

# The Evolution of Marketing Influence in the Innovation Process: Toward a New Science-to-Business Marketing Model in Quadruple Helix

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**Abstract** It is well known about today's knowledge-based economy that knowledge has become its key resource, and therefore new knowledge and innovation have become of central importance. However, we should not forget that knowledge creation is not the only engine of this economy. For regions, enterprises, and universities, it is not the creation of knowledge that signifies distinctive competitive advantage but the way they can apply this knowledge. As the social application of innovation has founded new approaches in recent years and the Triple Helix (Leydesdorff and Etzkowitz *Science and Public Policy* 23:279–286, 1996) and then the Quadruple Helix (Carayannis and Campbell *International Journal of Technology Management* 46(3/4):201–234, 2009) models have emerged, the related marketing tools have also had to change inevitably. Our article aims to review the connection points of innovation and marketing in the course of changes in the models of knowledge production and innovation on the one hand and provide an answer to the latest innovation-marketing challenges with an extended marketing mix model on the other. In our paper, we examined how marketing can support the involvement of the affected segment of society into today's changed innovational context.

**Keywords** Early stage technology transfer · Science-to-business marketing · Quadruple helix · Academic innovation

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## Introduction

The central resource of today's economy is knowledge. The efficiency of this resource is determined not merely by its creation and production but by the way of its application and use. Traditionally, the centers of knowledge production were the universities, but in terms of the ways of knowledge application earlier—in the case of second-generation universities—only education and the spread of scientific publications were dominant (Wissema 2009). By the end of the twentieth century—primarily as a result of the Bayh-Dole Act adopted in 1980 in the USA—the process of knowledge application altered: the way was opened for the commercialization of research results and technologies produced in universities, the “third-generation” universities emerged, where the commercial application of knowledge became predominant (Wissema 2009). The industrial relationships of universities began to expand, and special institutions and technology transfer offices were established to coordinate them (Buzás 2005). In the knowledge-based economy of the twenty-first century, this process has gained a new impetus; university knowledge has now become the foundation stone of the knowledge-intensive economy of a region, and the “fourth-generation” universities have emerged, which influence their environment including the community and the society of the region in a proactive way (Pawlowski 2009; Zuti and Lukovics 2014).

In terms of universities, the application of technologies has thus transformed from a possible source of additional income to a task having a crucial effect on local economy. To meet the requirements of this role, it is no longer sufficient to have an occasional system relying on researcher discretions, supervised by disciplinary peers and bearing academic aspects in mind, but it requires a professional, business-like attitude and a real entrepreneurial university model. In this model, the adequate coordination of the supply realized in university innovations and the demand of the market has an important role. Commercialization is itself a field of science: marketing, thus the situation described above, actually highlights the necessity of connecting innovation and marketing. It is not new that the innovation process is linked to marketing elements, as the concept of innovation itself makes application essential: “innovation leverages knowledge for knowledge application, diffusion and use, and thus translates knowledge into application” (Carayannis and Campbell 2010, p. 44), and marketing as an activity required for the commercialization of innovation already appeared in the early linear models of innovation (Miyata 2003).

In our present paper, we review the change in the models of knowledge production and innovation and describe the essence of the marketing concepts related to the particular approaches. In relation to the application of innovation results, marketing was important in the early linear models; however, in today's knowledge-based economy, a renewed marketing concept is needed for the changing role of universities. We summarize this new marketing mix with the 6P model within the science-to-business marketing concept providing the theoretical framework of university-business relationships (Baaken 2013), highlighting how marketing can serve the social application of innovation within today's changed innovational context.

## The Linear Models of Innovation and Marginal Marketing Role

The traditional approach of the innovation process starting out from research development (so-called technology push type) is the linear model, which can be linked to Vannevar Bush's work from 1945,<sup>1</sup> who created the theory—which has been altered and interpreted several times—to emphasize the significance of basic research. The essence of the model is that innovation is rooted in basic research and it reaches the stage of market introduction through the stations of applied research, development, and production. The role of marketing is significant in the latter station, when successful commercialization is supported by marketing tools (Miyata 2003). The linearity of the model implies that the development is one way, sequential, and is not characterized by feedbacks.

