

# ENHANCING RADICAL INNOVATION USING SUSTAINABILITY AS A STRATEGIC CHOICE

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## **Abstract**

Radical Sustainability Orientated Innovations (SOI) are realised novel ideas that create significant improvement of the environmental and/or social performance of a system while simultaneously considering its economic sustainability. While appealing in principle, empirical research suggests that this is easier said than done. Two streams of literature have developed so far. The first one has shown that companies engaging in SOI often encounter considerable challenges in reconciling multiple objectives because of increased complexity and ambiguity in the innovation process. The second stream has sought to identify the specific factors which make SOIs successful. Our paper adds to this literature by challenging previous findings from the first stream of literature, and enhancing the second stream of literature by presenting an in-depth process perspective: in our case study of a new product innovation process within a multinational life sciences company, we show that the strategic decision to embed sustainability in new product innovation processes has enhanced radical innovation by enabling various success factors despite increased complexity. Through an empirically grounded understanding of the new product innovation process, we identify five concurrent and loosely coupled critical process factors; sustainability orientated technology super-scouting, searching for a radical sustainability solution, ensuring sustainability performance in product development, captaining the emerging sustainability value chain, and harnessing the benefits of sustainability strategy through open innovation. By doing so, we add to the literature by showing that the broader strategic context in the firm enhances successful SOI by means of adapting a set of processes facilitating this purpose.

**Keywords:** Sustainability orientated innovation, enabler, product innovation process, life sciences, radical innovation, open innovation

*“But we feel the world needs something else than oil based, fossil-based resources and we also feel we should limit our impact on the environment in terms of greenhouse gas emissions” (Interviewee M)*

## **1. Introduction**

Corporate sustainability has experienced a continuous rise on the business agenda as companies have sought to address the environmental and social problems to which they are intrinsically entangled. SOI is viewed as both the solution to improving sustainability performance (Hart & Milstein, 2003; Porter & van der Linde, 1995) and a potential source of competitive advantage (Hall & Wagner, 2012; Hart, 1995). SOI sees companies reducing and using resource inputs more efficiently, creating better products and forming new business models; all of which are aligned to traditional business principles (Nidumolu *et al*, 2009). The embracement of SOI is such that commonplace debates of whether or not it pays to being ‘green’ (Wu & Pagell, 2011), are being replaced with new discussions of how to most effectively conduct SOI as companies seek to maximise the value of meeting sustainability demands and at the same time retain commercial viability.

Contemporary management literature has reflected this rise in attention (*see* Arnold & Hockerts, 2011; Bansal & Hoffman, 2011; Boons & Lüdeke-Freund, 2013; NBS, 2012) as academics seek to understand and theorise upon SOI. The majority of studies to date have focussed upon specific success factors for SOI (Dangelico *et al*, 2013; Driessen *et al.*, 2013; Olson, 2013). These studies usually draw upon the general success factors for innovation, and seek to select the ones that promote sustainable innovation in particular. In some case, the definition of the success factors themselves have been modified, such as ‘extended’ market orientation and the acquisition of external knowledge from a broader set of actors than usual (Driessen *et al*, 2013). However, while useful for practitioners and academics, so far these studies have not led to a convincing set of factors explaining successful SOI.

This study takes another approach, and takes the strategic context in which innovation activities are embedded into account. By drawing on insights from a successful radical SOI project in a multinational life sciences company, we show that the broader strategic context in the firm enhances successful SOI by means of adapting a set of organisational processes, which in turn affect direction of the innovation project. Through an empirically grounded understanding of the radical SOI process of the product under study we identify five processual mechanisms including; sustainability orientated technology super-scouting,

searching for a radical sustainability solution, ensuring sustainability performance in product development, capturing the emerging sustainability value chain, and harnessing the benefits of sustainability strategy through open innovation. These mechanisms all emerge from the strategic decision to embed sustainability and significantly enhance the innovation process used by the firm from idea to commercialised innovation in ways that differ from conventional market-driven innovation.

## **2. Literature Review**

### *2.1 Sustainability Orientated Innovation*

There is currently a lack of conceptual consensus on SOI, embodied by the plethora of working definitions (*see Carrillo-Hermosilla et al, 2010*). This has helped to create an obscuring fuzziness to advancing its comprehension (Boons & Lüdeke-Freund, 2013). The first critical issue is that there is no set upon common term which is being defined. Foreshowing the roots of the domain many authors adopt environmental orientated terms such as eco-innovation, environmental innovation, and green innovation. As these terms exclude the social dimension it follows so that they are defined as such. To encompass the social dimension other authors use the term ‘sustainability’, defining terms such as sustainability-related innovation, sustainability driven innovation or simply sustainable innovation. This paper uses the term sustainability orientated innovation (SOI) to encompass the social dimension, to avoid reference to its potential drivers (sustainability may be a gratis side effect – ‘environmentally beneficial normal innovations’ (Kemp & Foxon, 2007)), and avoid confusion surrounding the sustaining of innovation itself.

### *2.2 Mapping SOI*

SOI utilises the traditional categories of conventional market-driven innovation to classify its type; product, process and organisational (Rennings, 2000). Product innovations, the focus of this paper, are significant improvements of environmental and/or social performance to existing goods or services which an organisation offers, or the development of new goods. The second way SOI is commonly characterised is between those changes which are deemed radical and those which are incremental in nature (Greenwood & Hinings, 1996).

