Research Assignment

STRATEGY AND TECHNOLOGY MANAGEMENT

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11-1-2023

Contents

Introduction

The concept of open innovation (OI) has been widely described in the literature, mainly by Chesbrough (2003) and others as a process by which multiple innovation actors engage and interact at various stages of innovation. Chesbrough later emphasized the purposive inflows and outflows of knowledge to accelerate internal innovation and expand markets for innovation's external use (2007). Although substantial research has examined the influence of OI on commercialization, few research papers focus on the role of universities in OI and innovation ecosystems. Due to its emphasis on a wide variety of innovation players, the OI process is pertinent to the higher education industry. In addition to carrying out their academic teaching functions, universities conduct extensive research and innovation-related activities. This has been acknowledged by existing literature that points out the gaps concerning the role of universities in what might be defined as the new open innovation landscape (Gassmann et al., 2010). Gassmann et al. also make the key point that open innovation and university-industry ties should be understood as deeper, more fundamental linkages, rather than just as generalised links (2010).

In the late 80s, the Netherlands started their so-called “Mainport strategy”. This strategy focused on the Port of Rotterdam and Amsterdam-Schiphol Airport, intending to boost them as hubs for mobility thereby increasing the investments in the area and developing them in terms of infrastructure that connected them with the rest of the world (Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 1988, 1990, 2004; Grey, 2022). This strategy proved to be successful, with Rotterdam developing as the main port in Europe and Amsterdam-Schiphol as one of the main airports of Europe. However, more and more areas in the Netherlands are developing into international powerhouses. These areas provide additional value to the Dutch economy through trade, infrastructure, or knowledge assimilation. One of these areas is the Brainport-Eindhoven region.

The Brainport-Eindhoven region has developed into one of the Netherlands’ leading locations for innovation and entrepreneurship. Therefore, it benefits from substantial innovation capabilities at multiple locations. According to Brainport Development, the foundation is charged with promoting the region's potential through hubs for Open Innovation and Co-Creation (Brainport Eindhoven, n. d.). Examples of these hubs are the High Tech Campus, a former research center from Philips converted into a center for high-tech companies, the Eindhoven University of Technology campus, a technical university or the Automotive Campus. In addition, the region is home to some well-known High-Tech companies such as ASML, VDL and NXP. The Eindhoven University of Technology ranks in the top three of the Collaborativeness Rank (World University Research Ranking, 2022). Thus, suggesting its essential role in Open Innovation in the Brainport Region.

Given the emergence of the region as a hub for innovation, it is interesting to compare it to the Delft University of Technology, a technical university located near Rotterdam and see the role of both universities in open innovation. Such a comparative study can be used by the Dutch government as an overview and a comparison between the two areas. Specifically, it is of interest to illustrate how the Brainport region, an area with less public investment compared to the Mainport region, has been growing much more rapidly which could be further used as a reason for a potential shift in the funding strategy of the government.

To compare both universities in their role of OI, it is important to find the right metric. For this reason, Joint Patents from these universities and other entities will be used to measure Open Innovation. Joint

Patents are the result of successful collaboration and can thus be seen as a successful form of open innovation (Lamberti et al., 2017). This leads to the following research question:

What is the role of Open Innovation in the emergence of Brainport Eindhoven as an economic and innovation hub, compared to the regions favoured by the Mainport policies, such as Mainport Rotterdam?

Theoretical Background

Open Innovation & Universities

For a firm or an organization to be classified as successfully incorporated with open innovation, it must be able to recognize, assimilate and utilize the use of external knowledge and ideas. Open innovation paradigms and practices at universities can describe the new role of universities from the "ivory tower to knowledge broker" (Padilla-Meléndez & Garrido-Moreno, 2012). Knowledge flow between universities and industries can be formal or informal. The outcome of a formal flow is more visible and could be e.g., patents, research papers or licensing agreements. IPR, or intellectual property rights are an impenetrable part of open innovation and creating an IP strategy can be seen as a requirement for successfully working with an external partner (Roshani et al., 2015). On the other hand, the informal flow is more intangible and can be seen in better-qualified employees for the industry, conferences, workshops, social networking or consultation. The informal strengthens the bonds between the two actors and enhances formal activities. Most studies on university-industry links have focused on the transfer of intellectual property but it has also been claimed that the collaborations occur due to the personal relations of actors within these two different organs (Padilla-Meléndez & Garrido-Moreno, 2012).

