroa and Conceiçâo, 2000)	Case study of 3M
Innovation performance • Productivity/process improvement • Product innovation • Quality (product/process/service) • Lead time (customer response/time to market)	(Gloet and Terziovski, 2004)	Questionnaire survey of Australian and New Zealand manufacturers
New product success • Overall success • Success/failure • Market shares (2 items) • ROI • Met objectives • Window of opportunity (2 items) **Innovativeness (market and technological newness)** • Highly innovative products • Moderately innovative products • Low innovativeness products	(Kleinschmidt and Cooper, 1991)	Managers interviewed according to pre-tested questionnaire: innovativeness ; determinants of success; 9 measures of new product success.
Business factors • Financial potential (sales, profits) • 3M Competitive position (marketing channels, product value)	(Krogh, Prager et al, 1988)	Case study of 3M
Financial • Profits • Sales **Market growth** • Entering existing markets • Entering new markets	(Millson and Wilemon, 2006)	58 North American electrical manufacturing firms, postal survey 54.7% response rate - Degree of NPD success

Economic and Innovative outputs (outcomes) • Introduction of technologically improved or new to the firm products and/or services onto the market • Technologically improved or new to the firm production processes brought into use • Sales of products that were new • Impact of innovation(s) on firm's position relative to market leader	(Oerlemans, Buys and Pretorius, 2001)	South African Innovation Survey for Manufacturing and Services 2001 Product or process innovations, Several levels of novelty, Percentage of sales, Effects of innovation
Innovation performance • Series of items interrogating performance relative to the competition, e.g. 'perceived to be at the leading edge of innovation' **Business performance** • Sales turnover • Net profit before tax	(Oke, Burke and Myers, 2007)	
Objective financial assessments • IRR, ROI, ROA, cash flow payback, benefit-to-cost ratio etc: 'Did the new product/service substantially lower costs for the firm?	(Patterson, 1983)	
Sales performance • Average percentage of sales derived from products newly introduced in the last 3 years • The percentage of sales accounted for by new products (indicator of innovation success)	(Roper, 2000)	A regional level perspective, but some firm level measures

Product advantage • More Innovative • Higher quality • Meets customers' needs better **Relative product performance** • Product profitability • Relative sales performance • Relative market share performance, • Window of opportunity	(Song and Parry, 1996)	404 Japanese non service coys, 312 US high technology companies
New product performance • Relative (to competition) NPD quality is higher • Relative (to competition) NPD cycle time is shorter • NPD objectives met • NPD programme was successful	(Song, Montoya-Weiss et al, 1997)	598 usable questionnaires from Mexican High Technology Industry
Value (Financial performance) • **M**arket-to-book ratio of the firm, i.e. (stock market value/book value of its assets) **Innovation output** • Radical innovation: 3 perceptual measures (e.g. our firm rarely introduces products that are radically different from existing products in the industry) plus a fourth based on percentage of sales based on radical innovations captures the radical innovation of the firm.	(Tellis, Prabhu et al, 2007)	759 manufacturing firms from 17 countries. An output measure based on type of innovation (in this case radical) contrasted against intermediate outputs (patents) or inputs (R&D) re impact on financial performance.

Number of innovative ideas adopted • New product ideas • New product concepts • Product upgrades and improvements • Number of patents and disclosures **Meeting established organizational objectives** • Agreed-on results & deliverables • Proven feasibility • Successful tests & validations • Favourable market reaction • Satisfied customer or client • Significant activity focus • Met expectations **Overall judgement of innovative performance** • Met objectives, including time and budget • Unified team effort toward established goals • Useful innovative results • Adapted to changing conditions • Results applicable in other areas	(Thamain, 1990)	Two-year field study of 360 new product managers in 52 high technology companies, postal survey.

Innovation index matrix • Innovation and pipeline yield • "IT Hero" products ("IT Hero" products are particularly successful, having been rapidly adopted by more than 5,000 users) • IT innovations crossing the 'chasm' • Innovation campaigns • Ideas submitted • Ideas accepted for implementation (yield) • Invention disclosure forms (IDFs) • IDFs approved for patent filing, publishing, or trade secret • Innovation-related rewards and recognitions • Innovation-related business value • R&D proof-points	(Westerman and Curley, 2008)	Intel's IT units systematically gather many process and output measures. The Innovation Index includes several weighted components including net value delivered as well as the number of invention disclosures, research proof-points, ideas gathered, and innovation campaigns conducted. These leading and lagging indicators All components of the Innovation Index metric are clearly defined and approved by relevant Intel departments. One complex component—innovation-related business value—is calculated with the help of the finance staff.

