A Systematic Review of the Debate and the Researchers of Disruptive Innovation

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Abstract: Despite the popularity of the term "disruptive innovation", its applications have taken on different meanings. Clayton Christensen is a prominent author in the field but his approach has not been applied in a consistent manner. To elucidate the use of the term in business studies, this paper employs a bibliometric approach to provide a descriptive analysis of researchers and their relevant works in the network formed by the related literature, in addition to distinguishing and grouping associated authors. The results suggest a dissimilarity of objectives between two subgroups using the term "disruptive innovation"; and the discussion about Clayton Christensen's specific meaning of the term seems to make sense to only one of them.

Keywords: disruptive innovation; disruptive technology; innovation; disruption

Introduction

The terms “disruptive innovation” and “disruptive technology” have gained prominence in recent years, with academic interest evidenced by special editions of reputed journals dedicated to the theme of disruption, such as the Journal of Management Studies, Journal of Product Innovation Management, IEEE Transactions on Engineering Management and Technological Forecasting and Social Change, as well as by the terms’ inclusion in management and innovation textbooks (e.g., Garud, Kumaraswamy & Langlois, 2003; Besanko, Dra- nove, & Shanley, 2004; Trott, 2008; and Hill, Jones, & Schilling, 2015). The terms are usually associated with Clayton Christensen, whose academic papers obtained high citation grades and whose books achieved great commercial success. In 2011, The Economist magazine included Christensen’s 1997 book, The Innovator’s Dilemma, among the six classics in management literature of the past fifty years.

Despite Christensen’s accomplishments, the concept of disruptive innovation generated well-known controversies in the field of management studies (Hopp, Antons, Kaminski, & Salge, 2018a). An innovation that causes disruption in a market is not necessarily a disruptive innovation as Christensen defines it (Schmidt & Druehl, 2008). If, on the one hand, media success or sales figures do not necessarily represent the truth about the development of Christensen’s work, then some criticisms seem extreme, in terms of both the theoretical quality of his work and the originality of his contribution. The debate over the validity of Christensen’s approach has been intense over the past decade, with exalted condemnations or nonconsensual modifications of the theory by some authors (e.g., Markides, 2006; Daneels, 2004; Markides, 2013; and King & Baatartogtokh, 2015). Above all, the discussions manifest the existence of a dispute in this field of knowledge.

An important and possibly related fact about some of the criticisms is that, even with the frequent use of the term, the theory’s concepts are not always applied in a consistent manner. It is not unusual for the expression “disruptive innovation” to be employed with a radical meaning that is distant from what was intended by Christensen. According to the Organization for Economic Cooperation and Development (OECD), for example, disruptive innovation “has a significant impact on a market and on the economic activity of firms in that market. This concept focuses on the impact of the innovations, as opposed to their novelty” (OECD, 2005, p.58). Famous examples such as Uber, which has already caused significant changes in the taxi industries of several cities around the world and is frequently referred to as a disruptive innovation, does not fit into the concept proposed by the theory’s authors (Christensen, Raynor, & McDonald, 2015). In another example of imprecise use, Souza and Takahashi (2012) disregarded the possibility of new market disruption when they stated that “the evolutionary trajectory of the performance of a disruptive innovation makes it eventually competitive in the main market (otherwise it is not a disruptive innovation)” (our translation, parentheses in the original, p.123). The authors reduce the predictive qualities of the approach when they suggest that the theory can only be explained ex post facto.

Semantic confusion is undesirable in scientific postulates. The conflict over the use of “disruptive innovation” in academic evaluations can reduce the relevant by-products from research and, consequently, the contributions to managers and their organizations. Hence, efforts to reduce asymmetries in terminological understanding are welcome. In English, where the word “disruption” already belongs to the language, the confusion between Christensen’s sense and its popular meaning is apparent and raises heated discussions among some authors. In other languages that do not embrace the word “disruption” as a native term, such as Spanish or Portuguese, the confusion should be less frequent but still manifests itself and, therefore, the correct meaning must be clarified in specialized publications.