Another interpretation of universities' role in OI can be described through the approach, or classification, of the four main organizations generating innovation: explorers, merchants, architects and missionaries (Chesbrough, 2003). The university can be viewed as a knowledge finder, which embodies the role of an explorer or a missionary. Innovation explorers specialise in performing the discovery research that previously took place primarily within corporate R&D functions. Missionaries consist of actors that create and advance technologies to serve a cause. Their objective is not to seek financial benefits from their participation in the knowledge transfer (Chesbrough, 2003). Interest in the social value of education and research has grown over the past ten years. Valorisation is a specific label given to a university's activities. Universities valorise knowledge in all academic disciplines, including the humanities and social sciences. Many innovative companies have come out of universities, partly thanks to the creation of incubators (Benneworth & Jongbloed, 2009).

Both universities and industries benefit from open innovation, enabling relationships between the two players. Companies seldom have all the competencies, skills or equipment to research an idea in depth within the company (Roshani et al., 2015). The investment of such infrastructure can be expensive if companies are to fulfil those areas themselves. From the university's perspective, it is in its interest to commercialize its ideas, ensure finances for research and enhance its reputation to be more attractive to future students and researchers. A collaboration between players established companies and a university would exploit the resources and capacity already in place by both parties (Roshani et al., 2015). The most dominant trade-off is between university researchers being interested in finding applications for their research findings and the industry is motivated by new product development. Other motivations for researchers can be when projects are sponsored by policy initiatives and therefore funded (Freitas & Verspagen, 2009).

Open Innovation in the Mainports

The Brainport-Eindhoven region has become the leading location for DeepTech entrepreneurship in Europe. Fields under development are new synthetic materials, artificial intelligence, embedded

software and mechatronics. The ecosystem of Eindhoven has significantly increased its performance since the global financial crisis in 2008 (Romme, 2022). Regional policy is based on cooperation between industries, universities and government. In addition, the region has an emphasis on business incubation accounting for 25% of all R&D investment by industrial companies in the Netherlands (Romme, 2022), where the region's population is only 5% of the total Dutch population (Statistics Netherlands, 2022). What is more, the ratio of patents per capita is the best in the world. The Eindhoven ecosystem also leads all other Dutch ecosystems in terms of project intensity, as measured by the number of innovation projects per thousand companies (Romme, 2022). An initiative that can be mirrored in Brainport in Eindhoven is Seaport in Rotterdam. The main aim of Seaport is to solve specific practical questions in construction, mobility, product design, marine and maintenance through innovation teams and communities of practice, i.e., where students, teachers, professors and entrepreneurs work together (Zhou et al., 2014; Hollen et al., 2013).

Patent Analysis

Figure 1 gives an overview of the number of patents filed by Eindhoven University and Delft University. The query setup, complete dataset and a full-page image of figure 1 can be found in the appendix. After a first review of the data, the output of the patents from the universities was cross-referenced to the AEX-Index. The patent output of universities appears to strongly reflect the volatility of the market, which is essential for understanding the data. An interesting observation is that the Delta seems to correspond with the market volatility as well. During the big recessions, in 2000 (dot-com bubble) and 2008 (housing bubble) the TU's filed more individual patents than collaborative ones, especially the TU Delft seems to be sensitive to this.

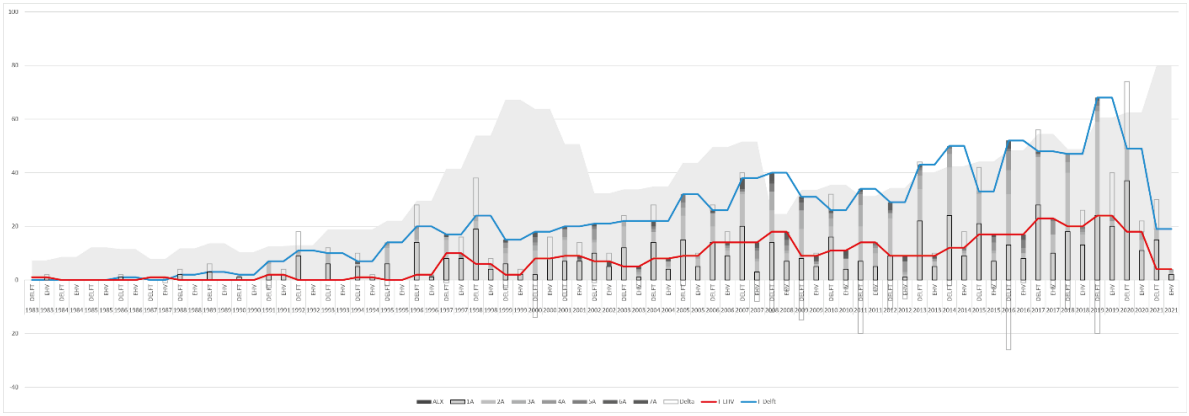

Figure 1: Number of patents filed by Eindhoven and Delft over time period 1983 - 2021

