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## **A Status-Update on the Radical Innovation Management Family: A Literature Review**

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### Abstract

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Extended abstract

The acknowledgement of innovation as a driver for economic growth has intensified for several decades, resulting not only in an increased amount of contributions to the academic literature, but also an increased diversity in innovation typologies (Garcia & Calantone, 2002). Consequently, the literature referring to the management of radical innovation activities is dispersed, manifested in various typologies that have been justified by a modification of existing and new, nuanced perspectives on the phenomenon. In connection to this, two inexpedient conditions have occurred: (1) Some authors have been utilizing different typologies for phenomena with the same attributes, and (2) different authors have been using the same typologies to describe different attributes of a phenomenon.

Besides these two detrimental types of confusion in innovation typologies, another issue is the degree of variance in between terms. Related phenomena within radical innovation management have been classified differently, resulting in a myriad of classifications in terms of radical innovation typologies. In this study, 11 related, sometimes identical, typologies within radical innovation management have been detected. The issue of the latter example, although somewhat justified, lies within the detachment between business management in practice and that of the literature; the

fine distinctions within the literature does not translate to a highly differentiated set of actions in terms of management.

In the general innovation literature, attempts have been made to rectify the situation by converging typologies. However, there is yet no empirical evidence that the efforts of consolidating concepts have been successful ? contrarily ? multiple typologies are still very much alive.

As there is no dominant convergence of typologies in the radical innovation management literature, this paper suggests that parallel research is taking place. As a consequence, the development of knowledge within radical innovation management may have been drastically inhibited, as the accumulation process of knowledge is hindered without a converged terminology. This paper seeks to consolidate the advice/results provided within the radical innovation management family, in order deliver an overview that illustrates the actual progression in the literature ? taking into account differences in typologies.

The method used for literature search is by adding a Boolean logic to search strings within EBSCOhost (all databases), including multiple combinations of search strings on the 11 typologies (e.g. radical innovation mana\*). This method alone cannot be considered valid, as search strings in some cases give a poor yield, coupled with the difficulty of making precise Boolean phrases to identify the literature needed (sometimes e.g. process and strategy are also related to management). Consequently, multi-level reference searching has also been utilized, coupled with reference searching on frequent and prominent research to detect progression (e.g. authors as Clayton Christensen & Gina Colarelli O'Connor).

Results are expected to include an indication of parallel studies within the field, emphasizing an inexpedient development in the radical innovation management literature. This gives reflections on future practices in conducting new research, including literature reviews in order to determine whether ?new? contributions actually are new, or merely reiterations of previous work. Results shall also unveil areas for future research.

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# A Status-Update on the Radical Innovation Management Family: A Literature Review

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**Abstract:** This paper accentuates that the literature referring to the management of radical innovation is dispersed and inconsistent. The literature in the field is relatively new and unconsolidated, resulting in a myriad of radical innovation typologies that are identical or related. The paper suggests that parallel research is taking place within the field, and the accumulation of knowledge is inhibited due to a frivolous, interchangeable use of innovation typologies. 11 related, sometimes identical, typologies have been identified. As there is no dominant convergence of typologies present, 110 papers/articles, based on 11 typologies, have been included in this literature review. Cross-typological overlaps have been detected, along with areas that are relatively unexplored. This is commented upon as a reflection on future research. Academic and Managerial implications in connection to these findings are discussed.

*Keywords:* Innovation management; Innovation Typologies; Radical innovation; Discontinuous Innovation; Breakthrough Innovation; Disruptive Innovation; Exploratory Innovation; Open Innovation; Architectural Innovation; Modular Innovation; Competence-Destroying Technological Change; Disruptive Innovation

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## INTRODUCTION

The acknowledgement of innovation as a driver for economic growth has intensified for several decades. In addition to the impact on economic development, this has resulted in an increased amount of contributions to the academic literature, yet also an increased diversity in the contributing scholars, where core disciplines are within economics, business & management, engineering and technology. The typologies within the innovation literature have been widely debated. This has led to a multitude of typologies in the attempt to classify distinctions between concepts within the innovation literature (Garcia & Calantone, 2002). Using different typologies is evidently a sound way of a nuanced development of the literature and accumulating knowledge within respective fields. However, there is no clear consensus between authors concerning the attributes that belong to the different typologies. Neither do authors use the same typology name when they describe similar phenomena. This implies that knowledge is accumulated inexpediently in different tracks. A wide set of typologies may not translate to a highly differentiated set of attributes. As a consequence, parallel research may be taking place, resulting in ineffective accumulation of knowledge within innovation research. Concurrently, it has become increasingly difficult to navigate in the literature in terms of identifying actual progress (Garcia & Calantone, 2002).

In the innovation literature, attempts have been made to rectify the situation by converging innovation typologies (Chandy & Tellis, 2000, Garcia & Calantone, 2002, Harmancioglu et al, 2009). However, there is yet no

empirical evidence that the efforts of consolidating concepts have been successful – contrarily – multiple typologies are still present. This also applies to typologies within the subfield of radical innovation management.

