Review: Disruptive Innovation & Information Technology –Charting a path

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Abstract

While it has been established that the Information technology (IT) capability of an organization contributes to its ability to innovate and respond to threats, very little has been done in understanding the significance, if any, of the role of IT in disruptive innovation (DI) scenarios. This paper systematically reviews prior research on the concept of DI in relation to IT. Importantly, this paper lays out a research agenda for the exploration of IT and IS research on the subject of DI. Topical questions are raised and calls are made for further studies to position the relevance of IT/IS to the maturing discussion of disruptive innovation. Concurrently, a general review of the evolution of the theory of disruptive innovation and its current status is also presented. A framework classifying disruptive innovation based on typology and definitions is demonstrated in tandem with ensuing questions on the role of information technology.

Keywords:

Disruptive Innovation, Information Technology, Literature Review, Research agenda

INTRODUCTION

An era is emerging where organizations are not just thinking about innovating in order to sustain a business but are also consciously thinking about how to disrupt others with their innovations. It is increasingly becoming an apparent threat that has led to the quote – "Disrupt or be Disrupted". At a time like this, it is worth asking if the existing traditional organization designs are well structured to combat ambidextrous challenges of this nature. Similarly, it has long been established that information systems are central to the core of an organisations' design. Volonino, Robinson and Watson (1992) put it in this way *"The need for innovation, flexibility, and adaptability has fostered significant changes in information system requirements, particularly those that are hosted on information technology (IT) infrastructures. Attempts to respond to these competitive needs in dynamic and at times disruptive environments by applying IT is driving dramatic changes in how organizations are designed to conduct business".* In this emerging era the value of information to a business enterprise cannot be over emphasized. Although, Information has been and will continue to be a valuable resource that can be a defining differentiator between the success of firms (Johnston and Vitale 1988), hardly as there been a time in history when we have had as much information processing abilities like today (Power 1983). Information Technology (IT) and Information Systems (IS) have thus been central to the ability of firms to harness the latent advantages of the information available within and outside their networks (Bakos 1991 and Johnston and Vitale 1988). The value and utility of the information at an organization's disposal, plays a significant role in the quality of knowledge and decision making abilities of such an organization (Thomas and McDaniel 1990 and Power 1983). The pursuit of Disruptive Innovations (DI), either to create or respond to an emerging one, are (among other things) largely knowledge and decision based activities. The decisions made by firms in regard to disruptive innovations are known to have usually either made or broken them. The impact of disruptive innovations can be so extreme that a virtually non-existent firm can rise to dominance while a leading incumbent can basically cease to exist or largely diminish in importance. These extreme outcomes underscore the need to understand the role played by information technology and information systems in the occurrence of disruptive innovation.

Consider a company that has attained a significant maturity in its industry both in market position and profitability, which suddenly find itself on a decline spin and gradually losing its esteemed position in all these attributes. This is a typical illustration of a company contending with the threat of disruptive innovation. Basically, disruptive innovation introduces a different set of rules to the traditional act of doing business in a domain. In the face of disruptive innovation, the functional knowledge and operational process skills gathered by

a company over several years could see itself gradually facing a rising risk of irrelevance and obsolescence (Johnson, Christensen and Kagermann, 2008). These accumulated knowledge and process frameworks are logically related to the *business processing structure* and *the information processing capacity* possessed by such an organization. Among other things, an organization's business process and its information processing ability are likewise entrenched in the IS capability that defines the organization (Chesborough, 2010; Pavlou and El Sawy 2006). This therefore suggests that the IS/IT of an organization plays a significant role in disruptive innovation scenario, either in its creation or in strategically responding to its threat.

Generally, disruptive innovation can be considered as innovations regarded by incumbent companies as unsuitable for their mainstream customers but which gradually matures to threaten the esteemed position of such companies. They usually begin with simplistic applications at the fringe of a market but gradually surge 'up market' and then develop with a potential to eventually displace established market leaders (Christensen, 1997). This has led to the displacement of leading incumbents by new entrants and fledging entrepreneurs. Typical examples include the disruption of mainframe companies (UNISYS) by minicomputers and subsequent disruption of minicomputer companies by desktop companies (IBM), Xerox photocopiers by Canon copiers, wired telephone companies by mobile phones (Nokia). Recent examples of innovations with similar tendencies include: the iPad (Apple) disrupting the PC, smart phones disrupting GPS (TomTom) and Skype/VoIP disrupting the telecom industry (T-Mobile) among many others.

