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Academia-industry Innovation Interaction: Paradigm Shifts and Avenues for the Future

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Abstract

Innovation is the application of an idea/invention, technology or process to a product/service that will satisfy a specific need and can be replicated at economical cost. Innovation creates value, playing a vital role in growth and social well-being. Mounting economic pressure, environmental challenges, diminishing resources, the exponentially accelerating pace of science and knowledge development, open innovation proliferation call for a deep assessment of academia-industry relationships. Fundamental research as the sole thrust of academia is no longer a sustainable approach. Instead, innovation must focus on the integration of fundamental and applied research, technology development, new business models and processes, and enhanced social responsibility. Innovation novel blueprint mandates paradigm shifts in mindsets, strategy, research focus, academia-industry relationships, IP policies and government involvement. Key elements include: academia's participation in industrial development teams and technology networks, enhanced support for fundamental and applied research, advanced thesis research conducted in the industry, creation of joint-value programs and resource-sharing, new business models, and enhanced societal responsibility. Academia should also promote the participation of industry representatives in their teaching staff and advisory boards. Special emphasis should be placed on institutionalizing innovation and on the role of small and medium enterprises, promoting their transformation into effective catalysts of change. EU authorities, academia and the food industry should collectively develop a mutual vision for reforming the "old push" curriculum into a "pull" ecosystem that attracts all stakeholders, enabling academia and industry to build trust-based relationships, promoting performance improvements in teaching, learning and entrepreneurship, and increasing social responsibility. Attracting venture capital to drive innovation, incubators and start-ups is also vital. Without compromising on the highest standards, adaptation and taking up these challenges is a necessity. Time is precious and it is our utmost responsibility to provide leadership, instil confidence, encourage and embark upon this journey to galvanize efforts and institutionalize innovation.

Keywords: Open innovation; innovation partnerships; Sharing-is-Winning model; valley of death.

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1. Introduction

The Europe 2020 strategy is focused on the EU's capacity to create millions of new jobs to replace those lost in the recent economic crisis, and on the fact that future standard of living depends on the EU's ability to drive innovation in products, services, business models and social processes. Innovation is at the heart of this strategy and has been identified as the best means of successfully tackling major societal challenges, such as climate change, energy and resource scarcity, health and ageing, all of which are increasing in urgency. There are a large number of definitions of innovation, but the most direct one is: "The process of transforming an idea/invention into good/service that consumers/customers are willing to purchase." It is important to note that to be defined as innovation, an idea and or an invention must be replicable at an economical cost, and should satisfy a specific need(s). Innovation provides a significant driving force and unique opportunity to address global economic pressure, unstable economic markets, accelerated exponential growth of scientific knowledge and technological complexity, and new consumer needs and expectations. Innovation is the application of ideas, technology and processes in new ways to gain a competitive advantage and create value, and it plays a vital role in all facets of modern life [1]. Innovations can become commodities at an unprecedented speed and consequently, continuous effort is required.

The mantra "innovate or die" is no longer sufficient. Open innovation (OI) and innovation partnerships could be the leitmotif for today's companies. OI has been defined as “a paradigm that assumes firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology” [2]. A more recent definition: "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" [3] highlights the fact that OI has become a widespread practice. OI is founded on the reality that, in a world of vastly distributed knowledge and accelerated rates of development, companies can no longer afford to rely on their own research: they must utilize outside sources and buy or license processes, technology, inventions and solutions [4].

OI has seen a massive expansion in recent years [5]. The goal set back in 2000 by Proctor & Gamble for their OI model of "Connect + Develop"—that 50% of innovation be acquired from outside the company—has made significant inroads [6]. OI has spread and mushroomed in many industries (e.g., pharmaceuticals, chemicals, biotechnology, drugs, software) and the large food industry has followed suit [1,7].