Based upon this, two inexpedient conditions have occurred: (1) the same authors have been utilizing different typologies for phenomena *with the same attributes* (O'Connor & Rice, 2001, Rice et al, 2002, O'Connor 2008), and (2) different authors have been using the same typologies to describe *different attributes* of a phenomenon (Damanpour 1991, Henderson & Clark, 1990, Ettlie & Bridges, 1984, Dewar & Dutton 1986, O'Connor & Rice, 2001). Besides these two detrimental types of confusion in innovation typologies, another issue is the degree of variance in between terms. Related phenomena within radical innovation management have been classified differently, resulting in a myriad of classifications. In this study, 11 related, sometimes identical, typologies within radical innovation management have been detected. Although the differences are justified in the academic literature, it can still be regarded as a detachment from business management in practice; the fine distinctions within literature do not translate to a highly differentiated set of actions in terms of management.

As there is no dominant convergence of typologies in the radical innovation management literature, the development of knowledge within radical innovation management may have been drastically inhibited, as the accumulation process of knowledge is slower without a converged terminology (Garcia & Calantone, 2002).

The objective of this paper is to consolidate knowledge within radical innovation management, present in an array of typologies, in order to accentuate the development that has taken place within the literature. An overview and categorization of academic contributions will be made, emphasizing that related knowledge is created in many different settings, covered with different labels.

First, a discussion of how to unveil the “Radical Innovation Management Family” in a firm level context is made. The subsequent section introduces the methodology of the paper. This is followed by a section that uncovers the typologies that are included in what can be denominated the radical innovation management family. Concurrently, a depiction of the consolidated knowledge within the radical innovation management family literature is created. The final section discusses the implications of the findings and suggestions for future research.

### NAVIGATING BETWEEN INNOVATION TYPOLOGIES

Incremental innovation and radical innovation have often been perceived as two entities that are located in opposite sides of the innovation continuum (Veryzer, 1998). The determinants describing the differences from one side of the continuum to the other have been widely discussed (Veryzer, 1998). However, a range of authors concur upon the two

dimensions of market and technology as indicators for distinguishing between radical and incremental innovation (e.g. Johnson & Jones, 1957, Chandy & Tellis, 1998, 2000, Lynn & Akgun, 2001). One way of making distinctions is by adding levels of uncertainties in relation to market and technology. According to Dewar & Dutton (1986: 1423), incremental innovations entail minor improvements or adjustments of existing technologies. This is coupled with a low marketing uncertainty of slight modifications/low development in accordance with Veryzer (1998), Lynn & Akgun (2001) and Garcia & Calantone (2002). In this respect, radical innovations can be found on the opposite side of the matrix including new technologies/markets or a high uncertainty level of technology/markets (Lynn & Akgun, 2001). Evolutionary innovations introduce combinations of a new/existing technology and market (Lynn & Akgun, 2001). What is radical or evolutionary is however not clear in the literature, making the boundary very difficult to detect (Garcia & Calantone, 2002). The typologies are depicted in table 1 below. As the focus area in this paper is that of management, the level of scope in the study is at the firm level. On a firm level, the application of uncertainties is useful as a point of reference, as uncertainties depict the pre-innovation considerations an organization may have when developing ideas into successful innovations.

<b>Market uncertainty</b>	<u>High</u> (New)	Evolutionary market innovation	Radical innovation
	<u>Low</u> (Existing)	Incremental innovation	Evolutionary technology innovation
		<u>Low</u> (Existing)	<u>High</u> (New)
		<b>Technological uncertainty</b>	

Table 1: Adapted from Lynn & Akgun, 2001: 375. Incremental innovations utilize existing markets with existing technologies. These have slight modifications on a technological level, in some cases also slight modifications on how markets are addressed. Evolutionary market innovations encompass existing technologies on new markets. This may include an identification of needs and wants on the market, coupled with new business models on new markets to sell existing technologies. This also entails that customers may be unfamiliar with the products, encompassing that these will have to develop skills to utilize the products. Evolutionary technology innovations introduce new technologies on existing markets. In this respect it is assumed that the needs and wants of customers are known, yet there are uncertainties related to developing the technology behind the product/service. Radical innovations entail new technologies on new markets, and are thus related to a very high degree of uncertainty. As uncertainty levels rise, the degree of risk associated with the innovations rise (O'Connor, 2008). As in investment logic, increasing or decreasing risks *cet. par.* entail a corresponding change in the potential gains the company may have by a successful innovation (Melnyk et al, 2010).

Besides including a market/technology dimension in terms of classifying the radical innovation management family, it is also relevant to address the performance of an innovation. From a firm’s perspective, the *performance of an innovation* is ultimately measured by *the monetary value an innovation* creates, be it in terms of generated profits or reduced costs. Although often correlated, it is argued that the newness of technologies and markets alone are of lesser importance to the firm than the actual performance of the innovation. In terms of performance, incremental innovations hold smaller rewards than their radical counterparts (Laursen & Salter,

2006). Consequently, radical innovations are considered to yield a significantly higher performance than incremental innovations. Along with market and technology uncertainties, performance can be seen as a core element to establish whether an innovation is radical or not.

Besides the variations in the determinants of market, technology and performance, there are related areas as the need for new knowledge and the risk associated with radical vs. incremental innovations (Dewar & Dutton, 1986). Risk has traditionally been explored by Edwards (1954, cf.

