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From Broken to Linked Innovation: The Underlying Concept

Abstract Promising to drive economic sustainability in research centers while preserving research quality, linked innovation is framed in this chapter as the connected process between research and commercialization, a route in which the investigation done is transformed into economic value to make the process sustainable. It is a track that interconnects two aspects: the pull of market needs and the push of knowledge. Perceived demand will be met only if the appropriate knowledge is available, and innovation will happen only if there is a market for it. Eight symptoms are then described for identifying the gaps in the innovation process, called broken innovation, through the examination of four challenges: performance metrics, market understanding, industry collaborations, and innovation ecosystems.

Keywords Broken innovation · Linked innovation · Knowledge push · Market pull · Invention · Innovation funnel · Discovery commercialization · Knowledge transfer · Research center · Economic sustainability · Value creation · Value appropriation

2.1 The Stages of the Innovation Funnel: Research, Transformation, and Commercialization

Last week, I met an executive of the healthcare company Roche. We were discussing a study, published in the journal *Research-Technology Management*, that describes how most industries appear to require 3,000 raw ideas to produce one substantially new, commercially successful industrial product.

3,000 raw ideas turn into 300 ideas for which minimal action is taken—such as simple experiments, patent filing, or management discussion. Then 125 of those 300 ideas become small projects; 9 out of the 125 become significant projects with a significant development effort; 4 out of the 9 become major development efforts; 1.7 out of the 4 is commercially launched; and 1 out of the 1.7 launched (59%) becomes commercially successful. (This last success rate varied from 40 to 67%, depending on the source of information, industry, and geography.) [1].

Joseph A. Schumpeter, who is regarded as one of the greatest economists of the first half of the twentieth century, explained this process of innovation as “the same process of industrial mutation [...] that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one” [2].

This mutation process is analogous to the three classic states of matter. First, the research activity generates discoveries that are intangible and highly adaptable, like a gas. Second, the transformation activity transforms discoveries into inventions that are modestly tangible but still adaptable, like a liquid. Third, commercialization activity transforms inventions into innovations that are tangible and nonadaptable, like a solid [3, 4].

Across each activity of the innovation process—research, transformation, and commercialization—there is an innovation output: discovery, invention, and innovation. Although many discoveries start at the research stage, few inventions reach the commercialization stage.

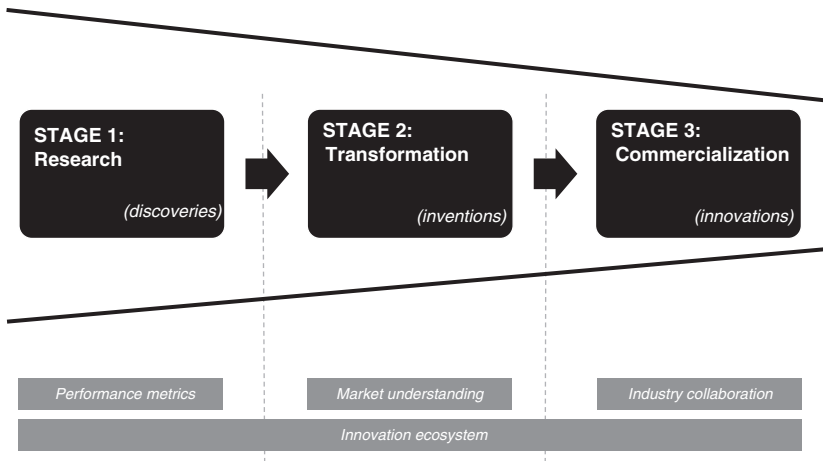


Fig. 2.1 Innovation funnel: stages, outputs, and main challenges. *Source* Prepared by the author. *Note* In each stage, the *top-left corner* shows the activity and the *bottom-right corner* shows the output. In the literature, authors use several names for each stage (e.g., research, development, innovation). However, for simplification, after the interview process, these names were chosen by contrasting the perception of academics and that of practitioners

In summary, we can visualize this selection process as an innovation funnel with three stages. First is the research,¹ which includes the generation of discoveries or knowledge assets. Second there is the transformation, which includes the translation of knowledge assets into tangible assets—inventions. Third is the commercialization, which includes the capturing of economic value, with those tangible assets being transformed into commercial assets—innovations² (See Fig. 2.1).