What role does IT play in *enabling* the creation of disruptive innovations? Perhaps a question of more significance to an organization dealing with the threat of disruptive innovation would be - What role does IT play as a *sustainer* in the face of disruptive innovation threats? To add a rather balancing perspective to these questions, it would be relevant to also seek to understand the answer to the question – How can IT stand as a *barrier* in responding to or creating disruptive innovations? These are few of the important questions that remain unanswered. Without targeted studies seeking to bring light to this presently grey area of research, they would continue to be unknown. This paper is therefore aimed at highlighting the dearth of research studying the significance of IT in DI scenarios. Furthermore, the paper is also geared at evoking attention to themes and questions that are open to be researched. A point to additionally note is that while these questions pose important issues to reflect on in the IT/IS domain, IT alone may not be the only determining factor in each case. This however does not diminish the value of understanding the significance of the role of IT in this phenomenon.While it might be hypothesized, that the IS/IT capability of an organization could be an enabler or a sustainer specifically in cases of disruptive innovation; it is open to be empirically proven. This has led to the need to carry out this review as an essential forerunner and agenda for future research on this hypothesis.

The paper is structured in two main parts. The first part presents a systematic literature review and a comprehensive analysis of the existing literature which have specifically related IT to disruptive innovation. The second part is a general literature review on the concept of disruptive innovation which is interlaced with topical questions on information technology revealing open areas of research within the DI context. Although, there has been copious studies on DI, the diversity and misconceptions associated with DI literature, may stand as a source of ambiguity and hindrance for future research (Yu and Hang 2010). This has informed the need to carry out a general review of present knowledge on DI as a pilot study for future DI research in the IT/IS domain.

In addition, by analyzing the evolution of the disruptive innovation discussion, we present a categorization of disruptive innovation by – a) innovation type and b) market diffusion. By innovation type, disruptive innovation is subdivided into three distinct classifications: *Disruptive Technology Innovation, Disruptive Business Model and Disruptive Radical Products.* By market diffusion, identified types of disruptive innovations are: *Low-end Disruption, High-end Disruption and New Market Disruption.* The paper further presents the implications of having consistency in the DI concepts for the IT/IS research domain and for subsequent DI research in general.

DISRUPTIVE INNOVATION AND INFORMATION TECHNOLOGY/SYSTEM – FINDING THE LINK

This section presents a systematic review of existing literature on IS/IT. Generally, the goal of this review is to discover and present what has been done on DI specifically in relation to the IS/IT field. The review is steered towards highlighting the varying perspectives with which research relating this concept has been approached over the years. Subsequently, the goal is to identify similarities, differences and possible areas open to further research investigation (Okoli and Schabram 2010).

Methodology

The methodology adopted for this paper follows an adaptation of the guidelines outlined for conducting a systematic literature review provided by Webster and Watson (2002) Okoli and Schabram (2010) and Tranfield, Denyer and Smart (2003). For the review, Web of Knowledge journal database was initially used.

The first search criterion was to identify existing prior literature that demonstrates some degree of relationship between IT and DI. This was the central inclusion or exclusion factor on which the eventually selected papers

were evaluated. The search term "Disruptive Innovation and Information Technology" returned 61 articles. From the 61 articles returned, 23 were selected from the inclination of their title to the afore-mentioned selection criteria. After a further drilling down with the aid of the abstracts of these articles, 14 articles were finally identified as more relevantly fitting the IT – DI criteria. Having such a few number of articles returned, it was decided to add another search term in order to hopefully find more relevant literature. Therefore the knowledge that the abbreviation of information Technology as IT is widely adopted and used by many articles, the search term "Disruptive Innovation and IT" was employed for the second search iteration. A total of 217 articles were returned from this search.

