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Increased Variation or Higher Fences? Understanding Typological Evolution in Radical Innovation Management

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Abstract: This paper addresses a key issue of typological confusion in relation to radical innovation management research. Previous research has emphasized the need for a more parsimonious understanding of innovation typology, where a myriad of types are still present. We use a dataset of the radical innovation typology created through a systematic literature review to map and understand the typological evolution in the field. By following a scientometric research methodology and utilizing "popularity-based" and Social Network Analysis (SNA) research approaches, this study is empirically evaluating the evolutionary process of "radical innovation" as an innovation type. We comment and discuss critical points in time where the typology evolves. This allows us to precisely determine if an added innovation type or attribute indeed was a novel contribution. We discuss the novel contributions made over time, and also which innovation types did very little to contribute to our current understanding of the typology.

Keywords: Radical innovation, scientometrics, social network analysis

1 Introduction

Contributions to the innovation management literature have vastly increased in the past three decades (Crossan & Apaydin, 2010). While this has provided a lot of nuances and perspectives in the debate, it has simultaneously introduced an issue of confusion on different definitions of innovation and "innovativeness". This is also true for the domain of radical innovation, often referring to very novel technology introductions, addressing markets in new ways or introducing new business models (Lynn & Akgün, 2001; Chesbrough & Rosenbloom, 2002). Previous academic contributions on "radical innovation typology" have been addressing the issue of overlapping and indistinguishable definitions by offering an increased understanding of typology interconnectedness and a more parsimonious typology (Garcia & Calantone, 2002). However, while the prior studies offer some clarification towards understanding the current radical innovation typology (e.g. Garcia & Calantone, 2002; Kristiansen and Gertsen, 2014), these contributions do not focus on explaining how the typology has developed over time to reach the current state. Science builds on previous knowledge, which evolves over time; refining and developing knowledge while serving as a foundation for further research. In the process of scientific development, the way we label our efforts, that is, the typology, also develops. In this regard, typologies do change over time as a result of increasing research efforts. Therefore, an in-depth understanding of the temporal evolution of scientific knowledge in any research domain is vital.

Recent debate on innovation typology has been shedding light on an unfortunate development of "free interpretation" of innovation types, where e.g. Clayton Christensen's term "disruptive innovation" has suffered from loose and sloppy usage, associating the term with other scenarios than what was intended (Christensen, Raynor & McDonald, 2015). We argue that this typological confusion within the academic (and professional) community does not happen overnight. Rather, we argue that this is the product of a longer, evolutionary process.

The studies focusing on the historical evolution of innovation management research is limited, although few studies have evaluated innovation management research trends over time (Santonen and Conn, 2015; Balzat and Hanusch, 2004; Crossan and Apaydin 2010; Becheikh et al., 2006; Kim et al. 2012). However, these prior studies have not covered the historical evolution of innovation typology in similar detail to what is seen in other research domains (e.g. Lind, 2004; Eby, 2007; Gest, 2002). With this paper, we would like to uncover how the radical innovation typology has developed over time, in order to understand when "true" novelties to the definition has been added, and when associated innovation types have been generated based on more questionable grounds. Knowledge is not static, but evolves via the interactions among conceptual worlds, representational worlds, and the real world (Hori et al. 2004). In this paper, we are interested to explicitly analyse the relationships and frequencies of contents (attributes) constituting the radical innovation typology.

1.1. Objectives of this study

The aim of this paper is to provide an explanation of typological evolution relating to radical innovation, with special emphasis on how typological definitions develop over time. Radical innovation has many associated innovation types, e.g. discontinuous innovation and breakthrough innovation, and we will build an understanding of when and

how these types are introduced intro the domain. We are explicitly describing the evolution of "radical innovation" definitions by illustrating how other affiliated innovation types (and their attributes) become inter-linked with each other over time. First, we will identify "critical events" in the typological evolution timeline in order to describe how innovation types and attributes diffuse and converge over time. Based on these findings, we will investigate and discuss whether distinct features of new entrant innovation types become diluted over time due sloppy interpretation or because the terms in their inception were not "new" in the first place. This study is structured as follows. The literature review section summarizes the known radical innovation definitions and determines what kinds of attributes have been linked to them. The methodological section describes the research design and data collection. In the results section, we explore and discuss the innovation type popularity and evolution, to which the final conclusions are made.

2 Literature review

2.1. Introducing radical innovation and affiliated innovation definitions

In the scientific literature, it is common that definitions and typologies are continuously evolved as part of the research field's maturity. This is making it somewhat difficult to build an unambiguous body of knowledge within research streams, including radical innovation. As definitions are built over time, it becomes arduous to snapshot the correct definition of a type, as it is often contextual to the time and level of maturity of the field when built. For the broader concept of "innovation", numerous definitions and dimensions have been identified (Crossan and Apaydin, 2010). Felin and Zenger (2014: 915) consider innovation as a process in which *"existing knowledge and inputs are creatively and efficiently recombined to create new and valuable outputs"*. Combining two words– *radical* and *innovation* – into one term and their possible variants, can be quite cumbersome, even if many systematic efforts have been made to that respect to define innovation (Baregheh et al. 2009) or radical innovation (Veryzer, 1998; Lynn & Akgün, 2001; Garcia & Calantone, 2002). Giving an unambiguous definition for radical innovation (firm level) is a complex and challenging task, since the current typology of radical innovation is overly complex and has led to overlapping and parallel definitions. This was also found in more recent research conducted by Kristiansen & Gertsen (2014).

Importantly, Kristiansen & Gertsen's (2014) recent literature review identified the following eight related innovation types for Radical innovation: "Breakthrough innovation", "Discontinuous innovation", "Architectural innovation", "Modular innovation", "Disruptive innovation", "Strategic innovation", "Exploratory innovation" and "Really New Products". Furthermore, their study proposed that these identified "radical innovation" types encompassed the following attributes: Technology, Market, Business Model, Performance, Uncertainty, New knowledge (firm), New knowledge (user) and Time Horizon. In the following, we will introduce these key terms and attributes briefly.

