PREDICTING DISRUPTIVE INNOVATION: WHICH FACTORS DETERMINE SUCCESS?

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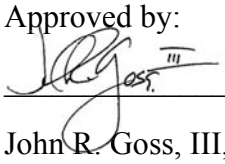

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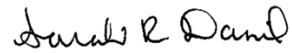

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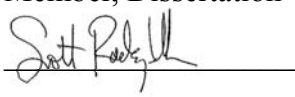

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ABSTRACT

PREDICTING DISRUPTIVE INNOVATION: WHICH FACTORS DETERMINE SUCCESS?

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Disruptive Innovation theory explains how industry entrants can defeat established firms and quickly gain a significant share of their key markets, in spite of the fact that incumbents tend to be significantly more experienced and better resourced. The theory has been criticized for being underspecified: whilst the general mechanics of the phenomenon of disruptive innovation are clear, it has not been established which individual variables are essential to the process and which ones are merely ancillary. As a consequence, to date it has not been possible to build a predictive model on the basis of the theory managers can use to assess the disruptive potential of their own and their competitors' innovation projects. In this research project the predictive power of each of the main variables that are mentioned in the literature has been assessed on the basis of a qualitative analysis of five real world case studies. Only variables for which information can be collected using publicly available data *before* disruption happens have been retained. By clarifying the detail of disruptive innovation theory, this study has been able to address a key issue in the debate, namely, whether products that are more expensive and more complex than the market standard can ever be classified as 'disruptive innovations' or whether they should always be regarded as 'high-end anomalies'. In this study two distinct disruptive innovation strategies have been identified based on the current phase of the product life cycle, the current focus of mainstream demand and the market segments first targeted when coming to market. The first strategy entails growing an existing market by moving the focus of demand on to a secondary market driver as soon as customers begin to lose their willingness to pay a premium for upgrades in the performance areas they historically used to value. Early on in the product life cycle, disruptors can conquer the mainstream market 'from above' with products that are different and more reliable or more convenient *but not simpler or cheaper*. The second strategy creates a new separate market by offering a radically new type of additional functionality. Over time the new market replaces the old market. These products are likely to be expensive because of their small production run and difficult to use because they are the first models of their kind. High-end customers constitute a natural foothold market for these products as they are wealthy and highly skilled.

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Chapter 1: The Incomplete Theory of Disruptive Innovation, Discussion and Problem Statement

All firms are faced with the need to find a strategic balance between the price and the performance of their products. Successful efficient firms operate on the frontier of this trade-off; they offer the highest level of performance within their particular cost bracket. Innovation enables firms to break through this trade-off frontier and strategically position themselves outside of their competitors' reach, at least temporarily (Raynor, 2011). Many different analytical categories have been developed to examine and explain innovation strategies, but none offer the same promise of dramatic innovation success as the analytical framework developed by Harvard professor Clayton Christensen. Since Christensen published his seminal works *The Innovator's Dilemma* (Christensen, 1997) and *The Innovator's Solution* (Christensen & Raynor, 2003) the concept of *disruptive innovation* has become popular and mainstream.

However, in spite of its popularity, the term *disruptive innovation* is often misunderstood and misused by business professionals (Anthony, 2005). Furthermore, even though the theory has enabled some innovation decision makers to develop highly lucrative innovation strategies (Christensen, 2006), to date no model has been developed that can reliably forecast how successful a potential disruptive innovation will be in a particular market. This study holds that the confusion that surrounds the concept, and the difficulty researchers encounter who seek to model it, can largely be attributed to the theory of disruptive innovation itself: the theory remains under-defined and is unclear on which aspects of *disruptive innovation* are essential to the

construct and which ones are merely ancillary. Until this matter has been cleared up, the practical utility of the theory to business professionals will be limited. This study aims to explore and address the current theory's ambiguities and identify and add the detail required for quantitative modeling. Furthermore, it will also clarify and further develop disruptive innovation theory to ensure that it can account for an important category of anomalies the theory cannot currently explain: so called "high-end disruptive innovations", a phenomenon that will be discussed in detail below.

The intended outputs of this study were 1) an internally consistent and externally valid theory, as well as 2) a comprehensive set of predictor variables corresponding with a number of mutually exclusive outcomes. These outputs were intended to enable the systematic forecasting of disruptive success and form a basis on which a future quantitative study could develop a predictive causal model.

A Brief Overview of Christensen's Theory

Clayton Christensen distinguishes between innovations that build upon and strengthen the existing ways of doing business in an industry (sustaining innovations) and innovations that render existing business models uncompetitive; the dominant product design is outdated and brings about a dramatic change in the relative market positions of industry players (disruptive innovations). In his seminal study of innovation in the rigid disk industry, Christensen (1997) found that new firms that followed a disruptive innovation strategy had a much greater chance of dramatically improving their market position than those who followed a sustaining innovation strategy (p. 145). Many managers are for this reason now interested in following a disruptive strategy in order to boost their firm's commercial success. The reason disruptive innovation strategies have a significantly higher rate of success is the fact that such innovations offer a fundamentally different trade-off between price and

performance compared to the market standard. Whereas sustaining innovations constitute improvements along the established innovation trajectory within an industry, disruptive innovations offer vastly superior solutions to secondary or new needs that are not adequately met by existing products. At the same time, however, they offer *an inferior performance* against the dimension mainstream customers have historically valued most. Christensen, Anthony and Roth define a disruptive innovation as "an innovation that [initially] cannot be used by customers in mainstream markets [and that] defines a new performance trajectory by introducing new dimensions of performance compared to existing innovations" (2004, p. 293). As a result of steady technological improvements, over time these initially "unusable" innovations end up dominating the mainstream market, displacing incumbent products and disrupting old ways of doing business. Incumbents generally lack the skills required to properly evaluate the potential of such unconventional innovations, because their research and decision making processes are deeply attuned to the dominant technology in their industry and the current expectations of their mainstream customers (Henderson, 2006). Christensen (1997) argues that mainstream customers, as a rule, will ask for better versions of existing products rather than for products that offer a radically different performance package. The deeply embedded routines and skills of incumbents help them quickly catch up with their competitors' sustaining innovations but hinder them when they are faced with disruptive opportunities or threats. Young firms and industry entrants are not held back by these deeply embedded but outdated information processing routines when pursuing a disruptive innovation strategy. They are therefore significantly more likely to recognize and commercialize a disruptive opportunity, in spite of the fact that they are

faced with the not insignificant challenge of competing in a market dominated by more experienced players with much larger resource bases.

New Market and Low End Disruptive Innovation: Similarities and Differences

Given that mainstream customers do not initially want disruptive innovations, disruptors need to establish themselves first in foothold markets. On this basis Clayton Christensen and his colleagues distinguish two types of disruptive innovation: *new-market* and *low-end*. Whereas the former targets mainstream customers with the lowest willingness to pay when first coming to market, the latter first targets customers who value a radically different performance package compared to mainstream customers. New-market disruptive innovations "create new markets by bringing new features to non-consumers", while low-end disruptive innovations do not create new markets but "offer more convenience or lower prices to customers at the low end of an existing market" (Christensen, Anthony & Roth, 2004, p. 293). In spite of these differences, Christensen et al. hold that both types of disruptive innovation encroach on the mainstream market *from below*. They argue that both low-end and new-market disruptive innovations are characterized by greater simplicity, an inferior but still adequate performance and a lower cost compared to mainstream products.

Learning Curves and the Disruptive Process

Central to Christensen's (1997) theory is the idea that industry entrants are significantly more likely to successfully implement a disruptive strategy than industry incumbents. This means that disruptive products often tend to be commercialized by firms that have significantly less resources and sector specific experience than the established industry leaders. Disruptors are as a consequence generally very vulnerable to retaliation when they first come to market. However, it is the hallmark

of successful disruptors that they very quickly catch up and then overtake incumbents in a number of key areas. Time is central to disruptive innovation and successful disruption is characterized by rapid exponential growth. The fast pace at which disruption takes place explains to a significant extent why incumbents often fail to respond on time and effectively to successful disruptors. Incumbents tend to be slow to recognize the competitive threat posed by disruptors (Christensen, 1997). As has been mentioned above, this is, in part, due to the fact that incumbents have fine-tuned their business models and organizational capabilities to optimally respond to existing demand patterns (Christensen, 1997; Henderson, 2006).

The Six Stages of the Disruptive Process: Keys to Success Among Non-Entrenched Enterprises.

One of Christensen's key arguments is that established firms struggle with disruptive innovation because of their commercial need to satisfy the current interests of mainstream customers and investors. These stakeholders are unlikely to request the development of products that offer a radically different performance package from what they are familiar with. Instead, they are likely to demand better versions of existing products. To illustrate, as Henry Ford is reputed to have said, "If I had asked people what they wanted, they would have said faster horses". When disruptive products are first rolled out they are generally not perceived as a threat by incumbents because these products do not initially meet the minimum level of performance against the main market driver that mainstream customers are willing to accept. Another reason incumbents are unlikely to retaliate against disruptors when they are most vulnerable is the fact that they tend to first establish themselves in low-margin foothold markets. Christensen argues that, because incumbents tend to have higher-cost business models compared to disruptors, it appears to make little economic sense for them to compete for these relatively low-value customers. Henderson (2006)

argues that incumbents struggle with disruptive innovation as a result of deeply ingrained organizational routines, values, and ways of thinking that have developed over years in order to operate optimally under the existing status-quo with the old dominant technology.

It is for these reasons that Christensen argues that successful disruptors tend to be industry entrants that are unencumbered by outdated organizational capacities. These industry entrants can be either new firms or independent sub-divisions of existing firms that do not yet operate within that particular sector. Either way, they generally lack the sector specific experience, networks and access to capital that incumbents have.

Rafii and Kampas (2002) have identified six stages of the disruptive process that disruptors need to complete in order for disruption to occur. These six stages are shown in Figure 1, below.

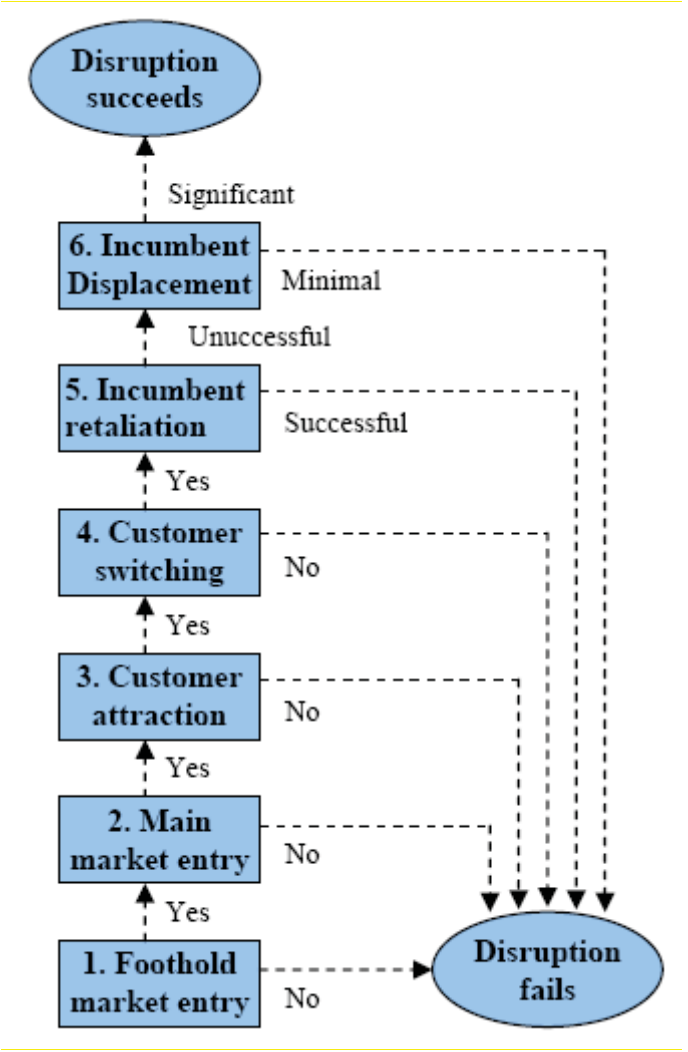


Figure 1 - The Six Stages of the Disruptive Process
Source: Rafii & Kampas as cited in Lindqvist, 2005, p. 50

First, firms need to identify and establish their products in small foothold markets that value their unconventional performance packages. These footholds give new firms the opportunity to gain the capital and know-how required to take their products to the mainstream. It gives them the time and experience needed to improve their products´ performance against the dominant market driver enough to meet the minimum requirements of mainstream customers in this area. Large corporations moving into a different market with a radically different product are sometimes able to skip this step. Once aspiring disruptive innovators launch their products in the mainstream market, they need to convince mainstream customers that their products´

superior performance against *secondary* market drivers makes it worth their while to switch, even if their performance against the old dominant market driver is inferior. Incumbents can retaliate against aspiring disruptors at any stage and block the process of disruption, as is shown in Figure 1. Potential disruptors are most vulnerable during the early stages when they do not yet have enough momentum to overcome barriers and withstand retaliation. The most challenging step for most new firms is the move from foothold market to mainstream market.