Attempts have been made to use bibliometric techniques to better comprehend the development of the field. From what is known, bibliometric analysis was applied with a focus on disruptive innovations in Pilkington (2009); Cândido (2011); Schiavi and Behr (2017);...
processes, and routines available to large corporations in concentra-

tions is not entirely clear, with specific contributions coming from

different areas. From a wider perspective, if one looks at improve-
ments in productivity achieved through the use of machines and
new processes as innovations, the discussion has been going on since
the time of Adam Smith. In his classic The Wealth of Nations ([1776]
2007), Smith characterized the division of labor as a facilitator of ma-
chine inventions, which expanded productivity and production and
allowed greater economic development of contemporary societies.
In recent times, Schumpeter (1912) emphasized the importance of
entrepreneurial activities for technological development and con-
sequent economic growth. The author’s work is considered to be
an important reference in many studies directed at organizations.
Schumpeter’s ([1942] 2014) vision of the innovative process evolved
throughout his career, culminating in the recognition that resources,
processes, and routines available to large corporations in concen-
trated markets provide advantages for these companies to innovate.

Over the years, more refined constructs have been developed for the
benefit of both countries and organizations.

Among the first studies to mark the contemporary view of innova-
tion from an organizational perspective are Utterback and Aber-
nathy (1975) and Abernathy and Utterback (1978), which extended
the analyses beyond cases of an incremental nature that occur with
knowledge accumulation in established firms. The authors describe
radical innovations as those associated with the recognition of new
demand and the introduction of superior performance, without solely
seeking to reduce costs with standard technologies. Such innovations
would create recognized competitive advantages over the existing
supply (Porter, 1985). In recent decades, innovations have come to
be evaluated based on other dimensions, incorporating not only a te-
chnological aspect but also demand types (Abernathy & Clark, 1985;
Christensen, 1997) and a system facet (Henderson & Clark, 1990).
In the past, the one-dimensional view of innovation left gaps while
explaining the progress of some technologies and organizations; the-
therefore, it seems that more sophisticated models are required.

Christensen’s Disruptive Innovation

The theory of disruptive innovation was developed in the 1990s by
Clayton Christensen while pursuing his Doctorate in Business Ma-
nagement from the Harvard Business School and emerged as an at-
ttempt to shed light on why companies failed to identify that some
innovations with less embedded technology threatened their domi-
nant positions. This anomaly was articulated by Christensen and his
colleagues (e.g., Bower & Christensen, 1995; Christensen & Bower,
1996; Christensen, 1997; Christensen & Overdorf, 2000; Christensen &
Raynor, 2003; Christensen, Anthony, & Roth, 2004) with impor-
tant managerial lessons, including that paying exclusive attention to
the best customers and the current values in an established company
would increasingly disengage it from disruptive innovations and
could jeopardize its future growth.

For Christensen, Anthony, and Roth (2004), disruptive innovations
“either create new markets, bring new attractiveness to nonconsu-
mers, or offer more convenience, at lower prices, to lower-income
consumers in an existing market” (p.321). Additionally, domination
by a new entrant in a breakthrough movement in an established mar-
ket may occur, but it is not necessary to characterize an innovation as
disruptive in Christensen’s sense.