Despite OI's widespread applications, small and medium-size enterprises (SMEs) and others operating in traditional sectors are struggling with its implementation due to their relatively low level of absorptive capacity, and management challenges which are perceived as unattainable [8]. The untapped potential and full adaptation of OI is particularly relevant for the EU Food and Drink (F&D)—the EU's largest manufacturing sector, which employs some 4.4 million people generating 14% of the total manufacturing jobs. The SMEs are especially struggling with OI implementation [9,10], and although they comprise 99.1% of the total 310,000 companies, they generate only 49% of the F&D turnover (http://www.ciaa.be/documents/brochures/annual%20report%20CIAA%2009/pdf; visited Nov. 14, 2010). This topic has attracted much attention and is under deliberation by various EU bodies, as well as EFFoST and IUFOST [1].

The overall objective of this paper is to delineate the strategy and paradigm shifts required to: 1. identify key elements, and highlight academia/industry innovation paradigm shifts to meet mutual future challenges; 2. propose "pull" elements to enhance academia/industry collaboration, and 3. promote new approaches to encouraging partnerships, networking and innovative thinking and implementation.

2. Academia-industry innovation interactions

Collaboration is a key piston in the engine that drives economic growth. Value creation is the ultimate goal of any partnership: without it, the concept holds no real merit for the partners. The five main principles of the "Sharing Is Winning" model (SiW) are [1,4]: partner selection, co-creation of intellectual properties (IPs), joint creative problem-solving teams, implementing best practices, and sustainable and continuous processes affecting people, mindset, metrics, culture, and education. Ultimately, the overall objective of SiW is alignment of the value chain with consumer-centric innovations. SiW extends the definition of OI, namely, a new avenue for collaboration in all areas of discovery and development, with external partners bringing competence, commitment and speed to the relationship, while also sharing the risk of innovation [7]. The SiW roadmap is founded on the OI principle of "outside-in" for co-creation with complementary partners through alliances, cooperation, and joint ventures, and has proven very effective in a wide spectrum of industries and applications. However, the counter aspect of OI, inside-out, still faces steep slopes which are, in numerous cases, insurmountable. Many large food companies feel that they are not ready to share their IPs and consequently, the inside-out route is seldom utilized. SMEs are lagging behind on both "outside-in" and "inside-out" approaches, and their utilization of SiW is limited or nonexistent due to real and/or perceived issues of time, resources and adequate human resources.

Despite the great potential of SiW, significant inroads still need to be made in collaborations between industry and academia. Academia's long history of working in isolation, its different value chains and a general misunderstanding between parties furnish a partial explanation for their "staying at arm's length." So-called ethical conflicts threaten academia by distracting it from teaching and basic research, undermining collegiality, encouraging secrecy, preventing or delaying publication, and devaluing the human component [11]. Traditional collaborative conflicts between academia and industry include confidentiality, publishing, IP rights and ownership. The mindsets and research foci of the two institutions are also quite different: while university is mainly focused on fundamental research (R), industry works primarily on development (D), with a typical ratio of D to R in the food industry exceeding 4:1. Concerns about potential conflicts of interest arise when members of the academic community interact with industry (e.g., consultants, scientific advisors). These concerns are alarming, but SiW principles should serve as a platform for promoting the development of mutually beneficial collaborative relationships. Other factors, such as culture and funding, have also been identified as significant constraints stifling fruitful collaboration.

Another basic difference between academia and industry is their value chain. While industry is driven mainly by its bottom line and gaining full IP rights, academia is primarily motivated by the pursuit of basic science and knowledge dissemination, student education, publications and often also full IP rights. OI proliferation has proven that academic freedom is not affected, and that biased company-sponsored research is quite rare. It is generally accepted, especially by EU countries, that university innovations have an underutilized and unrealized potential that continues to lie dormant. Consequently, sustained efforts to advance university innovations are needed. Building bridges between university researchers and businesses is critical for knowledge transfer—this is no longer an option but a must, and SiW can pave the way. However, even OI focuses on quite narrowly defined, short-term transactions. The latter miss the opportunity to build much longer, trust-based relationships that can be used to engage diverse teams in tackling more diffuse and broadly framed challenges [12]. This issue may be due to the fact that OI has only recently seen broad utilization and it should continue to adapt a larger scope for driving collaborations between academia and industry.