Considering the relatively low number of research articles found from this search process and also considering the fact that the essence of this review is really to understand what knowledge has been documented in prior research about the relationship between IT and DI, it was decided to repeat this process in three other journal databases. This was done with the presumption that there could be some relevant articles unearthed via this process. For this process the Science Direct (Elsevier) journal database, Science Direct (Scopus) journal database and EBSCO Host journal database were employed. However, repeating the search process for these three did not significantly increase the number of articles meeting the inclusion criteria to be included in the review.

The essential pivot term for the article search was disruption. For an article to be considered it has to have a clear association with the concept of disruptive innovation. When this has been satisfied then the article was then further tested for a relationship with an aspect of IT and DI. It is worth stating that getting prior research that has clearly studied IT and DI was not a very straightforward activity as IT is a very broad domain and it is associated with a vast number of constructs. Therefore articles were included on the IT criteria based on if the study represents one aspect, artefact or construct of the Information Technology field. With the large option of key IT terms, the determination of the relevance of an article required first checking the title for keywords, then reading the abstract of papers with any inclination towards the IT-DI criteria.

With the shortage of prior research explicitly studying the relationship between IT and DI, it became necessary to expand the scope of the literatures to be reviewed. Hence the criteria were broadened by totally eliminating the IT restriction and then filtering the returned list with information technology. However, at the end of these search iterations in the journal databases, the total number of articles which were selected was 17.

Lastly, from a quick glance at the articles collected so far, it was obvious that the Management Information System Quarterly (MISQ) and Information System Journals (ISJ) have more articles represented in the selected articles. For the purpose of thoroughness and with the hope of increasing the number of articles, it was decided to search solely through some of the top IS journals - MISQ, ISJ and the Information System Research (ISR) journal archives for exactly same search terms. By repeating the process highlighted below, no additional article was found to be added to the already selected articles. *Hence, it became apparent that there has indeed been very little research done to relate or study the role of IT in cases of disruptive innovations.*

It is worth noting that there are a number of disruptive innovation articles that have mentioned IT in some form, however the aim of this review is specifically to review disruptive innovation articles where the core focus has been IT or IT has been centrally considered in the discussion.

Review Analysis

The articles collected for the review are presented in table 1. The table highlights the journals in which the articles have been published, the year and the context with which IT was viewed relative to the concept of disruption in each article. Although the sparse number of articles available for this review limits the scope of analysis that can be done, it however makes it apparent that there is room for more research in this area. Despite the fact that not much extensive analysis can be done, the review does achieve the goal of revealing the lack of research in this area and this is an open call for researchers.

Table 1: List of articles discussing disruptive Innovation in relation to an aspect of IT

Year	Author	Article	Journal	Relationship to IT
2013	Downes,L	The role of ICT in supporting disruptive innovation- a multi-site qualitative study of nurse practitioners in emergency departments	Harvard Business Review	Role of IT in DI
2013	Sultan N	Knowledge management in the age of cloud computing and Web 2.0: Experiencing the power of disruptive innovations	International Journal of Information Management	IT as the DI
2012	Mohan, K., Ramesh, B., Cao, L., & Sarkar, S.	Managing Disruptive and Sustaining Innovations in Green IT	IT Professional	IT as the DI