The linear innovation model can be linked with more extensive marketing support based on Livingstone (1997). In the course of this, marketing accompanies the process of innovation, enriching the entire process with continuous market reflection aligned with the activities related to the particular stations, i.e., marketing activities take place in parallel with the R&D&I process (Fig. 1).

The first step of the above linear R&D&I process is the elaboration of the idea, where marketing can provide a useful feedback with a market-based potential evaluation whether it is worthy of further development in market direction. If so, the innovation process continues entering the phase of implementation, which is supported by the marketing and business planning of the emerging product and strategy formation, thereby preparing for the last step of the innovation process, market entry, and distribution (Livingstone 1997).

This process goes beyond the traditional linear innovation model in that the feedbacks stemming from marketing can modify research directions based on market aspects. It typically characterizes business innovation models, such marketing support of university innovation is not a widespread practice.

In the linear model of innovation, the feedback role of marketing is generally marginal; the further development of basic research and its occasional commercialization frequently do not happen according to marketing aspects and typically a non-marketable product is licensed. It is demonstrated by Jensen and Thursby's (2001) research where only 12 % of the licensed technologies they examined was in a marketable condition; the majority required considerable development and further cooperation with the researchers in order to develop a marketable product.

In the linear model, the aim is the further development of basic research and not the operation of a process sensitive to market reflections. Gibbons et al. (1994) call it mode 1 phase, in which knowledge production can be achieved by traditional “discovery” research in universities and the process is supervised by disciplinary peers, thus the quality of the innovation is determined by its scientific value, while applicability and the resolution of a problem valuable for society are not a concern. However, in a knowledge-driven economy universities, the application of knowledge is considered not only a potential direction of further development but an important expectation from business—moreover, society—point of view. In this regard, the market aspects and

<sup>1</sup> “Science the Endless Frontier: A Report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development”. National Science Foundation. July 1945. Retrieved April 22, 2012.

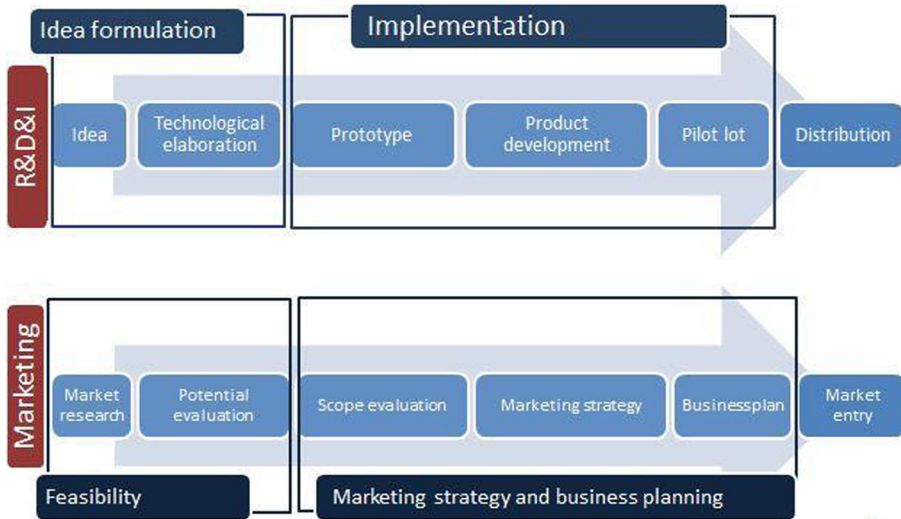


Fig. 1 Innovation process and related marketing activities

feedbacks have to become an integral part of the innovation process and this calls for the non-linear models of innovation.

