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Abstract. For manufacturers to remain competitive, there is a recognised need to be highly innovative in the creation of new products and enhancements to existing ranges. Since its conception in 2003, Open Innovation (OI) has developed into a prominent research theme within innovation-related literature and is seen to impact positively on company performance. Many large manufacturers are now adapting their innovation processes to adopt OI and seek valuable expertise from external sources, including customers, suppliers and even competitors. This study explores the OI practices of three multinational manufacturers operating in three distinct sectors: aerospace, electronics and beverages. Findings suggest that by adopting the OI model, companies can remain competitive through co-creation and greater engagement with stakeholders. However, companies must explore and identify best practices for inbound and outbound co-creation.

Keywords. Open Innovation, Innovation Performance, Co-Creation, Innovation.

1. Introduction

In 2003, Henry Chesbrough, Director of the Garwood Center for Corporate Innovation at The University of California Berkeley, coined a new model and pattern for innovation, termed Open Innovation. The term introduced a new "distributed innovation process, based on purposively managed knowledge flows across organizational boundaries" [1], extending the traditional closed organisational boundaries, where innovation occurred solely internally within product development teams, to 'open innovation', where innovation occurs through enhanced collaboration and co-creation with external sources. The benefits of OI include: increased collaboration and communication with external partners; improved ability to discover new ideas and the potential for enhanced products and services; access to additional competence; and greater access to global marketplaces.

Open innovation relies on knowledge and idea inflows from both external and internal sources. Traditionally, Research and Development (R&D) departments have operated in silos to complete innovation activities, relying on the cooperation of dedicated technical specialists in an 'insular manner'. More recently, R&D departments have expanded their reach for innovation to external partners located outside a firm's boundaries, often involving contractors, customers and suppliers *inter alia*. This increased collaboration and greater exposure to external innovation enables the uncovering of new ideas and concepts, while lowering the cost and risk associated to innovation; this is achieved by combining external competences, such as people who

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already have the required knowledge, skills or developed technology, with internal innovation resources, reducing the need to reinvent pre-existing ideas or technological solutions. The practices commonly involved in open innovation are viewed as "not yet pervasive among large companies" by some academics [2], however in the manufacturing industry, especially in high-tech organisations, open innovation is considered on the rise, encouraged by senior management, especially as benefits become more evident. OpenInnovation.EU [3] identify the key differences between closed and open innovation principles, as shown in Table 1.

Table 1. Principles of Closed vs. Open Innovation [3]

Closed	Open
The smart people in the field work for us.	Not all the smart people work for us, so owe must find and tap into the knowledge and expertise of bright individuals outside our company.
To profit from R&D, we must discover it, develop it, and ship it ourselves.	External R&D can create significant value: internal R&D is needed to claim some portion of that value.
If we discover it ourselves, we will get it to the market first.	We don't have to originate the research to profit from it.
The company that gets an innovation to the market first will win.	Building a better business model is better than getting to the market first.
If we create the most and the best ideas in the industry, we will win.	If we make the best use of internal and external ideas, we will win.
We should control our intellectual property (IP) so that our competitors don't profit from our ideas.	We should profit from others' use of our IP, and we should buy others' IP whenever it advances our business model.

To identify the current practices of manufacturing firms adopting open innovation, we conduct three separate case study investigations into multi-national manufacturing firms operating in distinct sectors. These include Thales (Aerospace and Defence), Sony (Consumer and Professional Electronics) and Coca-Cola (Beverages). To conduct our study, we consult industrial literature, identified via corporate websites and industrial white papers, and explore academic publications, consulting the Social Sciences Citation Index (SSCI) to source articles via the Web of Science database.

2. Case Study 1: Thales (Aerospace and Defence)

2.1. Company Overview

Founded in 1893, Thales engages in the manufacture, marketing and sale of electronic equipment and systems for the aeronautics, naval and defence sectors. In 2015, the company's annual sales rose 10% from 2014 to €6.43 billion [4]. The company's defence and security division design and deliver systems for land, air, naval and cyberspace domains, while the aerospace division covers the avionics and space global business units. The Transport division develops ground transportation systems and services, such as rail signaling, control systems and passenger payment collection solutions [5]. In 2015, the company sourced 80% of its purchases from its over 7,600 suppliers located in the European Union, including 43% in France [4].