A range of authors accentuate that the attributes of **technology** and **market** represent a key differentiating factor when distinguishing incremental- from radical innovation. In this respect, radical innovations concern new technology- or market introductions,

contrasted to only few or minor improvements when discussing incremental innovation (Chandy & Tellis, 1998, 2000; Lynn & Akgün, 2001). Chesbrough and Rosenbloom (2002) have accentuated the importance of **business model** alterations when entering new territory in terms of markets, or introducing new technologies. This is to properly capture the value of the new market or the new technology introduced. In turn, a new business model may also offer radical potential for existing markets or technologies (Markides, 2006). Radical innovation have often been associated with its potential to yield significantly **better performance** compared to existing incremental innovations, and has thus received a lot of attention in terms of generating value to the firm (Laursen & Salter, 2006; O'Connor & Rice, 2001). The potential in performance of the introduction of radical innovation also represents a trade-off. Working with the introduction of new technologies, markets or business models also encompass **uncertainty** for the firm. In this respect, uncertainties are dissimilar from risk, in that they are not quantifiable, and may often introduce unanticipated showstoppers during the project period (Knight, 1921; Dow & Werlang, 1992; O'Connor & Rice, 2013). This introduction of uncertainty to the projects is affiliated with, often, a substantial input of **new knowledge to the firm** in order to introduce radical innovations (Dewar & Dutton, 1986). Similarly, for successful market adoption, **users are also often required to gain new knowledge** in order to utilize the product/service introduced (Markides, 2006). Finally, radical innovation takes a substantial **time** to mature, both in terms of making and developing a project within the firm, but also as part of market maturity (O'Connor, Leifer, Paulson, & Peters, 2008).

2.2. Explaining the problem of parallel and overlapping definitions

Previous researchers have accentuated the potential issue of parallel and overlapping research as part of an unconverged typology (Garcia & Calantone, 2002). In terms of the academic discipline, researchers have used strategies of "coining" innovation types in order to gain a substantial imprint on the research community (e.g., Christensen, 1997; Leifer et al., 2000; O'Connor, Leifer, Paulson, & Peters, 2008; Chesbrough et al., 2006; Cooper, 2013; Bessant, Lamming, Noke, & Phillips, 2005). Researchers position themselves according to different traditions, definitions and associated attributes; which may lead to a tough discussion and competition for rivalling types. This may imply that higher fences between positions may be raised. Many researchers and research communities, journals and networks build an established understanding of how the typology is shaped, and may actually not serve the better purpose of the academic community in terms of research efficiency. Therefore, our problem identified is to understand how different innovation types have developed over time to become different. In the same vein, we wish to identify whether and how there are true differences between the types which are included in the radical innovation typology.

We argue that an inexpedient differentiation of innovation types may lead to the risk of authors not properly recognizing work conducted in relation to another innovation type, even though this may be of high importance to one's research. The scenario we depict is obviously extreme, yet explains the root of the issue: we do not fully understand how innovation typology develops over time, and how true or pseudo novelty in terms of definitions within the radical innovation domain are emerging.

As an example of the typological confusion existing within the field, we emphasize that different authors have been using the same innovation type (radical innovation) to

describe different attributes (Damanpour, 1991; Henderson & Clark, 1990; Ettlie, Bridges, & O'Keefe, 1984; Dewar & Dutton 1986; O'Connor & Rice, 2001). Specifically, this implies that using "radical innovation" in a management context may be defined quite differently depending on which authors are followed. In the example, the expediency or inexpediency of the varying attributes of radical innovation as a definition may be detected through our evolutionary analysis of the typological development of radical innovation. Here, we will be able to identify the typological evolution of the concept to understand how and why it is defined in a certain way. The following section describes the methodology of our paper.

3 Research methodology

3.1 Research design

In innovation management research, many literature reviews have been narrative (McLean, 2005), and to a lesser extent do we see more rigorous research methods such as systematic literature reviews (Becheikh et al., 2006), meta-analyses (Tornatzky & Klein, 1982) or scientometrics (Larivière et al. 2012). In this study, we follow a scientometric approach, which is often equated to bibliometric analysis (Pritchard, 1969) and can be defined as the quantitative study of science and technology (Van Raan, 1998).

Recently, Santonen and Conn (2015) illustrated a comprehensive framework for classifying various types and combinations of scientometric studies while identifying the following three main approaches: 1) "popularity-based" studies analysing the frequency of actors and/or contents (Choi et al, 2011), 2) social network analysis studies (later SNA) analysing relationships of actors and/or contents (Wasserman and Faust, 1994) and 3) citation/co-citation studies analysing the importance or impact of an actor and/or a content (Pilkington and Meredith, 2009). For this study, we apply both a "popularity-based" and a SNA research approach in order to describe and evaluate the evolution of the radical innovation typology.

In this study, we are critically assessing the contributions to the "innovation type" definition discussion at the type-attribute connection level. Therefore, in this study, a *"contribution"* is defined as "*a novel attribute introduced for the first time and connected to a type".*

3.2 Data collection

This study utilizes the "radical innovation" definition dataset as presented originally by Kristiansen and Gertsen (2014). After a rigorous multi-staged process covering 1750 publications from EBSCOhost (all databases, from 1980-2014) they had found 83 non-identical "radical innovation" definitions. In their dataset, the nine types of "Radical-", "Breakthrough-", "Discontinuous-", "Architectural-", "Modular-", "Disruptive-", "Strategic-", and "Exploratory-" innovation, as well as "Really New Products" were identified. These were each defined by one of the following eight attributes: "Technology", "Market", "Business Model", "Performance", "Uncertainty", "New knowledge (firm)", "New knowledge (user)", or "Time Horizon". All contributions identified were timestamped by publication year. Then, for the purpose of the present study, this original dataset was re-formatted into twenty two-mode adjacency matrices

(Borgatti et al., 1992), which all encompassed the above presented 9 different innovation types as columns and 8 different attributes as rows. An entry in row "i" and column "j" in each year represented a cumulative valued tie between the given innovation type and attribute (i.e. the tie value was calculated by summing the prior years to current year). Each following year represented single adjacency matrices while including publications cumulatively from years 1984, 1986, 1990, 1993, 1996, 1997, 1998, 2000, 2001, 2003, 2005, 2006, 2007, 2008, 2010, 2011, 2012, 2013 and 2014 (note. 2014 was the last year to be included in the original data set). Hereafter, standard SNA methodologies were applied to analyse and visualize our results from a social network analysis viewpoint (Wasserman & Faust, 1994).