2012	Sultan, N and van de Bunt-Kokhuis, S	Organisational culture and cloud computing: coping with a disruptive innovation	Technology Analysis & Strategic Management	IT as the DI
2011	Christophe M. Elie-Dit-Cosaque and Detmar, Straub	Opening the black box of system usage: user adaptation to disruptive IT	European Journal of Information Systems	Use of disruptive IT
2011	Menon, Siddhartha	Linking generativity and disruptive innovation to conceptualize ICTs	Internet Research	linking DI to IT Innovations
2011	Carlo, J. L., Lyytinen, K., & Rose, G. M.	Internet computing as a disruptive information technology innovation: the role of strong order effects	Information Systems Journal	IT as the DI
2010	Westbrook, J and Braithwaite, J	Will information and communication technology disrupt the health system and deliver on its promise?	Medical Journal of Australia	How IT can disrupt health system (IT as the DI)
2009	Latzer, M	Information and communication technology innovations: radical and disruptive?	New Media Society	IT as the DI
2009	Garrison, G	An assessment of organizational size and sense and response capability on the early adoption of disruptive technology	Computers In Human Behavior	IT as a DI sensor
2009	Lucas CH. and Goh M	Disruptive technology: How Kodak missed the digital photography revolution	Journal of Strategic Information Systems	IT as the DI
2009	Nagle, T and Golden, W	An Examination of the Disruptive Innovation Paradox: The Application of the Innovators Dilemma to SME's	Information Systems - Creativity And Innovation In Small And Medium-Sized Enterprises	effect of IT as the DI
2008	Brydon, M and Vining A.R	Adoption, improvement, and disruption: Predicting the impact of open source applications in enterprise software markets	Journal Of Database Management	potential of Open Source IT to be disruptive
2006	Sherif, K., Zmud, RW and Browne, G	Managing peer-to-peer conflicts in disruptive information technology innovations: The case of software reuse	MIS Quarterly	IT as the innovation
2003	Lyytinen, K and Rose GM.	Disruptive information system innovation: the case of internet computing	Information Systems Journal	How DI affects use of IT (and IT as DI)
2003	Lyytinen, K and Rose GM.	The disruptive nature of information technology innovations: The case of Internet computing in systems development organizations	MIS Quarterly	IT as the DI
2000	Nault, BR and Vandenbosch, MB	Research report: Disruptive technologies - Explaining entry in next generation information technology markets	Information Systems Research	IT as the DI

Journal Distribution and Year of Publication Analysis: It is worth noting that over half of the articles identified come from the IS discipline while the others are from very different fields. In context of individual journals, MISQ and Information System Journal takes a representative proportion as they are the only two journals to have more than one article in the review. The analysis of the year of publication shows that most of the research studying some form of relationship between IT and DI are quite recent. While the research on DI has been around since Christensen introduced it in 1997, the majority of the IT-DI research have been largely published in the last decade which is indicative that the research stream is still at its early days.

Relationship to IT: While it is important to realise how IT has been disruptive it is equally important perhaps even moreso to study the role that IT plays in scenarios of disruptive innovation. As can be seen in table 1, most of the research so far have focused mostly on how IT is or can be the disruptive innovation. It is of particular interest for IT and IS researchers to understand the importance of this phenomenon to their discipline especially as it concerns a topic which is laying a trend that is of high impact to organisations and even entire industries across the globe.

Charting a path for future research

Evidently very little research has been done in the IS domain to understand the role of IT/IS in the occurrence of DI. There are however notable exceptions like Lyytinen et al. (2003) and Nault and Vandenbosch (2000), who among others advanced knowledge of this phenomenon for the IS research community. Having identified the

status of research on these concepts, the remaining of this paper is aimed at reviewing current knowledge from the disruptive innovation literature. This is expected to serve as a reference platform from which future IS/IT research relating to disruptive innovation can leverage. It will be of value for instance to answer the question: How does IT contribute to the *disruptability* of an organisation. Where disruptability is the ability of an organization to identify and create a disruption and/or its ability to identify and react to an oncoming disruption.

Without reinventing the wheel, this disruptive innovation review aims at consolidating the different school of thoughts on DI and presenting a pointer to substance that are relevant and peculiar to the IS/IT research scholars. Key items that could be of importance going forward in building research in this stream can include - definitions of key constructs, a clear taxonomy and a granular classification. These among others are the goals of the next section of this paper.

DISRUPTIVE INNOVATION OR DISRUPTIVE TECHNOLOGIES?

In the beginning, it was disruptive technologies (Christensen 1997). Then it became disruptive innovations (Christensen and Raynor 2003). Yet it appears many researchers either did not notice the change or could not grasp the difference. The terms have therefore been often interchanged as one and same. Firstly, why was the terminology changed? Secondly, what then are the significant differences between both? How do we proceed in using this terminology in a consistent fashion without falling into the confusion and commonly repeated errors of past research?