Comparing the overall patent output from Delft University and TU/e it is quite clear that TU Delft produces more patents than TU/e. However, it needs to consider that the TU Delft also has twice the number of subscribed students as the TU/e (Universiteiten van Nederland, 2022). Still, even with twice the capacity, the TU Delft appears to have an output which is a little over 3 times higher than the TU/e, measured since 1996, after both universities consistently started to file patents.

To better understand the open innovation nature of these patents, the data was split into patents that were filed with multiple assignees and with the TU as the only assignee. Table 1 shows the distribution of the number of assignees per patent. Comparing the total number of patents that have been filled solely by a TU to a TU plus a partner resulted in a surprisingly strong 50/50 balance (603-solo vs 604-collab).

TU Delft has filed 901 patents compared to the TU/e who filed 306 patents. Therefore, the data of TU Delft is first normalized with a factor of 3~ to fairly compare the number of collaborative patent fillings.

Table 1: Assignees per patent field

	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12A	13A	14A
Total	602	350	100	68	34	22	10	4	2	9	2	2	1	1
Delft	432	297	82	38	21	13	5	4	1	4	1	2	1	0
EHV	170	53	18	30	13	9	5	0	1	5	1	0	0	1

Table 2: Patent data with a normalization for TU Delft with a factor of 3

	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12A	13A	14A
Delft	146,9	101	27,9	12,9	7,1	4,4	1,7	1,4	0,3	1,4	0,3	0,7	0,3	0,0
EHV	170	53	18	30	13	9	5	0	1	5	1	0	0	1

Table 2 shows that the TU/e filled 15.7% more individual patents and that the TU Delft filled 47.5% more patents with one other assignee and 35.5% more patents with two others. Interestingly the TU/e filed significantly more patents with 3, 4, 5 and 6 other assignees. Patents filed with 6 or more assignees were excluded from this analysis since they were deemed too insignificant to the conclusion.

Conclusion

The main research question for this paper was: What is the role of Open Innovation in the emergence of Brainport Eindhoven as an economic and innovation hub, compared to the regions favoured by the Mainport policies, such as Mainport Rotterdam? From the research, a couple of conclusions can be drawn that can be used to answer this research question.

Firstly, open innovation has played a significant role in the development of Brainport Eindhoven. The analysis indicated that from 2013 and onwards the TU/e filed for more patents with two or more assignees, thus indicating collaboration with other partners. This correlates to the growth of the Brainport region, as this region grew exponentially following the market rise from 2011 onwards. This also matches the data from the theoretical background. Information flow between university and industry is a necessity for the growth of an industry, as these provide the backbone of innovation. Furthermore, a collaboration between universities and industries allows for the exploitation of the resources and capacities of both parties, thus increasing innovation and increasing the growth of industries. It can therefore be concluded that open innovation played an important role in the emergence of the Brainport region. As it allowed the region to grow through collaborative innovation between multiple parties.

Secondly, open innovation played a less significant role in the development of the Mainport Rotterdam. From the patent analysis, it became clear that the TU Delft had far more patents filed for both individual and collaborative patents. However, after normalizing the data, it became apparent that this was no longer the case. The TU Delft filed much more patents with either only 1 or 2 assignees compared to the University of Eindhoven. This seems to suggest that the Seaport Rotterdam relies much more on closed innovation. This also correlates to the information from the theoretical background. Open innovation originally gained traction in 2003 with the paper from Chesbrough. At that time, the seaport was heavily developed with it already being one of the largest ports in Europe. This meant that while open innovation certainly played a role in the growth of the seaport, it could not play as big of a part as in Eindhoven. For that reason, it can be concluded that open innovation had a smaller role in the development of the seaport Rotterdam. Open innovation played a role in further growth but was not a catalyst for the growth of the Seaport.

To conclude, open innovation played a role in the development of both the Brainport Eindhoven and the Seaport Rotterdam. However, due to the development of both areas, open innovation had a larger role in the development of the Brainport region than in the development of the Seaport.

Discussion

It is important to denote some limitations to this research. Firstly, both the Brainport region and the Seaport region were not willing to share any data regarding patents or other innovation indicators. Furthermore, both the Gate, the Innovation Space and the Innovation hubs in TU Delft were unwilling to share any data. This meant that a patent analysis had to be performed, which ultimately means that there might be some errors in the conclusions.