Finally, in order to get an idea of how the different innovation types have developed on a broader basis, a Google Scholar search for the identified innovation types in each year from 1980-2013 was made (omitting 2014, as the accumulated numbers of total contributions were not updated in Google Scholar at the time of search). Subsequently, a "popularity-based" analysis was conducted. This focused on the relative frequency of each innovation type. For every year, the relative share of each innovation type was calculated to illustrate how popular the given term was at that particular point of time.

4 Results

4.1 Exploring Innovation Type Popularity

Before evaluating individual innovation types popularity trends more in-depth, in Figure 1 we have presented absolute and relative growth profiles for the number of publications in Google Scholar including search terms "Radical-", "Breakthrough-", "Discontinuous-", "Architectural-", "Modular-", "Disruptive-", "Strategic-", and "Exploratory-" innovation, as well as "Really New Products".

Figure 1 Absolute and relative growth of all innovation types

As Figure 1 indicates, there is strong correlation between year and cumulative amount of publications (0.827**), but weak negative correlation (-0.437*) in the case of annual growth rate. Basically, this indicates that the body of knowledge related to radical innovation and the related terms is growing, but the growth rate has been levelled out.

Figure 2 presents the development of the three most popular innovation types including radical, disruptive and strategic innovation types relative popularity changes from the 1984 to 2014. Concurrently, Figure 3 presents remaining innovation types relative popularity including "breakthrough innovation", "discontinuous innovation", "really new products", "modular innovation" and "exploratory innovation".

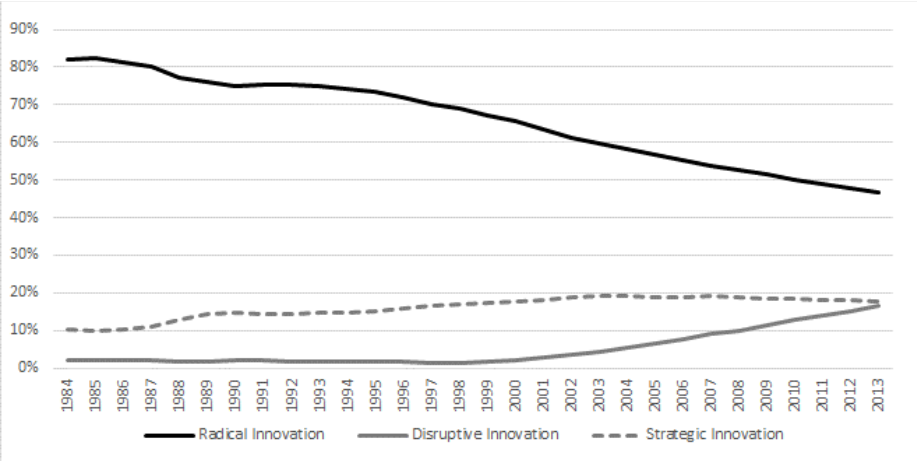

Figure 2 Relative popularity changes of "radical", "disruptive" and "strategic innovation" types from the 1984 to 2014

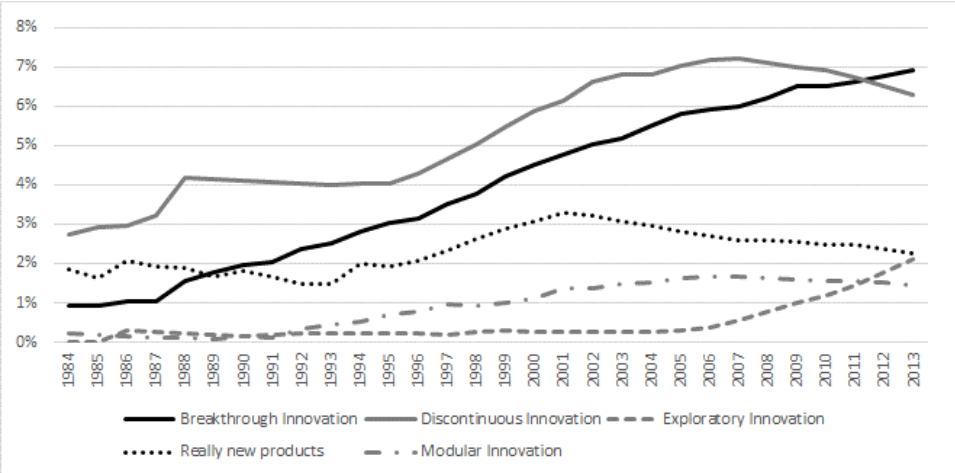

Figure 3 Relative popularity changes of "breakthrough innovation", "discontinuous innovation", "really new products", "modular innovation" and "exploratory innovation" types from the 1984 to 2014

As Figure 2 indicates, the relative share of the "radical innovation" type has a strong negative correlation (-0.982**) with year, suggesting diversity in the typology related to radical innovation. Radical innovation as an innovation type (firm level) has slowly lost territory from a very dominant position in the pioneering years of over 80 percent to a 46.8 percent share in 2013. Especially disruptive innovation has gained significantly more popularity in the 2000s starting from 1.9 percent share (year 2000) and ending up to 16.4 percent share in 2013[1]. The second most popular innovation type, "strategic innovation," has retained its relative share stable in the 2000s, constituting an average portion of all the types of a 18.5 percent with a standard deviation of less than 0.5 percent. Within the less popular types grouped in Figure 3, "breakthrough innovation"" is showing steady growth and have reached 6.9 percent share whereas from mid 2000s, "discontinuous innovation" have drifted into a downward trend and ended-up on 6.9 percent share. The remaining other types – "really new products", "modular innovation" and "exploratory innovation" – have been clearly less popular terms having 2.3 to 1.4. percent share in 2013. From these types, only "exploratory innovation" has shown an upward trend in the recent years.

To summarize the above popularity based analysis, we argue that the concepts in the radical end of the innovation continuum have increased their popularity over the years. However, the results are also revealing that diversity between different types is existing and becoming stronger, since radical innovation as in innovation type is losing its relative share comparing to other rivaling innovation types.

4.2 Exploring the Critical Events in Innovation Type Evolution

With reference to the search and dataset introduced by Kristiansen & Gertsen (2014), the first entry for "radical innovation" in a management context was introduced in year 1984. Here, the main explanatory factor and thus attribute of this type was "new technology". The attribute of "new technology" is thus the starting point for the radical innovation type evolution explored in our dataset, which in year 1986 was complemented with the "new knowledge firm" attribute as presented in Figure 4.