O'Connor et al, 2008), emphasizing that risk takes into account probabilities of a situation or phenomenon, enabling managers to make decisions on this basis. When working with uncertainties and continuous learning, the probabilities are in constant fluctuation, making it difficult to estimate probabilities, thus increasing risk in a radical innovation environment. The degree of new knowledge associated with radical innovation activities will often increase, as organizations may be inclined to explore new areas of knowledge in order to achieve enough combination potential in different areas of knowledge (Dewar & Dutton, 1986). Knowledge and risk are seen as related to the three prior aspects, as e.g. the development of a new technology implies that new knowledge must be acquired, hence an increased risk is seen as a departure from known knowledge and practices. Finally, the factor of time is also present when authors have been distinguishing between radical- and incremental innovations (O'Connor, 2008). The time-horizon on radical innovations is often longer than of incremental innovations, as a great deal of exploration and experimentation is included in the process. The determinants distinguishing radical from incremental innovations can be seen below:

Incremental	Determinant	Radical
<i>Existing</i>	Technology	<i>New</i>
<i>Existing</i>	Market	<i>New</i>
<i>Lower</i>	Performance	<i>Higher</i>
<i>Lower</i>	Risk	<i>Higher</i>
<i>Less</i>	New knowledge	<i>More</i>
<i>Shorter</i>	Time Horizon	<i>Longer</i>

Table 2: Determinants for differentiating between incremental- and radical innovations.

As it will appear later in this study, there are variations in addressing typologies that are in the radical innovation management family. Simultaneously, it is necessary to use the basic principles of technology, market and performance on the firm level, in order to clarify the distinction between innovations. The next step is to consider how it is possible to place the radical innovation management family in the innovation continuum.

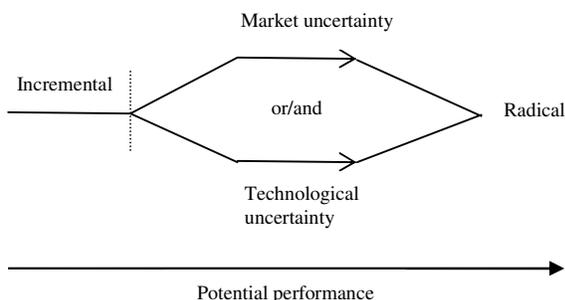


Figure 1: The Innovation Continuum

As it is arduous to generate a specific point along the innovation continuum to portray where incremental innovations end and where radical innovations begin, a theoretical boundary can be set on the left side of the continuum when innovations no longer include existing

technologies and/or markets. Again, this construct poses new challenges, as the market/technology distinction is not prevalent in all corners of the literature. This is neither the case for the related performance, risk, knowledge level or time horizons connected to different innovations. Establishing this theoretical construct as the lower boundary poses another challenge; it introduces a minimum set of requirements, yet is imprecise in fathoming radical innovations specifically. However, a more precise definition could induce discarding a large amount of false negatives. Conversely, the approach applied is rather to address a larger portion of typologies, then gradually exclude false positives. Consequently, a point of departure is to commence with the term radical innovation management in the literature, and follow references through this typology, in order to detect and follow sources that are related to this literature. As this method progresses in the paper, the concept of the radical innovation management family will be unveiled.

## METHODOLOGY

This paper holds two levels of ambition. Firstly, it is necessary to establish what constitutes The Radical Innovation Management Family. Secondly, contributions given in this literature are consolidated in this paper, eventuating in a discussion of the future research needed in the field, along with academic and managerial implications.

The identification of the radical innovation management family is commenced by searching through the literature in an online database. The method used for literature search is by adding a Boolean logic to search strings within EBSCOhost (all databases). The search will have a gradual development in the application of new search strings as typologies appear. The first search string utilized is radical innovation mana\* (taking into consideration multiple suffixes). The process is repeated as new typologies emerge. This method alone has limitations, as search strings in some cases give a poor yield, coupled with the difficulty of making precise Boolean phrases to identify the literature needed (sometimes e.g. process and strategy are also related to management). However, the aim of this paper is to discover whether a phenomenon is present, not how widespread it is. In order to make this first review more manageable, only first level search results from the database are included in this review.

As the typologies to be included in the radical innovation family have been identified, the next step is to systemize the knowledge generated in the literature by the respective typologies. The approach utilized in this respect is by making keywords and core points to the main contributions of papers, thus creating an overview of the respective typologies. Papers do not have to be published in a specific journal or from a specific discipline, yet has to be applicable in the area of management. A second criterion is the limitation towards a firm level perspective. Contributions concerning the single firm and management areas related to the single firm are thus prioritized. The focus is moreover seen as a term of product innovativeness, and thus the firm's capability to deliver new

products/solutions/value. Therefore, radicalness is not a measure of how “innovatively” the firm is organized. Further methodological considerations are described as the paper unfolds.

#### COMMENTS FOR TYPOLOGY COMPARISON

By applying a Boolean search, 11 typologies related to radical innovation management were present when examining the literature. The typologies will now be processed.