According to Christensen’s theory, firms that innovate in a radical or
incremental manner in a struggle to improve their overall quality in
order to further improve their products, usually pursue the attribu-
tes of a dominant design. Such firms practice so-called “sustaining
innovations” and compete to serve a class of unsatisfied consumers
who would pay more for improvements in features or attributes of
the product consumed. This group should comprise the majority of
firms and innovations. On the other hand, there are companies that
seek to serve satisfied consumers and accept or desire a lower qual-
ity or quantity of certain attributes. Such companies practice low-end
disruptive strategies. As an example, Christensen (1997) presents 3½-
inch floppy disk readers as low-end innovators over their 5¼-inch
competitors in the 1980s. Until that date, although the 3½ disks were
smaller than the dominant 5¼ disks, they did not meet the storage
capacity required by leading minicomputer and PC makers and were
thus produced by companies that served a limited and less profitable
market comprised of the nascent laptop industry. Over time, through
incremental innovations, the 3½ floppy disks met the standard stor-
age capacity required by the minicomputer and PC market, capturing
a significant portion of the market from its 5¼ competitors. A similar
pattern was found in the previous period:

For example, the 8-inch floppy disk would store 20 MB when
it was first introduced, while the primary floppy disk market at
that time was mainframe and required 200 MB disk. Not surpris-
ingly, leading computer producers rejected the architecture
of the 8-inch floppy disk initially. As a result, vendors, whose
mainstream products consisted of 14-inch disks with more than
200 MB of capacity, did not aggressively track disruptive pro-
ducts. (Bower & Christensen, 1995, p.45)

Finally, Christensen's theory states that there are innovations that
bring new consumers to the market, previously untapped due to lack
of ability to consume or enjoy the good (or service) or insufficient
resources. By making products and services simpler and cheaper, firms
enable the emergence of consumers requesting attributes that are di-
fferent from those demanded by the conventional market. Firms that
practice such strategies are called new-market disruptive innovators.
The Sony Walkman is a typical example (Christensen, 1997), as it per-
sonalized music to people who walked or jogged and had no option
available except for portable radio alternatives. More recently, Kenya's
Vodafone-Safaricom M-Pesa provided another example of a new-
market disruptive innovation when it started offering Short Message
Service (SMS) payment services at a time when more sophisticated
and faster technologies were available but did not reach a significant
portion of potential consumers (Ngugi, Pelowski, & Ogembo, 2010).

**Figure 1. Model of the Disruptive Innovation Theory developed by Christen-
sen, Anthony, and Roth (2004)**

Figure 1 summarizes the essential elements of Christensen's theo-
retical model. The dotted lines are the evolutionary trajectories of
the attributes demanded by the average consumer, and the thick
arrows represent the technological evolution of different companies.

Company A is one that seeks to increase the supply of attributes
valued by its current customers, and its innovations are called sus-
tainable. Company B, on the other hand, innovates by reducing the
number of attributes in its products (low-end disruptive innovation)
and potentially, but not necessarily, achieves this goal in the future.
Finally, company C captures nonconsumers, who place more value
on a different set of attributes than the design favored by dominant
consumers (new-market disruptive innovation).

Christensen argues that his approach is subject to fewer observable
anomalies than previous theoretical constructs, especially with the
incorporation of its most recent advances. In Christensen (2006),
for example, the scope of the theory has been expanded and it now
considers changes in business models as innovation, preferring the
term "disruptive innovation" to the previous "disruptive technology".
Since the second edition of his book, The Innovator's Dilemma, in
the year 2000, Christensen has pointed out that resources, processes,
and values would delineate an organization's innovative possibilities
by building up relevant knowledge applicable to firms threatened by
disruptors.

**Criticism of Christensen’s approach**

Christensen’s (1997) approach provided an important theoretical ad-
vance. It added constructs and filled gaps left by previous theories
of innovation. Even critical authors recognize the virtues of the ap-
proach and suggest that we do not abandon it (e.g., King & Baatar-
togtokh, 2015). However, similar to any theoretical construction, it
does not evolve without criticism.

Henderson (2006), for example, exposes the fact that the theory is ba-
sed on the cognitive failures of agents who do not identify disruptive
opportunities within the spectrum of indicators already consolidated
by the dominant design and their current clients. The author argues
for the rationality of the leaders of organizations that do not respond
to disruptive innovations, given the characteristics of competencies
already present in established firms. The decision to serve current
customers in the mainstream market, which provides the best profits,
rather than pursuing a disruption with a lesser probability of success
and lower profitability, would be reasonable and consistent with the
empirical data. In reference to disruptive innovations that create or
rely on new patterns of market preferences, the author states that it is
"particularly difficult for established firms to respond effectively for
reasons that are embedded in firm competencies" (2006, p.9).