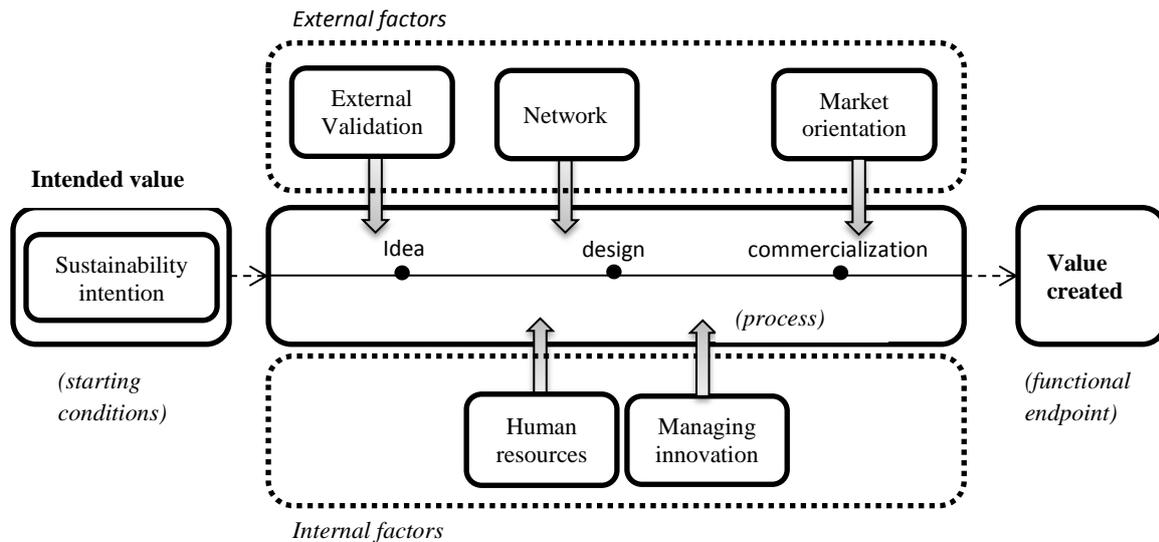
The primary focus of management studies on SOI to date have been on incremental changes, often known as ‘end-of-pipe technologies’, which are competence-enhancing, small adaptations made on a continuous basis (Carrillo-Hermosilla *et al*, 2010). As such changes only seek to minimise and repair negative sustainability affects without necessarily addressing

the root causes they have shown to make little impact on effectively dealing with environmental and social challenges degradation (Hart & Milstein, 2003; Meadows, Randers, & Meadows, 2005; Whiteman, Walker, & Parego, 2012). In contrast the case studied in this paper is of a radical change. These are innovations which are commonly thought as episodic and ‘frame bending’ (Plowman *et al*, 2007), and often replace existing parts or entire systems (Carrillo-Hermosilla *et al*, 2010). For our purposes, we build upon Arnold and Hockerts, (2011) definition of SOI by defining this type of radical SOI as *realised novel ideas that create significant improvement of the environmental and/or social performance of a system while simultaneously considering its economic sustainability*. This definition recognises that while an increase in economic capital is not sufficient criteria for a SOI it should not be neglected. Furthermore, in homage to the situated nature of SOI it does not necessitate an improvement in both the environmental and social dimensions. During the course of this paper the SOI under study is referred to with respect to the above definition.

### *2.3 Understanding the process of radical sustainable innovation*

Conventional market driven innovation literature presents that even without the sustainability aspects, radical innovation is particularly difficult as it usually requires a departure from the present knowledge base and/or market relations (Abernathy & Clark, 1985, Bower & Christensen, 1992) and is more likely to be discontinued than its incremental counterpart due to the greater uncertainty and time required (Green & Welsh, 2003). Management studies have shown however that in conducting radical SOI such challenges will not only hold true (Alakeson & Sherwin, 2004), but a new set of issues to specific to SOI also need to be addressed throughout the innovation process. Studies have demonstrated that innovation teams often face added complexity of integrating potentially opposed sustainability dimensions (Chen, 2001) and ambiguity in understanding sustainability due to either scientific uncertainty (Hall & Vredenburg, 2003) or incomplete information (Wu & Pagell, 2011). Furthermore commercialisation is seen to be fraught with difficulties as companies struggle with issues such as ensuring commercial viability (Dangelico & Pujari, 2010) and battling user path dependency/lock-in mechanisms (Carrillo-Hermosilla *et al*, 2009; Walker, 2000). With little distinction between incremental and radical SOI, the result is that management studies have branded SOI as an expensive process with high uncertainty and risk (Hall & Wagner, 2012), and furthermore commonly producing technologies with inferior performance compared to market incumbents (Geels *et al*, 2008).

While studies have ably identified numerous challenges of SOI, current research has yet to provide a clear picture of the success factors. Drawing upon the general innovation management literature, several researchers have investigated specific success factors for SOI (Berchicci & Bodewes, 2005; Dangelico *et al*, 2013; Driessen *et al*, 2013; Olson, 2013). An example is the study of Keskin *et al* (2013) (see Figure 1), who point at factors such as external validation, human resources and marketing orientation in their study of small entrepreneurial firms.



**Figure 1. Internal and external factors that influence the innovation process (Keskin *et al*, 2013)**

Existing studies usually seek to select success factors from larger sets that promote SOI. In some case, the definition of the success factors themselves have been modified, such as ‘extended’ market orientation and the acquisition of external knowledge from a broader set of actors than usual (Driessen *et al*, 2013). However, so far the findings have been fragmented and it is hard to generate a more general picture on what determines the success of SOI within a multinational company. In addition, many of the studies once again do not explicitly distinguish between success factors for incremental and radical innovation.