The Greatest Challenge: Moving from Foothold to Mainstream

In his seminal work *Crossing the Chasm* (1991), Moore argued that launching a new product in a niche market requires a completely different skill set from conquering the mainstream. While entrants face other potential barriers such as protective patents and a lack of capital, he argues that the main reason firms fail to enter the mainstream is the fact that they do not evolve their organizational mindset and capabilities quickly enough. Niche market customers may be relatively indifferent towards the mainstream market's dominant driver, but mainstream customers will not switch to the new product unless it meets their minimum performance expectations in this area. After establishing themselves in foothold markets, disruptors therefore need to switch their focus from niche to mainstream expectations and adjust their innovation and marketing strategies accordingly. Given that industry leaders are generally significantly more powerful than industry entrants and can retaliate at any point during the disruptive process, speed is of the essence for successful disruption. Even though incumbents are unlikely to contest low margin niche markets, they will not fail to notice the switching of large numbers of mainstream customers. Therefore, in order to successfully complete all stages of the disruptive process it is essential for disruptors to move fast once they have entered the

mainstream. This requires the rapid acquisition of the relevant technological and market-related capabilities. The disruptive process therefore entails a steep learning curve for disruptors. Clearly not all firms learn quickly enough and many are confined to niche markets as a result. It is for this reason that successful disruption is characterized by exponential growth once the product enters the mainstream. As a consequence of its steep curve, incumbents who failed to spot the competitive threat when the disruptive product was initially rolled out in a niche market find themselves scrambling and struggling to catch up when mainstream customers are starting to switch.

Disruption Friendly Environments

Raynor (2011) has argued that some sectors are inherently more disruption-friendly than others, pointing out that, for example, the hotel industry has consistently resisted disruption because to date no technology has been invented that would enable aspiring disruptors in this sector to conquer the mainstream with their existing niche business models. By contrast, in his seminal study of the hard disk drive industry, Christensen found that 38% of firms that deployed a disruptive innovation strategy reached sales of at least 100 million dollars for at least one year during the period under study (1976-1994) compared to only 6% of firms that used a sustaining innovation strategy (Christensen, 1997:145). The incidence of disruptive innovation in any sector ranges thus from very low to moderate, depending on the sector. However, whenever disruption does occur, the financial rewards are much greater for industry entrants than those yielded by sustaining innovation. In the study just mentioned, Christensen found that annual sales for entrants following a disruptive strategy were on average $62 million, compared to only $3 million for those following a sustaining strategy (Christensen, 1997). Two defining characteristics of

disruption friendly environments are, therefore, *highly successful outliers*, products that far exceed the average upper sales limits in their markets, and *exponential payoffs* for successful disruptive innovators.

A Case Study: Tesco Conquers the South-Korean Market

Christensen (2003) has argued that disruptive innovations are typically cheaper, have fewer features and are easier to use. Christensen appears to assume to these three variables are correlated, but this is not necessarily the case. In some cases, complexity of use decreases as cost and technological complexity increases. Tesco, for example, conquered a significant proportion of the mainstream Fast Moving Consumer Goods (FMCG) market in South Korea, not by offering inferior products at lower prices but by greatly enhancing customers´ ease of access to their products using technologically complex means. Ease of access can be seen as a key subcomponent of Christensen's variable *ease of use*. In cooperation with Samsung, Tesco developed billboards with pictures of their products and smart phone enabled barcodes. They hired wall space in key locations, enabling customers to shop at virtual Tesco stores in convenient places. While waiting for the subway, for example, consumers can now take pictures of products displayed on the billboards using their smartphones. These products are then added to their online carts and delivered to their homes after checkout. Tesco entered the South Korean FMCG market in 1999 in partnership with Samsung and over a period of only ten years became its second largest player. It also became the country's largest internet home-delivery business (Brown, 2011).

Even though the firm's innovative approach scores low against *complexity of use*, its products are not cheaper than those offered by other key market players and its services rely on advanced technology (smartphones). Therefore, if cost,

technological complexity and usage complexity were all found to be *necessary* attributes of disruptive innovation, Tesco's impressive success in South Korea could not be classified as disruption in Christensen's sense of the word and would constitute another *high-end anomaly*. However, if it was found that only "ease of use" were a necessary predictor of successful disruption and that "low cost" and "greater technological simplicity" were only ancillary attributes, it would lend strength to Carr (2005) and Govindarajan and Kopalle´s (2006b) argument that the concept *high-end disruptive innovation* is compatible with Christensen's theory.

The Gaps in the Theory

In its current form disruptive innovation theory is unclear and underspecified. Christensen himself (2006) admits that the concept could have been defined with greater clarity and detail (p.48). One point of contention is the question as to whether *high-end disruption* is a form of disruptive innovation.

High-End Anomalies

Christensen acknowledges that there is a significant number of what he terms *high-end anomalies*, expensive and technologically superior innovations that encroach on the mainstream from above and "disrupt" the market. He writes, "The weight of these high-end anomalies is so heavy that another category of innovations must be out there. These are not low-end or new-market disruptions, as I have defined the terms, yet they seem to have had the similar effect of leaving the leader flat-footed, unable to respond effectively" (Christensen, 2006, pp. 50-51). Govindarajan and Kopalle (2006b) have termed this type of innovation *high-end disruptive innovation* and Carr (2005) has called it *top-down* disruptive innovation. Christensen however rejects labeling these "anomalies" as a type of disruptive innovation. He

argues that "disruptive" as he defines the construct refers not to just to the outcome but to a specific process to which *an attack from below* is key (Christensen, 2006).

Christensen's insistence that disruption always involves conquering the mainstream from below is in part a response to critiques that the label "disruptive innovation" can only be applied post-hoc (Christensen, 2006, p. 50). Critics (e.g. Sood & Tellis, 2010; Barney, 1997; Danneels, 2004) have argued that Christensen's definitions of "disruptive" and "sustaining" innovation are tautologous or circular because, in their view, these constructs are measured by effects that lead to premises that are true by definition, i.e. "the impact of this innovation has been disruptive therefore it is a disruptive innovation". On this basis they contend that his framework can only be used for post-hoc explanation but not for ex-ante prediction (Sood & Tellis, 2010; Barney, 1997; Danneels, 2004). In order to avoid the post-hoc critique, Christensen insists that the high-end anomalies should not be considered instances of disruptive innovation. He writes, "I am trying to give specific meaning to the term, independent of the outcome... If we label the high-end phenomenon as disruption as well, people will make the post hoc mistake" (Christensen, 2006, p.50).

Other Critiques of Disruptive Innovation Theory

The original theory is also unclear about a number of other important points, for example whether *disruptiveness* is a permanent or a temporary attribute of innovations. Given that incumbents can retaliate against disruptors and block the process of disruption at all stages (Rafii & Kampas, 2002), treating *disruptiveness* as a permanent and innate attribute of innovations would only enable researchers to use the framework for post-hoc analysis. For this reason, many researchers now analyze innovations in terms of *disruptive potential* rather than inherent disruptiveness (e.g. Keller & Hüsig, 2009; National Research Council, 2009). However, even though

disruptiveness is widely seen as a temporary attribute, there is no consensus on when a disruptive innovation starts and ceases to be disruptive. Sood and Tellis (2010) found for example that some "disruptive technologies" have in time again been overtaken by the old technology due to significant improvements to the latter. In addition, Markides (2006) points out that many "disruptive innovations" have stopped well short of completely conquering the mainstream market, leaving a significant customer base for the old incumbents. The original theory leaves it unclear whether such innovations have simply stopped being disruptive or whether they were never proper *disruptive innovations* in the first place.

Another key criticism of disruptive innovation has been that the original theory is unclear about whether *disruptiveness* is an absolute or a relative phenomenon. Christensen (2006) later clarified that "disruptiveness is not an absolute phenomenon but can only be measured relative to the business model of another firm. In other words, an innovation that is disruptive relative to the business model of one firm can be sustaining relative to the business model of another" (p. 48). From this explanation it is clear that in Christensen's view, the construct of disruption relates to the area of business models. The original theory further implies that *disruption* also refers to market standards, technological paradigms, the market positions of incumbents and entrants, and the expectations of customers. The theory has been criticized for not specifying which of these areas (apart from business models) become necessarily and *per definition* disrupted as a result of successful disruption and which areas are simply likely to become disrupted (Sood & Tellis, 2010). This is but one aspect of the main problem with current theory, which is that it is not clear which attributes of *disruption* are essential to disruptive success and which ones are ancillary (Danneels, 2004, p. 250).

The Consequences of a Poor Definition

Christensen has been accused of "sampling on the dependent variable" (Danneels, 2004) or "cherry-picking examples to support his framework" (Cohan, 2000). Christensen denies these charges, arguing instead that he is in fact a strong advocate of an anomaly-seeking approach to research, as will be discussed in detail in the chapter on Methodology. Nevertheless, Danneels points out that retrospective analysis is always subject to bias. He writes, "The real challenge to any theory, especially if it is to be useful managerially, is how it performs predictively" (Danneels, 2004, p.250). Given that disruptive innovations radically change the rules of the game, classical time-series modeling techniques cannot be used to forecast the disruptive impact over time of particular innovations. For this reason it is necessary to explore the theory for ex-ante indicators that make forecasting possible under highly changeable circumstances. If the constructs of disruptive and sustaining innovation had been sufficiently specified, it would be relatively unambiguous to identify and test the relevant variables. However, because these constructs have been poorly defined, it is by no means obvious how they should be operationalized. Given that the original theory does not clearly distinguish between essential and ancillary attributes of disruptive innovation, it is not apparent which variables should always be included in predictive causal models and which can be left out. Furthermore, it is possible that important indicators key to successful predictive modeling of disruptive innovation have not yet been clearly articulated in existing studies but rather need to be inferred from the current body of work. This lack of clarity has significant consequences for researchers' ability to validate the theory through predictive modeling. So long as the definition remains underspecified, they are at risk of failing to include some essential predictive attributes of the construct.

In an attempt to validate Christensen's theory, Sood and Tellis operationalized and modeled disruptive innovation and applied this framework to *all* platform technologies, 36 in total, that were ever commercialized in seven selected markets (Sood & Tellis, 2010). Most of their findings did not correspond with what disruptive innovation theory would predict. This may be largely due to the way in which they chose to operationalize the constructs of disruptive and sustaining innovation. In order to avoid circularity they defined these on the basis of their technological and performance characteristics rather than in terms of their business model, market or demand-related attributes. This choice is however in essence completely random. It is likely that this operationalization did not capture the essential attributes of disruptive innovation and that the study therefore neither confirms nor disproves the validity of disruptive innovation theory. Indeed, until it is established which characteristics of disruptive innovation are essential and which are ancillary, it is not possible to accurately model and validate the theory.

The Assumptions That Formed the Starting Point of this Research Paper

This research was premised on the idea that the post hoc critique resulted from the fact that Disruptive Innovation Theory could not be validated because it remained under-specified and ambiguous. A key assumption was the idea that if variables that held no ex-ante predictive power were removed from existing theory and if key predictors of disruptive success that were not included were added, it should be possible to use the theory for systematic prediction, which would validate the theory. This study's starting point was that the phenomenon of "high-end disruption" should not be dismissed until testing showed conclusively that "an attack from below" is essential to the construction of a coherent theory that has ex-ante predictive power. As will be discussed in detail in the chapter on Methodology, this project has explored

the boundaries and content of the existing theory's constructs and categories through the analytical lens of "high-end anomalies". Its aim was to test whether it was possible to develop existing theory so that it could also account for and predict "high-end disruption".