It was noted in the introduction that issues were present of using (1) either different typologies for phenomena with the same attributes or (2) the same typologies for phenomena with different attributes. An example of the former is the typology consistency between radical-, breakthrough- and discontinuous innovation. Some authors have been utilizing a definition related to the performance of the abovementioned innovations by emphasizing that radical- or breakthrough innovations introduce “*Unprecedented performance features or with already familiar features that offer potential for a 5-10x (or greater) improvement in performance, or a 30-50% (or greater) reduction in cost*” (Rice & O’Connor 2001: 99). Discontinuous innovations are in this regard seen as having: “*New to the world performance features (i.e. fundamentally a new product or service), five- to ten-fold (or greater) improvement in known performance features; 30% to 50% (or greater) reduction in cost.*” (Rice et al, 2002: 332). The definitions, involving overlap in authors, are strikingly similar, and have thus introduced three typologies to cover the same attributes.

The second issue of identical typologies with different attributes can be exemplified with typologies introducing the overarching themes of technology, market, performance, knowledge, risk and time. Garcia & Calantone (2002: 122) suggest that radical innovation introduces a new market- and technology S-curve. Magnusson et al (2002: 5) argue that discontinuous (radical) innovations involve both the introduction of new component technologies and the formation of new linkages. Dewar & Dutton (1986: 1422) argue that radical innovations introduce fundamental changes that represent revolutionary changes in technology, representing clear departures from existing practice and introduce a very new knowledge component. The risk and time components have lesser presence in the definitions, but are often introduced in the literature as a primary concern when distinguishing between radical- and incremental innovations (e.g. Lynn & Akgun, 2001, Cabrales et al, 2008, O’Connor et al, 2008). Although different, the literature, with these distinctions of radical innovation, touch upon the overarching themes of market/technology uncertainty, performance, knowledge, risk and time. The above instances introduce three typologies; *radical- breakthrough- and discontinuous* innovation.

Expanding the definition of the radical innovation management family becomes trickier, as this involves further argumentation for connections to the term, also involving a

“lesser degree of radicalness” in the definitions. However, the definitions depart from those of incremental and imitative innovations and are thus included in this study to avoid false negatives.

Other terminologies include *Really New* innovations or *Really New* products (Veryzer, 1998, Garcia & Calantone, 2002). This may involve a combination of market and technology discontinuities (Garcia & Calantone, 2002). Really New innovations are also considered to include dramatic leaps in terms of customer familiarity and use (Veryzer, 1998).

*Major innovations* can be seen as either introducing technology or market uncertainties - or both (O’Connor, 2008).

Henderson & Clark (1990: 10) argue that *architectural innovations* change the way of which the components of products are linked together, while leaving core design concepts (and the basic underlying knowledge components) untouched. Contrarily, *modular innovations* change only the core design concepts of a technology. Architectural innovations may induce market uncertainties, as new linkages between components involve potentially new market opportunities. Modular innovations foster technological uncertainties, as changing core design concepts may involve technological challenges. In either case, a discontinuity to known bases of knowledge is created. While Henderson & Clark (1990: 11) state that the knowledge concerning the single components of the innovation remain untouched in architectural innovations, the relationship between components has been changed – involving new knowledge on the architecture of products. Thus, although emphasized as subtle changes, architectural innovations’ implications in component relationships and market may be substantial (Henderson & Clark, 1990). In turn, modular innovations challenge the key components of technologies, thus primarily concerning technological uncertainties of the innovations (Magnusson et al, 2002).

Chesbrough (2006: 1) defines *open innovation* as “...*the purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively (internal and external ideas, existing or external use of paths to markets)*”. This definition includes gathering new knowledge in order to accelerate the innovation activities of the firm. Simultaneously, this also indicates an approach where markets are affected as part of open innovation.

Smith & Tushman (2005) accentuate *exploratory innovation* as associated with experimentation, flexibility, divergent thinking and increasing variance. This definition is slightly vaguer than the former definitions, yet however still draws upon uncertainties and new knowledge acquisition as part of the process (Phelps, 2010). Phelps (2010) furthermore defines exploratory innovation as the creation of technological knowledge novel to a firm’s existing pool of knowledge. Phelps (2010) explains that exploratory innovations embody

knowledge that differs from knowledge used by the firm in prior innovations, demonstrating that firm has broadened its technical competence. Phelps (2010) also state that exploratory innovations typically take longer to realize and are more variable in their nature.

Tushman and Anderson (1986: 442) have stated that *competence-destroying* technological change creates a new class of products which “...require new skills, abilities, and knowledge in both the development and production of the product. The hallmark of competence-destroying discontinuities is that mastery of the new technology fundamentally alters the set of relevant competences within a product class”.

Finally, an interesting typology is *disruptive innovation*. Disruptive innovations have often been separated from radical innovations, primarily being reasoned by poor initial performance and delivery of new value propositions mismatching current customer requirements (Christensen, 1997, Sandström, 2008).

An important factor must however be taken into consideration in this regard; time. The time to impact of the radical innovations are often regarded as significantly longer than incremental innovations (Veryzer, 1998). Therefore, a lower initial performance of disruptive innovations does not necessarily transfer to a worse performance per-se in a radical innovation context. For established firms with the strategic willingness to pursue radical innovations, critical lessons from the disruptive innovation literature may be obtained. This is argued bearing in mind that disruption in itself is of less interest to the firm than what disruptive innovations may incur, should the firm be on the forefront of the development.