This study takes another approach, and explicitly investigates how radical innovation is enhanced by the strategic context in which innovation activities are embedded. The influence of strategic direction on radical innovation has hardly received attention in the innovation management literature so far. While existing literature does recognise the importance of innovation strategy (Wheelwright & Clark, 1992) and resources for innovation (Henard & Szymanski, 2001), and timing as an element of strategy (Miles & Snow, 1978), the influence of formal strategic direction is under researched with respect to radical innovation and SOIs in particular.

This also applies to the mechanisms by which strategic direction affects innovation activities. Prior research has considered portfolio management as a mechanism to translate firm strategy into innovation activities (Cooper *et al*, 2001; Kester *et al*, 2011). Portfolio management should ensure the alignment of the portfolio of projects with technology, market and timing set out by strategy. Studies have also shown that strategy should affect the fraction of radical versus incremental innovation in the firm's portfolio (Cooper *et al*, 2001) and that separation of innovation activities from other firm activities forms another mechanism to implement strategic choices (Bower and Christensen, 1992; Burns and Stalker, 1961). However other mechanisms to convert strategy into radical innovation, and more particularly strategic direction, are lacking.

Our purpose is to fill this void, focusing on a strategy aimed at accelerating the sustainability driven innovation portfolio of the firm. We explore to what extent and through which mechanisms such a strategy affects the outcome of innovation activities. We include both internal and external process factors in this study (Chesbrough, 2003; Henard & Szymanski, 2001). We focus on a specific innovation project, and address the different phases in which the process is executed, including the sequencing of the phases. By providing a rich and detailed narrative of this single case our paper gives greater insight into how explicit targets for sustainability positively impacts the process of radical SOI through processes such as internal and external knowledge exchange, involvement of different internal and external parties (Ancona & Caldwell, 1992; Sivasubramaniam, *et al*, 2012) and management support (Barczak *et al*, 2009; Brown & Eisenhardt, 1995).

### **3. Methods**

#### *3.1 Research Design*

Our study employs a qualitative case study research strategy investigating a single on-going process of SOI within a well-known corporate front-runner of sustainability within the life sciences industry – *CompanyX*. More specifically, the paper studies the process of radical sustainable product innovation of a 'new-to-the-world' product through which the company aims to help create a new sustainable technological paradigm – *BioX*. This 'project level' unit of analysis permits for a high level of focus, detail, and the ability to gain a rich understanding of the complex factors involved in the SOI process. Influences from the 'organisational level' will also to be given due recognition as the project is situated within a particular context. The research is inductively orientated, developing an understanding which is grounded in the empirical data (Charmaz, 2006). This methodological approach provides the best opportunity

to develop a novel understanding of the radical SOI innovation process and the influence of sustainability as a strategic choice upon the critical process factors within.

3.2 Selected Case Company and SOI

*CompanyX* has a long history of transformation and innovation and has been externally validated to offer very strong sustainability credentials winning the Dow Jones Sustainability Index of its respective industry on multiple occasions. The company has transited from sustainability as a responsibility to using it as a business driver (Public document, 2011c) and has very aggressive targets for transforming both its innovation pipe-line and running business (Public document, 2011a). The firm is in a healthy financial situation, operating with global annual revenues in excess of \$10bn. Positioned upstream in the value chain the products of the company are used to form components that reach a wide multitude of end markets and users from which it is traditionally far removed from. As such a more sustainable portfolio of product offerings has the potential for wide reaching impacts and a highly significant positive environmental impact. Table 1 provides summary statistics of the company. At this stage in the research project we have decided to retain the anonymity of the company which shall be given further consideration at a later date.

Company	Country of Origin	Sector	Ownership type	Size		Position in production chain
				Employees	Revenue	
<i>Company X</i>	Netherlands	Life Sciences	PLC	>20,000	>\$10.00bn	Early

Table 1: *Company X* summary statistics

The *BioX* product innovation studied in this paper is a ‘new to the world’ radical product development allowing plastics to be made from bio-renewable sources and with a substantially improved environmental footprint compared to using petrochemicals. *BioX* is a forerunner of a portfolio of bio-based products being development within the company and is located high upstream in the value chain acting as a building-block component for a multitude of diverse applications in approximately 80 value-chains. The development of *BioX* will result in the mass production and availability of a bio-based product, making the conversion away from a petroleum-based paradigm and toward a bio-based paradigm a commercial reality to a diversity of users for the first time. The extent of the environmental impact is such that if the expected market was completely served the annual CO2 reduction would be approximate to 2000kton in 2015 with the firm under study aiming to service approximately a fifth of this.

*BioX* is set within a Joint-Venture formed by *CompanyX* in partnership with a second strong multinational company. Within the context of *CompanyX* this Joint-Venture is situated within a new semi-autonomous innovation unit that reports directly to the *CompanyX* Innovation Centre. The firm has now started to operate its first small scale commercial sized production facility and continues to fully optimise the product for all possible applications. A second large scale commercial production plant is scheduled for 2015. Table 2 provides a summary of the characteristics of the innovation.

Innovation	Initiation Year	Innovation Type	Nature of Change	Environmental Impact Reduction
<i>BioX</i>	2006	Product	Radical – New Technology, New Market	Process

**Table 2: Innovation summary statistics**

*3.3 Research Procedure*

To investigate the case, we utilise the unique strength of the case methodology and collates data from multiple sources; qualitative interviews, documentary evidence and direct observations. This approach offers the opportunity for converging lines of inquiry and the processes of corroboration and triangulation (Yin, 2003). Extensive access was granted to the first author with data collected at several locations within the Netherlands. During this period formal research methods were supplemented by informal discussions, casual observations of workplace operations and four roundtable discussions on SOI (including specific to the case) involving representatives of the company and selected other multinationals. Data was collated from September 2012 until August 2013, ending when a perceived saturation point had been attained (Eisenhardt, 1989) whereby no new insights or new information could be gathered.