[1] Note that disruptive innovation has received tough discussion concerning it's affiliation with radical-, "sustaining" innovation. Newer contributions related to new-market-disruption however suggest an incoming convergence and potential overlapping definition and confusing to the original concept of disruptive innovation (Markides, 2006). Therefore, we have chosen to include the concept for the purpose of this paper.

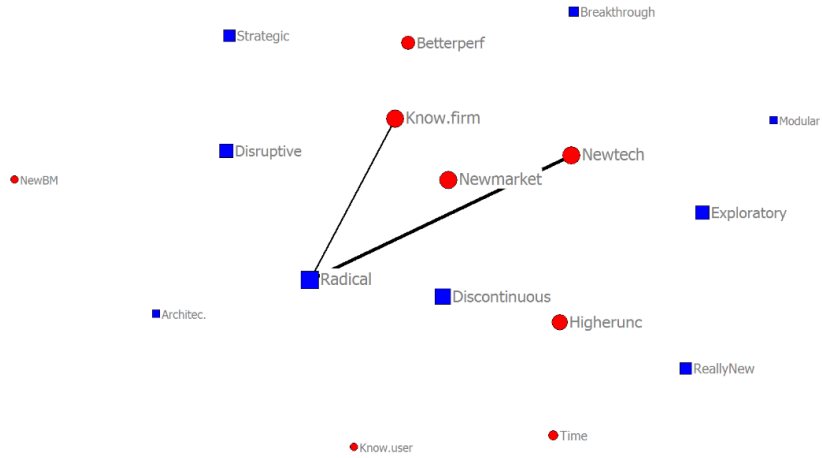

Figure 4 Innovation Type Definition Evolution in year 1984 to 1986

In year 1990, two types of "Architectural innovation" and "Modular innovation" were introduced. Both these terms can be regarded as genuine contribution, since besides being linked to already known "new knowledge firm" (both) and "new technology" (modular) attributes, these two types introduced also the following novel attributes: 1) "higher uncertainty" in the case of both types and 2) "new market" in the case "Architectural innovation". Similarly, scrutinizing the work of Henderson and Clark (1990), initially introducing these concepts, architectural and modular innovation provided also a novel understanding of technological newness, product modules and product architecture to the debate, rather than primarily focusing on the function of the new technology introduced. These connections are illustrated in Figure 5.

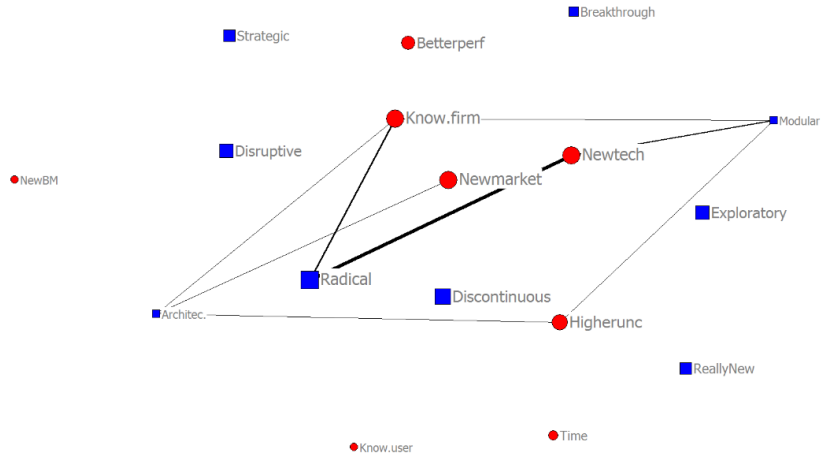

Figure 5 Innovation Type Definition Evolution in year 1990

In year 1996, "Discontinuous innovation" was introduced in the dataset. Also, this type can be regarded as genuine contribution, since it both encompassed the linkage of the already present attribute of "higher uncertainty" with the attribute of "time" as shown in Figure 6.

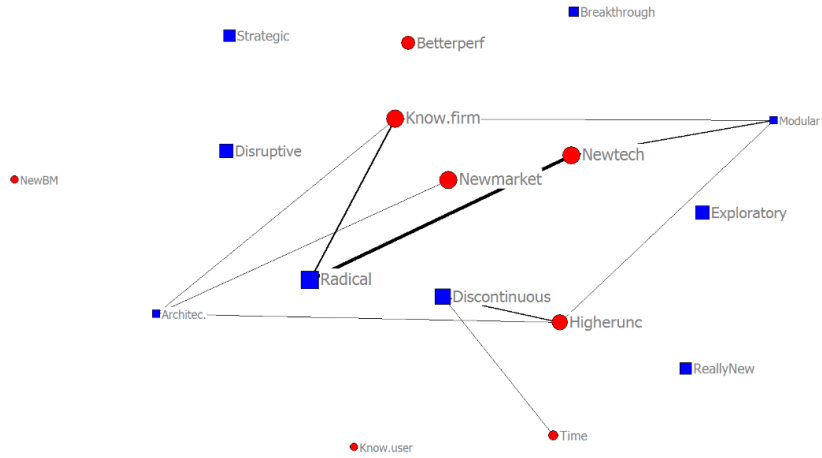

Figure 6 Innovation Type Definition Evolution in year 1996

In year 1997, the innovation type "Disruptive innovation" was introduced in the dataset[1]. Disruptive innovation over times becomes trickier for the purpose of our dataset, as the definition holds within-attribute differences, emphasising low-end market disruption and the differentiation between sustaining- and disruptive innovation. The type itself did not add new attributes, yet heavily discussed the existence and premise of the state and understanding of theory at the time. In year 1998, "Strategic innovation" contributed to the definition evolution by adding the "new business model" attribute. Also, "Really New Products" was introduced in year 1998, but it was linked to already known attributes, thus having questionable contribution. Furthermore, "Discontinuous innovation" made another contribution by adding a novel "new knowledge user" attribute. As presented in Figure 7, 1998 could be considered as a relevant point in time, as radical innovation here also was affiliated with the "new market" attribute.

In year 2001, the last new attribute of "Better performance" was suggested and connected to "Radical innovation" and the newly introduced type of "Breakthrough innovation" (Figure 8), which both therefore made contribution to the body of knowledge of the innovation type definition evolution.