It is important and necessary to make this distinction clear, because the IS research discipline by its structure and definition, is a field that is closely related to several other research fields (Wade and Hulland 2004), hence it is inherently valuable and necessary to utilize theories and concepts outside the IT/IS domain. While this is a useful step in IS research, it is however of importance to avoid transferring external theories blindly, in order not bring along the disensus associated with such theories into the IS domain (Wade and Hulland 2004). Therefore, to examine this change in terminology in the Disruptive Innovation concept, we would look at its evolution through the explanation of Christensen - the founding researcher of both terminologies. Christensen (2006) explains:

"… I decided that labeling the phenomenon as disruptive technology was inaccurate. The technology did not [always] make incumbent response difficult. The disruptive innovation in business models made it vexing, and I have subsequently sought to use the term disruptive innovation."

In essence, Christensen observed an anomaly that the initial construct of disruptive technology could not properly account for. That observation was an opening to improve the theory such that the anomaly can be addressed. Hence the ensuing changes from 'technology' to 'innovation'. This among many other improvements to the theory was only more clearly articulated after his initial popular book - Innovators Dilemma which chronicled the disruptive technology theory. The central element of Christensen's theory is the disruptiveness. However framing it as disruptive technology limited the theory and with more insight into the concept of disruption, it became clear that the disruption is not necessarily only as a result of advancement in technology, it could be as a result of an innovation in business model *but not limited to these two*. It therefore was logical to use an encompassing term that captures these possibilities therefore the change from disruptive technology to disruptive innovation.

However, this improvement or expansion in terminology does not necessarily rule out the use of the term disruptive technology, it on the other hand shows the limitation of using that terminology comparatively to disruptive innovation. The widespread acceptance of the innovators dilemma also resulted in many subsequent studies referring to the disruptive technology definition, while in principle they were referring to the disruptive innovation construct. Although this has been the case in early studies, this does not have to be the case moving forward, particularly in the evolving DI research in the IS field.

Additionally, from the root meaning of the words technology and innovation, one can infer that Disruptive Technology would be fundamentally different from Disruptive Innovation. From a technological standpoint, not every technological invention makes the shift to becoming an innovation. For the purpose of clarity in making DI research, it is evident that in many cases, no single company can lay claim to a particular technology (For example – the internet which has been a platform for many disruptions). On the other hand the company that brings a technology (or its application) to the market can easily lay claim to that brand as its innovation. For example, VOIP technologies kept advancing from different research communities but Skype popularized and marketed a creative application of it. Similarly, smartphones or mobile phones in general evolved gradually with input from different firms and research institutes. However, while Nokia was the trail blazer in the initial mobile phone landscape, it was Apple that initially creatively designed, marketed and promoted the smartphone to strike the chord that widely diffused the smartphones to a larger market population. So in essence when researchers are structuring there research design, it is worth noting the distinction between the technology and the firm that boosted the technology to the status of a disruptive innovation. Therefore the question to be asked would be: Is this research interested in the technology (DT) that is causing the disruption or in the firm that has made it into a disruptive innovation (DI)?

CLASSIFYING DISRUPTIVE INNOVATION BY INNOVATION TYPE

To carry out progressive IT related research on the topic of disruptive innovations, it is of import to understand the different types of this phenomenon that have been identified by prior research. This is particularly so, due to the different and unique type of challenges that each DI type poses and the rather diverse implication of each DI to organizations and researchers alike (Markides 2006). Lumping all the different DI types into one category potentially implies that we would lose the fine granularity that can be achieved, compared to when DI research is conducted with the lens of each of the unique DI types.

The three classes of disruptive innovation that can be deduced from prior literature are: Disruptive Technology Innovation [DTI] (Christensen 2006, 1997; Markides 2006), Disruptive Business Model [DBM] (Christensen 2006; Markides 2006) and Disruptive Radical Innovation [DRI] (Govindarajan and Kopalle 2006; Markides 2006). The underlying similarity between all three DI classes above is that they are (or become) disruptive relative to an existing organization. However, the mechanism with which they disrupt is significantly different in each case. If we look at disruption as the central theme of the theory of disruptive innovation, it can be logically deduced that these are indeed subcategories or finer divisions of the disruptive innovation construct.

We would examine these three classes of DI with a generally accepted modification to the definition of disruptive innovation as presented by Govindarajan and Kopalle (2006) (and more recently Govindarajan, Kopalle and Danneels 2011) which states:

*"A disruptive innovation introduces a different set of features, performance, and price attributes relative to the **existing product**, an unattractive combination for mainstream customers at the time of product introduction because of **inferior** performance on the attributes these customers value and/or a **high price**—although a different customer segment may value the new attributes. Subsequent developments over time, however, raise the new product's attributes to a level sufficient to satisfy mainstream customers, thus attracting more of the mainstream market."* (Emphasis ours).