18.23 APPENDIX 23: PROPOSED MEASURES FOR HIGH-TEC MANUFACTURING

Measurement theme	Measure	Supporting evidence	Significance	Feasibility	Precision
Product advantage	Extent to which the product/service is superior to competing products in terms of meeting customers' needs	Supported in the literature and by survey responses	Moderate, but a well established measure of product innovativeness	Feasible. Tends to be measured with a large number of indicators	
Strategic importance of innovation	Extent to which strategic objectives have been met by the innovation	Supported in the literature and by survey responses	High. Captures a range of innovations	It is not clear how routinely such data are gathered in the industry	
Innovativeness	Number of patents, new product ideas, new product launches	Supported in the literature and by survey responses	Moderate. Oriented toward product innovations	Feasible. But limitations of 'counts' should be noted	
Financial performance	Proportion of sales and profits from new products less than *n* years old	Supported in the literature and by survey responses	Moderate. Captures product sales	A fairly common metric in the sector, often available from secondary sources (other surveys)	
Business performance	Number and value of new customers reached by the innovation and, new market niches entered	Supported in the literature and by survey responses	Moderate. Externally focused, misses organisational, managerial and process innovations.	It is not clear how routinely such data are gathered in the industry	

18.24 APPENDIX 24: ICT – SURVEY AND INTERVIEW RESPONSES

Measures of innovation output performance
Business growth • Potential • Venture Investment (Angels and VC's) • Number of new start-ups • Creation and maturing of go to market offers **Strategic considerations** • Competitive positioning/competitive advantage • Relevance to our overall mission • Risk • Effectiveness index (outcomes) of the services we provide **Innovativeness** • Number of patents • Development of new services/products • Collaborative projects pursued and publications **Financial** • Internal spend on "new" technologies • Internal spend on "new" products **Customer evaluations** • Customer feedback **Resource exploitation** • All licensed patent usage in new product development (not just company patent creation) **Process innovation** • Commercial innovation which enables client value to be delivered within the constraints of client budget

18.25 APPENDIX 25: ICT – LITERATURE REVIEW

Measure(s)	Reference	Notes
Financial • Profitability • Sales Growth **Technological innovation** • Degree of change of products and services changes • Introduction of new products and services before competition	(Aaboen, Lindelof et al, 2006)	Survey of 183 small high-tech firms, new, technology-based firms (small high-tech firms) in Sweden
Project performance • Did the new product/service achieve important cost efficiencies for the firm • Goal attainment (market share, revenue, revenue growth, volume, customer numbers etc) • Did the new product/service substantially lower costs for the firm **Market performance** • Project lead to future opportunities • Did the new product/service enhance the sales and customer use of the firm's other products and services	(Atuahene-Gima, 1995)	Survey of 275 Australian firms. Sample comprised 13% chemical, pharmaceutcal and biotechnology; 11% food and beverage; 13% electrical, electronic, scientific equipment firms; 12% metal and industrial equipment; 6% computer software firms; 3% communication and information technology; 16% banking and trusts; 8% insurance and superannuation and the rest from industries such as transport equipment, wood products, engineering , architectural and construction services.
Success • Respondents selected successful and unsuccessful innovations	(Balbontin, Yazdani, Cooper and Souder, 1999)	Analysis is based on an in-depth survey of 49 British firms (58 successful and 41 unsuccessful projects) and 38 American companies (59 successful and 50 unsuccessful projects)

Firm success • Profitability • Profitability growth • Sales growth **Development outputs** • Proportion of products first to market • Proportion of significant changes in product introduction • Technical product performance = product performance as reported by senior managers (self-reported) • Strategic performance position = percentage of sales created by technically superior products (self-reported) • Proportion of sales from products introduced in the last 12 months • New products normalised by life cycle • New major products compared to industry • Unit cost reduction compared to industry	(Loch, Stein and Terwiesch, 1996)	95 electronics companies in the USA, Japan and Europe
R&D effectiveness index • % of revenues from new products * (net profit % + R&D%) / R&D%	(McGrath and Romeri, 1994)	45 electronic systems companies : communication systems 35.6%; Industrial/medical electronics 22.2%; Consumer electronics 15.6%; Computers 13.3%; Peripherals 13.3%