2.2 Commercializing Discoveries: Main Challenge Areas

Worldwide innovation capital represents 42% of gross domestic product (GDP), increasing at a rate of 4.6% a year (as of 2013). Research and development account for 23% of the innovation capital [5]. Although innovation has many benefits, the process has several barriers.

The most important motives for commercializing discoveries at research centers are the extension of the product or market portfolio, the reduction of entry costs into new markets, the amortization of R & D expenditure and the strengthening of technological leadership (See Sect. 8.1) [6].

However, research inputs do not always trigger commercialization outputs. Broken innovation is defined as the unconnected process between research and commercialization, a route in which the investigation undertaken is not transformed into economic value to make the process sustainable.

So what makes this process unconnected? To identify the bottlenecks in the innovation funnel, my initial goal was to prioritize the main challenges faced by research center managing directors when trying to commercialize their internal discoveries along the stages of the innovation funnel.

My results suggest that there are four main challenge areas for capturing value from discoveries: performance metrics, market understanding, industry collaboration, and the innovation ecosystem [6, 7].

First, the performance metrics are used to decide how to choose from among different initiatives in the research stage. In other words, how do I grade, prioritize, and select from several initiatives. For example, should I measure the number of potential new publications? Should I measure the synergies I expect to achieve within the institution? Should I measure the number of people who may be cured of the illness being studied? And so on.

Second, there are principles and actions for understanding the market and successfully transforming discoveries into products and services. For instance, how to choose among different transformations of a discovery—an article, a patent, a license, a spin-off, etc.? How do I know what the market demands?

Third, there are mechanisms to apply, during industry collaborations, to commercialize discoveries effectively. For example, how do I collaborate with the industry, keeping in mind its tight schedules and short-term demands for returns on investment? How do I keep the academic freedom to avoid biases in the process? How do I commercialize the inventions?

Fourth, in the innovation ecosystem, there are ways to fill stakeholder gaps throughout the process.³ For instance, how do I commercialize discoveries if there are no companies with enough revenue to pay for those products or services? How can you overcome the internal bureaucracy involved in releasing intellectual property when you are a researcher and not a legal expert? How do you launch experiments when you do not have the labs or internal capabilities to do so? (See Fig. 2.1).

In each challenge area, I identified the differences between those centers that achieved a connected process among the innovation stages and those that did not. Is there any way to identify the unconnected process through those patterns?

2.3 Broken Innovation: The Symptoms

1772, 1929, 1973, 1997, and 2007. If you like to play with numbers, what do these five have in common?

These are the approximate starting dates of five of the world's most devastating financial crises. Financial crises are, unfortunately, quite common in history and often cause economic tsunamis.

It was difficult to predict those crises. However, in a lesson learned, policymakers have suggested reducing the risk by identifying symptoms and monitoring vulnerabilities. Possible alarm signals are asset price bubbles and credit booms, which can entail substantial costs if they deflate rapidly. A monitoring of sharp increases, for instance, may help to determine whether they would be followed by a steep and rapid decline [8].

There are still signals that some research centers are disappearing (See Sect. 1.2). Is there any way to identify the symptoms of broken innovation to avoid a Lehman Brothers-style crash among research centers?

In some cases, problems can be predicted by identifying symptoms which are indicators of negative underlying issues that can potentially lead to an undesirable situation or unwanted scenarios (e.g., broken innovation).

My results suggest eight scenarios that trigger broken innovation: two triggers per each identified challenge. These symptoms have been identified

through an analysis of research centers, the triangulation of public information, interviews with their managing directors, on-site visits, a review of the available literature, and so on (See Sect. 8.4) [9].

For each problem across the three stages of the innovation funnel, the symptoms are illustrated as well as the two most common scenarios for each case (See Table 2.1). These triggers are a thermometer to identify whether you are suffering because of the undesired situation.

First, when deciding on the performance metrics on how to pick the best one among several initiatives during the research process (stage 1), there were two triggers. There were the centers that prioritized only academic metrics (e.g., the number of refereed articles published in top journals) used to find their economic sustainability was on a downward slope. Alternatively, there were the centers that prioritized only economic metrics (e.g., profits) also experienced a decrease in the quality of their research. In summary, there was a lack of alignment in priorities.