Disruptive Technology Innovations [DTI]: These are the disruptive innovations whose disruptive tendencies stem from the advancement in the technological component of the innovation (Christensen 1997; Markides 2006). A classical and well referred to example is the disruption of the disk drive used by Christensen (1997) in his seminal thesis. While the disk drive featured advancement or changes in technology, the business model employed in taking it to the market from one disk drive generation to another was not significantly different. The innovation involved was also neither radical nor new to the world. Another typical DTI example can be found in the disruption of film cameras by digital cameras and also the disruption of mainframe computers by the minicomputer and the subsequent disruption of minicomputers by PC and the looming disruption of laptops by tablet PCs + smartphones.

In recent years the rapid flux of innovations in IT has become an urgent force to be reckoned with in the discussion of disruptive innovations. Frequently, the introduction of a new information technology innovation comes along with a potential to be disruptive (Lyytinen and Rose 2003). For example, with the introduction of the internet, we witness the emergence of Amazon and Google; with the introduction of VOIP, we witness the emergence of Skype; with the introduction of smartphones we witness the emergence of GPS navigation apps among many other examples. *What lessons can we learn from the past of IT innovations that can be projected to understand the disruptive potentials of future innovations?*

Disruptive Business Models [DBM]: In contrast to the DTI, the core of the disruptive business model concept is *not* the technology but the manner the business model has been employed (Crockett McGee and Payne 2013 and Markides 2006). In most cases, the business model innovation is at a tangent with the traditional or existing models and gradually results in the eventual disruption on an industry or incumbent organization. For example, Amazon did not invent the art of bookselling neither did Amazon invent e-commerce. What Amazon did was to change its approach of generating revenue while selling books. Another typical example of the DBM is Google's subtle disruption of the advertising landscape. Google provided valuable services for free while generating revenue by making it possible for businesses (large and small) to do targeted national and even international advertising, without hiring costly ad agencies or direct marketing firms.

For the disrupted firm, adjusting to disruptive business model could require making existing competencies and functional processes redundant while simultaneously rendering long acquired operational knowledge obsolete (Christensen and Raynor 2003; Henderson 2006). These are changes (or cannibalization) that are challenging for organizations (Govindarajan et al. 2011; Chandy and Tellis 1998) which managers rationally tend to be reluctant to undertake – hence the dilemma. From an IT researcher perspective, it would be interesting to understand how the fast pace of change in IT innovations can stimulate the emergence of DBM. More so, for managers the question of practical value would be: *How can advancement in the IT frontier be exploited in creating disruptive business models?*

Disruptive Radical Innovations [DRI]: According to Markides (2006), these are innovations that are new-to-the-world that grow in significance to a point that ultimately disrupt an existing product or technology. These category of innovation products are distinctively novel and dissimilar relative to existing products or technologies. They are mostly not *demand driven* and they usually tend to have a slow adoption rate (for one or more of several reasons – complexity, cost, and performance among others) but they become disruptive If/when they become mainstream and considerably attract customers away from an existing market (Rogers 2003; Markides 2006). For example, the telephone was a radical innovation which grew to be disruptive to the telegraph industry. The process of disruption in this case usually involves late entrants coming into the picture to disrupt the original radical innovator (or early stage innovators of the product) in a manner similar to the other disruptive innovation categories. These entrants basically grow the market from a niche to a mass market. For example, Xerox pioneered the creation of the photocopying machine, however it found itself facing disruption from Canon and other new entrants who ended up diffusing the innovation to the mass market.

It is important to mention that not all radical innovations are disruptive innovation. For example while Teflon or the film camera can be considered as radical innovations, they arguably cannot be said to have disrupted any industry, hence they do not qualify as disruptive radical innovations.