In year 2002, the prior introduced "Better performance" attribute was adopted by "Discontinuous innovation" while also "Disruptive innovation" adopted the already known attributes of "New technology" and "higher uncertainty". In year 2003, "Really new product" adopted the "known to user" attribute which was originally proposed by "Discontinuous innovation": Figure 9 presents these new linkages.

[1] This refers to the impact of the book "The Innovators Dilemma" which was referenced in the search of the dataset. As seen in Figure 2, the innovation type of disruptive innovation took off in the late 1990s and early 2000s, arguably as a result of this particular publication. It was discussed earlier in the 1990s, e.g. in the HBR in 1995 (cf. Bower & Christensen, 1995).

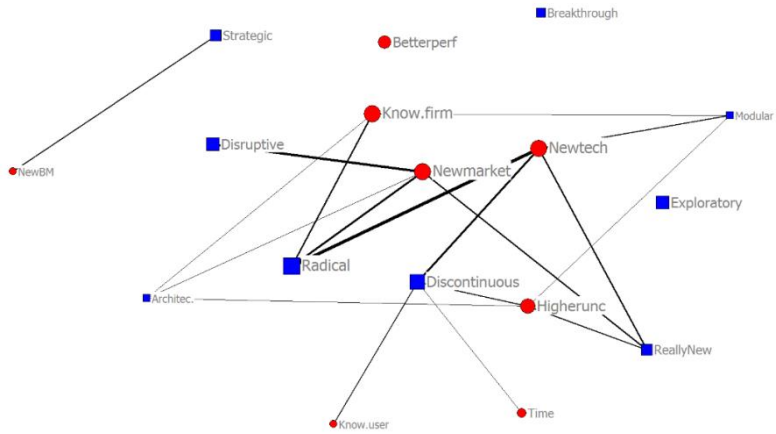

Figure 7 Innovation Type Definition Evolution in year 1998

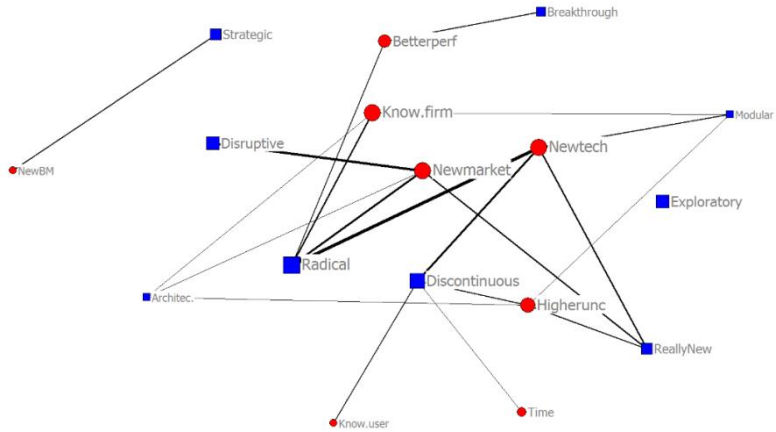

Figure 8 Innovation Type Definition Evolution in year 2001

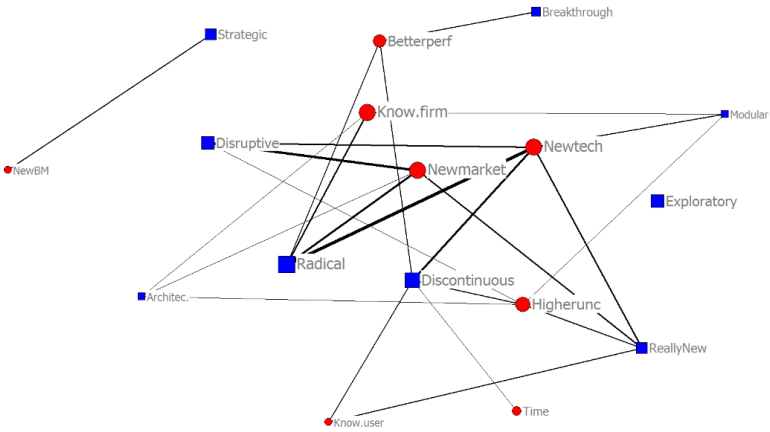

Figure 9 Innovation Type Definition Evolution in year 2002 to 2003

In year 2005, the last new term "Exploratory innovation" was proposed, which however was linked only to already known "higher uncertainty", "new technology" and "new market" attributes. Furthermore, also "Breakthrough innovation" adopted "new technology" and "new market" attributes as shown in Figure 10.

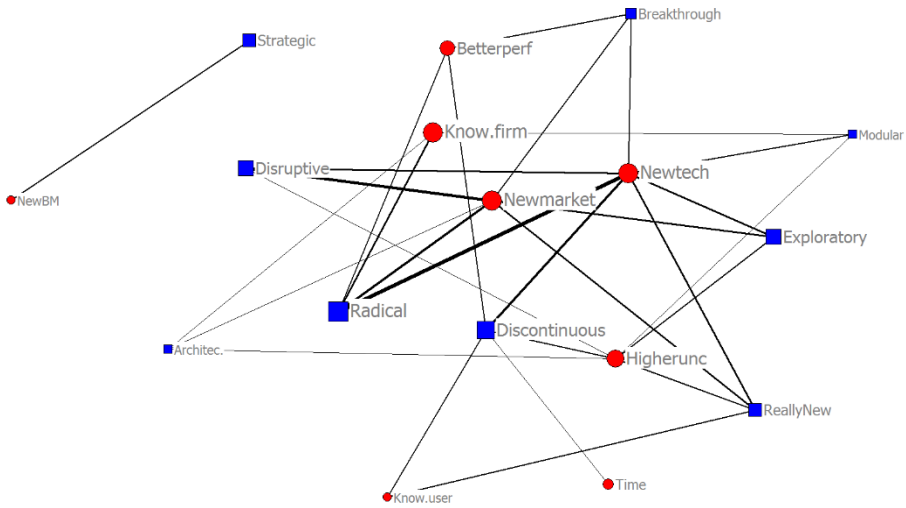

Figure 10 Innovation Type Definition Evolution in year 2005

After year 2005, the innovation type definition evolution have been limited since new attributes have not been introduced and evolution includes only adding new linkages between already known attributes and types. In Figure 11, we have consolidated all links between different terms and attributes in year 2104.