Interviews with multiple respondents from various hierarchical levels and functional areas were used as the primary method for this study. All interviews were conducted with the informed consent of the interviewees who were selected on a snowballing basis starting from an interview with the case ‘gatekeeper’. Interviews were semi-structured in design and ranged from 30-120 minutes in length with over 16 hours conducted. In total 19 formal interviews were conducted. 13 interviews were with employees of the case company, 3 with Joint Venture employees, 1 with an ex-case company employee, and 2 interviews performed with two academic institutions involved in the SOI process. Interviews were undertaken in the respective work setting of the interviewee. Such a setting offered a number of benefits

such as it being the easiest place for interviewees to think about and describe working practices, and allowing them easy access to assisting information and resources. Interviews were all conducted on a one-to-one, face-to-face basis helping for a good rapport to be quickly and easily built. 17 of the 19 interviews were audio recorded with the informed consent of the interviewee with extensive notes taken in the case of the exception.

Supplementing interview data the paper made use of direct observations. Observations were made during interviews conducted at the interviewee's place of work, accompanied tours, a project team meeting, and those made casually whilst situated within the company. Within the project team meeting the researcher was a 'passive participant observer' (Schwartz & Schwartz, 1955) with minimal exposure and interaction to minimise influence and interference with the observed. In total 12 unique visits were made to a variety of the firm's facilities. Finally a multitude of publically and privately available documentary evidence was utilised such as the company website, company project presentations, sales brochures and internal project posters. Data was analysed using the computer qualitative analysis software NVIVO to identify and code data incidents, and subsequently compare and categorise patterns of similar incidents (Charmaz, 2006). Finally the findings of the study were validated by two key interviewees in addition to two senior managers within the company.

#### **4. Case Analysis**

Sustainability is a core value of *CompanyX* (Private document, 2012a). The company is led by a strong CEO/Chairman with a clear and public vision that the company should help tackle the sustainability challenges facing the global society: "It's not only about growing the profits and share price...but at the same time [we] have the responsibility to improve it (the planet) in such a way that our children can continue to build on it, too." (Public document, 2011d: 1). His strategic drive to contribute to solving the world's problems permeates the organization and top management team.

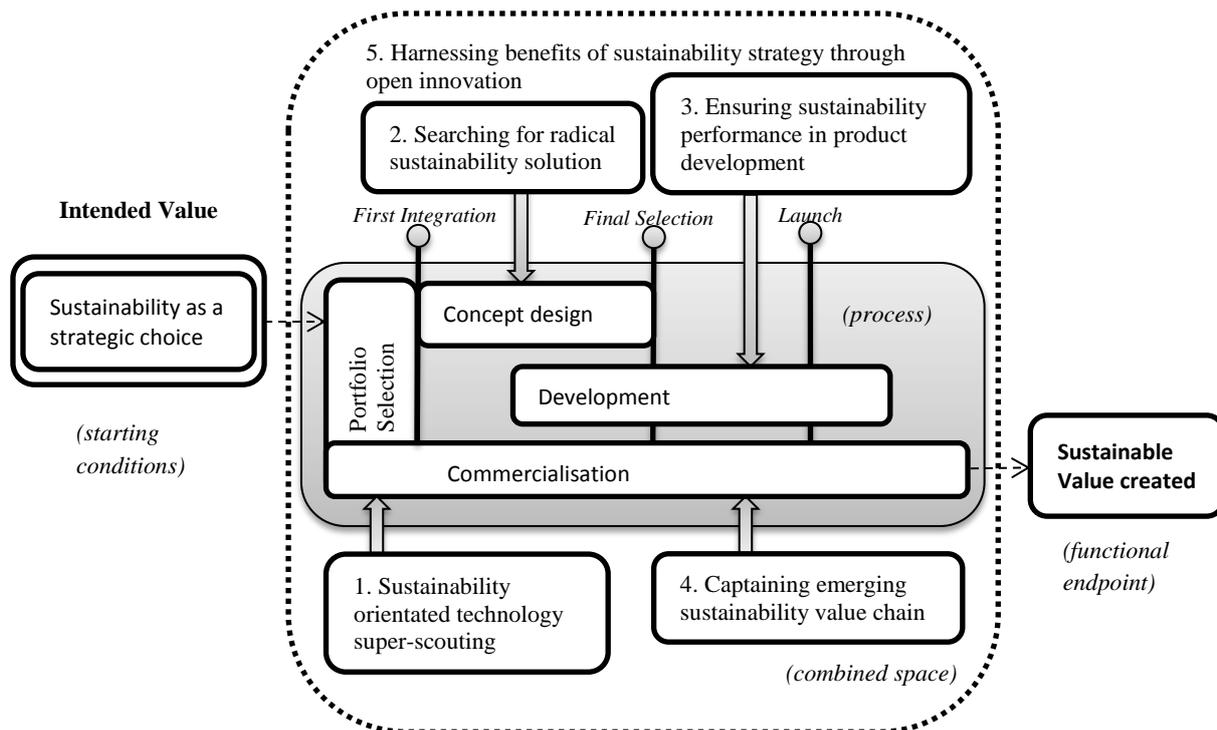
*CompanyX* adopts the Brundtland (UNWCED, 1987) definition of sustainability and fully embraces the Triple P concept of People, Planet and Profit. This general policy setting is not unusual. However, the company has made a conscious strategic choice to shift its sustainability posture from responsible contributors to society, to placing sustainability as one of its four strategic business drivers (Public document, 2010b). Through a company-wide strategy formation process conducted approximately every five years *CompanyX* identifies the defining key global megatrends (such as a changing climate and increasing energy needs) and determines the sustainability challenges these pose to society. Through this strategy