These two symptoms can be expressed in questions for self-reflection: are you experiencing a decline in research quality? This might involve, for example, whether you perceive a decline in the research projects' rigor or in the number and quality of the center's publications, or whether you experienced external biases from collaborators. Are you facing a decrease in economic profitability?

Second, when it came to understanding the market to translate discoveries into products and services during the transformation process (stage 2), there were two triggers. There were the centers that assumed what the market needed rather than validating what the market actually wanted (in terms of research questions, feedback, etc.). Then, there were the centers that were merely faithful followers of market trends, closing the door on creating something beyond those trends. In summary, there was a lack of alignment in needs.

These two symptoms can be expressed in questions for self-reflection: are you coming up with products or services that no one wants to buy? Are you producing outdated products? Are your researchers always changing their focus and research interests?

Third, when it came to managing collaborations with the industry in the commercialization process (stage 3), there were two triggers. On the one hand were the centers that focused on research collaborations

Table 2.1 Challenges and symptoms of broken innovation

	Stage 1: research	Stage 2: transformation	Stage 3: commercialization
Broken innovation	Performance metrics Economic vs. academic <i>Are you facing a decline in research quality or in economic profitability?</i>	Market understanding Assuming vs. following <i>Are you coming up with products that no one wants to buy or that are outdated?</i> Innovation ecosystem Internal vs. external <i>Do you lack an innovation catalyst inside or outside your organization?</i>	Industry collaboration Research vs. furtive <i>Are you experiencing increased difficulty in monetizing your discoveries or in getting access to industry data?</i>

Source Prepared by the author based on analysis of the cases, interviews, and a literature review [10–16]

only to gather data and nurture databases to develop their own projects, without giving much consideration to how to help the other stakeholder. On the other hand were the centers that were seen as future sales centers, whose only goal was to capture economic value from research results. In summary, there was a failure to ensure that both stakeholders benefited.

These two symptoms can be expressed in questions for self-reflection: are you experiencing increased difficulty in monetizing your discoveries? Are you experiencing increased difficulty in getting access to industry data and professional networks?

Finally, there was the matter of choosing the right internal and external partners to enhance your center across the three stages of the innovation funnel. There were the centers that chose their partners according to internal proximity—those inside their offices or institutions—and assumed that the whole innovation ecosystem should be kept inside the organizations. Alternatively, there were the centers that prioritized partners according to external proximity—those that were geographically near their research centers—and assumed that the whole innovation ecosystem should neighbor their organizations. In summary, proximity was prioritized rather than meritocracy.

These two symptoms can be expressed in questions for self-reflection: do you lack innovation catalysts inside your organization? In other words, is your research center prevented from successfully commercializing its discoveries by the fact that the center is missing an actor? Otherwise, do you lack innovation catalysts outside your organization?

If you have answered “yes” to any of the previous four pairs of questions, you are probably suffering the symptoms of broken innovation.

2.4 Linked Innovation: Mixing the Knowledge Push and Market Pull

During the past 4 years, several directors of research centers in the private and public sector, who were aware of this research project and who were conscious that their institutions were experiencing a process

of broken innovation, came to me and said: “OK, Josemaria, now I know that I have a broken innovation process. How can I solve the problem? How can I solve the lack of a connection between the research quality of my center and the economic results?”

After identifying the four common challenges and symptoms in terms of commercializing discoveries across the innovation funnel in a process of broken innovation (See Table 2.1), the following sections will set out the causes of the problems identified and suggest several solutions for moving to linked innovation.

Linked innovation is defined as the connected process between research and commercialization, a route in which the investigation done is transformed into economic value to make the process sustainable.

This model of linked innovation is based on several models, such as the chain-linked innovation model of Kline and Rosenberg that embodies the technical activities occurring in the innovation process, the external forces of the marketplace, and the complex interactions between the various stages of the process [17].

In my proposed model of linked innovation, two aspects are interconnected: the pull of market needs and the push of knowledge (See Fig. 2.2). In other words, you try to get the best of both the offer side and the demand size. Perceived demand will be met only if the appropriate knowledge or technology is available, and innovation will be realized only if there is a market for it.

This model is a virtuous circle in which the more resources we receive from research, the more resources we can invest in additional research, and so on.