For Markides (2006), the theory developed by Christensen has been
mistakenly used in the analysis of different disruptive innovations.
Although Christensen and Raynor (2003) expanded the scope of
disruptive innovations beyond the technological context previously
outlined in Christensen (1997) to also encompass business model and
products, Markides (2006) emphasizes that disruptive innovations
may have some effects on competition that must be administered in
a manner different than that advocated by Christensen (1997). Mar-
kides’ argument is that there are different kinds of disruptive innova-
tions and that they should be treated differently. The author explores
two phenomena present in the literature: innovation in business model and radical product innovation. According to Markides, these two types of innovations threaten unprepared firms in a manner similar to Christensen’s (1997) description, but inhibiting excessive proximity to customers, as suggested by Bower and Christensen (1995), would not be the most appropriate approach to innovations that were not purely technological.

While some authors argue that upmarket innovations that improve the quality of a product or service may be disruptive innovations (Markides, 2006), Christensen, Raynor, and McDonald (2015) reject this idea and reiterate that disruptive innovations are exclusively low-end or new market innovations. Improving what is already being offered to the mainstream market is not a disruptive innovation in Christensen’s sense, but rather is a sustaining innovation.

**Bibliometric analysis**

The evaluation begins with the selection of articles in the Web of Science database from 1995 to 2017 that have the terms "disrupt* innovat*" or "disrupt* technolog*" in their titles, abstracts or keywords. This method generated 876 papers and 2,299 authors, amounting to 11,941 citations, excluding self-citations. Because the set of articles was also filtered based on the category of interest, (e.g., Business & Economics), the selection was restricted to 333 publications by 675 different authors. As an additional filter, only articles with at least one citation were kept, resulting in a sample of 266 articles in 82 journals by 500 different authors. We restrict the sample further by selecting the ten journals with the highest JCR indices, listed in Table 1, resulting in a universe of analysis consisting of 140 articles.

**Table 1. Search filters - Web of Science database**

<table>
<thead>
<tr>
<th>Codes</th>
<th>Filters</th>
<th># papers</th>
<th># authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A)</td>
<td>Title, abstract or key-word containing &quot;disrupt* innovat*&quot; or &quot;disrupt* technolog*&quot;</td>
<td>876</td>
<td>2,299</td>
</tr>
<tr>
<td>(B)</td>
<td>Category: Business &amp; Economics</td>
<td>333</td>
<td>675</td>
</tr>
<tr>
<td>(C)</td>
<td>Number of citation &gt; 0</td>
<td>266</td>
<td>500</td>
</tr>
<tr>
<td>(D)</td>
<td>Journals: (D1) Technological Forecasting and Social Change; (D2) Journal of Product Innovation Management; (D3) Harvard Business Review; (D4) Technovation; (D5) Research-Technology Management; (D6) Research Policy; (D7) Technology Analysis &amp; Strategic Management; (D8) Creativity and Innovation Management; (D9) International Journal of Technology Management; (D10) IEEE Transactions of Engineering Management.</td>
<td>140</td>
<td>301</td>
</tr>
</tbody>
</table>

The temporal evolution of the publications in the universe of analysis begins in 1995 with Bower and Christensen’s (1995) seminal article, Disruptive Technologies - Catching the wave, in which the “disruptive innovation” concept was still referred to by the term “disruptive technology”. Between 1995 and 1999, there were no articles in the sample. The peak of representation occurred in 2013 with the publication of 17 articles. Table 2 summarizes the distribution of the number of publications in each journal in the research universe.