formation *CompanyX* begins to seek the business opportunities by conducting a detailed analysis of technology fit with the organizational capabilities and strengths, and then firm-specific analysis of competitive advantage: “Where can we win?” This analysis provides the basis for the firms’ innovation activities: “We make sure that innovation leads to sustainable developments that really help us long term, so for generations to come” (Interviewee A).

This process of strategically selecting sustainability as a business driver was integral to the formation of the new semi-autonomous innovation unit in which the *BioX* innovation is set. Taking the assessment of sustainability challenges, such as the end of the oil age and climate change (Private document, 2012b), and the firm’s current and developing competencies, *CompanyX* identified the market opportunity of setting up a business platform to deliver innovations that “meet the growing demand for sustainable materials that deliver value for performance, have less impact on the environment, and minimize the burden on our limited natural resources” (Public document 2011b: 3). Interviewee B explains the creation of the innovation unit; “This sustainability and innovation is central of our unit because it actually is the key driver for our business why our business has been set up. We want to look at specifically sustainability aspects and we see bio-based economy as an important development and now we try to create new businesses in the bio-based economy, looking at the opportunities that are just in the trends and that I just mentioned.”

Our research indicates that the strategic choice for sustainability in the case company went far beyond simply affecting the start-up of the innovation unit but had a strong effect on the activities and outcomes of the *BioX* innovation process. It created a mindset amongst people involved to search for directions in the project that would lead to an outcome that was both attractive from an environmental sustainability and a commercial perspective. This attitude affected all activities which were executed in an adapted way compared to projects in firms which do not set out such a specific strategic direction. This also means that it is hard to point to specific success factors that explain the successful outcome in terms of environmental sustainability and economic performance of this project. In fact, we have to conclude that many of the success factors were implemented in an adapted way.

Nevertheless five process factors seemed to be most critical to the success of developing the radical SOI. These features were empirically grounded and stand-out in their significance from the multitude of factors identified along the innovation process. We give a representation of how these factors affected the innovation process in Figure 2, by adapting the conceptual model (Figure 1) presented earlier in the paper with our empirical findings.



**Figure 2. How *Company X*'s sustainability strategy influenced the innovation process and resulted in radical SOI**

This model presents the innovation process for *BioX* from its starting conditions of sustainability as a strategic choice to successfully creating sustainable value as the functional endpoint. Within the innovation process space (shown in grey) different stages are shown to have proceeded concurrently, but with key points of integration. Moreover the activities of commercialisation and those of development continue beyond the product launch as *CompanyX* sought further improvements in product attribute and commercial performance. Surrounding this process are the five critical processual factors residing in a combined internal and external space due to the heavy practice of open innovation. The model presents the innovation process of *BioX* as more dynamic (and less linear) than that set out by Keskin *et al* (2013) and without an internal/external distinction of the organisational process factors.

The five critical process factors were also identified to have overlapped chronologically within the stages and in their influence upon one another. Thus they must be seen as loosely-coupled rather than distinct and stand-alone. These critical process factors present how the selection of sustainability as a strategic direction influenced the new product innovation process from initiation to the commercialisation activities. Furthermore the case shows how by applying an open innovation approach throughout the process the company could harness the benefits offered from a sustainability orientation in the internal and external environment. Table 3 presents a summary of the five primary case findings with illustrative comments.

Finding	Key Representative Comments
<i>Sustainability orientated technology super-scouting</i>	<p>“the first meetings with [value chain intermediate A] and [value chain intermediate B] were before the sustainability drive, but just a curiosity: ”Hey, new materials! This is my job!” and “NPD, new materials”. But couple that to the sustainability drive, of course we really wanted to build a partnership, because they were thinking about an application of what we could make bio-based” (VP of Open Innovation)</p> <p>“I gave a presentation in Boston and that was at the [plastics trade association] and there was a booth, not of Nike, but I think it was Adidas. I got the second confirmation that there is value in bio-renewable. These companies, close to the end user, to you and me, they know the value. And they say we are willing to increase the price a little bit.” (VP of Open Innovation)</p>
<i>Searching for a radical sustainability solution</i>	<p>“in the end it (sustainability) enabled us to do something that was really breakthrough. Otherwise we would not have done that. Would have probably said: ‘could we make [standard production process] maybe a bit better than others have done?’ Something like that” (Interviewee P)</p> <p>“We start with the back end production process. What does the ideal process look like? That led us to discover [radical production process] and not [standard production process] as the best option for [BioX]” (Interviewee A)</p>
<i>Ensuring sustainability performance in product development</i>	<p>“People don’t see it (sustainability) as something that it is complex, an extra burden. People see it as a business driver that makes a lot of sense. And I think, that is kind of, again, a mind-set change. That also comes when you see that you breed success with that, because when you see that these things work you are going to take a different look at it. It is not about the reduction of an emission, or something like that it is about a completely different way of thinking. Just forget about the past, look at how we can do it now. It is more revolution, it is not evolution.” (Interviewee P)</p> <p>“From the technical point of view, for my own role, you have quite a number of options to steer your LCA in term of what kind of equipment do I use, do I go for energy efficient equipment which are slightly more expensive in investment compared to a rather cheap evaporator which is less energy intensive or less energy efficient.” (Interviewee G)</p>
<i>Captaining the emerging sustainability value chain</i>	<p>“If we can become value chain captain we win time” (Interviewee O)</p> <p>“What is different is how it is now in our marketing strategy working out. Because we’re now trying to create this pull. Find the brand owners. We would probably not have done that if we were just coming with something that is cheaper. You show [it to] your customer. You’re done!” (Interviewee L)</p>