Problem Statement and Research Questions

Christensen has argued that ''disruptive technologies are typically simpler, cheaper, and more reliable and convenient than established technologies'' (Christensen, 2003, p.192) and hence attack from below. However, this definition needs further clarification. Christensen appears to assume that technological complexity, ease of use and cost are correlated. In his view, products that have fewer features are generally easier to use and cheaper. However, Sood and Tellis (2010) show this assumption to be erroneous. Govindarajan and Kopalle (2006a) have successfully built a model that correctly classifies historic cases of disruptive innovation on the basis of a small number of indicators. This model does not include any cost elements, which suggests that lower cost may not be an essential attribute of disruptive innovation but only an ancillary one. Unfortunately, the findings of Govindarajan and Kopalle may not be reliable because their data collection method suffered from significant weaknesses, which will be discussed in the literature review. Furthermore, they did not provide a theory-based rationale for their selection of indicators. In addition, because of their chosen indicators, their model can only be applied post-hoc to historic data and not be used for ex-ante prediction. Nevertheless, their research constitutes an indication that lower cost is not an essential predictor for disruptive innovation. Likewise, given that technological simplicity is not correlated with either cost or ease of use, as shown in the case study of Tesco's success in South Korea above, it is probable that this characteristic is not an essential attribute either.

These facts support the view that "high-end disruptive innovation" is not necessarily incompatible with disruptive innovation theory and that it is possible to revise this theory's current constructs and categories with an eye to ensuring that it can also account for this variant of the phenomenon. This research has consequently sought to answer the following research questions:

1. Can core constructs, categories and theorized causal links be revised so that disruptive innovation theory can also account for "high-end anomalies"?

2. What are the key predictor and outcome variables for "standard" and "high-end" disruptive innovation that can be measured ex-ante?

Purpose and Scope of the Study

The aim of this research has been to clarify disruptive innovation theory, remove its ambiguities and fill in the detail so as to enable future quantitative analysts to develop a predictive model that can reliably and accurately predict the disruptive timeline of disruptive innovations. By focusing on a category of anomalies the original theory could not explain, i.e. "high-end disruptive innovations", this study has explored the very foundations of disruptive innovation theory. The aim has been to review and, when needed, revise the key attributes pertaining to the main areas this theory focuses on (i,e, business models, demand, technological trajectories, networks, etc.) in order to develop a comprehensive set of ex-ante predictor variables that can form the basis for future quantitative studies. By doing so, this study has helped clarify the construct and made it clear which variables always need to be included in its core definition. Establishing which attributes of disruptive innovation listed in the literature are strictly necessary and which ones can be eliminated has also made it possible to evaluate Christensen's premise that disruptive innovations necessarily

conquer the mainstream from below, as will discussed in Chapter 6. This project's aim has been to contribute to the development of a logically coherent, internally consistent and externally valid theory of disruptive innovation that can account for "high end anomalies". Its outputs include a clear overview of the causal relations that mark disruptive innovation theory as well as a comprehensive set of ex-ante predictor variables that can be used to forecast both standard as well as "high-end" disruptive success.

Objectives

As stated above, this research's goal has been to clarify and operationalize the concept of disruptive innovation by exploring it through the analytical lens of "high-end anomalies". Its aim has been to revise existing theory to ensure it can also account for "high-end disruption" and establish which variables mentioned in the academic literature constitute vital predictors of the phenomenon, both in its standard and "high-end" variants. To this end, this study has analyzed real world cases of innovation using the historical method, discussed in detail in the chapter on Methodology. Given that disruptive innovation radically changes the rules of the game within an industry, classic time-series forecasting premised upon a steady state situation cannot be used to predict the disruptive timeline of innovations in a given market. This study has therefore attempted to identify the key causal mechanisms that define disruptive innovation and developed predictor variables that can be measured ex-ante. This will enable future quantitative analysts to use methods that go beyond steady state time series modeling, such as predictive causal modeling. Suggestions for quantitative methods have been included in Chapter 6.

This study's goal has been to construct a logically coherent and valid theory of disruption on the basis of historic evidence that demonstrates that an attack from

below is not *essential* to some variants of disruptive innovation. Furthermore, it has developed predictor variables for disruptive innovation (including "high-end disruption") that can be tested and validated in future quantitative analyses. The main objective of this research has been, then, to clarify disruptive innovation theory and carry out all the required preliminary work to enable quantitative analysts to build a predictive model that can forecast the timeline of specific disruptive innovations, both those who aim to conquer the mainstream from below and those who intend to do so from above.

Scope of the Study

As the aim of this research has been to clarify the concept of disruptive innovation. To this end, the academic and professional literature have been explored in order to identify and analyze the key attributes in the areas affected by this phenomenon. Taking a broad approach, this study has looked at attributes that pertain to the product, its producer and its environment. The goal of this study was to establish whether current theory could be expanded upon or revised so that it could also account for "high-end anomalies" and address its ambiguities and gaps so that its key constructs could be operationalized and measured in a clear and straightforward manner. To this end, this study has analyzed historical case data about successful and failed disruptive innovation projects from a number of selected markets. The aim has been to include cases from a diverse range of markets that are, or have historically been, characterized by at least two competing products that each offers a profoundly different performance package. At the same time, the study also aimed to include markets that had been studied by Christensen for the sake of theoretical comparison. On the basis of these criteria, the following sectors were selected for analysis: the disk drive industry, the automobile sector, the amateur photography market and the

US health care sector. The aim has been to develop a comprehensive list of variables that appear to have ex-ante predictive power based on the disruptive innovation literature and explore their relevance in the context of the key areas affected by disruption through the exploration of actual historical cases of innovation.

Utility of the Study

Since Clayton Christensen published his seminal works *The Innovator's Dilemma* (Christensen, 1997) and the coauthored *The Innovator's Solution* (Christensen & Raynor, 2003) the concept of disruptive innovation has become popular and mainstream. Christensen has shown that a disruptive innovation strategy has a much greater chance of dramatically improving a firm's market position than an innovation strategy that builds on and strengthens the current ways of doing business in an industry (Christensen, 1997, p. 145). As a consequence, many managers have become interested in following a disruptive strategy in order to boost their firms' commercial success. However, as Anthony (2005) points out, the concept of disruptive innovation is often misunderstood and misused by business professionals. This can in part be attributed to the fact that in the English language the word "disruptive" has a meaning that is much broader and shallower than Christensen's specific use of the term in the context of his theory. According to Merriam Webster (Disruption, 2013) the word is "to cause (something) to be unable to continue in the normal way: to interrupt the normal progress or activity of (something)." Christensen, by contrast, uses the term specifically to refer to the destructive impact of an innovation on established business models, market positions and consumer preferences that is the result of incumbents' inability to recognize and respond to the threat / opportunity on time. The fact that in business the term is often used to refer to any type of radical innovation significantly adds to the confusion of its interpretation.

Furthermore, the current lack of clarity in the academic literature on which attributes of disruption are essential and which ones are ancillary is an important reason why to date no tools exist that enable business managers to forecast the disruptive timeline of innovations with disruptive potential. In order for disruptive innovation theory to be of direct practical use to business strategists, it is vital that the theory be clarified and operationalized so that such a tool can be developed.

The current work makes a useful contribution to the academic literature on innovation: it is the first qualitative study to develop an internally consistent and externally valid version of disruptive innovation theory that can account for "high-end anomalies". By removing attributes that hold no ex-ante predictive power and adding key predictors of disruptive success that are implied but not spelled out in the original theory, this paper provides the theoretical clarity and detail needed for quantitative modeling. Its outputs include a clear overview of the key causal mechanisms that define disruptive innovation as well as a comprehensive set of ex-ante predictor variables. These outputs can form the basis for future quantitative studies that validate the theory through predictive modeling. This paper's findings will also be of significant benefit to decision makers in the business community who are responsible for planning their firm's innovation strategy. The ex-ante predictor variables are presented in the format of a tree diagram that can be used to forecast the likelihood of disruptive success of a particular innovation on the basis of information that should be available before disruption occurs (if it occurs). It can be applied to a project the firm is planning or to that of a rival firm as all indicators, presented in the form of questions, should generally be answerable on the basis of data that is in the public domain.

Chapter 2: Literature Review

In the 20th century, various theoretical frameworks have been developed in order to explain the causes and consequences of innovation. This chapter will start by discussing those early and more recent seminal works in the field of innovation studies that constitute the theoretical background against which Clayton Christensen developed disruptive innovation theory. Next, this chapter will review the work of other important disruptive innovation theorists by looking at the different areas of disruption to which they paid particular attention. In their aim to identify the key causal and impact variables that shape disruptive innovation, different researchers have over the years focused on different areas. Some have, for example, analyzed the phenomenon by exploring technological development, whereas others have looked at demand patterns, business models, organizational competencies, market standards or market positions. Researchers who focus on different areas affected by the same phenomenon, in this case disruptive innovation, generally consider a somewhat different set of variables to be essential for explanation and prediction. The areas to which a theory refers are therefore of central importance to analysts who seek to operationalize and model its key constructs for either explanatory or predictive purposes. This is because the areas of focus determine the scope of the constructs used by the theorists and constitute the locus of the key explanatory variables. As the aim of this study has been to model disruptive innovation theory, it is important to be clear on nature and scope of the different analytical frameworks disruptive innovation theorists use. It is for this reason that the significant part of the literature review has

been dedicated to analyzing the different foci of disruptive innovation theory. This chapter will conclude by looking again at Clayton Christensen's argument that disruptive innovations always conquer the mainstream market from below.

Seminal Works in Innovation Studies: the Theoretical Background to Disruptive Innovation Theory

This section will provide an overview of the key theoretical and empirical works in the academic literature on which Clayton Christensen's theory of Disruptive Innovation is built. It provides the basis for the more detailed discussion of the different focus areas of DI theory that will follow next.

The Different Topics Explored In Innovation Studies

Joseph Schumpeter (1942/2003) was the first to identify innovation as the process through which industries and economies incessantly mutate and revolutionize from within (p. 83). In his seminal work *Capitalism, Socialism and Democracy* he calls this process *creative destruction* and argues that it is an integral part of capitalism. Ever since Schumpeter highlighted the important role innovation plays in capitalist market competition, researchers have sought to explain why incumbent firms thrive on certain types of innovation but are unable to respond effectively to others and often lose a significant proportion of their total market share as a result. As has been discussed in Chapter 1, this is also one of the key questions Clayton Christensen sought to answer when he undertook his important study of the hard drive industry and developed his theory of *disruptive innovation*.

In their efforts to identify the key variables and mechanisms that shape the innovation process and its outcomes, different researchers have built different theoretical frameworks focusing on different aspects of disruptive innovation theory. Some have, for example, sought to explain the process of *creative destruction* by

looking at the role of technological development. Others have focused on changes in demand patterns and yet others have approached the topic from the analytical viewpoint of organizational theory. Most analytical frameworks refer to several areas at the same time. In their important work on innovation life cycles Abernathy and Utterback (1978), for example, analyzed the process of creative destruction within industries by focusing on the business models of incumbents and entrants, on the nature and rate of technological developments over time and on the emergence and consolidation market standards. However, they treat demand patterns largely as a given and leave them under-explained. They argue that once a new technology is introduced into a sector, after a period of intense experimentation and innovation by all market players, a particular technical design comes to dominate the market. At this point, incumbents no longer invest in the development of radically different designs but instead start to focus their innovation efforts on further improving the dominant technical model. At some point, industry outsiders who are not committed to the established design introduce a new innovation into the sector at which point the innovation life cycle starts again. This theory underlies one of the central points of disruptive innovation theory: the idea that incumbents fail to recognize the value of disruptive innovations on time and "overshoot the market" because they have fine-tuned their business models and innovation decision making processes to function optimally within the constraints of the dominant technology.

Unlike Abernathy and Utterback, Dosi did not focus on the business models or market positions of firms and made *demand* one of his central foci of analysis. In his seminal work on technological paradigms, Dosi (1982) sought to explore the interconnections between demand, the emergence of market standards, and technological developments. Dosi argues that generic needs – what Christensen

would later refer to as "jobs to be done" – are given specific shape by available technology. He argues that such needs emerge out of specific socio-economic processes and contexts and give rise to specific technological paradigms. Dosi sees technological paradigms as patterns of solutions for selected technological problems. They define the relevant problems, shape the patterns of inquiry and solution seeking and determine which scientific principles and material technologies are used (Dosi, 1982, p. 152). New paradigms represent discontinuities in these trajectories of progress. They redefine the meaning of progress itself and shift the focus of innovators to a completely new class of problems (Dosi, 1982). Clayton Christensen's idea of *value networks*, central to disruptive innovation theory, is to a large extent based on this earlier work by Dosi. This idea will be discussed in detail below in the section *The Different Foci of Disruptive Innovation Theory*.