### The Non-linear Models of Innovation and Marketing Approach Related to the Triple Helix Model: Science-to-Business Marketing

The Bayh-Dole Act of 1980 changed the conditions in the USA in a way that it allowed universities and state-owned research institutes the ownership and commercial application of the intellectual property they produced. Earlier, the intellectual property of these institutions was owned by the state, which in turn made commercial application more difficult—it is demonstrated by that in the USA only 5 % of nearly 25,000 state patents before 1980 were applied and used in the industry. As a consequence of the act, the number of the American patent applications submitted in the decade between 1990 and 2000 increased from 2004 to 6375, the number of granted patent grew from 1267 to 3764, the number of signed license agreements and exercised options rose from 1043 to 4362, and the revenue from the total licensing increased from US\$153 million to US\$1335 million.

From this point, however, the importance of university technology transfer processes started to grow. This new form of innovation in universities is called mode 2 phase by Gibbons et al. (1994), in which knowledge production is a transdisciplinary process taking place with the purpose of application. This creation and use of knowledge is characterized by heterogeneity and organizational diversity, and its important part is social reflexivity and quality control. This process was supported by several environmental factors (Bercovitz and Feldmann 2006):

- Technology sectors with new and high potential started to develop: information technology, molecular biology, materials science

- The scientific and technological elements gained increasing weight in every industrial production
- Due to budgetary constraints, a demand for new research resources emerged in universities
- The endeavor of governments to increase the returns of publicly funded research intensified, and thereby in the direction of promoting technology transfer

In this situation, the leading enterprises of the market, which operated under continuous pressure of innovation, started to build their strategy around their core competency, which provided the main competitive advantage for them (Prahalad and Hamel 1990), at the same time narrowed their business focus, and they started to incorporate the necessary additional competencies through establishing technology transfer relationships (Buzás 2005).

Besides the public and business sectors, the university sector also appeared in the economy. The relationship of these three sectors and their overlaps are modeled by Leydesdorff and Etzkowitz's (1996) Triple Helix model: "The Triple Helix thesis states that the university can play an enhanced role in innovation in increasingly knowledge-based societies" (Etzkowitz and Leydesdorff 2000, p. 109). Universities in this context have to be involved in the "third mission" besides education and research (Laredo 2007), i.e., they have to support economic development (Etzkowitz and Leydesdorff 2000).

Instead of the traditional linear innovation model, a non-linear model of innovation has been developed in which university-industry relationships and market feedbacks have an increasing role. The essence of non-linear innovation model is that it no longer understands the commercialization of university research as a process where first knowledge is created and then it is commercialized but during the entire process, there is an ongoing relationship between the university conducting the basic research and the industrial actors applying it (Carayannis and Campbell 2010). Knowledge creation and production have to be connected with knowledge application and use, and the feedbacks related to the latter have to reach the source of knowledge production. This is the essence of the structure of the non-linear model of innovation, where the system is not characterized by sequential processes but many parallelisms and partly causality (Carayannis and Campbell 2010).

Universities therefore have an increasing role in the knowledge-based society. The social application of the knowledge produced in universities has now become a crucial economic factor and has founded marketing solutions that match the specificities of this special knowledge commercialization. This new marketing trend is called science-to-business (S2B) marketing, which covers the marketing tools and solutions related to the knowledge production and innovation activity in (research) universities and research institutes, with the purpose of the application of the produced intellectual properties and innovations (Baaken 2013).

Although the S2B marketing is related to already known marketing fields (business-to-business marketing; non-business marketing), it still requires a separate approach, since according to Prónay and Buzás (2013), it has characteristic specificities:

- *Regional characteristics:* On the one hand, the regional characteristics become apparent in that the technology transfer activity carried out by the local

university—as a knowledge center—is crucial for the given region. On the other hand, as the effect of the country of origin is also well known in the case of products—which implies that the consumer considers the place of production of the given product as an important feature in the purchase (Porter 1998; Jaffe and Nebenzahl 2001)—the marketability of intellectual property is also influenced by where, i.e., from which university it originates.