There has been a debate on what can be classified as a [disruptive] radical innovation (Christensen 2006; Markides 2006 and Govindarajan and Kopalle (2006). Govindarajan and Kopalle (2006) take a stimulating stance on radicalness of an innovation. They position radicalness of an innovation as a *measure* and not a *binary* value of either radical or not radical. They referred to certain innovations as high on radicalness or less radical in nature. With this point of view in conjunction with the new-to-the-world definition of Markides (2006) we can therefore express the concept of the radicalness of an innovation based on how new-to-the-world-ish an innovation is. Most innovations are generally advancement of what exists before. The degree to which the advancement is new or unexpected would then determine the radicalness of such an innovation. A truly radical innovation would be a truly first by several measures. Like Christensen (2006) stated, there was indeed a first wheel, a first photograph, a first boat e.t.c Whenever an innovation cannot be expressed relatively to an earlier existing product or technology, it then suffices to claim it indeed is new to the world.

Combined View: The Three Classes of Disruptive Innovation

It is worth noting that although these DI classes exhibit certain unique differences, there can in fact be combinations of two or all of them present in a particular disruptive scenario. A technological disruptive innovation is usually also a product innovation and by extension it could also be a disruptive radical product innovation. [Example: The calculator disrupting the slide rule was both a DTI and a DRI]. Similarly a DI scenario could also be the combination of both a disruptive technology innovation and a disruptive business model innovation. [Example: Google's search algorithm in combination with its adwords and freemium business model]. Another possibility is the combination of a disruptive radical innovation and a disruptive business model. [Example: Amazon was the first to create an online bookstore as a platform to offer books in a business model fundamentally different from the traditional book stores].

If we reconsider the definition of Govindarajan and Kopalle (2006) in light of the above discussion, we would realize that all classes of DI can readily fit into this definition. However, one can also identify certain areas in need of improvement in this definition. Firstly, the focus in the definition has mostly been about products but as demonstrated with the DBM class of DIs, *the disruption does not necessarily have to be as a result of a **product** innovation.* Secondly, as illustrated in the case of DRI, most radical innovations are usually not demand motivated but mostly supply driven hence *there does not always have to be an already **existing** product/market for the innovation.* Thirdly, from the examples given of the three DI classes (DTI, DBM and DRI), it becomes apparent that *the disruption is not essentially dependent on whether the offering is of **inferior** performance and/or **high price**.*

To address this anomaly that is not addressed by the earlier definition (Christensen 2006), and in line with calls for an encompassing definition (Danneels 2004; Markides 2006; Schimdt et al 2008) an extension to the definition of Govindarajan and Kopalle (2006) is necessary. This can be stated to capture these identified points without altering the core as follow: *A disruptive innovation introduces a different set of **attributes** relative to a **market** which are unattractive for mainstream customers on inception due to **variance** in attributes valued by this market - although a different market segment may value the new attributes. Subsequent developments over time, however, raise the innovation's attributes to a level sufficient to satisfy mainstream customers, thus attracting more of the mainstream market.*

> Where: Market = (products, business models, goods, services... and/or technologies).
>
> Variance = (inferior, superior, complexity…) and
>
> Attributes = (features, performance, price, operations, business rules... and/or processes)

To conclude this section, after reviewing the three classes of DI by definition, one can easily recognize the existence of a stream of IT/IS research on each of the supporting root class (i.e Business models and Innovation). It is indeed a recognized fact that IT and IS research have contributed to the knowledge on business models (Bharadwaj, El Sawy, Pavlou and Venkatraman 2013; Keen and Williams 2013 and Onetti and Capobianco 2005) Similarly IT and IS research have contributed to the (technological and radical) innovation capacity of organizations (Swanson and Ramiller (2004); Fichman 2001; Carlo, Lyytinen, and Rose 2012; Xue, Ray, and Sambamurthy 2012 and Westerman and Curley 2008). *How then can we extend these accumulated understanding of IT/IS in these areas to specifically embolden our knowledge of disruptive innovations?*