Key Dichotomous Constructs in Innovation Studies

Many of the analytical frameworks that have been developed to explain the causes and consequences of innovation have included dichotomous constructs that embody the key theory being put forward. Christensen's distinction between disruptive and sustaining innovation is an example of this. Other key examples include competence-enhancing vs. competence-destroying innovation (Tushman & Anderson, 1986) and architectural vs. component innovation (Henderson & Clark, 1990). Both constructs refer to the areas of business models, market positions, market standards and technological paradigms. However, because of their very different theoretical underpinnings, they result in very different explanations as to why incumbent firms thrive on certain types of innovation but are unable to respond effectively to others. Gatignon, et al state that while competence-enhancing innovations build upon and reinforce a firm's existing competencies, competence-

destroying innovations obsolesce and overturn a firm's existing skills and know-how (2000, p.9). Using this analytical framework, they found that competence-destroying innovations are generally introduced by industry entrants and that competence-enhancing innovations are usually initiated by incumbents. Whereas the former results in major shifts in market position in an industry, the latter consolidates the market positions of incumbents (Tushman & Anderson, 1986, pp. 444-455). These views are in line with those of Abernathy and Utterback in their seminal study on innovation life cycles mentioned above.

The dichotomy architectural vs. component innovation refers to the same theoretical areas as Tushman and Anderson's constructs but has led to very different findings. Based on the fact that products are systems of components, Henderson and Clark (1990) distinguish between innovations at component level and innovations at system level. The former only affect individual components whereas the latter affect the way components are designed to work together in a system. Using this analytical framework, they found that incumbents struggle more with architectural innovation than industry entrants because they are handicapped by a legacy of embedded and partially irrelevant architectural knowledge (p. 18).

In addition to the categories just outlined, a distinction is generally made between two classes of innovation. On the one hand, there are revolutionary, discontinuous, breakthrough, radical, emergent and step-function technologies, and on the other hand there are evolutionary, continuous, incremental and 'nuts and bolts' technologies (Yu, 2009, p.4). The former class encompasses innovations that do not follow existing technologies or methods but bring something genuinely new to the world. The latter, on the other hand, encompasses innovations that build upon existing methods or technologies by either improving things that are already available or

reconfiguring existing tools or approaches to serve different purposes (Lindqvist et al, 2005, p.8). The construct validity of the three dichotomous concepts radical vs. incremental innovation, competency enhancing vs. competency destroying innovation and architectural vs. component innovation has been established by Gatignon et al. (2000). Furthermore, Govindarajan and Kopalle (2006a) later established the construct validity of disruptive vs. sustaining innovation, showing that these concepts measure something unique and distinct from the constructs tested earlier by Gatignon et al.

Technology S-Curves

Another important study that influenced Christensen is Foster's seminal work *the Attacker's Advantage* (1986). Focusing exclusively on technological development, Foster found that the relationship between R&D effort and technological performance follows an S-curve pattern, leading him to conclude that incumbents fail if they do not switch technologies when a new technology comes up from below and crosses the S-curve of the current technology. Christensen contends that S-curve phenomena have convincingly been shown to exist at aggregate levels (Christensen, 1992a). He agrees that those firms that led the industry in switching to new *architectural* technology S-curves enjoyed powerful first-mover advantages (Christensen, 1992b) but points out that firms that led in switching to new *component* technology did not enjoy such advantages. His research into innovation in the disk drive industry shows in fact that firms that followed a strategy of extending or "riding" the S-curve of conventional technology and switching component technology after their competitors were more successful (Christensen, 1992a). The difference in analysis and recommendations between Foster and Christensen can at

least in part be attributed to the fact that Christensen looked at a wider range of areas related to innovation, whereas Foster looked only at technology.

The Diffusion of Innovations

The studies described above cover a wide range of areas related to innovation and constitute the theoretical background against which Clayton Christensen developed disruptive innovation theory. The research presented in this particular paper also draws heavily on work done by Everett Rogers and later studies based on his work. Although of central importance in the field of business innovation studies, the key ideas presented in *Diffusion of Innovations* (1962/2003) are not found in Christensen's theory. Various studies have focused exclusively on the diffusion of innovations. Rogers examined the way in which innovations spread through social systems, famously introducing a five-way classification for different types of adopter: *Innovators, Early Adopters, Early Majority, Late Majority and Laggards*. He found that these categories - and the sequential diffusion through them - follow the pattern of a bell-curve. Moore (1991) later built on this work, arguing that firms faced with discontinuous change need to "work the curve" from left to right, adapting their market-facing strategies whenever they enter a new market segment. He argued that industry entrants often fail to switch strategies when moving into the mainstream market (from *Early Adopters* to *Early Majority*) because their organizational processes, staff, and culture remain fixed in pioneer mode. Markides (2006) later argued that incumbents should leave the development of disruptive innovations to entrants - as this is their area of strength - and focus on what they do best: rolling out new products in the mainstream market. He suggests therefore that incumbents faced with a disruptive threat should not attack, but buy or partner with the disruptors thus creating a win-win situation for both firms.

Christensen's Work

This section has described the different foci academics have historically used to study innovation and the dichotomous constructs they have deployed to describe and analyze the phenomenon. Like the innovation experts before him, Christensen also sought to explain why incumbent and entrant firms thrive on certain types of innovation but are unable to respond effectively to others. In his seminal work *The Innovator's Dilemma* Christensen (1997) describes disruptive technologies as technologies that offer an inferior performance against the performance dimensions mainstream customers value most, but that still, over time, end up displacing the mainstream technology in the mainstream market. Disruptors normally come to market with products that initially do not meet the minimum performance expectations of mainstream customers and are for this reason normally first rolled out in niche markets that value their unconventional performance package. Incumbents are often happy to cede these low margin markets to the new products, which they do not perceive as threats given that their most valuable customers do not need or want them. It is however the hallmark of successful disruptors that they keep improving their products after they have established themselves in a foothold market and that as a result, over time, their innovations start to meet and then exceed the minimum expectations of mainstream customers. The consequent process of market disruption happens to a large extent as a result of incumbents being 'locked into' their existing business models, value networks and established trajectories of technological progress. The fact that incumbents are trapped in this manner often results in inertia when faced with disruptive threats and a tendency to 'overshoot the market' in product development. The latter refers to the fact that the pace of technological progress along a particular trajectory often exceeds the rate of improvement that

mainstream customers can or want to absorb. As a result, over time, mainstream products will start to deliver performance that exceeds market demand. Mainstream customers become 'over-served': they do not need or cannot use the high level of performance mainstream products now all offer. When this happens, mainstream customers become willing to switch to products that are inferior compared to the current market standard, provided these new products address latent or new needs in a better way than the dominant product.

The Different Focus Areas of Disruptive Innovation Theory

Having provided an overview of the seminal papers and books in innovation studies that form the theoretical background to disruptive innovation theory, as well as a quick summary of Clayton Christensen's work, this chapter will now proceed to give an overview of the academic literature on disruptive innovation theory by focus area. It is important to highlight that in order for a theory to have explanatory value and predictive power it is not necessary for that theory to relate to all areas that pertain to a phenomenon under study. It is however important that the theory's scope be clear so that causal hypotheses that are based on a careful analysis of one or more areas are not uncritically applied to areas the theory does not refer to. One of the main criticisms of disruptive innovation is that the scope of the construct is unclear (Sood & Tellis, 2010). Different disruptive innovation experts have analyzed the phenomenon by focusing on different areas and consequently arrived at different conclusions and recommendations that are not always consistent or compatible. Raynor (2011) for example stresses the centrality of business models to the process of disruption, whereas Henderson (2006) emphasizes the importance of organizational capacities, Sood and Tellis (2010) look primarily at technological development and Adner (2002) prioritizes demand conditions. Each expert defines the essential

characteristics of disruptive innovation on the basis of his or her specific analytical framework and its theoretical underpinnings. Therefore, even though all subscribe to the broad definition of disruptive innovation outlined above, there is no consensus on the detailed specifics of the theory. Furthermore, no explanatory framework(s) can be privileged so long as there remains a lack of clarity regarding which areas the disruptive innovation theory applies out *of necessity*, i.e. per definition, and which areas the framework also *coincidentally* frequently applies. Clayton Christensen (2006) admits that *disruptive innovation* could have been defined with greater clarity and detail (p. 48). So long as the theory remains under-specified with regards to its exact scope, its key constructs prove difficult to model since key attributes of disruptive innovation remain unclear.

Disruption of Technological Trajectories

Sood and Tellis (2010) argue that Christensen's definition of disruptive innovation is circular because it is based on effects – disruptive or sustaining – that can only be measured post hoc and are, therefore, per definition true. Consequently, in their efforts to model and test disruptive innovation theory they sought to operationalize its key constructs in a way that avoids circularity. However, in doing so they chose to focus exclusively on the technological side of disruptive innovations. This choice seems arbitrary as it is not the case that the other areas that relate to this construct do not suggest indicators that can be measured a-priori. Furthermore, Sood and Tellis consider all component and design innovations that are based on the same unique scientific principle as belonging to the same technology and analyze only those innovations at platform level. This choice again seems arbitrary, as they have not proven that disruptive innovations cannot, for example, be exclusively architectural in nature. Sood and Tellis identify two types of technological attack on

the mainstream market: lower and upper attacks. One of the aims of their research was to test Christensen's theory that disruptive innovations necessarily conquer the mainstream *from below*. In line with Christensen's theory they write that "a lower attack occurs when, at the time of its entry, a new technology performs worse than the dominant technology on the primary dimension of performance. An upper attack occurs when, at the time of its entry, a new technology performs better than the dominant technology on the primary dimension of performance... Technology disruption occurs when the new technology crosses the performance of the dominant technology on the primary dimension of performance" (Sood & Tellis, 2010, pp. 3-4). Their findings appear to disprove Christensen's thesis. Their statistical analyses show that contrary to Christensen's theory, technological attacks from below were *less likely* to disrupt firms than attacks from above. Furthermore, they show that Christensen's assumption that technological performance and cost are positively correlated is erroneous (Sood & Tellis, 2010, p. 14). Even though their findings are insightful and open up new areas of enquiry, it cannot be said that they have disproven disruptive innovation theory due to the arbitrary manner in which they chose to operationalize and model the theory.

Christensen himself has pointed out that even though the technological side of disruptive innovation is important, the construct is much broader than this. Christensen (1997) originally labeled the phenomenon "disruptive technology" but later decided rename the construct "disruptive innovation" (Christensen & Raynor, 2003) in order to make it clear that the construct's scope is wider than just the technological side of innovation. Some have argued that this broadening of the construct has led to the current lack of clarity about the theory's scope (e.g. Danneels, 2004; Markides, 2006). However, in spite of this lack of clarity about the detail and

scope of the construct, the theory is very clear about the importance of the interplay between market and technology. Paap (2004) points out that technology itself does not directly lead to a return; rather, it merely creates change in the processes, materials, functionality or utility of a product or service. It is this change that creates value, but only if this change addresses existing or future market needs.

Central to Christensen's theory of disruptive innovation is the idea that, in terms of technological development, incumbents tend to *overshoot the market*, while disruptors conquer the mainstream from below. The extent to which existing technology can be improved upon is known as its *productivity*. The extent to which such improvements are valued by internal operations (for process innovation) or the external customer base (for product or service innovations) is referred to as *leverage* (Paap, 2004). It is quite possible for existing technologies to still be productive when they have reached their *leverage limit*. This is the point at which internal operations or the external customer-base no longer value further improvements in the technology (Paap, 2004). Successful innovations target those performance characteristics whose leverage is the greatest in a particular market segment (Paap, 2004). These are known as the market segment's *drivers* (Paap, 2004).