**Table 2. Distribution of the number of articles by periodical and year of publication. Codes (D1) and (D10) follow as in Table 1**

<table>
<thead>
<tr>
<th>Journal</th>
<th>Publication year</th>
</tr>
</thead>
<tbody>
<tr>
<td>(D1)</td>
<td>4</td>
</tr>
<tr>
<td>(D2)</td>
<td>1</td>
</tr>
<tr>
<td>(D3)</td>
<td>1</td>
</tr>
<tr>
<td>(D4)</td>
<td>2</td>
</tr>
<tr>
<td>(D5)</td>
<td>1</td>
</tr>
<tr>
<td>(D6)</td>
<td>1</td>
</tr>
<tr>
<td>(D7)</td>
<td>1</td>
</tr>
<tr>
<td>(D8)</td>
<td>1</td>
</tr>
<tr>
<td>(D9)</td>
<td>1</td>
</tr>
<tr>
<td>(D10)</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1</td>
</tr>
</tbody>
</table>

Within this research universe, the core subjects selected were the 25 most cited articles, produced by 55 different authors, and representing more than 75% of the citations in the universe; that is, 3,215 citations out of a total of 4,281 from 140 articles. Then, after this selection of authors and their co-citations, the metadata were submitted to analysis, carried out with the support of the Bibexcel and Stata software. The set of the 25 articles selected is presented in the appendix.
Assuming that authors can be identified with a single theoretical framework, the analysis of co-citations was made using the authors of the 25 papers selected as units of analysis, resulting in a total of 55 names. Based on these names and those present in the co-citation list, a network was constructed and the centrality and intermediation grades were calculated. The network is visualized in Figure 2, which was restricted to authors cited at least 300 times in the research universe and has distinct coloration for each of the two groups formed: Group 1 in red and Group 2 in green.

Figure 2. Author co-citation network

The clusters suggest that authors who are critical of some Christensen’s ideas, such as Erwin Danneels, or even authors who employ a concept distinct from that proposed by Christensen, such as Michael Tushman, are in the same cluster (Group 2 (green)). On the other hand, Group 1 (red) contemplates authors whose papers focus more on the application of innovation management tools and techniques, such as technological roadmaps, and who rarely discuss the theoretical aspects common to other areas of investigation. The centrality and intermediation degrees for the authors calculated in the standard and normalized versions are presented in Table 3 and show that Christensen has both high centrality and intermediation, suggesting that the author not only concentrates attention but also aids in the development of the network close to several pairs, even from a different group.

Table 3. Grouping, degrees of centrality and intermediation of main authors

<table>
<thead>
<tr>
<th>Author</th>
<th>Group</th>
<th>Centrality</th>
<th></th>
<th>Author</th>
<th>Group</th>
<th>Intermediation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Standard</td>
<td>Normalized</td>
<td></td>
<td></td>
<td>Standard</td>
<td>Normalized</td>
</tr>
<tr>
<td>Christensen</td>
<td>2</td>
<td>37</td>
<td>0.804</td>
<td>Walsh</td>
<td>1</td>
<td>419.02</td>
<td>0.202</td>
</tr>
<tr>
<td>Bower J</td>
<td>2</td>
<td>36</td>
<td>0.783</td>
<td>Daim T</td>
<td>1</td>
<td>321.00</td>
<td>0.155</td>
</tr>
<tr>
<td>Danneels E</td>
<td>2</td>
<td>29</td>
<td>0.630</td>
<td>Lee J</td>
<td>1</td>
<td>315.51</td>
<td>0.152</td>
</tr>
<tr>
<td>Baker W</td>
<td>2</td>
<td>25</td>
<td>0.543</td>
<td>Christensen C</td>
<td>2</td>
<td>259.45</td>
<td>0.125</td>
</tr>
<tr>
<td>Daim T</td>
<td>1</td>
<td>22</td>
<td>0.478</td>
<td>Kirchhoff B</td>
<td>1</td>
<td>225.85</td>
<td>0.109</td>
</tr>
<tr>
<td>Lee C</td>
<td>1</td>
<td>21</td>
<td>0.457</td>
<td>Newbert S</td>
<td>1</td>
<td>178.10</td>
<td>0.086</td>
</tr>
<tr>
<td>Lee J</td>
<td>1</td>
<td>21</td>
<td>0.457</td>
<td>Phaal R</td>
<td>1</td>
<td>165.11</td>
<td>0.080</td>
</tr>
<tr>
<td>Johnson M</td>
<td>2</td>
<td>21</td>
<td>0.457</td>
<td>Robinson D</td>
<td>1</td>
<td>164.76</td>
<td>0.080</td>
</tr>
<tr>
<td>Gassmann O</td>
<td>2</td>
<td>19</td>
<td>0.413</td>
<td>Prusak L</td>
<td>2</td>
<td>151.36</td>
<td>0.073</td>
</tr>
<tr>
<td>Lee S</td>
<td>1</td>
<td>19</td>
<td>0.413</td>
<td>Baker W</td>
<td>2</td>
<td>147.35</td>
<td>0.071</td>
</tr>
</tbody>
</table>