NPD Performance • Technical product performance - TPP relative to competition as perceived by senior management • Market leadership - % of significant product innovations that were first to market in the reported period • R&D intensity - development personnel for the product group in question divided by product group revenues in the last year reported • Product line freshness - proportion of sales from products introduced in the previous 3 years, as of the last year reported • Innovation rate - number of significant product line changes over the last 3 years reported, multiplied by product life cycle in years, and normalised as the relative deviation from the industry mean **Firm success** • Profitability (return on sales)	(Terwiesch, Loch and Niederkofler, 1998)	
Installation success • Software still operating fully and successfully after 1 year **Commercial success** • Sold after the initial installation of software for a period of greater than 1 year **Composite measure of success** • Based on diffusion coefficient equation	(Voss, 1985)	16 versions of shipping documentation software (i.e. 16 innovations)

18.26 APPENDIX 26: PROPOSED MEASURES FOR ICT

Measurement theme	Measure	Supporting evidence	Significance	Feasibility
Financial performance	Sales, profitability and savings arising from innovations in last *n* years	Widespread across many sectors in literature and practice.	Moderate-high. By extending measure to incorporate efficiencies it can capture value of process innovations	Generally high, but reliant on common understanding of ‘innovation’.
Business performance	Number and value of new customers reached by the innovation, and new market niches entered		High. Captures performance of a range of innovation types	
Innovativeness	Number of new (degrees of newness apply) products, goods or services in last *n* years	Strong support in literature. Important, though to move away from dichotomous measures of innovativeness	High. Product-focused measure but inclusion of ‘ideas’ may capture other innovation types	Feasible. Graduated measure of innovativeness may be more difficult to administer, also unknown just how generally available is the data
Knowledge conversion	Number of new business start-ups/commercial opportunities/collaborations etc arising from technological and knowledge development	Supported in the literature and by our survey findings	Potentially high	Connection between the exploitation and the innovation may not always be clear.
Knowledge utilisation	Proportion of new knowledge assets (<3years old) incorporated into new products	Proposed new measure	Captures a fundamental aspect of ICT innovation, but is product and technology oriented.	We have no knowledge whether or not such data is currently collected

18.27 APPENDIX 27: PHARMACEUTICALS – LITERATURE REVIEW

Measure(s)	Reference	Notes
Efficacy • Product replacement, extensions and development **Efficiency** • Time, cost and satisfaction	(Alegre, Lapiedra and Chiva, 2006)	Instrumented tested in biotechnology. Items assessed relative to knowledge of competitors performance along the dimensions. Relies on wide knowledge of others' performance
Product Innovativeness • Rate how innovative the product was—its degree of innovativeness—relative to products then in your market area. **Product Advantage** • To what extent was the product superior to competing products in terms of meeting customers' needs? • To what extent was the product quality—however quality is defined by the user—superior to competitive products? • To what extent were the benefits offered highly visible ones to the customer . . . they were very apparent to users? **Customer Familiarity** • To what extent did this product require little or no change in customer behaviour, the way he used the product, or did things? • To what extent did this product require little or no learning on the part of the customer? • To what extent did this product require little or no change to the customer's own product or process? **New Product Profitability** • To what extent would you rate the product a financial success	(Calantone, Chan and Cui, 2006)	Survey of product line managers (USA), 451 usable responses.

Performance benchmarking • Top performer • Middle performer • Bottom performer	(Cooper, 1994)	
• Success rate • Profitability rating • Technical success rating • Domestic market share • Impact on company • On-time project	(Cooper and Kleinschmidt, 1995a)	Chemical industry studies (UK/USA) 21 companies, 68 successful and 35 failed NPD projects
• Percent of sales due to products introduced in the last X years	(Cooper and Kleinschmidt, 1995a)	Data were collected on 103 actual new product projects in the chemical industry in four countries. A total of 21 major multinational firms and divisions-such as Dow Chemical, DuPont, Exxon Chemicals, Rohm & Haas, ICI, Shell Chemicals-UK, Sachtleben Chemie-Germany
• Annual sales revenue from the product • Rated profitability = extent to which profits exceed/fall short of minimum acceptable level • Relative market share = share ratio relative to next largest competitor	(Cooper and Kleinschmidt, 1993)	103 projects in 21 firms in chemical industry in USA and Europe
Patent counting • Patent applications	(Deeds, 2001)	
New product development • Total products = products on the market plus the number of products that a firm has in regulatory trials (field trials, pre-clinical, and clinical trials) **R&D Intensity** • Total R&D expenditure reported by the firm in the prior year, divided by the total expenditures of the firm	(Deeds, DeCarolis and Coombs, 2000)	