Furthermore, only one patent database was chosen for this research. This might mean that certain patents were not included in the analysis. Also, the assignee was not able to distinguish between the multiple assignees within an organization. For instance, it was not able to distinguish whether or not

multiple research groups within the university worked together on a patent. For that reason, there might be some errors with the number of collaborative patents. This could also cause some errors with the conclusions.

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Appendix

A1. Query setup

In order to discover the different number of patents for Eindhoven and Delft, a patent analysis was performed. For this analysis, the Derwent Innovation Index (DII) was chosen as patent database. In the DII each company is assigned a Patent Assignee Code. This code is a 4-letter code and refers to the patentee on the patent document. Table 1 provides an overview of the different patent assignee codes for Eindhoven and Delft. As can be seen, each university uses multiple codes in the database. This is because Derwent differentiates between standard and non-standard codes. Standard codes are four-letter codes unique to the university. These codes indicate the importance of the patent to the university. Non-standard codes are four-letter codes with a hyphen at the end. These indicate that the patent is not applied uniquely to the university and is therefore of limited value (Clarivate, 2022).

Table 3: Patent Assignee Code for Eindhoven and Delft

Eindhoven University of Technology		**Delft University of Technology**	
TEHO-	Tech Hogeschool Eindhoven	TUDE-	TU Delft
UYEI-	Univ Eindhoven Technology	UDLF	Univ Delft Technology
UYEV	Univ Eindhoven Technology	UYDE-	Univ Delft
UYTE-	Univ Technische Eindhoven	UYTE-	Univ Tech Delft Applied Materials

Table 4: Initial search queries for Eindhoven and Delft

Eindhoven University of Technology	**Delft University of Technology**
Assignee = (TEHO- OR UYEI- OR UYEV OR UYTE-)	Assignee = (TUDE- OR UDLF OR UYDE- OR UYTE-)

Table 2 gives an overview of the initial search queries for Eindhoven and Delft. These resulted in 8686 and 8136 search results respectively. This resulted in a final query with 306 results. For the Delft search query, similar things happened. Just like with the first query, over half of the results were from the University of Shenyang. These were excluded and the final query resulted in 901 results.

A2. Data sheet

The following table contains the dataset used to generate Graph 1

- 1A-7A stands for the number of assignees that filed the patent.
- Delta is the difference between 1A and 2A-7A, showing which patents have been created in collaboration.
- T-EHV & T-Delft show a total number, of patents filed that year, generating a supportive line that allows for interpretation of the data.
- AEX is comprised from the AEX index yearly closing number. The numbers have been downsized with a factor of 10 to fit in the graph.

Year	Location	1A	2A	3A	4A	5A	6A	7A	Delta	T-EHV	T-Delft	AEX
1983	DELFT	0	0	0	0	0	0	0	0	1	0	7,3
1983	EHV	1	0	0	0	0	0	0	1	1	0	7,3
1984	DELFT	0	0	0	0	0	0	0	0	0	0	8,6
1984	EHV	0	0	0	0	0	0	0	0	0	0	8,6
1985	DELFT	0	0	0	0	0	0	0	0	0	0	12,2
1985	EHV	0	0	0	0	0	0	0	0	0	0	12,2
1986	DELFT	1	0	0	0	0	0	0	1	0	1	11,5
1986	EHV	0	0	0	0	0	0	0	0	0	1	11,5
1987	DELFT	0	0	0	0	0	0	0	0	1	0	7,8
1987	EHV	0	1	0	0	0	0	0	-1	1	0	7,8
1988	DELFT	2	0	0	0	0	0	0	2	0	2	11,8
1988	EHV	0	0	0	0	0	0	0	0	0	2	11,8
1989	DELFT	3	0	0	0	0	0	0	3	0	3	13,7
1989	EHV	0	0	0	0	0	0	0	0	0	3	13,7
1990	DELFT	1	1	0	0	0	0	0	0	0	2	10,4
1990	EHV	0	0	0	0	0	0	0	0	0	2	10,4
1991	DELFT	2	4	1	0	0	0	0	-3	2	7	12,6
1991	EHV	2	0	0	0	0	0	0	2	2	7	12,6
1992	DELFT	9	1	1	0	0	0	0	7	0	11	13,0
1992	EHV	0	0	0	0	0	0	0	0	0	11	13,0
1993	DELFT	6	4	0	0	0	0	0	2	0	10	18,8
1993	EHV	0	0	0	0	0	0	0	0	0	10	18,8
1994	DELFT	5	1	0	0	0	1	0	3	1	7	18,8
1994	EHV	1	0	0	0	0	0	0	1	1	7	18,8
1995	DELFT	6	6	1	1	0	0	0	-2	0	14	22,0
1995	EHV	0	0	0	0	0	0	0	0	0	14	22,0
1996	DELFT	14	1	4	1	0	0	0	8	2	20	29,4
1996	EHV	1	0	0	1	0	0	0	0	2	20	29,4
1997	DELFT	8	7	1	0	0	0	1	-1	10	17	41,5
1997	EHV	8	0	0	2	0	0	0	6	10	17	41,5
1998	DELFT	19	3	2	0	0	0	0	14	6	24	53,8
1998	EHV	4	1	1	0	0	0	0	2	6	24	53,8
1999	DELFT	6	4	2	2	0	0	1	-3	2	15	67,1
1999	EHV	2	0	0	0	0	0	0	2	2	15	67,1