<b><i>Exploiting the benefits of sustainability strategy through open innovation</i></b>	<p>“So sustainability is a door-opener. It’s an important aspect that helps us talk to many people, have many customers willing to look at it, willing to spend time on investing it and so on” (Interviewee C)</p> <p>“Yeah, I was already preaching open innovation when I talked to Nike, because we were invited because of the sustainability issue. Can you please help us? So they were applying open innovation too. They wanted to have sustainable materials. And then, more and more, you’re getting a clear picture of bio-renewable vs. biodegradable.” (VP of Open Innovation)</p>
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**Table 3: Illustrative comments supporting case findings**

#### *4.1 Sustainability orientated technology super-scouting*

The first task of the newly created innovation unit was to form a new portfolio of bio-based products to develop. The strategic choice for sustainability and the firm’s vision of using bio-based technology to help solve the world’s challenges was very much central to this process. Interviewee D presents the thinking; “I think basically at that time, once you have said ‘so let’s go for sustainable products’ the obviously next question is; ‘which products precisely?’” This process involved ranking potential new products based on potential market size, fit with the current competencies of the firm, the perceived chance of developmental success, and ultimately a strong sales value proposition. These criteria explicitly encompassed the requirement for the product to offer a clear environmental improvement. Interviewee P explains; “First of all, there is a real advantage by doing it through biotech. Not just to do it because it’s fashionable, but it needs to create a real advantage. The expectance that it will should meet the lowest possible cost. So it should be much lower than what was available. It should have quality advantages over what was available. And it should have environmental advantages over what was available. And only they would meet really meet these three things it would be worthwhile to pursue. And that was why we selected [*BioX*].”

One of the interesting organizational features within this portfolio management process was the influence of the relatively independent VP of Open Innovation, who described part of his job as acting as a “technology super-scout” (Interview O) – travelling around the world to scout out new and potential uses of bio-based technology, and to discuss challenges and opportunities within the value chain; “*CompanyX*, the board and [the CEO]...was starting (in 2004) to mention global warming as a real threat to the world, where the chemical industry should take its responsibility” (VP of Open Innovation). In 2004, during discussions with a number of Asian companies it was identified that the immediate market potential for *BioX*

could be enormous if innovative technology could be developed to allow the bio-based product to be used in particular applications that were not currently using bio-based inputs.

Furthermore the super-scouting of the VP of Open Innovation sought to identify which sustainability value propositions may work in the marketplace, helping to not only form the product portfolio but inform on how such products should be produced. The VP of Open Innovation explains; “I visited Nike, the headquarters...And, of course, tested the value proposition. Is it biodegradability for the shoes if we make [plastic X] soles and replace certain parts or apply [*BioX*] to the glue? Or is it bio-renewability? It was bio-renewability but not biodegradability.” These engagements were thus successful in giving the firm a better idea of the challenges faced by downstream companies, perceptions towards bio-based activities and value propositions, and more specifically a feeling that *BioX* specifically may be well received in the marketplace.

#### *4.2 Searching for a radical sustainability solution*

Once *BioX* was seen as a particular attractive option an innovation team was formed to given consideration of how it could theoretically be produced and to make an assessment of the benefits and weaknesses of each approach. This is termed by *CompanyX* as a ‘technology challenge session’; “An important point at that moment was that I also did a technological challenge session within [*CompanyX*] to see what were the strong and weak points of the technology and what should we focus on? Which is a kind of standard thing to do because jumping on the technology may not be the best one” (Interviewee D).

While Interviewee D describes such a session in retrospect as a ‘standard’ practice, it is one which was critical to allowing the strategy of sustainability to promote finding a radical solution. As a strategic business driver, “sustainability is a guiding principle” (Private document, 2009: 39) of the product innovation process within *CompanyX*. This means that from the very start of innovation project practice; “every step should support [*CompanyX*’s] Sustainability mission” (*ibid*). This guiding principle was evident in the project targets for *BioX* as they searched for the optimal production process – “sustainable with lowest carbon footprint” (Public document, 2012c: 5). The technology challenge session set towards this target by backcasting from the ideal production process – both in terms of an economic and environmental solution; “But we were at that point in time looking at will this technology be good enough from an economic perspective? but also from an environmental perspective” (Interviewee K).

The innovation team quickly realised that more conventional production routes did not offer the best solution; “To be honest, the line of thought was at first that if you’re producing 100 kgtons of [*BioX*] and 100kgtons of [waste product] it doesn’t feel too sustainable” (Interviewee D). Instead the team was successful in finding a novel alternative route of production then what competitors were developing<sup>1</sup>. This critically offered a production route that could produce a product with a significant best in class carbon footprint and a potentially cheaper product, whilst simultaneously offering an additional benefit of 'greenfield' space in terms of Intellectual Property restrictions. Interviewee K explains; “you would like to have a much cleaner process, a much more focused production. Less side products. Etc. And by doing that, that’s good for the environment and by doing that, that’s also good for the economics.”