Although the identified problems and solutions are applicable to all types of research centers (e.g., from health care to engineering, and from science to business), the following sections will include a subtle classification using two independent variables that affect the commercialization of discoveries at research centers. These two variables will help you to identify, in more detail, when to focus on a problem or prioritize a solution, depending on the characteristics of your center.

The first segmentation is the age or experience of the center. Research centers that have been created within the past 7 years and that are at an

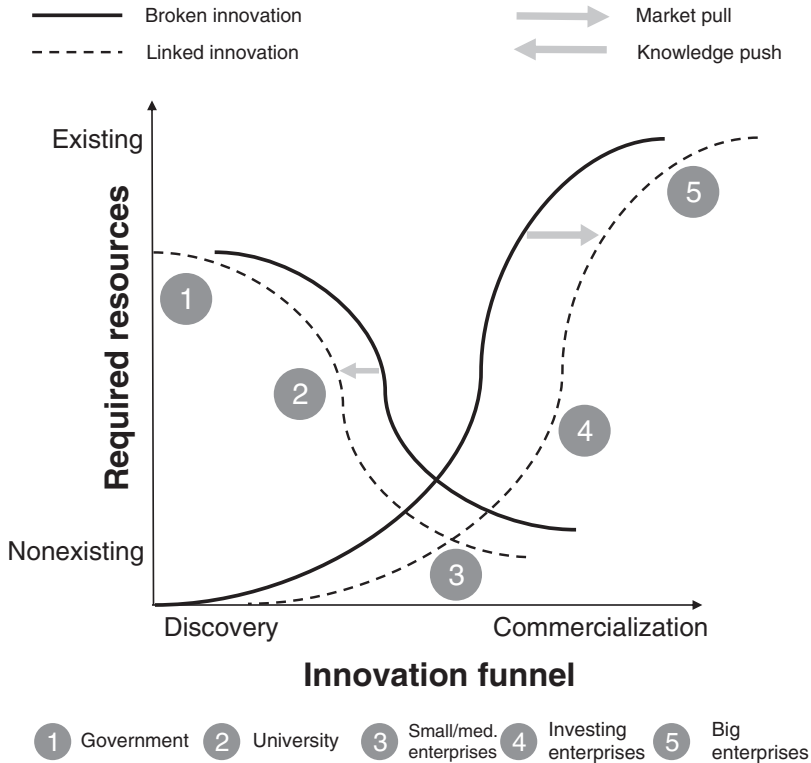


Fig. 2.2 From broken to linked innovation [18]. *Source* Adapted by the author from several models such as *ERC best practices manual* (National Science Foundation Engineering Research Centers Program, 2013)

early stage will be considered young. Otherwise, they will be considered mature. The second segmentation is by orientation. The research center is focused either on research (e.g., answering more theoretical questions, which is usually the case with centers in universities) or on innovation (e.g., answering more practitioner-oriented questions, which is usually the case with centers in industry) [19]. These two variables (age and orientation) give us four possible segments (See Fig. 2.3).

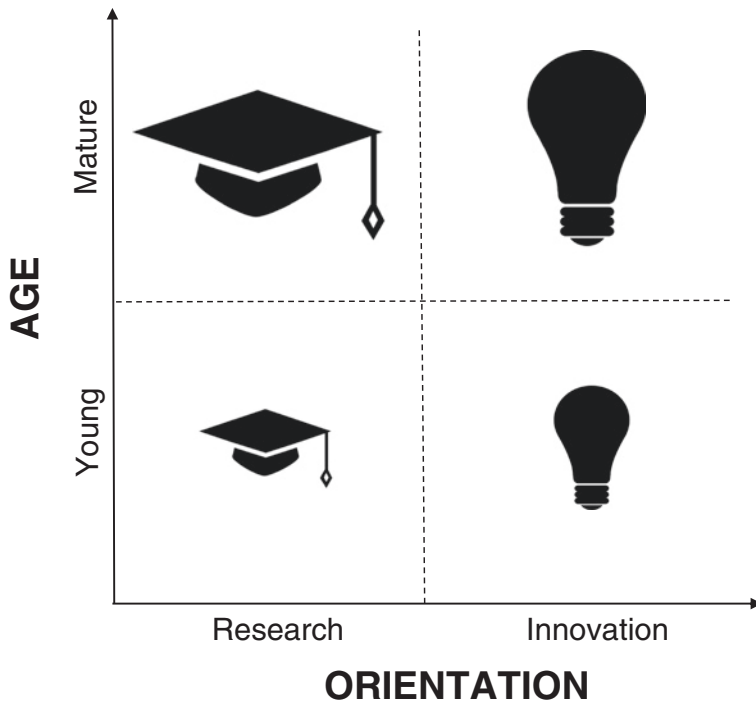


Fig. 2.3 Categorization of research centers by age and orientation. *Source* Prepared by the author