Once technology has adequately met the dominant drivers in a market segment, new dominant drivers emerge from existing lower order needs (Paap, 2004). Completely novel drivers can also come into being as a result of changes in the environment, for example the emergence of new technologies or the introduction of new regulations (Yu, 2009). Clearly, a successful long-term innovation strategy should address both current and potential future market drivers. Christensen (1993) argues that established firms that focus exclusively on their current customers'

expressed needs are at a significant disadvantage because their current customers are oblivious to the potential benefits and possibilities of new architectures.

Christensen's point is that because disruptive technologies generally perform worse with regards to the dominant market driver, they are not perceived as a threat by incumbents and are therefore ignored. However, he argues that these technologies generally outperform existing technologies with regards to existing 'lower order' needs or future novel needs that will emerge as a result of change in the environment. In addition, over time these technologies improve enough to take their level of performance to the *leverage minimum* of the mainstream market. That is to say that their performance reaches the minimum level required for customers to respond (Paap, 2004). Once these technologies have reached the leverage minimum with regards to the old market driver, they quickly start to dominate the market because of their superior performance against the new market drivers.

However, Ron Adner (2002) contests Christensen's analysis that "performance oversupply [triggers] a change in the basis of competition. Once demand for capacity [is] satiated, other attributes [size; power consumption], whose performance [have] not yet satisfied market demands, [come] to be more highly valued . . ." (Christensen, 1997, pp.166–167). Adner argues that customers with sufficiently satisfied functional requirements do not start to prioritize different performance attributes. He disputes for example Christensen's analysis that in the 1980s desktop users switched to computers with smaller hard drives because these disks adequately met their performance needs and used less energy than the larger hard drives that were the market standard at the time. Adner points out that the difference in energy use between the smaller and the standard disks was negligible but that the difference in unit price was significant. He holds that, provided products meet customers' minimum performance expectations,

customers will base their purchasing decisions primarily on total unit price and be fairly indifferent to variations between products in price-per-performance points (Adner, 2002). Adner's own analysis of how demand conditions enable market disruption will be discussed in detail below.

Disruption of Value Networks

Value networks play a central role in Clayton Christensen's theory of disruptive innovation. He defines a value network as the context within which a firm identifies and responds to customers' needs, procures inputs and reacts to competitors (Christensen, 1995, p.234). Value networks generally correspond with particular *technological paradigms* (Dosi, 1982) described above. Indeed, the very definition of value within a value network is a function of the dominant technological paradigm at the highest-level system of use of a product or service; that is, the patterns of solutions for problems and issues that are important to end-users (Christensen, 1995). This determines a unique rank ordering of the importance of various performance attributes for components at all levels. Christensen argues that customer-perceived value is best understood by looking at what the customer is trying to achieve when buying and using a product (Christensen, 1995). He argues for a categorization based on situation specific value. In order to examine end-user perceived value one should look at what result, with respect to what problem, a particular set of people or businesses tries to accomplish under certain circumstances (see also Wunker, 2005). The rank-orderings of performance attributes will differ according to the applications sought by different types of buyers, giving rise to distinct systems of use within one industry, and hence distinct value networks (Christensen, 1995). It is not the case therefore that each broadly defined industry is necessarily governed by one single value network. Parallel networks of value may exist within the same industry, each

corresponding to a different technical paradigm and each targeting a different type of end-user (Christensen, 1995).

Value networks thus shape and are shaped by *demand patterns*. A value network is not a static structure: incremental or radical innovations along the dominant paradigm's trajectory of progress influence end users' subjective assessments of the benefits and sacrifices linked to a particular product. Other changes in a product's ultimate system-of-use (be they technical, legal, environmental, etc.) can also change customers' perception of the value of that product. A value network can therefore be highly dynamic and the rank orderings of performance attributes, which define the boundaries of a network, may change over time (Christensen, 1995).

Value networks are also closely linked with *organizational competencies.* Christensen argues that a firm's position in a value network determines its priorities and shapes its processes of interaction, coordination, communication and decision-making (Christensen & Raynor, 2003). He argues that it determines "both the perceived attractiveness of a technological opportunity and the degree of difficulty a producer will encounter in exploiting it" (Christensen, 1995, p. 241). Being firmly established in a value network, incumbent firms generally have a clear, if sometimes inflexible, view on who their customers are, what their customers value and what kind of innovative progress is required. They tend to have a thorough understanding of how current or future technology can deliver the performance dimensions (non-price value) their target customers' want and develop their business strategies accordingly. However, incumbents are likely to undervalue innovations whose performance features are in accordance with a different value network. Entrants therefore greatly enhance their chances of successful disruption if they identify and/or

develop a different value network within the same sector, as incumbents are less likely to recognize the threat and retaliate in a timely manner.

Disruption of Business Models

In his recent work *The Innovator's Manifesto,* Michael Raynor (2011) explores the role business models play in disruptive innovation. Business models are defined by the tradeoff firms make between price and non-price value when they try to meet their target customers' needs. As has been described above, these needs are determined by the value network within which the firms operate. The minimum cost required to achieve the necessary set of performance features is whatever cost is incurred by the lowest cost provider in the market. The highest level of non-price value that can be delivered (if cost is no objection) is constrained by the limits of current technological development. The series of potential optimal tradeoffs that can exist within a value network at a given time is referred to as the *productivity frontier* (Raynor, 2011).

Innovation enables firms to break existing tradeoffs. It expands the productivity frontier of a value network and allows innovators to reach a point in strategic space that competitors cannot match, until they also adopt the new technology (Raynor, 2011). Raynor argues that competitors operating in the same value network will quickly adopt the new technology, even if they have different strategies, because they ultimately share the innovator's understanding of who the customers are, what the customers want and what constitutes progress. For this reason, this kind of innovation-based advantage rarely lasts long (Raynor, 2011). He argues that, by contrast, innovations that enable firms to take up a strategic location outside the dominant value network can dramatically alter the playing field and increase their market share.

Whereas strategic differentiators aim to take up different positions within the same value network, strategic innovators try to identify entirely different value networks and develop completely new business models (Raynor, 2011). Strategic innovators target end-users with needs and priorities that differ from those targeted by industry incumbents. Compared to strategic differentiators, strategic innovators tend to experience stronger growth and a higher return on capital (Raynor, 2011). In order to compete with strategic innovators, incumbents need to make far-reaching changes to their business models and shift to completely new value networks. Raynor states that shifting from one position on a productivity frontier to another on the same frontier (essentially changing strategy) is difficult, but not impossible. He points out however that changing frontiers is an entirely different, and vastly more challenging task (Raynor, 2011). Furthermore, there is no incentive for incumbents to shift to a different frontier if their current business model serves them well.

Disruptive innovators generally start out as strategic innovators. They typically operate outside an industry's dominant value network and occupy a strategic space that does not (significantly) overlap with that of industry incumbents. They create a new business model with a new productivity frontier that enables them to provide a combination of price and non-price value that mainstream customers (and therefore incumbents) do not value (Raynor, 2011). However, whereas pure strategic innovators serve a niche market and do not encroach upon incumbents' key customers, disruptive innovators do eventually conquer the mainstream. A disruptor deploys a technological innovation that, in time, enables it to expand its business model's productivity frontier and overtake a significant portion of the incumbents' strategic space (Raynor, 2011). At this point, the disruptor's value network becomes the dominant context for doing business in the industry and incumbents are forced to

undertake drastic measures if they are to survive (such as, for example, changing frontiers). Successful disruptive innovation therefore results in significant shifts in the relative market positions of old incumbents and new disruptive entrants.

Incumbents are often caught off-guard by disruptors and find it hard to respond effectively. Having firmly established themselves within a given value network, they continuously develop and fine-tune their capabilities, structures and cultures to 'fit' their positions better and meet their networks' distinctive requirements (Christensen, 1995). Consequently, they become progressively less able to compete in other value networks within their industry. Their business models have been perfected and to some extent 'locked' into addressing specific sets of tradeoffs between price and non-price value as determined by the rank ordering of performance attributes that characterize their value network. Niche markets that fall outside their value network cannot be served effectively by their business models and are therefore not lucrative or of interest to incumbents.

It is because incumbents are not interested in and ignore these niche markets that disruptors can get a foothold (Raynor, 2011). Their consequent taking over of incumbents' strategic space is known as their *upmarket march* (Raynor, 2011). This upmarket march is further facilitated by the fact that incumbents often fail to recognize the point at which further progress along their particular innovation trajectory is no longer valued by end-users (Paap, 2004). They persist with innovations that sustain their business model and overshoot the market as a result. Meanwhile, mainstream customers shift to disruptors who deliver a 'good enough' performance against the non-price value bundle incumbents focus on and a better tradeoff between price and performance attributes customers are now starting to

prioritize, or, as Adner (2002) argues, those disruptors who simply offer a lower unit price.

Disruption of Organizational Competencies: Processes and Markets

Paap and Katz (2004) argue that 'disruption' is not an attribute of technology but describes the effect that some new technologies have on the market positions of incumbent firms who fail to adopt these new technologies on time. Why incumbents fail to lead in rolling out such crucial innovations is the key question Christensen sought to answer in his study of the rigid disk drive industry. Most studies of innovation show that established firms were very aware of these new technologies, well before these innovations disrupted their market positions. These studies show that incumbent leaders were, in fact, often the creators or technical pioneers of these new technologies (Paap and Katz, 2004). Christensen argues, therefore, that disruption does not happen as a result of a lack of technical awareness on the part of incumbents, but rather as a consequence of their failure to link the development of these technical advances to changes in the marketplace (Paap and Katz, 2004). This is surprising because, as successful established firms, incumbents are very attentive to their customers' needs and respond quickly to them. Furthermore, Christensen found that incumbents did occasionally develop and implement discontinuous, radical, competence-destroying innovations (Christensen, 1993). Christensen argues that the main reason for this surprising fact is that disruptive innovations attack *from below*. This will be discussed in greater detail in the next section.

Christensen holds that incumbents generally do not follow a disruptive strategy because doing so often does not appear to make business sense to incumbents. He suggests that the most powerful protection small entrant firms enjoy as they build emerging markets for disruptive technologies is the fact that they are

doing something that simply does not make sense for the established leaders to copy. He argues that successful companies populated by good managers have a genuinely hard time doing things that do not fit their model for how to make money. He contends that disruptive technologies rarely make sense during the years when investing in them is most important and that therefore conventional managerial wisdom at established firms constitutes an entry and mobility barrier that entrepreneurs and investors can rely on (Christensen, 1997, p. 176).

One of the key barriers incumbents have to overcome in order to successfully respond to disruptive innovation is path dependency. As firms gain experience within a given value network, they are likely to develop their capabilities, structures and cultures to 'fit' that position better by meeting that network's distinctive requirements (Christensen, 1995). Over time, in their endeavor to achieve operational excellence (that is, provide the best tradeoff between price and performance attributes they know their customers value), incumbents take many strategic decisions and develop specific organizational routines and processes. These routines and processes eventually become embedded within the historical context of the business and its operations (Tidd, Bessant & Pavitt, 1997). As a consequence, strategic decisions that are in alignment with the strategic path that a firm has followed historically are less likely to meet with resistance than those that deviate from that path (Walsh & Ungson, 1991). The historically embedded routines and processes therefore generally influence a firm's future trajectory to a significant extent (Lettice & Thomond, 2008). When this happens, a firm's core competencies become its core rigidities (Leonard-Barton, 1992; Leonard, 1995; Ahuja and Lampert, 2001). Path dependency can cause incumbents who have never followed a disruptive strategy to perceive such strategies as significantly more risky than they truly are (Christensen & Raynor, 2003) and to

prioritize sustaining innovations, even in the face of clear indications that they are overshooting their market.

Path dependency is reflected by a firm's culture, i.e. its employees' way of perceiving things, deciding about things and acting upon things. Christensen writes that the stronger and more sustained a firm's success, the stronger these culturally embedded, 'pre-determined' perceptions, decisions and actions will become (Christensen, 1995). He further points out that when key choices are made by the norms of culture rather than by explicit decision, it becomes difficult for insiders to perceive that such decisions are even being made (Christensen, 1995). Lettice found that the perceptions and decision-making processes of managers at incumbent firms were significantly influenced by resource and path dependencies (Lettice & Thomond, 2008). The managers in question were unaware of the fact that their mental modes were restricted in this manner. Lettice found however that managers focused on historical perceptions of success, ignored the positive aspects of disruptive innovations, ignored the negative aspects of sustaining innovations and continued to hold beliefs in the face of disconfirming information (Lettice & Thomond, 2008). Path dependency, then, can place incumbent firms at a disadvantage with regard to following their own disruptive strategy or responding in time to a disruptive competitor: if they are to make the required organizational changes, they have to unlearn deeply entrenched ways of perceiving, deciding and acting.