At this early stage the innovation team also fully recognised that sustainability would be an integral part of the sales value proposition of the product. Early adopters, at least, would consider switching from the petro-based chemical based market incumbent based on environmental concerns. This awareness helped to promote a radical solution as for successful commercialisation it was perceived critical that *BioX* not only offered a significant sustainability improvement but furthermore could be differentiate from the other comparable products being developed on its ‘best in class’ carbon footprint. Interviewee G explains; “So, it is one of your sales arguments in combination with striving for the process with the lowest footprint. Assuming that a process with the lowest footprint will at the end also have the biggest change of breaking through at a commercial scale.”

#### *4.3 Ensuring sustainability performance in product development*

The strategy of sustainability retained its influence during the development of the product as environmental sustainability was considered alongside critical criteria of cost and quality. All three of these concerns were perceived critical to the success of the SOI and could not be discriminated against. Firstly achieving a high quality *BioX* was critical to enable entering markets whereby extremely pure monomers are required (Interviewee P). Secondly while price premiums for certain applications were seen to potentially available for short time periods before production scale is reached, it was acknowledged that these would not be available long term. Thus the product needed the capability of being produced at mass at a price comparable to existing prices of the incumbents it was proposing to replace. Environmental sustainability as the central business driver and already acknowledged to be

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<sup>1</sup> It must be noted that the developmental partner was simultaneously pursuing a conventional production route until the novel route was proven and given final selection.

integral to the sales value proposition (not least to attract early adopters), was a third concern given equal consideration by the product development team. Though the product was already from biorenewable sources<sup>2</sup> the development team was explicitly concerned with minimising the environmental footprint in terms of greenhouse gas emissions. This was based on an acknowledgment that bio-based solutions could potentially have an inferior footprint to petro-based products and biorenewable would not be a sufficient for a consumer switch; “Bio-based doesn’t necessarily mean sustainable” (Interviewee B).

Critically the concern for minimising the product’s environmental footprint was not considered an extra difficulty by the development team (Interviewee P). On the contrary finding ways to achieve a low environmental footprint was considered a key way to support a low cost production process and ultimately the commercialisation of product. Interviewee G explains this; “So, in our case we saw that both costs and LCA (life cycle assessment) went hand in hand in terms of carbon footprint versus euro per kilogram of product”. To this end the key performance indicators for the development of the product based on achieving a low cost could have been replaced by measures of environmental sustainability (Interviewee H).

A key example of the development team’s mindset was their pioneering use of life cycle assessments (LCA) within *CompanyX* (Interviewee G) to help understand the impact of different choices in production, using it to help provide guidance and validate decisions. Interviewee I explains how environmental data affected product development decisions; “they really used the LCA to say ‘Okay, are we going to choose this process or that process’. And they say ‘okay which one is better in terms of environmental point of view.’” Furthermore it was acknowledged that LCAs would also be necessary to validate green credentials to customers. For this work the development team decided to engage with an independent third-party. This not only offered the team assurances that their LCA calculations were accurate but also provided greater external credibility to results in the marketplace (Interviewee M).

#### *4.4 Captaining the emerging sustainability value chain*

In order for *BioX* to be successfully commercialised *CompanyX*’s direct customers serving a wide variety of value chains will need to decide to switch from using a petro-based market incumbent. Such a transformation will only be possible if these direct customers

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<sup>2</sup> During the course of the innovation the ‘food versus fuel (bio-based products)’ debate became more prevalent as a key environmental sustainability concern (Interviewee P). While *BioX* is currently produced from first-generation biomass it will be produced from second-generation once deemed commercially viable. Concurrent to the *BioX* project *CompanyX* has invested heavily in a second-generation biomass project which will facilitate the availability of such supply for its bio-based products.

perceive that they can still sufficiently materialise on their business with support from the value chain intermediates and downstream end-users. Acknowledging this situation *CompanyX* has sought to be the value chain enabler or ‘captain’ (Interviewee O).

This captaincy of the emergent value chain can be seen to start early with the super-scouting work and meant not only conducting the expected market-push commercialisation activities but also organising the market-pull from intermediates and downstream companies; “Working across the value chain with (ag)-feedstock players, (petroleum based) incumbents and/or downstream users” (Private document, 2012b: 27). Through this process *CompanyX* helps to speed up the development of the market and ‘wins time’ (Interviewee O) on when *BioX* (and the upcoming bio-based product portfolio) will be widely adopted in the marketplace.

Sustainability as a corporate strategy, and its significance within the product innovation process, is seen to support *CompanyX*’s value chain captaining approach. Actors throughout value chains were keen to talk with the innovation team when approached with a potential sustainability solution especially those with ‘sustainability aware’ consumer-facing brand owners. Interviewee D explains the brand owners interest in sustainability and the backward value chain pull it creates; “But people know Adidas, Nike, Puma, those are companies who want to distinguish themselves from their competition based on sustainability....Because Nike and Adidas don’t make shoe soles themselves. They buy that stuff. So they have to ask for more sustainable products (from their suppliers).” As a start of the value chain company life science companies can commonly have few engagements with brand owners. Sustainability provided *CompanyX* the door opening for these engagements and opportunities to influence value chain pull for *BioX*; “So big companies, [immediate customers], invited me to go talk to Nike, to go talk to Adidas, to Puma and so on... And that is only, coming back to sustainability, the reason that we can do that at this point is only the sustainability” (Interviewee L)

Also important to holding these discussions are the sustainability credentials and credibility of *CompanyX*. Without a strong reputation in both innovation and sustainability in the marketplace, it is perceived that engagements across value chains would be more difficult to arrange and would not be as easy. Interviewee A explains; “Sometimes you don’t even get in right; you have a new product and they say that we are not really interested. But if you are a Dow Jones Sustainability leader it can help you to have that discussion.”