CLASSIFYING DISRUPTIVE INNOVATION BY MARKET DIFFUSION

Disruptive Innovation can also be classified based on the difference in the approach and characteristics of adoption and diffusion to the market. Christensen and Raynor (2003) identified that disruption is characterized by two fundamentally different market phenomena which they named – low-end disruptions and new-market disruptions. Subsequently, other researchers notably of which are (Govindarajan and Kopalle 2006 and Schmidt and Druehl 2008) realized that the concept of disruption could also diffuse from the high end of the market. Hence, they expanded this classification to include what they term high-end disruption or high end encroachment (Schmidt and Druehl 2008 and Sood and Tellis 2011). It was based on this expansion that Govindarajan and Kopalle (2006) presented the updated definition of the disruptive innovation construct highlighted earlier in this article. This definition has, in similitude to the initial definition of Christensen, been accepted and adopted by many scholars on this topic (Christensen 2006; Yu and Hang 2010; Govindarajan, Kopalle and Danneels 2011 and Katsamakas and Georgantzas 2010).

Low-End Disruption (LeD): These are the type of disruptions that encroach on an existing market from the base of the market. The customers at this point in the market are not considered the most valuable customers by the business. This is the foundational illustration of disruptive innovation as presented by Christensen (1997).

High-End Disruption (HeD): As would be expected from the name, this category is the opposite of the LeD. The innovation that disrupts this market are usually not necessarily cheaper or simpler in comparison with the LeD. They could be of higher performance and price and yet attract the high paying customers of a market until it gains enough momentum to gradually cause a disruption to an existing market.

New Market Disruption (NmD): This is a unique type of disruption that initially occurs by creating a new market. However, like the other type of market disruptions it also gradually becomes attractive to customers of an existing market. It could gain market share from an existing market from any part of the market – LeD or HeD.

In IT/IS research, a number of researches have been carried out to understand the interaction of technology innovation and the market. An example of one such study includes the technology acceptance model (Venkatesh, Morris, Davis and Davis 2003; Venkatesh 2000) which extends to the acceptance of technological innovations. *Can the wealth of knowledge gathered in the IS circle be of value in dealing with DIs? Since NmDs are about markets which do not presently exist, what insight does IT/IS give us in analyzing such markets? Or should we conclude that markets that don't exist cannot be analysed? What then can the role of Big Data be here?*

Emerging Innovations in IT has left some industries dazed mostly because the industries hardly considered the innovation to be a threat to their business. However such innovations have enabled unseeming competitors to emerge and challenge whole industries. One of the central dilemma of DI for the executives of established incumbents is: how not to lose opportunities due to *hesitation* and simultaneously how to avoid being the fool who *rushes* in. (Pattinson and Woodside 2009). *Can IS provide tools/decision-making frameworks to ease this burden on the decision makers?* For example: the emergence of internet search engines was not an obvious threat for the advertising industry; the initially low quality VOIP innovation was not a competitive worry for the telecommunication industry and the introduction of the internet had a different enough focus not to be considered a threat by the newspaper industry. Such situations open up stimulating questions for the research community. Firstly, what insights can researchers extract from emerging trends in IT like SoMoClo (Social Media, Mobile and Cloud Computing), Big Data, 3D printing among others in predicting ex ante what industries are vulnerable to disruptive threats? Or conversely, how can we provide non-IT savvy managers with knowledge that suggests what industry may be disrupted or threatened by an emerging IT innovation?

CONCLUSION

This paper demonstrated by way of a systematic literature review the lack of research studying the particular role of IT in the occurrence of disruptive innovation. The paper highlights that while the importance of disruptive innovation as a phenomena with high organizational impact cannot be over emphasized, the IS and IT discipline are yet to explore the significance of IT and IS in such situations. Furthermore, the paper through a general review of literatures emboldened the current knowledge of the definition and classification of disruptive innovation. The concept of disruptive innovation was classified based on discussion in prior literature into DI by

innovation type (disruptive business model DBM, disruptive technology innovation DTI and disruptive radical innovation) and DI by market diffusion (low-end disruption, high-end disruption and new market disruption). Viewing the classifications with the lens of existing DI definition revealed gaps that could not be properly accounted for by the present definition. Hence, a consolidated definition which accounts for the missing pieces based on the prior definition was advanced. The values of having a precise and specific definition for DI going forward are that we can more clearly study it and recognize its benefits and its limits. Furthermore, the paper poses thematic questions all through the discussion to stimulate and exhibit areas open for research in this stream.

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