- *“Hit or miss” nature:* The basic research and its (early-stage) results can mean a qualitative leap—contrary to a simple technological development (Borg 2001). This high potential, however, signifies real market value only in a small percentage of the cases, while basic research de facto mainly results only in knowledge improvement. This is similar to the “hit or miss” type of swing in baseball, which is a large swing that mostly misses, but if it once hits the ball, it is a home run. This special product requires a special marketing approach.
- *Two-sided risk:* The essence of the concept known from service marketing is that the purchase means a risk not only for the customer—as they do not know exactly what they buy—but also for the seller (Veres and Buzás 2006). In S2B marketing, it results from the fact that it is quite difficult to predict the future yields of an early-stage research and thus it is almost impossible to calculate its present value. Thus, the customer risks that they buy a useless commodity, while the seller takes the risk that they undersell an innovation of huge potential.
- *Researcher vs. marketer:* While for a business venture the central aim is to sell the product or service, it is far from certain that at the university, the producers of the intellectual property (researchers) want to sell it (Bercovitz and Feldmann 2006).

The traditional marketing can be generally characterized along the 4P marketing mix based on McCarthy (1960). The four marketing mix elements of the S2B marketing can be interpreted based on Prónay and Buzás (2014) work on this field as follows:

- *Product:* The product is the intellectual property produced by the university, which is typically an early-stage technology, where the marketing challenge is significant as a result of the following characteristics of its application: (1) In most cases, it is not a marketable product but a basic research result, which was produced in a research workshop of the university mainly not for commercial purposes. (2) The scope of these products, i.e., the portfolio of the university is often only partially known by the university decision makers, since there are numerous ongoing research activities in several research workshops (departments, laboratories), but only a few researchers report the emerging innovation results for the technology transfer office of the university. (3) The products are in the initial phase of their lifecycle, so considerable risk is attached to them on the one hand, and they have a rather narrow market on the other. (4) The majority of university innovations is a result of knowledge improvement research that was induced by the producing researchers’ scientific interest, thus it is strongly personal, incidental, and cannot be standardized.

Taking the above specificities into account, the focus of the product activities of S2B marketing is the conscious portfolio management. It is important to operate an adequate invention report and registration system. In the course of this, the task of product marketing involves registering the intellectual properties produced in the

university, as well as evaluating them, including them in the portfolio and removing them from the portfolio, and thereby optimizing industrial property rights costs.

- *Price*: Setting the price in S2B marketing is characterized by personalized pricing (or first-degree price differentiation), because uniqueness is an inherent feature of innovation results. It is a possibility for higher pricing due to the unique nature on the one hand but also represents a barrier on the other, because it is difficult to find a reference point to determine the price (Reeves 2006); moreover, it is quite difficult to determine the future profitability of an innovation. The price can be influenced by several factors: validity of license (exclusive or non-exclusive), obligation to delay publication; industry, partners and the characteristics of their relation, geographical location, university regulations, etc. (Bercovitz and Feldmann 2006). This situation found specific pricing strategies in the field of S2B marketing: (1) not selling but licensing, (2) “upfront+royalty” model, and (3) cost share solution.
- *Place*: It covers the application and distribution of the knowledge produced in the university. Since S2B is a confidential business, distribution is characterized by personal selling, where knowing the seller and the customer and establishing a relationship of trust between them have an important role. Technology transfer often involves the transfer of tacit knowledge rather than codified knowledge; therefore, the personal involvement of the parties and interactive communication are essential parts of the process (Gertner et al. 2011; Walter et al. 2011; Plewa et al. 2013). Commercialization typically takes place through a short distribution channel—since it is important to maintain the connection between the end user and the inventor—nevertheless, the intermediary bridging institutions have a considerable role. They can coordinate the dispersed supply and the fragmented demand, establish relationship between them, and provide a platform for communication.
- *Promotion*: Traditionally, innovation results are promoted in scientific publications and conference presentations. These forms have limited business potential; moreover—through novelty destroying—they often make the protection of the given intellectual property impossible, thereby considerably decreasing its applicability. S2B marketing communication applies a more market-oriented approach; it focuses much more on image building. Its narrowly defined objective is providing information about the intellectual property and arousing the interest of potential customers. Its broadly defined objective is promoting the institution itself and its innovation activity. Its most important tools are (1) print publications about the innovation potential and portfolio of the university; (2) online knowledge map, knowledge base, which summarizes the commercially applicable resources of the university in a transparent, structured, and searchable form; (3) events within the university, between universities and university-industry workshops that are platforms for building personal relationships; and (4) business-like image (Park et al. 2006). Overall, successful S2B marketing communication is characterized by proactively building and applying a business-like image, in which the university and its intellectual properties are both presented in a manner that is comprehensible for business and social actors.