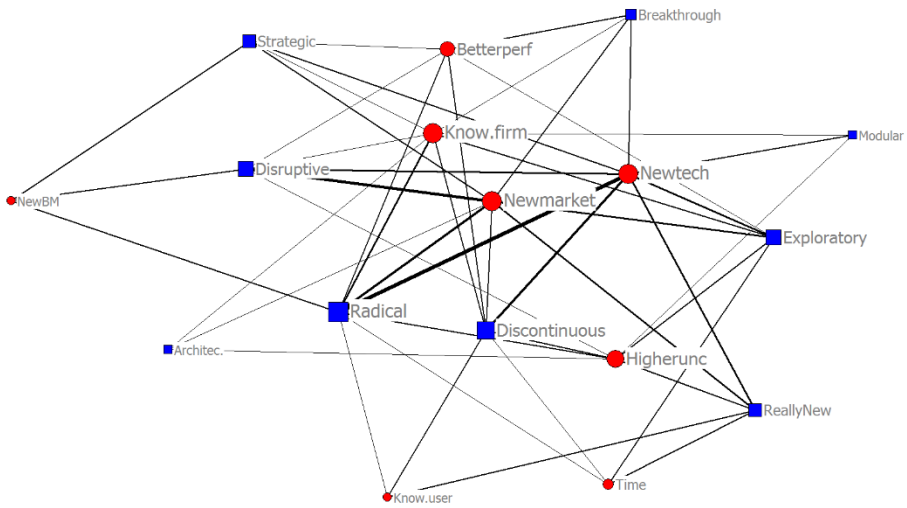

Figure 11 Innovation Type Definition Evolution in year 2014

4.3 Summary of Innovation Type Evolution

Table 1 summarizes the innovation type definition evolution 1) by showing in the first row when the given type was first time introduced in the dataset and 2) presenting the year when the given attribute was attached to a particular term (the first time indicated by *), 3) summarising how many novel attributes each type has introduced, 4) showing the total number of attributes for each type, 5) the number of attributes adopted from other types and 6) finally calculating novel vs. adopted attribute ratio. Furthermore, in Figure 12, an attribute timeline comparison between innovation types is presented and visualized.

Table 1 Summary of contributions

	Radical	Discontinuous	Disruptive	Strategic	ReallyNew	Architec.	Modular	Breakthrough	Exploratory
Type introduced first time	1984	1996	1997	1998	1998	1990	1990	2001	2005
New tech.	1984*	1998	2002	2011	1998		1990	2005	2005
Know. Firm.	1986*	2012	2006	2014		1990	1990	2006	2006
New market	1998	2011	1997	2011	1998	1990*		2005	2005
Higher unc.	2012	1996	2002		1998	1990*	1990*		2005
Time	2013	1996*			2006				2010
New BM	2012		2006	1998*				2001	
Know. user	2007	1998*			2003				
Better perf.	2001*	2002	2006	2012				2001*	2013
Number of novel attributes introduced	3	2		1		2	1	1	
Number of attributes	8	7	6	5	5	3	3	5	6
Number of attributes adopted from others	5	5	6	4	5	1	2	4	6
Novel / Total attribute.	0.38	0.29	0.00	0.20	0.00	0.67	0.33	0.20	0.00
Adopted / Total attribute	0.63	0.71	1.00	0.80	1.00	0.33	0.67	0.80	1.00