3. Discussion

Toward implementing significant changes in academia-industry collaborations and the pursuit of innovation, SiW principles should be expanded and an overarching common vision should be developed. This game-changing vision should be based on new shaping strategies (i.e., reshaping broader markets, industries, or social arenas [12]) which will be expanded to include academia as well. The new vision and shaping strategies should address the broad scope of innovation and furnish industry and academia with opportunities to seek improved means and tools to develop platforms that will maximize mutual efforts, enable participation, promote learning and societal responsibility, and lead to the creation of an innovation ecosystem. Academia should play a paramount proactive role in the conceptualization, deliberations and design of this new vision, and should contribute to its content. The EU should also play a pivotal role in integrating all stakeholders and provide the leadership and support required to create rich seedbeds for innovation, learning and collaboration. Continuous collaborations on this topic have already been addressed by the EU (e.g., European Technology Platforms, ETP; Lifelong Learning Programme, ISEKI). Academia-industry interaction toward innovation also calls for several paradigm shifts, four of which are outlined below.

4. Barrier removal

The road from a discovery stemming from basic research to a commercial product, process or service is long and rife with significant obstacles. Typically, a funding gap or "valley of death" (VoD) exists between basic research and commercialization [13]. To simplify the concept of VoD, the innovation sequence can be typically depicted in three stages: stage 1 is basic research, also termed pre new-product development (NPD), providing what is known as the "front end" (or "fuzzy front end") of innovation; stage 2 includes the transformation from basic research outcome into a potentially marketable product/service; stage 3 is commercialization and diffusion of a new product/service, translating projects into economic value. Government practices in R&D support may be the most significant contributor to the emergence of a VoD. Intervention at early stages of the innovation process can exacerbate the problem of underinvestment in intermediate-stage research. There are at least two ways in which this occurs: creation of a rift or "valley" in the innovation sequence by inflating the output of basic research above funding levels that will be invested at a later stage, and altering the provision of funds at intermediate stages. Therefore, a government that is concerned about generating economic value from its basic R&D efforts should enhance its support of intermediate-stage research [14]. These findings should be carefully considered by EU authorities when assessing if and how to shift resources to enhance SME innovation. Even the remote possibility that EU funding (e.g., 7^{th} Framework Programme) has contributed to proliferation of the VoD, and has probably negatively affected innovation, is striking and warrants in-depth analysis.

To traverse the VoD successfully, academia should recognize its cardinal role in reaching out to industry and playing a proactive role. Conducting and excelling in basic and fundamental research is a prerequisite. Crossing the VoD by learning industry's needs and driving inventions at least past the pre-NPD stage, until the industry can pick them up, is also paramount. The typical pre-NPD includes four steps: 1. affirming the technical viability of the invention as a product or service; 2. formalizing the product concept; 3. validating the concept with market research; 4. developing a business case to gain commercial support, again using consumer research, and marketing [13]. While initially, the invention is the major driving force, market research and the business model take the lead at later stages. Therefore, a sustainable partnership is required. This partnership calls for both academia and industry taking a proactive role and participating in each step of the innovation. Hence, it calls for a new mindset that supports and promotes the seamless free flow of knowledge, technology and solutions in all directions

across universities and industry boundaries as outlined in OI and SiW. Some specific recommended changes for academia include [1]:

a. Applied research status - Enhancing the importance of applied research is imperative. Applied research also plays an important role by significantly contributing to teaching quality, due to its focus on relevant topics. It can also can contribute to and improve direct interactions between students and industry, and create a magnet for resources that will further enhance collaborations. Ultimately, applied research can contribute to the university's reputation, by offering numerous benefits (e.g., recruiting higher-quality faculty, increased research funding), and possible breakthrough advances in fundamental research.
b. Academician's new role - The deep-rooted characteristics of a professor should be reassessed. He or she should play a proactive role also in industry, motivated by the synergistic power of collaboration and driven by the overall goal of becoming a full member of an industrial team. This could require devoting ample time in a particular industry to become an "organic" member of the industrial OI effort. The intimate presence of academicians in industry should create new possibilities, such as offering advanced industrial studies (PhD, MSc). This approach could lead to significant outcomes, such as opening the door to industrial internships, fellowships, advanced education, etc. Last but not least, with the ballooning cost of equipment, access to sophisticated industrial laboratory equipment and resources is a huge and very significant benefit. Encouraging academic researchers to supervise joint theses carried out in part or in full in the industry is very strongly recommended. In addition, becoming a full member of an industrial team should also be favourably considered. This recommended change also calls for an in-depth assessment of course curricula, teaching methods and learning models. Education should also reconsider their standard "push" curricula to expose students to codified information in a predetermined sequence of experiences towards "platforms" designed to flexibly accommodate diverse needs and new and more efficient learning modes. Thus, several broad forces will be addressed (e.g., increased uncertainty, growing abundance, intensified competition, increased emphasis on learning, consumer role), which are shaping the emergence and evolution of "pull" platforms [12].
c. Industrial involvement - The new model also calls for industrial involvement, mainly of its experts, transforming their role into a proactive one in teaching graduate courses, mentoring research, serving on university committees and boards, and contributing to the strategic thinking of the universities.

The new role for academia should also open the door for other significant modifications. The recently described power of "pull" [12] offers a very plausible approach to creating value and rapidly driving performance to new levels. It calls for the creation of environments that effectively integrate teams within a broader learning ecology so that performance improvements accelerate as more participants join in. Moving away from the old way of "push" to the new way of "pull" requires creating of an innovation ecosystem that will go beyond single university boundaries by transforming methods of learning and teaching, encouraging the combined efforts and full participation of all of the diverse stakeholders, and most importantly, making use of passionate human resources.

5. Revised IP Model

Innovation cannot exist without IP rights, and this creates what is known as a "Gordian knot." Resolving this issue is paramount. The traditional role of the technology transfer office (TTO), acting as a broker between academia and industry by providing expertise and managing the commercialization process related to technology transfer, patenting, licensing and the creation of start-up companies, should be modified. The TTO's main objectives should be reformulated to increase the likelihood of maximum impact. Focusing only on IP rights has become an impassable and sometimes even crippling barrier for innovation success. This concern is even more salient in an OI ecosystem. To avoid stagnant situations, the complex IP issue requires special attention and new business models for co-sharing. An example of IP

management can be taken from the University of California at Berkeley's Office of Intellectual Property and Industry Research Alliances (IPIRA), whose overviews of the university's transactions must be varied and flexible to achieve an array of outcomes that match the mutual goals of industry and the university. This array spans an entire relationship continuum. IPIRA supports Berkeley's research enterprise and its goal of deploying research results for social impact and public benefit. When universities elect to make academic discoveries proprietary by obtaining IP rights, and when they license those rights, they are demonstrating good stewardship [15]. Hence, it is important to note that revenue generation from IP rights should be considered in the overall context of network collaborations, partnerships, social impact and optimal accessibility. Multiple and diverse adaptable IP-management strategies are therefore required. Supporting and implementing this approach is a significant burden that rests on the shoulders of the academician and calls for leadership by personal example.

6. Management's role

Management commitment and leadership is vital in nourishing, embracing and facilitating OI and SiW principles, broadening the group of participating partners, enabling, and sustaining the innovation process. Management's foremost role in industry is to recognize that they are the "gatekeepers" of the innovation flow [16] and must promote, leverage and drive the required organizational changes to increase the likelihood of success. Counterpart management in academia should develop a strategy and sustain a culture that promotes collaborations, and elevates and enhances the academic status of applied R&D. Note that academia needs to undergo significant changes beyond embracing and promoting applied research: it must also value the importance of the overall impact of its research and inventions through the lens of social contribution. This calls for further in-depth consideration and each university should develop its own mission to comply with this requirement.