Henderson (2006) likewise argues that incumbent inertia when faced with disruptive innovations can partially be explained by the fact that such discontinuous change renders incumbents' existing market–related competencies obsolete in subtle ways that are hard to predict (Henderson, 2006). Borrowing Levinthal's (1997) metaphor, she describes organizational inertia as being driven by processes of a local

search over a bumpy landscape (p. 9). Established, successful firms develop highly effective routines for searching around their 'local peak', for example by building a deep understanding of their current customers and investing heavily in distribution systems to reach them (Levinthal, 1997). She argues that these local experiences of a firm create a shared system of understanding within the firm and result in a set of incentives that become deeply embedded and reinforce a particular cognitive model and set of values (Levinthal, 1997, p.10). Successful firms, then, become deeply attuned to their existing markets and would need to implement major changes in their patterns of behavior and information gathering if they were to successfully explore new, possibly disruptive, markets (Levinthal, 1997). Given that it is time consuming to learn about distant markets and that most of these markets will prove to be unattractive, to successful established firms such distant explorations will appear to be significantly more uncertain and less profitable than building deeper knowledge of their current markets (Levinthal, 1997). Henderson points out however that disruptive innovations often result in major shifts in customer preferences. She contends that it is difficult to understand previously unarticulated consumer needs but argues that the established routines of large incumbent firms make it particularly difficult for these firms first to sense and then to act on these kinds of major shifts in consumer preferences (Levinthal, 1997). The existing market facing or customer competencies of established firms, i.e. their ability to read, predict and respond to changes in demand, have been developed through experiences with the current generation of technology. This particular experience has resulted in a deeply embedded outlook on what customers want and what products should deliver. These deeply embedded routines mean that the information incumbent managers need in order to make a well-informed decision on the value of a disruptive technology is either not collected or

filtered out. Henderson argues, then, that the fact that incumbents' market facing or customer competencies has been developed through experience with the existing generation of technology makes it very difficult for them to evaluate the promise of disruptive technologies and respond appropriately (Henderson, 2006). He argues that outdated organizational competencies alone could explain incumbent inertia when faced with disruptive technologies but points out that this process is exacerbated by other factors such as entrenched cognitive frameworks of senior staff and organizational politics, resulting in the currently most profitable projects being allocated most resources (Henderson, 2006).

Additional barriers incumbents need to overcome in order to successfully address disruptive innovation that flows from the processes described above are resource and routine rigidity. The former refers to a failure to change resource investment patterns and the latter refers to a failure to change organizational processes that use those resources (Gilbert, 2005, p.742). Gilbert defines routines as repeated patterns of response involving interdependent activities that become reinforced through structural embeddedness and repeated use (Gilbert, 2005, p.742). He argues that routine rigidity can in part be explained by the fact that organizational processes that are tightly aligned with one environment can be difficult to change because they are self-reinforcing and are not built to adapt to discontinuities (Gilbert, 2005, p.742). He points out that the logic and knowledge underlying organizational routines often pervades the thinking of a company, having become tacit and deeply ingrained in the organization's cognitive model (Gilbert, 2005). This, he argues, makes it difficult to recognize and address routines that are counter-productive when a firm is faced with discontinuous change.

Resource rigidity is the result of two related factors. On the one hand it is caused by incumbent reinvestment incentives -- that is, constraints that stem from a firm's desire to preserve market power which incentivize it to reinvest in its current market position. On the other hand, resource rigidity is caused by resource dependency. Resource dependency theory (Pfeffer & Salancik, 1978) holds that firms are dependent upon their economic environments and that, as a consequence, a firm's external resource providers, e.g. its capital markets and customers, shape and constrain its internal strategic choices. A firm's immediate economic environment is the value network in which it operates. As we have seen, value networks are highly dynamic. A firm's investors and target customers are not only part of this network, but to a large extent dictate its evolution because firms depend on them for their financial survival (Ansoff, 1965; Pfeffer & Salancik, 1978). As a consequence of this dependency, management teams' freedom of action is often limited to satisfying important existing customers and to producing adequate returns for its most demanding investors (Lettice & Thomond, 2008). This, in turn, often results in resource allocation routines that inhibit the pursuit of potentially disruptive products and services (Lettice & Thomond, 2008).

Existing mainstream customers, as a rule, do not express the need for potentially disruptive concepts; they will simply ask for better versions of products they know and understand. Because well-managed firms listen to their customers, managers are likely to ignore disruptive innovations and channel resources into improving the status quo in order to better satisfy the expressed needs of this key resource stream (Burgelman & Sayles, 1986). Incumbents are further dissuaded from exploring disruptive strategies by their investors, their other key resource stream. Historic profit levels have created expectations regarding returns on investment. In

the light of these expectations, the small niche markets in which disruptors could potentially gain a foothold do not appear to offer quick and attractive solutions for growth. Therefore, when investors demand rapid and significant returns on their investments, resource dependencies divert managers' attention and finances away from disruptive innovation (Christensen, 1997). Furthermore, disruptors normally start with a business model that does not strategically overlap with that of incumbents. Because the business models of incumbents have been fine-tuned to operate optimally within a given value network, they cannot effectively serve customers outside of it. In addition, and this is central to Christensen's argument that disruptive innovation always constitutes an attack from below, existing customers are unlikely to show an interest in 'sub-standard' products outside their value network. In addition, because incumbents generally have a higher cost business model, the low margins that characterize the disruptors´ foothold markets render these niche segments economically unviable to incumbents. As a consequence, incumbents are often happy to cede these market segments to disruptors.

The level of resource and routine rigidity that characterizes a firm's decision-making processes is to a large extent determined by that firm's perception of the level of threat posed by competitor innovations. In line with Christensen's analysis, in his study of print newspapers´ reactions to online news sites in the 1990s, Gilbert (2005) found that incumbent firms failed to invest in discontinuous change if this change was not perceived as a threat. He points out that when firms did start to recognize online competition as a threat, managers were able to overcome both sources of resource rigidity outlined above (p. 747). Gilbert argues that this was the case *even in the absence of core customer demand* (Gilbert, 2005). His findings are therefore different from those of Christensen who argues that when discontinuities are led by noncore

customers, established firms do not allocate resources to a new business or technology (Christensen & Bower, 1996).

Gilbert (2005) also found that while a strong perception of threat helped firms overcome resource rigidity, it simultaneously amplified routine rigidity. He discovered that an imminent perception of threat resulted in a contraction of authority, reduced experimentation and an increased focus on existing resources (Gilbert, 2005). He also found that the willingness of firms to commit resources reinforced these three behaviors, which also reinforce each other, resulting in intense routine rigidity (Gilbert, 2005). Gilbert argues that threat perception leads a firm to focus rigidly on averting loss to the existing business. Conscious of the need to act, the firm aggressively deploys resources. The consequent aggressive pace of commitment reduces the firm's ability to experiment, creating lock-in effects and hardening the firm's focus on existing resources. The aggressive deployment of resources also demands increased corporate oversight and this contraction of authority further reinforces the focus on the established business at the expense of new opportunities (Gilbert, 2005). Gilbert argues, then, that threat perception simultaneously reduces resource rigidity and increases routine rigidity, causing managers to adhere more closely to familiar routines and behavioral patterns (Gilbert, 2005).

Gilbert proposes the same solution as Christensen to incumbents faced with disruptive innovation: the creation of autonomous business entities to deal with these threats and manage these opportunities. Engaging with disruption requires incumbents to enter into a different value network and adopt a correspondingly different mindset. Ambidextrous firms simultaneously pursue both incremental and radical innovations (Tushman & O'Reilly, 2002) and this works well so long as both types of innovation sustain the value network within which the firm operates.

However, if one management team were to try to pursue both sustaining and disruptive strategies at the same time, it would be faced with two contradictory sets of values and priorities. Christensen proposes that the way to solve 'the innovator's dilemma' is for incumbents to set up 'autonomous organizations' to develop and commercialize disruptive ventures (Christensen & Raynor, 2003). The key dimensions of Christensen's proposition for autonomy relate to the value network (the processes, values, cost structures) within which the spin-off operates rather than geographical separation or ownership structure (Christensen & Raynor, 2003). His argument is that a business unit with sufficient autonomy would be free from both the path dependencies and resource dependencies that characterize the parent company. Furthermore, Gilbert argues that structural differentiation decouples threat perception in the parent company from the new venture and thereby prevents the emergence of routine rigidity in the new business unit, enabling it to perceive and approach the instance of discontinuous change as an opportunity rather than a threat (Gilbert, 2005). The autonomy of the incumbent's business unit responsible for engaging with disruption, if at all present, thus appears to be a key variable that determines the success of disruptive innovation.

Disruption of Demand Patterns

Ron Adner approached the phenomenon of disruptive innovation from a game theory and microeconomics viewpoint, focusing on the demand conditions that enable disruptive dynamics. In his 2002 paper *When Are Technologies Disruptive*, Adner presents a formal model of the role of the demand environment in shaping competitive dynamics. He introduces the concepts of *preference overlap* and *preference symmetry* to describe the relationships between market segment preferences and through formal modeling examines how these two phenomena

interact to affect the emergence of competition (Adner, 2002). *Preference overlap* refers to the degree to which members of two market segments share the same relative preferences for functional attributes. It measures the extent to which the level of satisfaction with a given product's performance experienced by one market segment is indicative of the level of satisfaction experienced by another market segment. For this reason it is an indicator of how easy it is for firms to invade other market segments (Adner, 2002).

Each market segment has its own value trajectory that indicates the shape of the segment's indifference curves when technologies progress toward higher utility levels. *Preference symmetry* refers to the relative value each segment places on performance improvements *along another segment's value trajectory* (Adner, 2002). When preference overlap is completely symmetrical, members of both market segments derive the same utility from any given level of performance. However, when preferences are not symmetrical, a product positioned at a given distance along one segment's value trajectory provides a different level of utility to members of the other segment than a product positioned at the same distance along the other segment's value trajectory provides to members of the first segment (Adner, 2002). Thus, whereas preference overlap refers to the extent to which development activity that is valued in one segment is also valued in another segment, preference symmetry refers to the symmetry of this overlap, the relative size of the functional 'shadows' that segments cast on each other (Adner, 2002).

Adner found that while low preference overlap resulted in partitioning of the market between the different technologies, higher levels of preference overlap resulted in two distinct classes of competition: when segment preferences were symmetrical Adner observed that competing technologies sought to expand their

appeal in both their home market and their rivals´ market (Adner, 2002). However, when segment preferences were asymmetrical, Adner observed that one firm maintained its dominance of its home market while displacing its rival from the rival's market (Adner, 2002).

Adner's interpretation of his findings is in line with Christensen's argument that disruptive innovation constitutes an attack from below. Adner argues that when consumers' performance requirements are met and then exceeded by their home technology, their willingness to pay for further improvements decreases. This then enables lower-priced, lower-performing (disruptive) technologies to capture these consumers. He makes the point that when the overlap between the market segments' preferences increases, firms have greater incentives to enter rivals' markets. Furthermore, when there is sufficient preference overlap, a technology's performance will not only surpass the requirements of consumers in its home market over time but also begin to satisfy and surpass the requirements of consumers in the foreign market. However, when preferences are asymmetrical, the firm whose home market casts the larger functional shadow faces greater marginal incentives to pursue consumers outside its home market because its offer appeals to a larger number of consumers. As the invading firm pursues consumers at the low end of its rival's segment with low-priced offerings, the invaded firm is confronted with a much smaller set of potential users because its products do not appeal to the same extent to the foreign market segment. From the invaded segment's perspective, the appeal of the invading technology, which offers neither higher performance nor higher price/performance value, is due to its lower unit price. The choices of the invaded firm are therefore to defend its position at the low end through price reductions or focus on its own high-end consumers with higher price and performance offers (Adner, 2002). This research

has explored Adner's claim that consumers whose performance requirements are met can only be conquered through offering products that cost less and not, as Christensen argues, through offering products that have other superior secondary performance characteristics, such as for example greater ease of access. Its findings are described in chapters 5 and 6.

Disruptive Innovation Theory – An Attack From Below?