Outputs • Ideas, discoveries, new products **Outcomes** • Broad advance of human knowledge, improvements in health status and length of life, reduction in health-care expenditures, economic output, productivity improvements	(Jaffe, 1999)	
Innovation index ™ • Number of patents per employee/R&D as % of sales	(Jones and Austin, 2002)	
Patent counting • US Biotechnology patents	(Nesta and Saviotti, 2005)	
Sales/Financial • Percentage of current sales due to radically innovative products introduced in the past 3 years • Percentage of current sales due to incrementally innovative products introduced in the past 3 years	(Souitaris, 2002)	105 Greek manufacturing firms: Food & beverages 27.62%; Tobacco and products 1.9%; Textiles 8.57%; Wearing apparel and fur 5.71%; Footwear-leather goods 0.95%; Wood-cork products 0.95%; Pulp, paper and products 1.9%; Publishing, printing 2.86%; Coke, refined petroleum products 1.9%; Chemicals 6.67%; Pharmaceuticals 3.81%; Rubber-plastics 3.81%; Non metallic mineral products 4.76%; Basic metals 1.9%; Fabricated metal products 9.52%; Machinery 7.62%; Electrical appliances 1.9%; Electronic equipment 2.86%; Transportation means 0.95%; Furniture 1.9%; Miscellaneous 1.9%

18.28 APPENDIX 28: PROPOSED MEASURES FOR THE PHARMACEUTICAL INDUSTRY

Measurement theme	Measure	Supporting evidence	Significance	Feasibility
Financial performance	Percentage of current sales due to radically and incrementally innovative products introduced in the past *n* years	High. Widely used throughout the literature	Moderate-high. Overlooks variety of different types of innovation	Tracked in some national and regional innovation surveys
Innovation index™[15]	Number of patents per employee/R&D as % of sales	Applied in several sectors	Moderate. Captures output only related to patents	Data readily available
Innovativeness	Degree of change represented by the innovation (major technological advance over existing technologies, or outputs which made prevailing technologies obsolete)	Well-established approach with several frameworks available from which to choose or develop. Long tradition of measurement of innovativeness. Important, though to move away from dichotomous measures to degrees	High. Capable of capturing variety of types of innovation	Feasible. Graduated measure more complex to administer, but avoids danger of categorising firms as either innovative or not innovative
Market performance	Relative market share growth from the innovation (relative to important competitors)	Supported by the literature	Moderate. Product focus	Possibly accessible via literature-based review or other secondary data
Product advantage	Extent to which the product/service is superior to competing products in terms of meeting customers' needs	Supported by the literature	Moderate. Product focus	Perceptual measure. Otherwise, possibly accessible via literature-based review

[15] Jones and Austin (2002)

18.29 APPENDIX 29: PUBLIC SECTOR – SURVEY AND INTERVIEW RESPONSES

Measures of innovation output performance
Innovativeness • Number of successful changes in processes/products/services created • Annual number of teams and hours set aside for innovation/knowledge creation • Use of ideas schemes • Number of publications **Technology exploitation** • Number of multidisciplinary teams with evidenced outcome • Annual number of feasibility tests of new ideas • Number of non-person interactions between provider and citizen (on-line interactivity) **Financial performance** • Amount of funding attracted for research • Financial contribution from commercialisation of R&D • On budget and time **Public impact** • How has your innovation benefited the public • Testing successfully completed-ready for commercialisation • Customer satisfaction • Increased partnership working • How has the innovation influenced change **Organisational factors** • What is the potential for your innovation to be adopted or adapted elsewhere in the organisation