Endnotes

1. According to the Oxford English dictionary, the word “research” means “the systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions” and the word “innovation” means “the action or process of creating a new method, idea, product, etc.”
2. This is a simplification of the chain-linked innovation model of S.J. Kline and N. Rosenberg: An overview of innovation in *The positive sum strategy: harnessing technology for economic growth* (ed. Landau, R., and Rosenberg, N.), 275–305 (National Academy Press, Washington, DC, 1986).

3. An innovation ecosystem is as a set of components, relationships and functions. The components are stakeholders who participate in that environment and are necessary for its existence (from the point of view of both supply and demand). The existence of all of these stakeholders is as important as the nature of the multilateral interrelationships.

References

1. Stevens, G. A. & Burley, J. 3000 raw ideas equal 1 commercial success! *Research Technology Management* **40**, 16–27 (1997).
2. Schumpeter, J. A. Creative destruction. *Capitalism, Socialism and Democracy* 82–85 (George Allen and Unwin, 1942).
3. Lane, J. P. & Flagg, J. L. Translating three states of knowledge—discovery, invention, and innovation. *Implementation Science* **5**, 9 (2010).
4. Roberts, E. B. What we've learned: managing invention and innovation. *Research Technology Management* **31**, 11–29 (1988).
5. Baily, M., Haskel, J., Hazan, E., Marston, N. & Rajah, T. *Innovation Matters Reviving The Growth Engine* (McKinsey, 2013).
6. Lichtenthaler, U. External commercialization of knowledge: Review and research agenda. *International Journal of Management Reviews* **7**, 231–255 (2005).
7. Institute of Medicine (US). *Forum on Drug Discovery, development, and translation Challenges in Clinical Research* (2010).
8. Kose, A. & Claessens, S. *Financial Crises Explanations, Types, and Implications* (International Monetary Fund, 2013).
9. Şendoğdu, A. A. & Diken, A. A research on the problems encountered in the collaboration between university and industry. *Procedia—Social and Behavioral Sciences* **99**, 966–975 (2013).
10. Siegel, D. S., Waldman, D. A., Atwater, L. E. & Link, A. N. Commercial knowledge transfers from universities to firms: improving the effectiveness of university–industry collaboration. *The Journal of High Technology Management Research* **14**, 111–133 (2003).
11. Etzkowitz, H. & Leydesdorff, L. The dynamics of innovation: from national systems and “Mode 2” to a triple helix of university–industry–government relations. *Science and Technology* **29**, 109–123 (2000).
12. Azároff, L. V. Industry–University collaboration: How to make it work. *Research Management* **25**, 31–34 (1982).

13. Van Dierdonck, R. & Debackere, K. Academic entrepreneurship at Belgian Universities. *R & D Management* **18**, 341–353 (1988).
14. Cyert, R. M. & Goodman, P. S. Creating effective university–industry alliances: an organizational learning perspective. *Organizational Dynamics* **25**, 45–57 (1997).
15. Faems, D., Van Looy, B. & Debackere, K. Interorganizational collaboration and innovation: toward a portfolio approach. *Journal of Product Innovation Management* **22**, 238–250 (2005).
16. Vohora, A., Wright, M. & Lockett, A. Critical junctures in the development of university high-tech spinout companies. *Research Policy* **33**, 147–175 (2004).
17. Kline, S. J. & Rosenberg, N. *The Positive Sum Strategy* 275–305 (National Academies Press, 1986).
18. Sander, E. *ERC Best Practices Manual Chapter 5 Industrial Collaboration and Innovation* (National Science Foundation, 2013).
19. Perkmann, M. *et al.* Academic engagement and commercialisation: A review of the literature on university–industry relations. *Research Policy* **42**, 423–442 (2013).

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