Over time, Christensen came to realize that the process he had called "disruptive innovation" was actually comprised of two distinct phenomena: low-end and new-market disruptions (Christensen & Raynor, 2003). As discussed in Chapter 1, this distinction refers to the two different types of marginal market disruptors typically used as footholds. End-users in both categories differ in their perception of the relative value of a product or service's attributes. Low-end users prefer simpler or cheaper products and are over-served by the incumbents´ goods. They constitute the bottom segment of the mainstream market. By contrast, new market disruptive innovations are targeted at *non-consumers;* customers who do not use currently available products or services because they value a radically different bundle of non-price value from the one offered by incumbents (Raynor, 2011). In spite of these differences, in Christensen and Raynor's view, both types of disruptive innovation encroach on the mainstream market *from below*. This is immediately obvious in the case of low-end disruptive innovation. However, they also see new market disruptive innovation as a form of encroachment from below, arguing that such innovations "enable a larger population of people *who previously lacked the money or skill* to begin buying and using a product" (Christensen & Raynor, 2003, p. 102). Christensen argues that disruptors succeed *because of their low margin business models.* According to Christensen, the low margins of the disruptors´ foothold markets are

economically unattractive to incumbents because of their higher cost business models. As a consequence, incumbents are not inclined to defend these unattractive market segments. This gives disruptors the foothold markets they need to gain the experience and income necessary to further improve their products and eventually conquer the mainstream.

Utterback and Acee argue that by emphasizing only an "attack from below", Christensen ignores other discontinuous patterns of change that may be more important (Utterback & Acee, 2003, p. 2). They cite a number of innovations that completely replaced existing products that did not follow the process of disruption as described by Christensen. These innovations were not cheaper nor did they offer an inferior performance against the main market driver when they first came to market. Nevertheless, they completely replaced incumbent technologies. Their examples include the compact disk that virtually completely replaced the vinyl record, the electronic calculator that took the place of the slide ruler, and the fuel injector engine has largely replaced the carburetor (Utterback & Acee, 2003, p. 2). In spite of their disruptive effect, according to Christensen's terminology these are *sustaining innovations* because they offered a superior performance against the main market driver when first coming to market. Christensen discusses a number of anomalies of this type in his book *the Innovator's Solution* (Christensen & Raynor, 2003, p. 69). Govindarajan and Kopalle (2006b) point out however that there are technologically superior and higher priced innovations *that are initially unwanted by mainstream customers* because these customers do not value the cost-performance tradeoff these products offer when they first come to market. Most of the time, this will mean that the products are too expensive for all but customers in the highest segment of the market. Govindarajan and Kopalle argue that innovators of this nature use this highest

market segment as a foothold market. As a result of technological advances, over time they will be able to lower the cost of their products and eventually disrupt the market from above (p. 14). Govindarajan and Kopalle refer to this process as *high-end disruption*.

As discussed in Chapter 1, Christensen rejects this label. He holds that the process of *attacking from below* is key to his theory, arguing that disruptors succeed because their inventions initially do not appeal to mainstream customers and offer margins that are not interesting to incumbents. He points out that innovations that are first rolled out in the highest segment of the mainstream market immediately target customers that incumbents are both very motivated and able to defend (Christensen, 2006, p. 50). While he acknowledges that a significant number of "high-end anomalies" exist, he holds that these innovations should not be classified as *disruptive innovations* but should be given a different label.

This research has sought to establish the detail of disruptive innovation theory and test whether the construct *disruptive innovation* necessarily entails an inferior performance against the dominant market driver or whether it is sufficient for an innovation to simply not appeal to mainstream customers when first coming to market. Sood and Tellis (2010) have shown that the key components of what Christensen considers an *attack from below*, (inferior technological performance, ease of use and low cost), are not correlated. They consequently settled on defining an *attack from below* as an attack with an inferior technology (Sood and Tellis, 2010). Others have interpreted it differently. For example, Raynor (2011) approaches it as an attack with a lower-cost business model. Smith and Druehl (2008) have approached this phenomenon in yet another way. They interpret the scale from "below" to "above" purely in terms of customer product evaluations. On the basis of this

framework, they show that innovations that are technologically more complex overall and higher priced when they first come to market can encroach on the mainstream market from below. A key condition however is that these technologically superior products still offer an inferior performance against the key market driver. On this basis they explain the phenomenon of the cell phone displacing the landline as a type of new market disruption encroaching on the mainstream from below. The first customers to adopt the cell phone – mobile wealthy business people -- had a fundamentally different set of performance preferences compared to mainstream customers; they constituted what Schmidt and Druehl term a detached market. However, the first major segment of mainstream customers to adopt the cell phone were teenagers, students and apartment dwellers, the low-end of the mainstream, whereas many customers at the top-end of the mainstream market, business offices, still have not abandoned the landline (Schmidt & Druehl, 2008, p. 351). In the context of Smith and Druehl´s framework, a number of similar cases, which Christensen refers to as "high-end anomalies", are shown to attack from below and thus fit the theory of disruptive innovation. The explanation for these disruptors´ successes is also in line with the one Christensen provides. Schmidt and Druehl analyzed the diffusion patterns of new products in the context of Christensen's classical analytical framework, showing that the impact of high-end encroachment on the market is always immediate and striking whereas low-end encroachment initially has very little impact on the mainstream market, causing incumbents to ignore this threat until it is too late (Schmidt & Druehl, 2008, p. 347).

Chapter 3: Methodology, A Comparative Review

The purpose of this study has been to identify the essential attributes of disruptive innovation in order to clarify this construct. Its aim is to lay the groundwork for future quantitative tests and predictive modeling. This study has been based entirely on qualitative methods. The rationale for the chosen methodology will be provided in this chapter. The next chapter will provide detail on the actual steps this research project has taken. Chapter 6 will suggest methods which future quantitative analysts might wish to consider when modeling disruptive innovation theory. Toward the end of this dissertation, Chapter 6 shows how the research carried out in this study could form the basis for future quantitative analyses.

In spite, or because, of the numerous professional and academic papers on the topic, disruptive innovation theory remains underspecified and ambiguous. The aim of this project has therefore been to fill in the detail and eliminate ambiguities so that key constructs can be operationalized, measured and tested. This project's goal was to clarify the causal mechanisms that underpin the phenomenon and deliver a comprehensive set of predictor variables that can be measured before disruption takes place, if indeed it does. In other words, the aim of this project has been to further develop disruptive innovation theory. Following the advice of Clayton Christensen (2006), this study has gone about further building disruptive innovation theory by focusing on anomalies. Specifically, this study aims to build theory by focusing on one key category of anomalies established disruptive innovation theory cannot explain: innovations that conquer the mainstream from above and leave incumbents

flat-footed and unable to respond before it is too late; what Christensen calls "high-end anomalies".

In his article *The Ongoing Process of Building a Theory of Disruption,* Christensen (2006) highlights the important role anomalies play in improving theory. He writes, "[a]nomalies are valuable in theory building because the discovery of an anomaly is the enabling step to less ambiguous description and measurement and to identifying and improving the categorization scheme in a body of theory. These are the keys to being able to apply the theory with predictable results" (p.47). When trying to account for phenomena a theory cannot currently explain, researchers revisit and review the foundational layers of that theory. This project has consequently focused on exploring both confirmed cases of disruptive innovation and high-end anomalies. As Christensen suggested, by focusing on the latter this project has been able to go beyond describing surface detail and make some important basic structural improvements to disruptive innovation theory.

Collecting Data on Disruptive Innovations – The Historical Method

Abbott (2004) classifies the research methods used in social science projects firstly by their type of data gathering, secondly by their type of data analysis and lastly by the way in which they phrase their research question(s). As this will be a qualitative research project, no quantitative analysis or formal modeling will be used in data analysis. Instead, the data will be interpreted directly, as is customary in qualitative research. Furthermore, the research questions have not been phrased in the context of formalization or large-N sampling as this would, again, be more appropriate to quantitative analysis. This project has explored how best to break up a complex phenomenon into its constitutive parts. Studies based on a large sample and

multiple independent variables assume that this has already been established (Abbott, 2004, p.22).

Given that, the analysis of a single case study may not be representative and therefore not generalizable, this study has focused on a small sample of carefully selected cases that represent both confirmed historic instances of disruptive innovation and cases of "high-end anomalies". Speaking specifically about research within the field of business studies, Abbott (2004) proposes four types of data gathering by which research methods can further be categorized: ethnography, surveys, record-based analysis and history (by which he means the analysis of old records and documents).

Innovation researchers have used all of these data collection methods. For example, Henderson & Clark (1990) used interviews (one of the ethnographic methods), Stuart and Poldolny (1996) used record based analysis and Govindarajan and Kopalle (2006a) used survey research. Gatignon et al. (2002) strongly argue for the use of interviews and survey research in innovation studies pointing out that researchers are typically very distant from real world innovation and that this hinders their ability to properly assess the phenomenon (p. 3). Gatignon et al. (2002) argue that the views and insights of innovation decision makers and engineers are vital. The current study acknowledges that the views of industry insiders and innovation experts are central. However, this project has collected this data in a different way. Data exists only about the past, and interviews and surveys suffer from the shortcoming that they can only provide a *retrospective* view on events (Golder and Tellis, 1993, p. 162).

Retrospective data should be treated with caution. Interviewing and survey research rely on *recall* and it is a well-known fact that people often interpret what

happened in the past in the context of what they know in the present, rendering their recollections somewhat colored by current events. Significance might be given to historical facts to which little importance was given at the time and issues that once seemed very important but are no longer seen as relevant today might be omitted from interview and survey responses. Furthermore, when discussing decisions, actions and events that happened more than a few years ago, respondents are likely to draw heavily on their firm's "oral traditions" (Golder and Tellis, 1993, p.162). However, the stories that result from this collective telling and re-telling of events are not free from the cumulative influence of latter day concerns, interpretations and misunderstandings.

An analysis of primary and secondary sources that was created when an innovation was first commercialized, by contrast, offers a *prospective* look at the relevant data. It provides access to the views and opinions of industry insiders and external experts at the time events were unfolding and is therefore free from retrospective bias.

The Case for the Historical Method

The method discussed above is known as the *historical method*. It is based on two of Abbott's (2004) categories of data gathering: record analysis and history and has been used by a range of innovation experts (e.g. Chandler, 1977, 1990; Christensen, 1992c, 1997, 2003; Sood & Tellis, 2010; Anderson & Tushman, 1990; Tripsas, 1997; Van de Ven & Garud, 1994). In addition to providing researchers with a prospective view on innovation-related data, the historical method has the added advantage that "it can use multiple narratives of neutral observers such as reporters, experts, and students of the market" (Golder and Tellis, 1993, p. 162). Survey and interview data, by contrast, rely on self-report by (normally) one of two informants

per firm, who are (generally) neither neutral nor disinterested. Golder and Tellis argue that for this reason "the historical approach is more likely to collect data that are factual rather than interpretive" (Golder and Tellis, 1993, p.162).

The historical method involves the study of events that took place within living memory and not the documentation of ancient facts about industries that have little more than curiosity value for today's business strategists. It calls for the analysis and interpretation of data *in context* (Elton 1967). The current study has therefore carefully selected case studies for which an abundance of sources was available so that sources could be analyzed in the context of numerous other sources. This study has examined both innovation projects that were successful as well as projects that failed. Failed initiatives tend to be under-documented. The historical method was however was perfectly suited to this challenge as Murmann (2012) points out in his recent work *Marrying History and Social Science in Strategy Research*: "The strength of the historical method is precisely that it looks for evidence in all sizes and shapes to put together the most accurate account of what happened and why" (p. 102). Using the historical method, the currentproject has focused exclusively on documents and records that were available in the public domain.

As discussed, the current research has explored the fundamental constructs and categories of disruptive innovation theory in order to remove its ambiguities and to ensure that the theory could also account for "high-end anomalies". The historical method is well suited to rebuilding the fundamentals of a theory in a data driven manner as its primary objective is "to get the empirical facts right" (Murmann, 2012, p. 93). Its aim is to develop a picture of the key mechanisms and causal relations that define a phenomenon that corresponds accurately with actual historical data.