In the Triple Helix model, the business application of university knowledge became an important activity, which founded a special S2B marketing approach. Nowadays, the knowledge application have changed, the spectrum has widened. The knowledge

application and use interpreted besides the business commercialization at the overall level of society and consequently the S2B marketing model also needs to be transformed.

## S2B Marketing in the Quadruple-Helix Model: Potential and Partnership

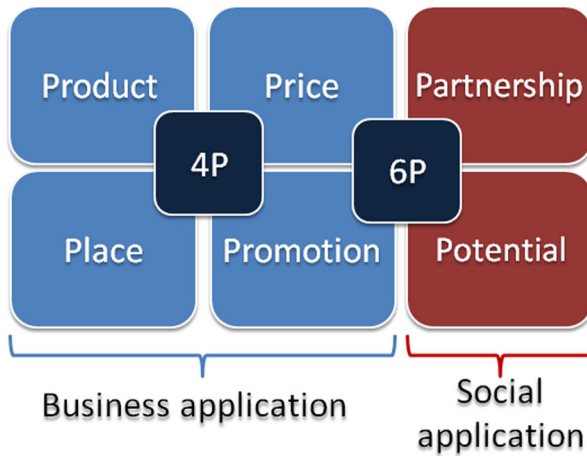
In the earlier presented approach of Gibbons et al. (1994), mode 1 phase can be described with the linear innovation model and only marginal marketing is related to it (see Graph 1). Contrarily, in mode 2 phase, the objective is, in fact, distribution, whose effective implementation is fostered by marketing tools. In mode 2, only such knowledge production can be considered successful which results in socially utilized, transdisciplinary problem solving. In this model, the role of social reflections and social sensitivity is stronger, as the effects of knowledge application and use have to be interpreted at an overall societal level (Gibbons et al. 1994). This knowledge application and use, however, goes beyond the Triple Helix model, as “social processes of a knowledge production must be sensitive for culture and the values that influence a society” (Carayannis and Campbell 2010, p. 51), thus besides the public, business and university sectors, society also plays a role in the application and use of innovation. This knowledge production and knowledge application can be better grasped with the Quadruple Helix model created by Carayannis and Campbell (2009), which “adds to government, universities (higher education) and the economy as further fourth helix the ‘public’,” more precisely being defined as the “media-based and culture-based public”: “media, creative industries, culture, values, life styles, and perhaps also the notion of the creative class” (Carayannis and Campbell 2009, p 51).

While in the Triple Helix model, the economic applicability of technology was the criterion of decision; in the Quadruple Helix model, knowledge application is also related to values and culture (Carayannis and Campbell 2010). This also means that the university in the Quadruple Helix model no longer intends to apply and use the produced knowledge and technology merely in commercial terms but it creates social value by distributing its knowledge. As a consequence, the above-described 4P marketing mix of S2B marketing also needs to be extended with a view to consider wider social aspects and provide feedbacks on its basis.