In sum, the following 11 typologies can be considered to be included in the radical innovation management family, encompassing one or more criteria of market uncertainty, technological uncertainty, performance, knowledge, risk and time:

Typology	Examples of authors
Radical, Discontinuous, Breakthrough	Rice & O'Connor, 2001 Rice et al, 2002 Garcia & Calantone, 2002 Magnusson et al, 2002 Dewar & Dutton, 1986 Lynn & Akgun, 2001 Cabral et al, 2008 O'Connor et al, 2008
Really New	Veryzer, 1998 Garcia & Calantone, 2002
Major	O'Connor 2008
Architectural	Henderson & Clark, 1990 Magnusson et al, 2002
Modular	Henderson & Clark, 1990 Magnusson et al, 2002
Open	Chesbrough, 2006

Exploratory	Smith & Tushman, 2005 Phelps, 2010
Competence-Destroying	Tushman & Anderson, 1986
Disruptive	Christensen, 1997 Sandström, 2008

Validity issues arise as a result of grouping different typologies together in this way, as it is difficult to establish with absolute precision whether progress made in one typology setting relates to the other. This especially goes for less radical typologies such as e.g. architectural or modular innovations. However, returning focus back towards the incongruence between the fine distinctions in the literature vis-à-vis that of management, it is necessary to make an effort in detecting the status within this field.

Garcia & Calantone (2002: 111) have accentuated that the myriad of innovation typologies present fosters managers in firms to decide which type of innovation they are working with. Until a better consolidation of typologies exists, managers will have to navigate in a wide array of literature to find the answers they seek. In practice, firms will most likely be conducting innovation activities reflected upon multiple typologies simultaneously. For instance: If one would ask an organization what kind of innovation their new department was conducting; they might answer: We are doing disruptive innovation (Christensen, 1997) as we are not expecting our products to be outperforming the industry for quite some time. If successful, we expect our innovations to have significant impact on how value is delivered to the market. The potential returns may be found 5-10 or even more years from now. Simultaneously, we have decided to establish a new department, in order to gain momentum in our innovation activities with a specific set of conditions that differ from our incremental innovation activities (Disruptive innovation: Christensen, 1997, Radical-, Breakthrough innovation: O'Connor et al, 2002, Discontinuous innovation: Tidd & Bessant 2010, Major innovation: O'Connor 2008). We understand that the uncertainty levels of these innovation activities require a lot of learning, including having to think in new patterns, sometimes revising our previous knowledge and competences in specific areas (Competence-Destroying: Tushman & Anderson, 2005). However, we see that the technology it brings, once introduced, proposes a knowledge base that can facilitate a range of new innovations that may be profitable for the company in the future (Exploratory: Smith & Tushman, 2005). We are moreover involving external partners in the development of our innovations to benefit from comparative advantages in key knowledge areas (Open: Chesbrough, 2006).

The above indicates that the typologies related to radical innovation management are indeed filtered together in reality, possibly meaning that single-typology studies bring about discoveries that have already been suggested in similar or related literature. The above provides an indication that the distinctions made in the literature to justify the utilization of different typologies lose validity, as there is an overlap in both the literature and particularly how the literature converts

to practice. In accordance with Garcia & Calantone (2002), this suggests that the amount of typologies is unnecessarily high, and thus could benefit from a convergence.

As there is currently no academic consensus between which typologies to use, literature reviews within the field have to take into account the research taking place in the related areas. Depending on the nature of the research, one or more related typologies may be necessary to detect the current status of knowledge within the field, in order to avoid overlap and parallel research.

For the purpose of this paper, the radical innovation management family can be considered to encompass technological and/or market uncertainties, have a higher potential performance than incremental innovations, be associated with greater risk as a result of departing from known practices. This is due to the often perceived necessity of gathering new knowledge when conducting radical innovation activities, which also require a longer time to mature than their incremental counterparts. This is the definition applied in this paper.

#### CONDUCTING A STATUS-UPDATE

This section seeks to gather the contributions made in the radical innovation management family. In order to attain validity, no preliminary groups are made in this process. As mentioned in the methodology, a Boolean logic was applied to the searches made to conduct this literature review. The search strings included were: *Radical Innovation Mana\**, *Discontinuous Innovation Mana\**, *Breakthrough Innovation Mana\**, *Disruptive Innovation Mana\**, *Really New Product Mana\**, *Open Innovation Mana\**, *Architectural Innovation Mana\**, *Modular Innovation Mana\**, *Exploratory Innovation Mana\**, *Major Innovation Mana\**, *Competence-Destroying*. All databases of EBSCOhost were enabled in the search.

Through this, a selection process sorting out various papers commenced. Correspondingly, criteria for inclusion and exclusion of papers from the review were the following:

**Inclusion:** All papers contributing to management of innovation as a result of the search string. This includes multiple sectors and multiple countries. When relevant, publications from e.g. Harvard Business Review, McKinsey Quarterly and similar were also included. It has to be noted that the ambition is not to argue about the validity of the single studies, but to give an overview of the publications and accumulated knowledge in the respective fields.