* Novel attribute connection

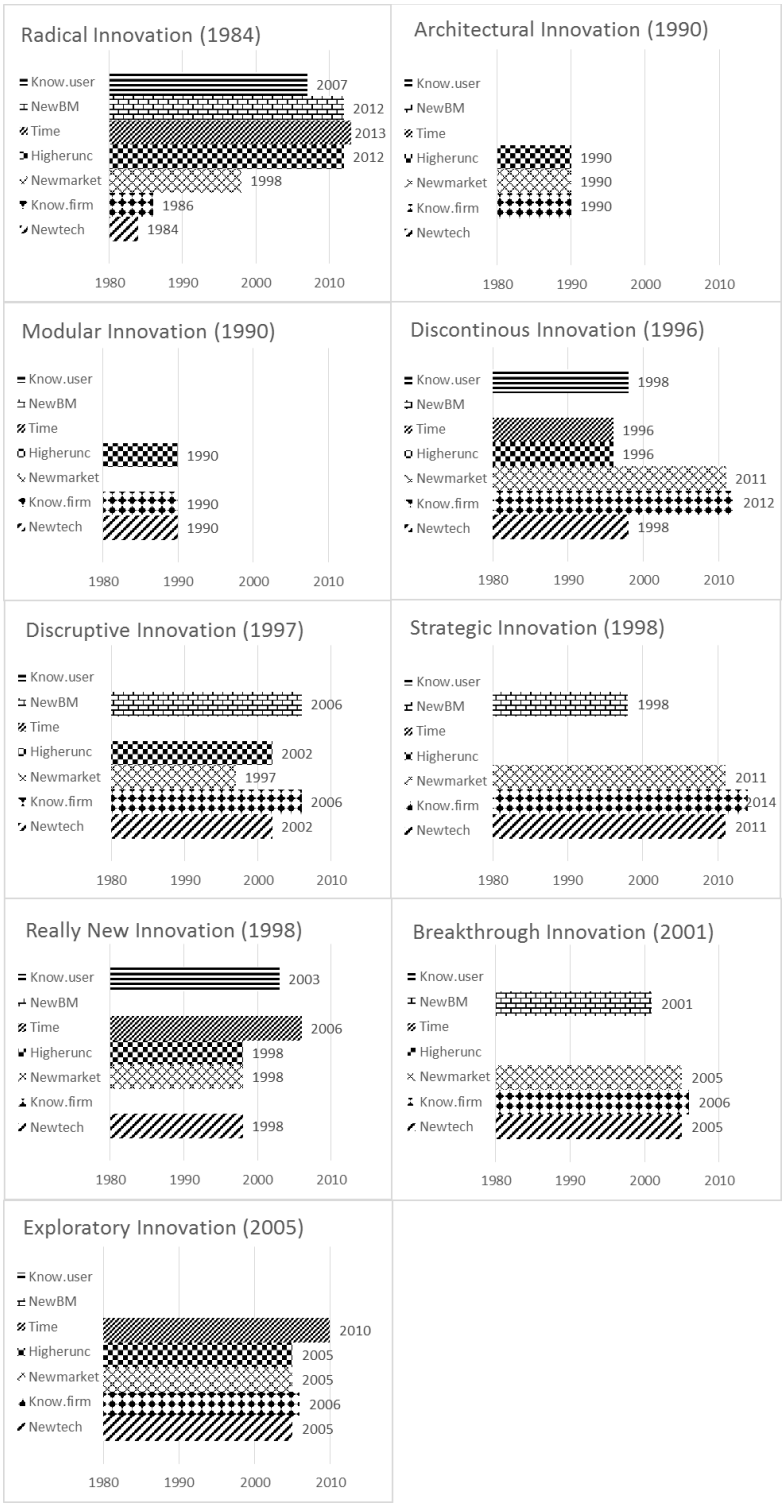

Figure 12 Attribute timeline comparison between innovation types

The top ranking type, *"Radical innovation"*, has introduced three novel attributes but also adopted all the other attributes which were originally suggested for other types. As a result the "novel vs. adopted attribute" ratio in the case of *"Radical innovation"* is 0.38 vs. 0.63. The second ranking types *"Architectural innovation"* and *"Discontinuous innovation"* have both introduced two novel attributes, but their novel vs. adopted attribute ratio is opposite. *"Discontinuous innovation"* has adopted five other attributes (novel vs. adopted ratio = 0.29 vs. 0.71) whereas *"Architectural innovation"* only one additional attribute is adopted (ratio = 0.67 vs. 0.33). The third position with one novel attribute introduction is shared between *"Strategic innovation"*, *"Breakthrough innovation"* and *"Modular innovation"*. *"Strategic"* and *"Breakthrough"* innovations have both adopted five other attributes resulting novel (0.2) vs. adopted (0.8) ratio while. *"Modular innovation"* has adopted only three other attributes and is therefore having a better novel (0.33) vs. adopted (0.67) ratio. *"Disruptive innovation", "Exploratory innovation"* and *"Really New Products"* did not add any new attributes, but were solely grounding their definition on prior defined attributes. Therefore, these types' contribution to radical innovation type evolution can be questioned.

5 Discussion and Conclusions

Previous studies have highlighted the need to clarify the radical innovation typology, which appears to be complex and has led to overlapping and parallel definitions. In general, the empirical studies focusing on the historical evolution of innovation management literature are limited. Therefore, this study was uncovering how nine radical innovation related types have developed over time and revealing how the different types have contributed or confused the body of knowledge. Interestingly, although *"radical innovation"* as a type is the starting point for this whole research stream, in fact only three out eight attributes which are currently linked to radical innovation typology are actually originated from *"Radical innovation"* as type. In this perspective, it could indicate that researchers within radical innovation are able to strongly implement findings from other research fields (in terms of using different types). This finding also indicates that overlapping and parallel definitions have been providing valuable contributions for theory development within radical innovation. For this particular case, the research community has benefited from definition ambiguity because the authors of radical innovation have been efficient in encompassing the attributes introduced by other types over time.

As an analogy, when a single company (or as in our case, "innovation type") has nearly all of the market it is treated as monopolistic competition, which often is resulting in inferior offerings; in our case poor definition development. According to our innovation type popularity results, *"Radical innovation"* as a type is not holding a monopolistic market share, but has been declining from a dominant to a strong market position. There are many ways to define a dominant market position, but market shares exceeding 60 percent is most probably indicating market dominance. A market share over 35 percent but less than 60 percent is typically an indicator of market strength but not necessarily market dominance. The market share of *"Radical innovation"* has dropped from substantially high (over 80 percent) share into a 59.7 percent share in year 2003, while the current (year 2013) share is 46.7 percent. Therefore, we argue that that *"Radical innovation"* as a type has lost its' market dominance but is still the dominant

type. A major reason for this is that radical innovation as an innovation type has over time included new attribute introductions from other innovation types. As a result, radical innovation encompasses "all attributes" and can be used in nearly any setting as a result. This can primarily explained by the popularity of the type accelerating research progression, and thus solidifying the position of the innovation type even though tough completion is present. *"Disruptive Innovation"* and *"Strategic Innovation"* together are holding about one-third of the market. However, the popularity of "*Disruptive Innovation"* has been steady whereas *"Strategic Innovation"* is showing a somewhat stagnant market share. Interestingly, *"Disruptive Innovation"* has adopted all attributes from other terms but has still gained third largest market share. Therefore, the introduction of a novel attribute or attribute combination appears to be irrelevant for gaining popularity. Basically this indicates that intelligently re-thinking and re-branding the known attributes (as was the case for disruptive innovation), can be a valid strategy for promoting one's own type. This has also been found in recent debates on e.g. open innovation (Santonen, 2016).

6 References

Balzat, M., & Hanusch, H. (2004). Recent trends in the research on national innovation systems. *Journal of Evolutionary Economics*, 14(2), 197-210.

Baregheh, A., Rowley, J., Sambrook, S. (2009). Towards a multidisciplinary definition of innovation. *Management Decision*, 47(8), 1323-1339.

Becheikh, N., Landry, R., & Amara, N. (2006). Lessons from innovation empirical studies in the manufacturing sector: A systematic review of the literature from 1993–2003. *Technovation*, 26(5), 644-664.

Bessant, J., Lamming, R., Noke, H., & Phillips, W. (2005). Managing innovation beyond the steady state. *Technovation*, 25(12), 1366-1376.

Borgatti, SP, MG Everett and LC Freeman (1992). *Ucinet – Guide – Ucinet for Windows: Software and Social Network Analysis*. Harvard, MA: Analytic Technologies.

Bower, J., & Christensen, C. (1995): Disruptive technologies: Catching the wave. *Harvard Business Review, Jan 1995, 73*(1), 43-53.

Chandy, R. K., & Tellis, G. J. (1998). Organizing for radical product innovation: The overlooked role of willingness to cannibalize. *Journal of Marketing Research*, 35(4), 474-487.

Chandy, R. K., & Tellis, G. J. (2000). The incumbent's curse? Incumbency, size, and radical product innovation. *Journal of Marketing*, 64(3), 1-17.

Chesbrough, H., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change*, 11(3), 529-555.