This situation is reflected by a new model, where the earlier described 4P elements are still presented because they properly grasp business aspects in the mode 2 phase; but on account of the holistic view, we developed the 6P model by adding two new elements (Prónay and Buzás 2013), which we interpret in accordance with the Quadruple Helix approach as follows (see Fig. 2):

- *Partnership*: This includes the tools which provide the contact with stakeholders and involvement in the social network in general. Proper partnership is essential to social reflexivity characterizing mode 2, which implies two-way information flow instead of one way and linear innovation distribution, i.e., an ongoing knowledge sharing between the stakeholders during the innovation process (Carayannis and Campbell 2010). Such feedback and involvement of the stakeholders has to be part of the marketing process; thus, its tools may include (1) university-business innovation workshops, (2) innovation competitions and start-up competitions, and (3) civil workshops.





**Fig. 2** 6P marketing mix model

- *Potential*: While partnership serves to provide information about social aspects, potential gives a tool to take them into account in the innovation process. When deciding about the applicability of an invention, besides considering the earlier, merely economic benefits, the factors of potential allow taking account of how the innovation relates to social value. The factor of potential summarizes marketing tools which relate to the social benefit achievable with the application of the given technology, such as: (1) studying the long-term effects of technology, (2) the cultural embeddings of technology and taking account of cultural changes resulting from its application, (3) the issue of knowledge patenting and its open access (open innovation and specially targeted open innovation), and (4) the effect of technology application on environmental sustainability.

It also applies to the 6P marketing-mix model that it is to be used in university knowledge application, and its appliers are primarily the decision-makers and technology transfer offices of higher education institutions. It goes beyond the former S2B marketing model in that it gives a role to the public and the social aspects it communicates and represents, which is explored by the factor of Partnership, and with the tools of Potential the university takes the social benefit of the given technology into account during the application of innovation.

It is important to separate the two new factors of the 6P model from the similar factors of the former 4P model. Partnership differs from Promotion, as the slogan of the 2014 Science-to-Business Marketing Conference reflected it: “Communication is shouting, marketing is listening.” Of course, feedback plays an important role in communication too, but the Partnership factor of S2B marketing encompasses tools which use feedback not for the purpose of delivering the technological message—as it is generally typical in communication—but attempt to manage it from a social aspect with a feedback to the source of knowledge production. Partnership also considers the aspects of the stakeholders that are affected by the social spread of the given technology but do not entail business potential in marketing terms. Therefore, Partnership requires much more interactive, open and involving information flow, and aligned solutions than Promotion.

Potential also has to be separated from the factor of Product. The latter only manages the marketable product and business benefit, since in marketing terms, it cannot be a product, which does not make business profit. Potential refers to the tools which are used for making a decision about what value an early-stage technology has for the society and how should this value be protected or shared and extended or further developed.

## Conclusion

Knowledge production is not a self-serving process, and although the importance of the innovations and basic research results springing from researchers' interest should not be underestimated, it still needs to be admitted that nowadays, only applied and used knowledge can be considered a real competitive advantage. Nevertheless, it is important to interpret use in a holistic way. It is not only commercial benefit and industrial application, which represent use for university intellectual property but also getting involved in the social value-creating process. Accordingly, we cannot limit our focus merely to business aspects and business actors in the course of application. Social actors, the broader stakeholders, and the public interpreted by the Quadruple Helix need to appear in the application process.

Our study pointed out how marketing can contribute to the commercial application and use of a product or technology—or even a university intellectual property—in many ways. Although marketing plays an important role in the social and business application of knowledge, we should not forget that this is only a tool, whose value is determined by the purpose it is used for. If it is applied to achieve a good aim, the above tools are socially beneficial too. However, if it supports the industrial application of a particular technology only according to business considerations, it can even be a socially harmful tool (e.g., formula displaces breast milk; we develop weapon of mass destruction instead of nuclear energy).

As the understanding of innovation had to change, so the related marketing mix has to develop. The 6P marketing mix we described is the first step to include the assessment, feedback, and consideration of social needs based on partnership besides business aspects in knowledge application. The latest approaches of innovation process—in particular the Responsible Research and Innovation Theory (Von Schomberg 2013)—open new perspectives in the application of the 6P marketing mix model, regarding which interesting research questions can be defined in the future.

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