18.30 APPENDIX 30: PUBLIC SECTOR – LITERATURE REVIEW

Measure(s)	Reference	Notes
Awards received	(Hartley and Downe, 2007)	The analysis is used inductively to construct criteria by which the attractiveness of award schemes and their effectiveness in service improvement can be conceptualized.
Innovations in governance	(Moore and Hartley, 2008)	"One is forced, we think, to evaluate the innovations not only in terms of efficiency and cost effectiveness, but also in terms of what might be considered right relationships in the society – some notion of justice and fairness"
Innovation types New product Technological (ITC) Technological (market orientation) Organizational Ancillary (partnership)	(Walker, 2004)	Study of determinants of adoption, but no performance indicators
Innovation count 257 innovations identified	(Walker, Jeanes et al, 2002)	257 innovations identified

18.31 APPENDIX 31: PROPOSED MEASURES FOR THE PUBLIC SECTOR

Measurement theme	Measure	Supporting evidence	Significance	Feasibility
Innovativeness	Number of ideas generated and innovations introduced	Support in the literature	Moderate	It is not clear the extent to which any of these data are routinely collected in the public services. It is likely that further development and validation of measures may be necessary.
Technology application	Number of non-person interactions between service provider and citizen (online interactivity) as proportion of all contacts	Proposed new measure based on interpretation of empirical data and sectoral context		
Reinforcement of innovation orientation	Employees are more incentivised and managers more tolerant of risk/failure as a result of the innovation	Proposed new measure based on interpretation of empirical data and sectoral context		
Public impacts	Customer/user perceptions of us as an innovative organisation	Proposed new measure based on interpretation of empirical data and sectoral context	High	
Outreach	New and hard to reach customer/user/stakeholder groups reached by innovation	Proposed new measure based on interpretation of empirical data and sectoral context	Moderate	

18.32 APPENDIX 32: RETAIL AND WHOLESALE DISTRIBUTION – SURVEY AND INTERVIEW RESPONSES

Measures of innovation output performance
Customer related • Response rate to CRM as communication tool to clients • Level of uptake of health monitoring systems • Response rate to electronic/physical communications **Technological exploitation** • Installation of new technology for diagnostic purposes MRI/Digital x-ray etc • Level of IT related systems for appointment/ treatments **Impact on other products and services** • Frequency of referrals for second opinion

18.33 APPENDIX 33: RETAIL AND WHOLESALE DISTRIBUTION – LITERATURE REVIEW

Innovation measure	Reference	Notes
• Introduction of new goods in the last *n* years • Introduction of new methods of production • Opening new markets • Utilization of new sources of supply • Introducing new organizational forms	(Bhaskaran, 2006)	Australian seafood retailers 87/337 responses to a postal survey – 28.5% response rate

18.34 APPENDIX 34: PROPOSED MEASURES FOR RETAIL AND WHOLESALE DISTRIBUTION

Measurement theme	Measure	Supporting evidence	Significance	Feasibility
Innovativeness	Number of new (degrees of newness apply) products, goods or services in last *n* years	Well-supported in the literature	High	Generally available at a firm level. Graduated measure of newness more complex to administer, but avoids danger of categorising firms as either innovative or not innovative.
Strategic importance of innovation	Extent to which strategic objectives have been met by the innovation			
Technological application	What proportion of the service offer comprises new products, materials, technologies etc?	Proposed new measure based on interpretation of empirical data and sectoral context	Moderate	It is not clear the extent to which any of these data are routinely collected in retail and wholesale distribution. It is likely that further development and validation of measures may be necessary.
Reinforcement of innovation orientation	Employees are more incentivised and managers more tolerant of risk/failure as a result of the innovation	Proposed new measure based on interpretation of empirical data and sectoral context		

18.35 APPENDIX 35: TELECOMS – SURVEY AND INTERVIEW RESPONSES

Measures of innovation output performance
Service variety • Range of tariffs and pricing available **Technological exploitation** • Deployment of technology in private and commercial premises