2000	DELFT	2	9	2	1	2	0	2	-14	8	18	63,8
2000	EHV	8	0	0	0	0	0	0	8	8	18	63,8
2001	DELFT	7	8	1	3	0	0	1	-6	9	20	50,7
2001	EHV	7	0	0	0	1	0	1	5	9	20	50,7
2002	DELFT	10	4	1	4	1	0	1	-1	7	21	32,3
2002	EHV	5	0	0	0	0	0	2	3	7	21	32,3
2003	DELFT	12	8	2	0	0	0	0	2	5	22	33,8
2003	EHV	1	1	1	1	0	0	1	-3	5	22	33,8
2004	DELFT	14	4	0	1	1	0	2	6	8	22	34,8
2004	EHV	4	1	2	0	0	0	1	0	8	22	34,8
2005	DELFT	15	9	3	2	3	0	0	-2	9	32	43,7
2005	EHV	5	3	1	0	0	0	0	1	9	32	43,7
2006	DELFT	14	6	5	0	0	0	1	2	14	26	49,5
2006	EHV	9	2	1	1	0	1	0	4	14	26	49,5
2007	DELFT	20	12	1	0	1	0	4	2	14	38	51,6
2007	EHV	3	4	1	3	1	1	1	-8	14	38	51,6
2008	DELFT	14	12	7	0	3	1	3	-12	18	40	24,6
2008	EHV	7	3	1	2	2	2	1	-4	18	40	24,6
2009	DELFT	8	11	7	0	3	1	1	-15	9	31	33,5
2009	EHV	5	1	0	1	0	1	1	1	9	31	33,5
2010	DELFT	16	4	3	2	0	1	0	6	11	26	35,5
2010	EHV	4	4	0	0	0	1	2	-3	11	26	35,5
2011	DELFT	7	13	8	4	1	0	1	-20	14	34	31,2
2011	EHV	5	5	2	1	1	0	0	-4	14	34	31,2
2012	DELFT	9	14	2	0	1	3	0	-11	9	29	34,3
2012	EHV	1	1	1	4	0	0	2	-7	9	29	34,3
2013	DELFT	22	12	5	2	1	1	0	1	9	43	40,2
2013	EHV	5	2	0	1	0	1	0	1	9	43	40,2
2014	DELFT	24	18	5	2	1	0	0	-2	12	50	42,4
2014	EHV	9	1	1	0	1	0	0	6	12	50	42,4
2015	DELFT	21	11	1	0	0	0	0	9	17	33	44,2
2015	EHV	7	3	1	3	2	0	1	-3	17	33	44,2
2016	DELFT	13	19	9	7	1	3	0	-26	17	52	48,3
2016	EHV	8	2	0	2	3	2	0	-1	17	52	48,3
2017	DELFT	28	18	0	1	0	1	0	8	23	48	54,5
2017	EHV	10	7	0	5	1	0	0	-3	23	48	54,5
2018	DELFT	18	22	4	3	0	0	0	-11	20	47	48,8
2018	EHV	13	4	1	1	1	0	0	6	20	47	48,8
2019	DELFT	24	35	4	2	2	1	0	-20	24	68	60,5
2019	EHV	20	2	0	2	0	0	0	16	24	68	60,5
2020	DELFT	37	12	0	0	0	0	0	25	18	49	62,5
2020	EHV	11	4	3	0	0	0	0	4	18	49	62,5
2021	DELFT	15	4	0	0	0	0	0	11	4	19	79,8
2021	EHV	2	1	1	0	0	0	0	0	4	19	79,8

A3. Graph 1