**Exclusion:** Papers that specifically targeted SMEs. Papers that had an imitative/incremental innovation focus were also excluded. Moreover, some papers were not available through the database, and despite numerous attempts to obtain the papers, some are unintentionally excluded for this reason alone.

Through this search process on the 11 different typologies, a total of 110 papers/journals/articles were included in this

literature review. A list of these papers can be found in the appendix. Note that on the search strings applied in this paper, the results on architectural and modular innovation were scarce, and thus merely duplicates of the publications present within search strings of other typologies. With a total of 44 papers, radical, breakthrough and discontinuous innovation management had the most results in the search. This was followed by open innovation management, with a total of 33.

As all the articles had been collected, processing the articles began. The process was straightforward: results/conclusions/implications/discussions from every article were transferred into a large excel sheet covering all the respective typologies. This was affiliated with a unique ID of each paper. When this was conducted, the next step was to systemize all the data into manageable portions, thus making it possible to detect whether parallel research is taking place, and if some areas within the radical innovation management family are over- or underrepresented. In order to avoid assimilation of concepts and imprecise labeling, a wide array of statements/topics have been created. This has been followed by plotting in the ID of each paper wherever a statement covers an area of a paper. This was repeated for each paper, and there was no limit as to how many or few categories a paper could be included in. If there was no fitting category, a new category would be created to ensure a better fit. This method creates a rich set of information, which possibly could undergo further convergence to create a more consolidated picture. However, with the risk of reducing validity of the review, a vast amount of categories remained.

#### INITIAL FINDINGS<sup>1</sup>

As can be seen in the appendix, the foci of papers within and across typologies are unevenly distributed. A relatively large proportion of the literature has been engaging in various top management issues. One explanation to this phenomenon could be the search of a general understanding of how a firm should navigate strategically before or after discontinuous conditions. This may also be related to the complex nature of radical innovations, where a vigilant strategic focus is necessary in order to allow top management to be responsive to fast-paced change.

Networks and the involvement of external partners in different settings is moreover a concept that is widely represented. This indicates a broad acceptance that conducting radical innovation activities is a multiplayer game, where different actors play each their part in order to achieve success.

Concurrently, when engaging in various network activities, it simultaneously becomes increasingly important to focus on how individuals interact in a radical innovation context. A proportion of the findings indicate that the management of individuals in this regard is situational, and that top management should carefully monitor- and develop

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<sup>1</sup> Please refer to the appendix for references to this section, where an overview of the above findings is given.

appropriate incentive systems for employees in order for radical innovation activities to be successful.

As a result of dealing with a great deal of uncertainties, a majority of the literature focuses on the discipline of knowledge management when conducting radical innovation activities. Acknowledging that radical innovation implies uncertainty and risk, assuring proper management of the learning taking place in the process is deemed important by the authors. This is seen in the context of both the knowledge generated outside the organization, which, for instance, is widely discussed in open innovation literature, yet also inside the organization. Another remark is the emphasis on creating separate departments for radical innovation activities, either formulated as SBUs with their own pool of money, corporate venturing, spin-out, or merely the creation of a new department.

The above findings seem either to have been repeated, or lightly modified in the development of the literature included in this literature review. As suspected, the above findings indicate that parallel research is taking place, and that a lack of convergence/coordination between different schools of typologies may potentially have inhibited accumulation of knowledge.

Besides indicating the suspicion set before this literature review, the study has also localized interesting areas or “niches”. For instance, Boscherini et al (2010) have discussed how firms can transition from being closed- to open innovation oriented. This may bring about interesting findings, as a great deal of firms struggle with the transition of merely creating innovation on existing, controlled, internal knowledge, to having to interact with a wide array of partners. Open innovation may in this instance perhaps seek inspiration in Exploratory innovation management, where Rampersad et al (2010) discuss power distribution in innovation networks, the need for organizing bodies, identifying the value proposition a firm has to a network etc.

Other interesting areas may be to incorporate lead users in the development of radical innovations. Radical innovation literature has often focused on interfirm networks (e.g. DeTienne & Koberg, 2002), and less on networks with customers. This could be reminiscence from Ford’s “Faster Horse” concept, which however is challenged by scholars in this literature review (Enkel, 2005, Eisenberg, 2011).

A point made by Yu & Hang (2010), stating that a lot of disruptive innovation management research has focused on the fuzzy front end, is moreover quite interesting. A general overweight of managerial implications, strategies for knowledge sharing, organization structure, etc. may have skewed the focus of radical innovation activities towards the fuzzy front end. An interesting approach taken by Reinders et al (2010), suggesting that bundling non-radical products with radical products in a meaningful way when presented to the market, may increase the success-rate commercialization of radical innovations. This output-end is interesting, as the success and performance of the radical innovations ultimately

depend on their ability to be sold on markets. Literature focusing on this output end is scarce in this review.

Possible areas for interesting research in the future do not conclude here. The review has introduced some preliminary findings using a method of cross-typological search within the radical innovation field. Yet, a vast amount of papers and publications may still be systemized this way by reference-through reference search, along with other criteria when conducting literature search.