Moreover, as this study took the approach of constructing groups by author, it was not possible to glimpse the situation in which the same author has works with distinct characteristics; for example, belonging to different groups. This is the case of Steve Walsh, who possesses the highest degree of intermediation. As an illustration of his importance, if one ignores the minimum node rule in each cluster, the author emerges at the head of a third cluster. To cover more details about the groups, the analysis continued with a focus on the keywords given by
the original set of 140 articles and the construction of their network. The resulting map is shown in Figure 3, with a cluster-oriented construction and a minimum of 13 occurrences, chosen ad hoc to improve visual representation of the network.

Figure 3. Keyword occurrence network

Figure 3 is in line with initial impressions that there is one group (red) which is associated with the development of management tools, such as the technology roadmap and is less concerned with discussing the term “disruptive innovation” or its meaning as suggested by Christensen. Disruptive innovations for this group are those that oppose incremental or architectural innovations and are usually taken as synonyms for radical or breakthrough innovations. This group has been more frequently featured in the journal Technological Forecasting and Social Change. On the other hand, the other group (green) exposes different typologies of innovation that are more associated with works that seek theoretical development in management disciplines, but which are criticized for having a retrospective view. They consist of texts written by Christensen and colleagues but also by authors who discuss or criticize their concepts (e.g., Daneels, 2004; Schmidt & Druehl, 2008). They are part of the business and management community, with major contributions made by the Harvard Business Review and the Journal of Product Innovation Management.

As a final point, based on the exercise carried out, a composition was constructed with two major thematic groups related to disruptive innovations. This conciliation is presented in Table 4.

<table>
<thead>
<tr>
<th>Group</th>
<th>Authors</th>
<th>Associated terms</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Bower J; Christensen C; Daneels E; Henderson R; Markides C; O’Reilly C; Tushman M; Utterback J;</td>
<td>Creative destruction; Business model innovation; Technological discontinuities; Radical innovation; Incumbents</td>
<td>It seeks to explain and test determinants of innovations; Related to the business and management community. Engages, discusses or tests Christensen’s concepts.</td>
</tr>
<tr>
<td></td>
<td>Daim T; Kostoff R; Lee S; Linton J; Phaal R; Porter A; Walsh S; Yoon B;</td>
<td>Technology roadmap; Innovation management; Technology planning; Technology entrepreneurship; Tech mining</td>
<td>Employs prediction or similar tools in innovation management; Related to multidisciplinary communities. Do not discuss Christensen’s concepts.</td>
</tr>
</tbody>
</table>

The Red subgroup is dedicated to assisting with the monitoring, planning, acquisition or employment of technologies, with a multidisciplinary focus and strong influence on engineering. Although the use of the term "disruptive innovation" is associated
with radical events, the discussion about the conceptualization given by Christensen is almost nonexistent. The Green subgroup has a greater adherence to the area of business and strategy and presents more enthusiasm for theoretical constructions. It is common for this group to test or discuss the conception of disruptive innovation proposed by Christensen. The authors from this group do not always agree with Christensen's conceptualization, but it is in this group that eventual discussions about the term tend to occur.