Chesbrough, H., Vanhaverbeke, W., & West, J. (2006). *Open innovation: Researching a new paradigm.* Oxford: Oxford University Press

Choi, J., Yi, S., Lee, K. C. (2011). Analysis of keyword networks in MIS research and implications for predicting knowledge evolution. *Information & Management*, 48(8), 371-381.

Christensen, C. M. (1997). *The innovator's dilemma: When new technologies cause great firms to fail.* Boston, MA: Harvard Business School Press.

Christensen, C., Raynor, M., & McDonald, R. (2015): What is disruptive innovation? *Harvard Business Review, December 2015*, 44-53.

Cooper, R. G. (2013). Where are all the breakthrough new products? Using portfolio management to boost innovation. *Research Technology Management*, 56(5), 25-33.

Crossan, M. M., & Apaydin, M. (2010). A multi-dimensional framework of organizational innovation: A systematic review of the literature. *Journal of Management Studies*, 47(6), 1154-1191.

Damanpour, F. (1991). Organizational innovation: A meta-analysis of effects of determinants and moderators. *The Academy of Management Journal*, 34(3), 555-590.

Dewar, R.D., & Dutton, J.E. (1986). The adoption of radical and incremental innovations: An empirical analysis. *Management Science*, 32(11), 1422-1433.

Dow, J., & Werlang, S. R. C. (1992). Uncertainty aversion, risk aversion, and the optimal choice of portfolio. *Econometrica*, 60(1), 197-204.

Eby, L. T., Rhodes, J. E., & Allen, T. D. (2007). Definition and evolution of mentoring. *The Blackwell handbook of mentoring: A multiple perspectives approach*, 7-20.

Ettlie, J. E., Bridges, W. P., & O'Keefe, R. D. (1984). Organizational strategy and structural differences for radical vs. incremental innovation. *Management Science*, 30(6), 682-695.

Felin, T., and Zenger, T. R. (2014). Closed or open innovation? Problem solving and the governance choice. *Research Policy*, 43(5), 914-925.

Garcia, R., & Calantone, R. (2002). A critical look at technological innovation typology and innovativeness terminology: A literature review. *The Journal of Product Innovation Management*, 19(2), 110-132.

Gest, H. (2002). History of the word photosynthesis and evolution of its definition. *Photosynthesis research*, *73*(1-3), 7-10.

Henderson, R. M., & Clark, K. B. (1990). Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms. *Administrative Science Quarterly*, 35(1), 9-30.

Hori, K., Nakakoji, K., Yamamoto, Y., & Ostwald, J. L. (2004). Organic Perspectives of Knowledge Management: Knowledge Evolution through a Cycle of Knowledge Liquidization and Crystallization. *J. UCS*, 10(3), 252-261.

Knight, F. H. (1921). Risk, uncertainty and profit. *Hart, Schaffner, and Marx Prize Essays*, *31*. Boston and New York: Houghton Mifflin.

Kristiansen, J. N., & Gertsen, F. (June, 2014). *Reviewing radical innovation typology: Remedying innovation type confusion.* Paper presented at The XXV ISPIM Conference – Innovation for Sustainable Economy & Society, Dublin, Ireland.

Laursen, K., & Salter, A. 2006. Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, 27(2): 131-150.

Larivière, V., Sugimoto, C. R., Cronin, B. (2012). A bibliometric chronicling of library and information science's first hundred years. *Journal of the American Society for Information Science and Technology*, 63(5), 997-1016.

Leifer, R., O'Connor, G. C., & Rice, M. (2001). Implementing radical innovation in mature firms: The role of hubs. *Academy of Management Executive*, 15(3), 102-113.

Lind, J. (2004, September). Convergence: History of term usage and lessons for firm strategists. In *Proceedings of 15th Biennial ITS Conference, Berlin*.

Lynn, G. S., & Akgün, A. E. (2001). Project visioning: Its components and impact on new product success. *The Journal of Product Innovation Management*, 18(6), 374-387.

Markides, C. (2006). Disruptive innovation: In need of better theory. *Journal of Product Innovation Management*, 23(1), 19-25.

McLean, L. D. (2005). Organizational culture's influence on creativity and innovation: A review of the literature and implications for human resource development. *Advances in Developing Human Resources*, 7(2), 226-246.

O'Connor, G. C., & Rice, M. P. (2001). Opportunity recognition and breakthrough innovation in large established firms. *California Management Review*, 43(2), 95-116.

O'Connor, G. C., Leifer, R., Paulson, A. S., & Peters, L. S. (2008). *Grabbing lightning: Building a capability for breakthrough innovation.* San Francisco, CA: Wiley & Sons.

O'Connor, G. C. & Rice, M. P. (2013). A comprehensive model of uncertainty associated with radical innovation. *Journal of Product Innovation Management*, 30(1), 2-18.

Pilkington, A., Meredith, J. (2009). The evolution of the intellectual structure of operations management—1980–2006: A citation/co-citation analysis. *Journal of Operations Management*, 27(3), 185-202.

Pritchard, A. (1969). Statistical bibliography or bibliometrics? *Journal of documentation*, (25), 348-349.

Santonen, T., & Conn, S., (2015). *Research Topics at ISPIM: Popularity-based Scientometrics keyword analysis*, in Huizingh, Eelko; Torkkeli, Marko; Conn, Steffen; Bitran, Iain (ed.). The Proceedings of The XXVI ISPIM Innovation Conference. 14-17 June, Budapest, Hungary.

Santonen, T., (2016), Management of diversity in open innovation processes, in Mention, A. L., & Torkkeli, M. (Eds.). Open Innovation: A Multifaceted Perspective (In 2 Parts) (Vol. 1). World Scientific.

Tornatzky, L. G., & Klein, K. J. (1982). Innovation characteristics and innovation adoption-implementation: A meta-analysis of findings. *Engineering Management, IEEE Transactions*, (1), 28-45.

Van Raan, A.F.J. (1998), (Ed.) Special Topic Issue: Science and Technology Indicators. *Journal of the American Society for Information Science*, 49, 3–81.

Veryzer Jr., R. W. (1998). Discontinuous innovation and the new product development process. *Journal of Product Innovation Management*, 15(4), 304-321.

Wasserman, S and K Faust (1994). *Social Network Analysis: Methods and Applications*. Cambridge: Cambridge University Press.