#### *4.5 Harnessing the benefits of sustainability strategy through open innovation*

Open innovation is the endorsed innovation approach of *CompanyX*, which it states is simply a competitive necessity (Private document, 2009). Open innovation was fundamental to the *BioX* innovation and the ability of the company to develop a timely, sustainable and commercially viable product. Examples of exercising the approach can be identified throughout the process from initial ideas of what product to develop through to the commercialisation activities at, and beyond its launch. Significantly this collaborative approach enabled the innovation team to harness the opportunities offered by adopting a sustainability strategy.

From the outset of the SOI and throughout its commercialisation (as detailed above) open innovation empowered the company in its desire to act as a sustainability solutions provider. Open innovation in the early super-scouting activities helped find the value chain actors interested in sustainability issues, whereby the company's strategy could act as a door-opener and the product could receive attention. The VP of Open Innovation notes the complimentary nature of the sustainability strategy and open innovation; "Yeah, I was already preaching open innovation when I talked to Nike, because we were invited because of the sustainability issue. Can you please help us? So they were applying open innovation too. They wanted to have sustainable materials." These engagements not only allowed for early feedback on potential products, potential sustainability value propositions, but also the identification of unexpected demand; "When we approached these people making running shoes, etc. We knew that they were using a lot of [alternative petrochemical], but never thought that they would consider to replace [alternative petrochemical] by [*BioX*] in their materials simply because it had all these advantages I was mentioning. But actually Nike and others they showed a high interest to consider that. So that was kind of an extra market outlet never thought about when we were kind of selecting the targets" (Interviewee P).

Open innovation was also strongly applied in the concept design and development phases and enabled *CompanyX* to take advantage of how the sustainability strategy can help to form new partnerships. For instance; industry experts interested in new bio-based products engaged in a session concerning the technology of the production route, and external institutions were eager to partner to help assess the environmental footprint of production route choices. Most significantly *CompanyX* was able to partner with another strong multinational company; a partnership based on a mutual belief of a bio-based economy and shared sustainability strategy (Interviewee D). This partnership brought many benefits such as access to quality and quantity of raw material, and most critically speeded up the time to

market as Interviewee G points out; “But the perception at that time was that we really would like to be one of the first launching customers or launching partners with this [bio-based] type of products. Otherwise it would be difficult to really convince the big players to switch.”

## **5. Conclusions**

In this paper we explore to what extent and through which mechanisms a strategic choice for sustainability affects the outcome of radical innovation activities. Our case study of a radical SOI at a large multinational company has shown that the strategic selection of sustainability as a business driver enhanced the innovation process thereby achieving a radical, environmentally sustainable and commercially viable product. Our paper provides an empirically grounded understanding of how the firm’s strategy has adapted a set of organisational processes affecting the direction of the innovation project from its initiation to its commercialisation activities. These findings have been presented as five critical processual factors in a model of the innovation process advancing the work of Keskin *et al* (2013). These five factors are; sustainability orientated technology super-scouting, searching for a radical sustainability solution, ensuring sustainability performance in product development, captaining the emerging sustainability value chain, and harnessing the benefits of sustainability strategy through open innovation. Critically sustainability as a strategy has shown to enable these organisational processes leading to a radical solution to the production of the process to make a commercially viable, best-in-class product with a long term sustainable value.

There are a number of ways in which our findings extend and enhance previous research. While contemporary management literature has reflected the rise in company attention upon SOI, studies have to date not set forth a conclusive set of factors to explain successful SOI. Moreover much of this work has either focused upon incremental innovations or failed to distinguish these from radical counterparts. Our study has contributed to this literature by providing empirical evidence of how the strategic decision to embed sustainability in new product innovation processes has enhanced radical innovation through an adapted set of critical organisational processes. Moreover we believe a number of these process features to be relatively new and novel to the current literature and will help to move research into the direction of how companies may use strategies for sustainability to directly influence new product innovation processes. In particular, the identified activities of sustainability orientated technology super-scouting and captaining emerging sustainability value chain offer novel insight into the radical SOI process of a corporate front-runner of sustainability.

The innovation literature more broadly can also be seen to have under researched the mechanisms to convert a firm's strategy to innovation activities beyond through portfolio management. The findings of our study have therefore made an additional contribution here having shown that while portfolio management is a key way of aligning innovation projects with strategy, there is also a strong strategic influence in the organisational processes.

Based on the findings of this paper we invite future research to give more empirical evidence to the process of radical SOI and how corporate front-runners are approaching this type innovation process. By providing a rich and detailed narrative of a single case of radical SOI our paper has been able to give greater insight to the mechanisms in which sustainability strategy can positively enable radical innovation. Although not the aim of our paper, this approach does not allow for statistical generalisations and further research is needed to give consideration to the transferability of the results. We discovered five critical implementation mechanisms, but our case study also shows that these were not exhaustive; other mechanisms may apply in different cases. In general we expect that many of the processes that are considered success factors for radical innovation also apply to radical sustainable innovation, but that these processes are implemented in different ways, with the combination of sustainability and commercial viability as a target outcome. The modifications in the innovation activities refer to the direction of search for knowledge, partners and ideas in the different processes. In this respect research on search heuristics in these processes, and the role of strategy and strategic vision, may be an interesting avenue for future research (Geels, 2004; Nelson and Winter, 1977).

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