Final remarks

The understanding of different types of innovation is relevant to the advancement of theoretical constructs and applications within organizations, an idea that has been accepted at least since Utterback and Abernathy (1975), and disruptive innovations should not be an exception. The present paper tried to map the main authors related to the theme and their respective publications. For readers less familiar with the debate, this enables the selection of important papers to obtain a better understanding of the insertion of Christensen into the research universe. For more experienced practitioners and academics, the work provides a panoramic view of the field associated with disruptive innovation, with an explicit suggestion for further development of the theory in the last paragraph.

Overall, the analysis showed that Christensen's prominence in the debate is evident. Even if a reader considers Christensen's disruptive innovation definition trivial, incomplete, or misleading, his name has acquired distinction in the literature. In addition to his high degree of centrality, he also has one of the highest degrees of intermediation. Although simpler terminology and definitions may be preferred (Hopp et al., 2018b), a semantic narrowing of the term “disruptive innovation” seems to be necessary for the consequent development of innovation theories. The narrowing of the concept has two advantages. Firstly, it provides a clearer path to theoretical improvements. More precise constructs may reduce undesirable ambiguities and help us to better understand how firms cope with disruptive innovations and introduce them. Secondly, it helps feed our hunger for knowledge on disruptive innovation and facilitates the collection of data and the production of missed quantitative-related studies. Along this line, instead of looking for a term best suited to explaining the multifaceted phenomenon of disruptive innovations, it may be the case that we are facing different phenomena and, if this is so, a different term is desirable. Consequently, for those contemplating Christensen's concept of disruptive innovation, the use of alternative terminology such as the “Christensen effect” (Christensen, 2006, p. 42) seems to be an attractive suggestion for further development of the theory.

References


## Appendix

Table A. Summary of selected articles

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
<th>Journal</th>
<th># Authors</th>
<th>Citations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walsh (2004)</td>
<td>Roadmapping A Disruptive Technology ...</td>
<td>Tech Forec &amp; Social Change</td>
<td>1</td>
<td>144</td>
</tr>
<tr>
<td>Massa and Testa (2008)</td>
<td>Innovation And Smes: Misaligned Perspectives ...</td>
<td>Technovation</td>
<td>2</td>
<td>110</td>
</tr>
<tr>
<td>Walsh et al. (2002)</td>
<td>Differentiating Market Strategies For Disruptive ...</td>
<td>IEEE Transactions On Eng Manag</td>
<td>3</td>
<td>91</td>
</tr>
<tr>
<td>Lee and Park (2005)</td>
<td>Customization Of Technology Roadmaps ...</td>
<td>Tech Forec &amp; Social Change</td>
<td>2</td>
<td>90</td>
</tr>
<tr>
<td>Lee et al. (2009)</td>
<td>Business Planning Based On Technological Capabilities...</td>
<td>Tech Forec &amp; Social Change</td>
<td>4</td>
<td>89</td>
</tr>
<tr>
<td>Lee et al. (2013)</td>
<td>An Integrated Service-Device-Technology Roadmap ...</td>
<td>Tech Forec &amp; Social Change</td>
<td>3</td>
<td>66</td>
</tr>
<tr>
<td>Daim and Oliver (2008)</td>
<td>Implementing Technology Roadmap Process ...</td>
<td>Tech Forec &amp; Social Change</td>
<td>2</td>
<td>66</td>
</tr>
<tr>
<td>Zeschky et al. (2011)</td>
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