2.2. Current Practices

Innovation, according to Patrice Caine, Chairman and Chief Executive Officer (CEO) of Thales, is nothing new to the organisation, stating that "it has always been part of the Group's history and remains crucial to our success today and into the future". Regarded as an integral part of the Thales identity, research is considered an invaluable source of innovation. As a result, more than 25,000 employees are directly involved in R&D, representing almost 3 billion euros in revenue every year and accounting for more than €700 million in self-funded R&D. Thales employs more than 20,000 researchers and invests €2.5 billion in R&D, the equivalent of 20% of its revenues yearly and has R&D centres in 18 countries around the world.

The organisations believes that innovation succeeds when creative forces and disruptive technologies come together to meet a real-life customer need and is, therefore, committed to partnerships with Small and Medium-sized Enterprises (SMEs), focusing on new technologies and solutions. SMEs are key to Thales' success as an innovator [6] and, in 2014, the company opened a series of innovation hubs, including its first multidisciplinary innovation centre outside of Europe, in Singapore. Thales aims, through the development of their innovation hubs, to co-design and produce in collaboration with end users. In addition to research and innovation, 'co-innovation' is considered one of the key enablers of sustainable growth and performance by the company. Thales operates joint laboratories with universities in France, the United Kingdom, the Netherlands, Singapore and Canada, and has formed more than 30 partnerships with universities and public research institutes in Europe, the United States of America (USA) and Asia.

Thales also sees great advantage in collaborating with start-ups. Marko Erman, Director of Research & Technology at Thales, states that "by accompanying incubators, such as Starburst Accelerator, we can find innovative technologies or services that we couldn't have brought to life within the group". Working alongside Airbus, Thales was one of the founding members of the aeronautic incubator, Starburst Accelerator [7]. The company also works closely with The MIT Media Lab at Massachusetts Institute of Technology (MIT) to find innovative solutions to problems experienced in avionics and to engage with Startups based in the United States.

3. Case Study 2: Sony (Consumer and Professional Electronics)

3.1. Company Overview

Sony Corporation was founded in 1946 and is headquartered in Tokyo, Japan. The company has major offices and research centres in the USA, China, Europe and Japan [8]. With approximately 125,300 employees, the company engages in the design, development, manufacture and sale of electronic equipment, instruments, devices, game consoles and software for consumers, professionals and industrial markets. In 2013, the company had a supplier list of circa. 1,000 [9].

3.2. Current Practices

In 2008, Sony included in their Corporate Strategy for 2008-2010, the need to promote open innovation across operations, advising it to be used to "not only look inside the company, but outside for technologies that foster innovation" [10]. The company perceived that the OI concept would enable R&D processes to be accelerated and become more efficient, using the internal expertise of engineers, programmers and designers with external expertise to develop innovative products or enhancements to existing ranges. Sony had, over the years, developed a closed culture of not engaging with others. Howard Stringer, CEO of Sony, believes that the company has worked hard to crack the perceived Sony Culture of 'not invented here' and admits it is a serious problem. In 2005, Surowiecki [11] stated that the company's Betamax video tape recorder product failed in part because the company refused to cooperate with other companies. To change this culture, Howard Stringer acknowledged that getting to market quickly takes priority over making everything in-house and, as a result, reached a licensing deal with an outside supplier for an essential component of 3-D televisions in 2010 [12].

The Seed Acceleration program is another example of change within Sony, with its goal being to gather and nurture new business ideas from beyond the boundaries of existing Sony organisations through its management and human resources. The company is accelerating its cooperation and collaboration with venture companies to produce superior technologies. One such example is the SETsquared Programme which brings together five leading UK research universities and one of Europe's top university business incubators. This programme helps its corporate partners to access new technologies, solutions and innovations by brokering relationships with its companies and researchers in a cost efficient and time effective manner. As part of the SETsquared programme, Sony EU is working with other organisations, such as Astrium Services, BAE Systems plc. and Barclays Corporate Banking to identify innovation issues, opportunities and challenges with a view of a long-term relationship that has the prospect of developing a deep understanding of their innovation requirements and responding with a tailored approach. The SETsquared programme has an extended network of researchers, innovators, entrepreneurs and investors, providing corporate partners with access and insight into the latest developments in open innovation [13].