## ACADEMIC IMPLICATIONS

The preliminary results provided in this paper indicate that there are cross-typological areas of research that dominate the radical innovation management family. Such a tendency may have led to unfortunate consequences, such as a reduced pace of knowledge accumulation within the discipline, or even worse, to some extent repetitions that are not as novel as presented in the papers. Consequently, as the convergence of typologies within the field is not sufficient, researchers need to refer to related typologies in some situations when conducting their research, as failing to do so increases the risk of repeating research efforts that have already been made.

Some of the variations in this literature could have been avoided would some of the authors have been more consistent in using their typologies in different settings. While using radical, discontinuous, breakthrough and major innovation interchangeably might improve linguistic flow in an article, authors must be aware of the potential implications of doing so.

Moreover, the cross-typological approach shall not be seen as a hindrance to writing papers in the form of extra work when reviewing literature prior to paper writing. Opening up the typologies may create new cross-typological insights that can facilitate the advancement of knowledge within the field.

## MANAGERIAL IMPLICATIONS

Based on the research in this paper, it is clear that managers interested in radical innovation activities must navigate in a wide array of literature in order to ensure that they have acquired the newest knowledge within the field. Acquiring a book on radical innovation may simply not suffice, as discoveries from related disciplines may be just as beneficiary in advancing the “radical” innovation activities of firms.

The present paper should create awareness among managers that a myriad of radical innovation typologies exist, some of which are more or less identical, some of which differ from one another, although overlapping in some areas. When exploring the literature, managers must be aware that the answers they seek may be found with a different label elsewhere.

## LIMITATIONS TO THE FINDINGS

The findings in this literature review are based on a first level literature search in an acknowledged database. As the search only resulted in 110 usable articles, it is not regarded as providing a complete picture of the current status of the advances within the radical innovation management family. Instead, future endeavors towards expanding the search should be made in order to properly substantiate where overlaps and potential duplications in the literature are present. One step could be to develop the Boolean logic of the search strings, or make a second-level search, i.e. reference-tracking through the papers found in this research. However, it is argued that the internal development within each individual typology has been benefiting from the accumulation of knowledge. Consequently, it can be assumed that the papers reviewed do represent some of the fore-front research within each of their respective fields.

Finally, it should be noted that the findings, e.g. on common areas of research across typologies, do not take into account the method and/or dataset used in the various papers. Consequently, the validity of each paper, i.e. the academic weight that can be affiliated with each paper cannot be determined. As a result, no generalization towards the tendencies can be made prior to thorough empirical testing or substantiation of empirical testing within selected overlapping papers.

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# Appendix 1

Radical	Discontinuous	Breakthrough	Really New	Disruptive	Major	Architectural	Modular	Open	Exploratory	Competence-Destroying
1. McDermott & O'Connor (2002)	31. Bessant et al (2004)	41. Anthony & Christensen (2006)	46. Schmidt & Calantone (2003)	48. Georgantzas & Katsamakas (2009)	56. Ross (2008)	63. (No. 36)	65. (No. 36)	66. Quintas et al (1997)	99. Alexiev et al (2010)	103. Tripsas (1997)
2. Annique (2010)	32. Biazzo (2009)	42. Fleming (2007)	47. Tellis et al (2004)	49. Gilbert & Bower (2002)	57. Crawford (1991)	64. (No. 53)		67. Chesbrough & Prencipe (2008)	100. Gillier et al (2010)	104. Rothaermel & Hill (2005)
3. Aronson et al (2008)	33. Brentani & Reid (2012)	43. Visser et al (2008)		50. Brown & Hagel (2005)	58. Dealtry (2008)			68. Enkel et al (2005)	101. Lee & Kelley (2008)	105. Afuah (2001)
4. Benedetto et al (2008)	34. DeTienne & Koeborg (2002)	44. Von Hippel et al (2000)		51. Rafii & Kampas (2002)	59. Tauber (1974)			69. Dahlander & Magnusson (2008)	102. Rampersad et al (2010)	106. Sosa (2009)
5. Cardinal (2001)	35. Gammoh et al (2011)	45. (Editorial) (2007)		52. Sherif et al (2006)	60. Khandwalla (2006)			70. Collins (2006)		107. Gatignon et al (2002)
6. Chao & Kavadias (2008)	36. Magnusson et al (2002)			53. Tran (2006)	61. Peng & Finn (2010)			71. Eisenberg (2011)		108. Reuber (2008)
7. Leifer et al (2001)	37. Philips et al (2006)			54. Voelpel et al (2005)	62. O'Connor (2008)			72. Harryson (2008)		109. Ahsan (2009)
8. Corso & Pellegrini (2007)	38. Rice et al (1998)			55. Yu & Hang (2010)				73. Lichtentaler (2007)		110. Ahsan et al (2010)
9. Emsley et al (2006)	39. Vanhaverbeke & Peeters (2005)							74. Kleyn et al (2007)		
10. Hall & Andriani (2003)	40. Veryzer (1998)							75. Knudsen & Mortensen (2010)		
11. Hommels et al (2007)								76. Lazarotti et al (2010)		
12. Koeborg et al (2003)								77. (Strategic Direction) (2007)		
13. Koskela & Vrijhoef (2011)								78. Hung & Chiang (2010)		
14. Lettice et al (2008)								79. Mohanbir et al (2000)		
15. Jokunc (2007)								80. Tierlinck & Spithoven (2008)		
16. Melnyk et al (2010)								81. Ulhøi (2004)		
17. Möller (2010)								82. Fetterhoff & Voelkel (2006)		
18. O'Connor & DeMartino (2006)								83. Chesbrough (2004)		
19. O'Connor & Ayers (2005)								84. Buganza et al (2011)		
20. O'Connor et al (2008)								85. Isckia & Lescop (2009)		
21. O'Connor & Rice (2001)								86. Lichtentaler et al (2011)		
22. O'Connor et										