18.36 APPENDIX 36: TELECOMS – LITERATURE REVIEW

Measure(s)	Reference	Notes
Importance of new products • Percentage of sales spend on R&D • Percentage of sales and profits accounted for by products which were introduced in the last five years **Goal performance** • On average, do new products tend to fall below, meet, or exceed sales, profit, and market share goals • How satisfied are you with your overall NPD efforts	(Barczak, 1994)	Postal survey of firms in the telecommunications industry who had over $25 million in sales. 140 usable questionnaires were returned for a response rate of 38%
Performance index • Percent of sales spent on R&D • Percent of profits and sales accounted for by products introduced within the last 5 years • Have new products fallen below, met or exceeded sales, profit and market share goals • Indicate overall satisfaction with the firm's new product development efforts	(Barczak, 1995)	An aggregate measure - 140 returns, 38% response rate

Project effect: technology factor • Technological difficulty • Technological distinctiveness • Degree of R&D learning **Project effect: Economy/market factor** • Satisfaction of marketing department's need • Cost advantage • Ability to sustain competitive advantage at current market • Ability to build competitive advantage at new market **Project effect: Production factor** • Technology transfer to production department • Manufacturability **Project effect: Strategy factor** • Enhancement of corporate image • Fit with corporate strategy • Enhancement of unit's technology competence **Project effect: External evaluation factor** • Success/failure to buyer's performance test	(Cho and Lee, 2005)	The project effect dimension measures the contribution of the project to the laboratory beyond the specified goal. Five factors were considered: technology, production, economy/market, strategy, and external evaluation. Fifty two senior researchers at a Korean telecommunications laboratory were surveyed.
Financial • Strength of impact the total new product effort has on the business unit's sales revenue or turnover **Technical success rating** • **H**ow successful the total effort is from a technological/technical perspective • All things considered, how successful the business unit's total new product efforts are when compared to competitors • Proportion of development projects that become commercial successes	(Cooper, 1998)	Chemicals/materials 12.6%; communications products 11.9%; Machinery/equipment 33.3%; electronic/electric products 1.5%; food 9.6%; automotive parts/components 3.0%; misc 8.1%

18.37 APPENDIX 37: PROPOSED MEASURES FOR TELECOMS SECTOR

Measurement theme	Measure	Supporting evidence	Significance	Feasibility
Innovativeness	Number of products and/or services introduced in the last *n* years	Well-established in the literature	Moderate	Tracked in some national and regional innovation surveys
Financial performance	Percentage of sales and profits accounted for by products/services which were introduced in the last *n* years		High, if able to capture value from diversity of innovation types	
Technological application	What proportion of the service offer comprises new products, materials, technologies etc?	Metric proposed on basis of innovation drivers in the industry and of respondent feedback. No supporting evidence found in the literature.	Moderate. But key area of innovation activity for the telecoms industries	It is not clear how routinely such data are gathered in the telecoms industry
Business model innovation	Number and scale of significant business model developments/conceptual initiatives in last *n* years		Moderate to high. Sector currently strongly driven by need to identify new business models	Firm contact required – likely requiring interview
Reputational enhancement	Customer and peer perceptions of us as an innovative organisation		High. Customer and peer perceptions will reflect on each of the above factors.	Straightforward on a company basis. But more difficult to generate an industry-level picture.

18.38 APPENDIX 38: TRANSPORT – SURVEY AND INTERVIEW RESPONSES

Measures of innovation output performance
Organisational and process change • The way things are done in the company • The way things are done in the directorate

18.39 APPENDIX 39: TRANSPORT – LITERATURE REVIEW

Measure(s)	Reference	Notes
Market performance • Did the new product/service enhance the sales and customer use of the firm's other products and services • The project lead to future opportunities **Project performance** • Did the new product/service achieve important cost efficiencies for the firm • Goal attainment (market share, revenue, revenue growth, volume, customer numbers etc) • Did the new product/service substantially lower costs for the firm	(Atuahene-Gima, 1995)	Cross sectional survey of 275 Australian firms. The sample comprised 13% chemical, pharmaceutical and biotechnology; 11% food and beverage; 13% electrical, electronic, scientific equipment firms; 12% metal and industrial equipment; 6% computer software firms; 3% communication and information technology; 16% banking and trusts; 8% insurance and superannuation and the rest from industries such as transport equipment, wood products, engineering , architectural and construction services.
Commercial success • The overall commercial average success rate of new products launched **Innovativeness** • Number of new product ideas partially developed • Number of new products launched per year in both countries.	(Balbontin, Yazdani et al, 2000)	NPD performance. 63 firms from the UK and 37 from the USA. These companies represent high technology business from key industrial sectors: computers (13 UK, 13 US), electronics (16 UK, 12 US), chemicals, pharmaceuticals, food and fibers (14 UK, 9 US) and transportation, aerospace, materials, industrial products (20 UK, 3 US). NPD performance was investigated based on the perception of top management with relation to their main competitors.