4. Case Study 3: Coca-Cola (Food and Beverage)

4.1. Company Overview

The Coca-Cola Company was founded in 1886 and is headquartered in Atlanta, USA. The company currently has 100,300 employees worldwide. Operating as a beverage company, Coca-Cola manufactures, markets and sells non-alcoholic packaged beverages, such as waters, juices, soft drinks and energy drinks to consumers around the world. In 2007, the company engaged with over 1,300 suppliers [14].

4.2. Current Practices

Innovation at Coca-Cola dates back to 1960 when the 'fountain dispenser' was first introduced by Raymond Loewy. David Butler, Vice President of Innovation at Coca-Cola believes this innovation placed the company among one of the pioneers of

innovation. The company currently adopts open innovation principles with the Coca-Cola Accelerator program, aimed at helping start-ups in eight cities around the world, including Sydney, Buenos Aires and Rio de Janeiro. Through open innovation practices, the company developed the 'Free dispenser machine' which allows customers to mix their own flavours and suggest new flavours for Coca-Cola products. The new product puts the customer at the heart of the production process by allowing them to select their preferred flavours using a mobile application and collect them at 'Freestyle machines' located in retail outlets around the world. This model of open innovation records and uses the suggested flavours as external idea that can be evaluated and processed as a new product line [15]. With this innovation model, Coca-Cola is forecasting that a successful future depends on being open and willing to engage with external sources of knowledge. Ronald Lewis, Senior-Vice President of Supply Chain at Coca-Cola admits that the company doesn't have the monopoly on good ideas, stating that the best ones "won't always come within the four walls of our supply chain." He believes that new Coca-Cola products may come from outside of the company through being openly innovative [16].

In 2012, the company launched a collaborative product innovation initiative with consumers, franchises and bottlers in a bid to be a less 'secretive' company by crowdsourcing ideas with the aim of doubling its size by 2020. The company led a consumer crowdsourcing project using the Facebook mobile application, asking its 50 million followers to suggest ideas to make the world 'A Happier Place', with the winning idea being funded by the company. Anthony Newstead, Coca-Cola's Global Director of Innovation stated that the company is aiming to turn the founding principles of its secret formula into a mantra of a 'sharing formula' to be more open. The company also sees social collaboration as a key method to move away from a command control top down secretive model to a more collaborative one. To this end, Coca-Cola has started using employee social networking tool, Salesforce Chatter, to share ideas globally across the business, starting with top executives who they hope will encourage departments to use the tool, marking a significant change in Coca-Cola's corporate culture [17].

5. Conclusions

The need to be continually innovative in manufacturing is critical to the success of any manufacturing project, thereby necessitating the need to create 'open' environments where manufacturers no longer design and develop everything internally, but now engage and co-develop with external sources. By doing so, manufacturers can reduce innovation-related risk, while improving the innovativeness and external commercialisation of products. Taking a cue from the Sony experience, the future of innovation is open and global. Companies must adapt their innovation processes, incorporating OI, to improve organisational performance. The captured experiences of Coca-Cola and Thales demonstrate that manufacturers should create more openly innovative processes, as innovation no longer only originates from within a firm's R&D department. To experience the most benefit from innovation, companies need to combine their internal knowledge and skills with external sources, providing the 'best of both worlds'. To integrate OI into organisational practices, Ollila and Ystrom [18] posit that the successful enablement of OI requires the collection of numerous intermediaries who facilitate various activities, including the development of corporate practices and enclosures which support the creation, transfer and co-creation of knowledge, the generation of innovation communities and communities of practice, which convene

people with shared interests and visions, and develops a centre for ideas, resources and technologies to be shared effectively and efficiently.

In future, research must explore the critical success factors in implementing open innovation through Web 2.0 technologies and extending to Web 3.0; the organisations investigated in this research show increasing reliance on social media and collaborative awareness platforms which enable enhanced co-creation and collaboration across boundaries. Further study could also be conducted into how the open innovation model is adopted in other knowledge-intensive industries, such as pharmaceuticals.

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