Random collisions and interactions among innovation contributors is not an option. The new mantra has changed from "innovate or die" only a decade ago, to "partner or perish" today—a new tune and way of life [7]. To thrive, management should institutionalize alliances/partnerships (i.e., inside-in, outside-in) to benefit from cross-fertilization and synergy. Aligning university and industry in the co-development of sustainable innovation is not straightforward: it requires considerable management planning and commitment. Different cultures and mindsets are significant hurdles to be overcome in obtaining a sustained co-development innovation process. Organization expediencies, cultures and especially people's personalities are also significant factors that need to be considered. Moreover, it requires truly new thinking at both academia and industry levels. True changes do not come about through simple incremental developments, and conventional stepwise improvements will not suffice. The changes have to be bold, requiring novel thinking and new leadership [17]. Openness cannot simply be wished for: it must be designed and engineered into the new system by its leaders. Academia and industry need a mutually shared vision, a coordinated thrust toward reforming the "old" systems, not only of relationships between industry and academia, but perhaps more importantly, of teaching, learning and studying. Academic leaders must plan to bring students into the new corporate reality that has emerged in the last decade and will continue to develop in the foreseeable future. Perhaps the first task is to inculcate a recognition of the new reality into students, namely that science, technology, knowledge, business and social responsibility are all part of today's new world requirements [17]. Last but not least, to facilitate partnerships and improve the chances for a successful innovation outcome, industrial and academic management should be aligned so that all stakeholders can split the efforts and benefits.

7. Social responsibility

For a business to create value for its shareholders over the long term, it must also bring value to society. Since its first emergence, the notion of corporate social responsibility (CSR) has moved from

ideology to reality: today it represents an important dimension in contemporary business practices and it promotes OI [18]. The concept of created shared value (CSV) recognizes that societal needs, not just conventional economic ones, define markets. It also recognizes that social harm or weaknesses frequently create internal costs for firms—such as wasted energy or raw materials, costly accidents, and the need for remedial training to compensate for inadequacies in education. Addressing societal harms and constraints does not necessarily raise costs for firms, because they can innovate through the use of new technologies, operating methods, and management approaches—and as a result, increase their productivity and expand their markets [19].

Universities also have an important social responsibility and therefore should play a major role in maximizing the outcome of their research's impact while simultaneously considering CSV. This should include scientific merit as well as the overall contribution to society. Metrics for quantifying scientific contributions have been developed over the years (e.g., journal quality, impact factor, number of citations), as have measures of financial success (e.g., patents, licensing, royalties). However, the social impact associated with CSR and CSV is still vague. The development of suitable metrics to assess and evaluate research's overall contribution lies at our doorstep, and it is our responsibility to address this complex topic. Metrics cover a spectrum of important dimensions: on the one hand, they should continue to promote the high quality of fundamental research, and reward scientific breakthroughs, enhanced OI and partnerships. On the other, they should also facilitate and enhance contributions to society. A genuine concern for society in all actions and decisions should become the norm and an integral part of the innovation process [1].

8. Conclusion

Four paradigm shifts are recommended: barrier removal, revised IP model, management's role, and social responsibility, highlighting measurable and meaningful actions. They constitute a blueprint for jump-starting the process that is required to meet the innovation challenges facing academia and industry. Although significant changes are recommended, it is realized that, in addition to moving forward, a consensus needs to be created, requiring open deliberations and further discussions. To effectively cope with the accelerating development of science and technology, universities and industry need each other. This need is amplified by the quest for highly qualified human resources and the ever-increasing cost of research and equipment. The innovation process creates value and should also include implicit social responsibility. SiW offers a win-win approach to addressing these topics but it requires additional input from all key players to galvanize the impetus of change. It requires passionate and committed leaders, academicians, human resources and organization. Partnerships offer an opportunity to co-innovate the future. Integrating the whole innovation process should therefore take into consideration the social contribution. That which has been the norm is no longer sufficient; together we can make a difference and we must not fail to try.

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