Financial • Profitability **Market factors** • Relative market share = share ratio relative to next largest competitor • Sales growth rate	(Kotabe and Murray, 1990)	71 responses from Japanese/European subsidiaries of US firms. Sample: Metal products 11.6%; Electronics 11.6%; Transportation equipment 7%; Motor vehicles and parts 2.3%; Aerospace 2.3%; Scientific and photo equipment 7%; Computers and office equipment 11.6%; Industrial and farm equipment 27.9%; Not specified 18.6%
Market level measures • Unit volume goals • Met revenue goals • Met sales growth goals • Met market share goals **Financial measures** • ROI or IRR • Met profitability goals • Met contribution margin goals • Development costs **Customer acceptance measures** • Customer acceptance • Customer satisfaction Number of customers • Customer competitive advantage **Product level measures** • Launch on time • Time-to-market • Break even time **Timing measures** • Launch on time • Time-to-market • Break even time	(Langerak, Hultink and Robben, 2004)	New Product Performance. Sample: Primary metal, fabricated metal, machinery equipment, transportation equipment and measuring instruments industries. 211 Dutch firms with independent R&D, production and marketing/sales departments in the appropriate sectors

Impacts from new or significantly improved products (goods or services) • Increase business unit's profitability • Increased the ability to adapt flexibly to different client demands • Allowed business unit to keep up with competitors • Improved the quality of products (goods and services) • Increased the speed of supplying and/or delivering services or goods • Increase business unit's productivity	(Lonmo, 2005)	Seven selected transportation industries were sampled, with 538 sampled establishments representing a total of 3,311 establishments. – in air, rail, water, truck, interurban and rural bus, airport and port and harbour transport operations. Canadian postal survey.
Sales/Financial • Percentage of current sales due to radically innovative products introduced in the past 3 years • Percentage of current sales due to incrementally innovative products introduced in the past 3 years	(Souitaris, 2002)	105 Greek manufacturing firms: Food & beverages 27.62%; Tobacco and products 1.9%; Textiles 8.57%; Wearing apparel and fur 5.71%; Footwear-leather goods 0.95%; Wood-cork products 0.95%; Pulp, paper and products 1.9%; Publishing, printing 2.86%; Coke, refined petroleum products 1.9%; Chemicals 6.67%; Pharmaceuticals 3.81%; Rubber-plastics 3.81%; Non metallic mineral products 4.76%; Basic metals 1.9%; Fabricated metal products 9.52%; Machinery 7.62%; Electrical appliances 1.9%; Electronic equipment 2.86%; Transportation means 0.95%; Furniture 1.9%; Miscellaneous 1.9%

18.40 APPENDIX 40: PROPOSED MEASURES FOR TRANSPORTATION INDUSTRIES

Measurement theme	Measure	Supporting evidence	Significance	Feasibility
Market performance	Relative market share growth from the innovation (relative to important competitors)	Metric proposed on basis of innovation drivers in the industry and of respondent feedback. Some support in the literature	Moderate to high. Could capture process, service and product innovation	Likely to require access to managers to elicit their perceptions
Financial performance	Percentage of sales, profits and savings due to innovative (radical and incremental) products/services introduced in last *n* years	Well-established in the literature	High, if able to capture value from diversity of innovation types	Tracked in some national and regional innovation surveys
Innovativeness	Number of new (degrees of newness apply) products, goods or services in last *n* years		Moderate	
Process improvement (i)	The innovation has allowed the firm to improve the quality of its products/services	No evidence of its use in transport, but widely applied measure in other areas of industrial activity.	Moderate to high	It is not clear how routinely such data are gathered in the transport industry
Process improvement (ii)	What new skills have been acquired by (and retained within) the firm as a result of the innovation	No evidence of its use in transport, but widely applied measure in other areas of industrial activity.		

Note: Because of the paucity of sector specific work, we find it difficult to draw strong conclusions with any sense of confidence and recommend further work to develop appropriate metrics for this sector.

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