al (2008) 23. O'Connor et al (2011) 24. Reinders et al (2010) 25. Stringer (2000) 26. Tran (2006) 27. Truffer et al (2002) 28. Varadarajan (2009) 29. Witkamp et al (2011) 30. Witkamp et al (2011)								87. Lichtentaler & Lichtentaler (2009) 88. Sjödin & Eriksson (2010) 89. Sieg et al (2010) 90. Bahemia & Squire (2010) 91. Bergman et al (2009) 92. Seitz & Reger (2009) 93. Brown & Hagel (2006) 94. Chatenier et al (2010) 95. Chiaroni et al (2011) 96. Boscherini et al (2010) 97. Ollila & Elmquist (2011) 98. Lichtentaler (2011)	
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9 typologies (Architectural and Modular included duplicates only)	Radical	Disc onti nuo us	Breakthrough	Rea lly Ne w	Dirsu ptive	Major	Open	Exploratory	Competence -Destroying
Topics addressed	Papers represented								
Top Strategic Management Issues/Contradictio ns	1, 7, 13, 19, 20, 25				49,		68, 72, 73, 89, 97,	99,	
Risk Management	1, 6, 22, 23, 26	38,	41,		53,				
Capability Stretch & Development	1, 26						98,		107, 109, 110,
Role of Sponsors and Mgt. Support	1, 17, 19, 22, 23,	33, 34, 37, 38,	45,		49, 53, 54,	57,	95,	101,	
Team Composition (employees)	1, 2, 3,		43, 45,			56, 57,			
Networks & Interfirm Linkages	1, 17, 20, 21, 27,	34, 37, 38,			49, 50, 54,	58,	67, 70, 72, 73, 74, 75, 79, 82, 83, 93, 98	99, 100, 102,	
People Management (employees)	2, 3, 4, 7, 9, 17, 20, 23, 25,	33, 38, 40,			55,	56,	86, 89, 94, 95,	101,	
Knowledge Overlap/Knowledg e Mgt.	2, 7, 10, 15, 17, 19, 21, 26,	33, 37,	41,		52, 53,	58,	66, 67, 69, 79, 81, 82, 89, 91, 92, 94, 95,	99, 100,	109, 110,
Leader Characteristics,	3, 7, 12, 14, 23								

Focus & Personality									
Strategic Capabilities	4, 29, 30,								
Country Comparison	4								
Project/Portfolio Management	5, 6, 14, 16, 18, 20, 21, 22, 27	31, 34, 36,		46,		61	83, 95,		
Radical Innovation Process	5	32,							
Generation of Separate SBUs/Corp. Venture/ New department	6, 8, 11, 18, 19, 20, 25, 27, 29, 30	31, 38, 39,			49, 54, 55,	60,	83,		
Current vs. Future needs	8,								
Exploration & Exploitation of knowledge	8, 19, 21,						82, 87,		
Internal networks	12, 21,								
Experimentation	12, 20, 22, 27,	33, 37,	41,						
Top-Down or Bottom-Up innovation	13,								
Management Team	14, 19								
Shifting from Incremental to Radical innovation	16,								
Finance &	17,								

Investment Decisions									
Organization Structure	18, 19, 25,						86,		
Dynamic Capabilities	20,					62,	87,		103,
Opportunity Recognition/Early Stage Discovery	21, 27	33, 40,							
Product Bundling, mix incre and radical to get market success	24,								
Incubation	27,				50,				
Incre needed to fund Radical Inno – Dual	28,								
Dextrous Organization	28,	32,			55,				
Consumers, consumer involvement		35,				57, 59,			
Entrepreneurial Activities		37, 40,	41,			60,		101,	
Set boundaries and constraints		38,	41,		49,				
Organizational Slack		40,	41,						
Lone inventors or multiplayer			42,						
Include Lead Users			44,				68, 71,		
External			45,				66, 67, 69, 79,	99, 100,	103,

Knowledge Inclusion							80, 81, 87, 91, 92		
From Idea to Cash flow, the process & time				47,					
Performance, future effects				48,					
Profit focus, business model				48, 55,					
Identification of Disruptions				51,					
Absorptive Capacity							69, 87,		103,
Degrees of open innovation							75, 76, 77, 84, 90, 95,		
Performance effects of open innovation							78, 85,		
External factors of the firm and firm performance							80,		103, 104, 105, 106, 108,
Supplier Integration and Open Innovation							88,		
From Closed to Open Innovation, strategic transitioning							96,		
Geographical Distribution of Research Sites									103,