Sampling Disruptive Innovations

Christensen's sampling approach has been criticized. As mentioned previously, he has been accused of ''sampling on the dependent variable" and of "highlighting only technologies that eventually turned out to be disruptive" (Danneels, 2004, p. 251). Barney has argued that the findings of Christensen's (1992c) seminal study into the hard disk drive industry lend themselves to an alternative explanation: *luck*. He writes, ''it may simply be the case that some firms are lucky in their technology choices and others are unlucky'' (Barney, 1997, p. 15). He argues that Christensen analyzed only those firms that made lucky choices and based his retrospective rationale for their success on this post hoc analysis. Christensen (2006) denies the charge that he omits anomalies from his analyses that disruptive innovation theory cannot explain. In fact, as we have seen, he considers the process of identifying and trying to account for anomalies to be central to the process of theory building. He gives the example of the Digital Equipment Corporation (DEC) that became disrupted by the makers of microprocessor-based computers in spite of the fact that its engineers "could design a PC with their eyes shut" (p.49). This anomaly let him to the realization that disruption was not a technology problem for incumbents but rather a business model problem and he consequently revised his original construct of "disruptive technology" to "disruptive innovation". Christensen (2006) writes, "[b]ecause the discovery of an anomaly is what triggers a cycle of improvement, it is important to design anomaly-seeking research rather than research that avoids anomalies" (p.47).

This is exactly the approach the current study has taken. Furthermore, by purposively including anomalies in its sample, this dissertation research has sought to avoid criticisms such as those made by Danneels (2004) and Barney (1997) discussed

above. As this is not a quantitative study, random sampling methods have not been used. Instead, a selection of confirmed historic disruptive innovations and high-end anomalies were included in the sample. Efforts were made to ensure overlap with cases studied by Christensen and to include innovations from a range of different industries. Future studies will be able to test, validate or revise this study's findings using quantitative analyses incorporating random samples. Suggestions for future quantitative modeling are given below in Chapter 6.

Chapter 4: Methods

Having provided the rationale for the chosen methodology in Chapter 3, this chapter will discuss the "how and why" of methods that were used in this research.

Data Collection and Analysis

This section describes the methods used to clarify disruptive innovation theory and resolve its ambiguities. This process, also known as *theory building*, is described by Clayton Christensen (2006, p.39) as a continuous moving back and forth between three steps: empirical observation, defining constructs (that is, establishing their key attributes) and exploring the causal relationships between the attributes of these constructs and the observed outcomes. In this study, the empirical data consisted of historic and current records and documents that describe actual innovation projects.

Literature Review: Clarifying Current Theory and Identifying Provisional Predictor Variables

This project started with a thorough review of the academic literature on business innovation in general and disruptive innovation in particular. The purpose of this review was to identify and list all business areas that affect and are affected by disruptive innovation, e.g. technological trajectories, business models, value networks, the regulatory framework, etc., as well as the variables and causal relationships that determine the disruptive process in each area, according to experts. The aim was to be comprehensive and to develop a clear picture of the boundaries and content of the current theory's constructs and categories. This process highlighted some of the current theory's gaps and ambiguities. Variables from the wider

innovation and business literature that are widely held to determine the commercial success of innovation projects were also noted down. This literature review can be found in chapter 2. The main causal connections identified during this review are shown in Chapter 6. The aim was to analyze the phenomenon of disruptive innovation in the context of the broader literature on business innovation in order to developed a detailed picture of disruptive innovation theory in its current form and identify a set of provisional variables and causal links that could potentially be used for ex-ante prediction of the phenomenon.

Selecting Cases and Data

Once the literature review had been completed, the next step in this project was to test whether the provisional variables and causal relationships described in the academic literature were actually present in historic real world innovation projects, and if so, to evaluate their usefulness as ex-ante predictors of disruptive innovation. Regarding the latter, this meant exploring whether data could have been collected against these potential indicators at a time before disruption actually happened. This second step was crucial in establishing which focus areas and attributes listed in the academic literature are essential to forecasting disruptive innovation and which ones are merely ancillary. The method that was used to collect and analyze data in order to fine-tune and clarify disruptive innovation theory is known as *the historical method*, which will be described in more detail below.

As discussed in chapter 3, this study used an anomaly driven approach to sampling. It sought to test and evaluate established theory by analyzing "high-end anomalies" and technologies labeled as "disruptive" by experts that have (so far) failed to disrupt the market. It has also looked at confirmed cases of disruption "from below" to ensure theoretical overlap with the work of confirmed experts on disruptive

innovation. The aim was to analyze a small sample of well-documented innovation projects from a range of different industries. On the basis of these criteria, 5 cases were selected. The first historic instance of disruption this study looked at was the US disk drive industry from its emergence up to the 1990s: the same case Clayton Christensen studied as part of his doctoral project and on the basis of which he developed the theory of disruptive innovation. This case was selected to ensure significant overlap with Christensen's work. Next, the market in electric vehicles was analyzed from its emergence up to the present day. This case was selected for analysis because Christensen dedicates a whole chapter to it in his seminal work *The Innovator's Dilemma (1997)*, calling it a "disruptive technology". However in spite of this potential, to date, the automobile industry has not been disrupted by electric vehicles. As a consequence, this case offered great scope for exploring which variables enable or block disruption from occurring. Next, this project analyzed the impact of digital photography on Eastman Kodak. This case was chosen because, even though it is often referred to as "a classical case of disruptive innovation", the first adopters of this new technology were in fact high-end customers, mainly professional photo-journalists. Furthermore, digital cameras replaced analog products in the mainstream market at a time when analog products were starting to become commodities, that is, when consumers were beginning to base their purchasing decisions primarily on price. As such, what happened in the amateur photography market can be considered a "high-end anomaly".

Next, this project looked at Apple Inc. because this highly successful firm defies one of disruptive innovation theory's key premises, namely that incumbent firms can only succeed at disruption if they entrust the management of such projects to highly autonomous business units. Furthermore, the iPod, iPhone and iPad can also

be regarded as “high-end anomalies” because they were first adopted by higher tier customers. After reviewing Apple, this project explored the Minute Clinic, an instance of disruptive innovation in the US Health Care sector. This case was selected for analysis to ensure further overlap with Clayton Christensen’s work; Harvard professor Christensen has undertaken significant research into the potential for disruption in this industry (see his important work *the Innovator’s Prescription*, 2009). This case has also been selected because, being set in such a heavily regulated sector, it offered great scope for exploring the enabling or limiting effect on disruptive innovation of variables related to government policies and regulations.

Once the five case studies listed above had been selected, two types of records were collected for each case. The first type were records that were created at the time the innovation was first commercialized and the second type were those that were created after the fact. This made it possible to gain both a prospective as well as a retrospective view on the relevant events and evaluate the usefulness of indicators for ex-ante prediction. In this study only indicators for which data could have been collected before disruption took place have been retained.

This research analyzed business journals, periodicals and industry-specific literature to gain access to the views of industry insiders such as innovation managers and business strategists as well as those of informed outsiders. The views and findings derived from these documents were compared to those found in academic texts. Thus, this phase was marked by a constant iteration between the professional and academic literature. Following Golder and Tellis (1993) who used the historical method in their study of business pioneers, this research used the following four well-established criteria for evaluating and accepting sources. Firstly the *competence* of the source was assessed; does the informant have the required expertise and access to the

necessary data? Secondly the *objectivity* of the source was evaluated; does the informant have any vested interests that might make him or her unwilling to report information correctly? Thirdly the *reliability* of the source was checked; is this informant a trusted source of information? Finally the project involved checking whether the facts reported by one source were *corroborated* by other sources. At the end of this second step, this project had included obtaining a small sample of well-documented historic innovation cases from a range of industries as well as a number of corresponding primary and secondary sources, both contemporary and posterior to the launch of the product that had been checked for validity and reliability.

Analyzing Cases and Fine-Tuning Theory

At this stage of the project, a detailed review of the academic literature had provided a clear picture of current theory's key constructs, categories and causal links as well as its gaps and ambiguities. Furthermore, five historic case studies had been selected and a set of valid and reliable sources had been identified for each. In this phase of the project, it was attempted to "fit" the events and attributes that mark these case studies to the constructs, categories and causal factors identified during the literature review. This step was theory building at its core and entailed a continuous iteration between the observation and interpretation of empirical data on the one hand and the revision of theoretical constructs and theorized causal relations on the other. This process is shown in Figure 2, below.

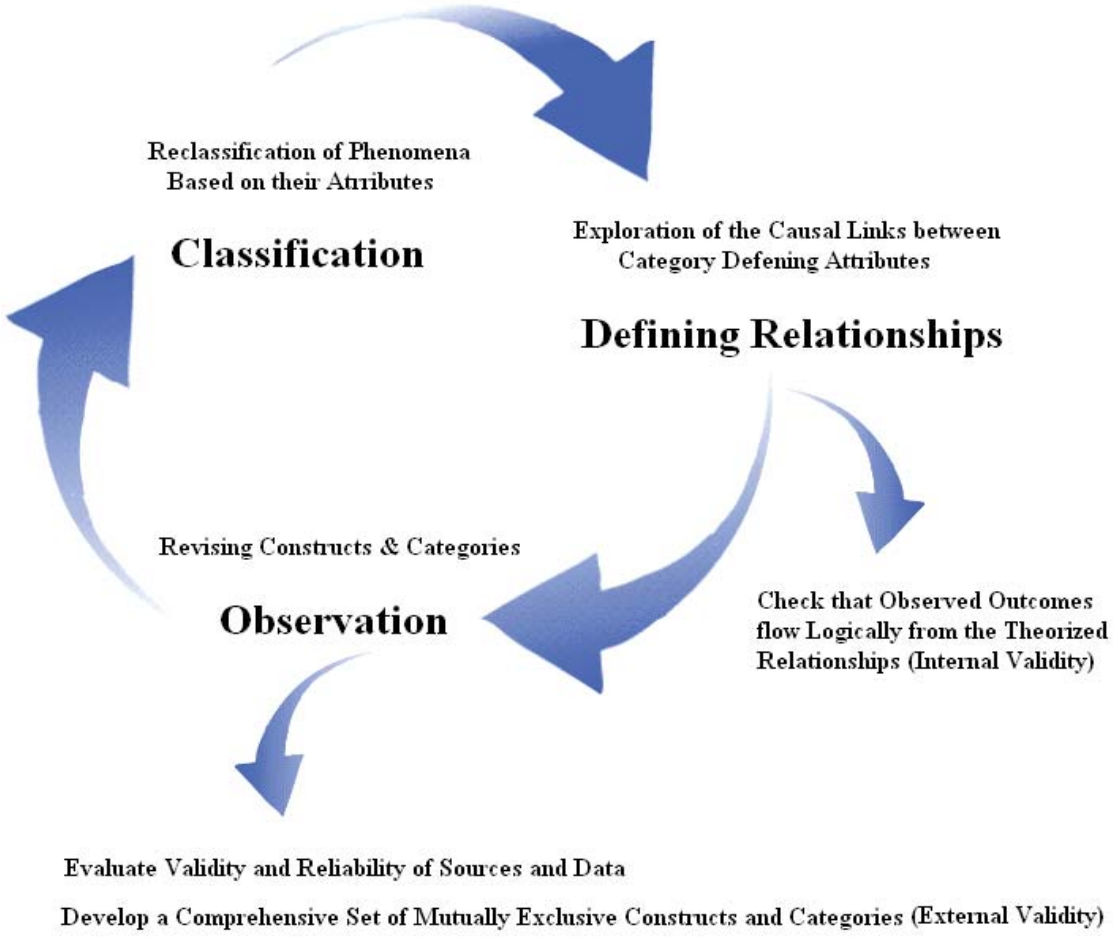


Figure 2 - Theory Building as Applied in This Study

Being a qualitative study, in this project the historical method was used to build theory: by attempting to fit established theory to actual historical cases, the boundaries and content of key theoretical constructs had to be examined and in some instances redrawn. Exploring the established boundaries of key constructs through the analytical lens of "high-end anomalies" by stretching existing theory to make these anomalies 'fit' helped clarify original theory and removed some of its ambiguities. As will be discussed in detail in chapter 6, it was found that disruptive innovation theory can be used to forecast both regular and "high-end" disruptive innovations if key concepts from established seminal studies outside the original realm of disruptive innovation theory are incorporated, e.g. the idea of the product life cycle and the staged adoption of innovations over time by social segment. Using these established

concepts from business and innovation studies, a revision was made of the two main strategies aspiring disruptors use to create initial foothold markets according to original theory. Christensen's original distinction between a "low-end" and "new-market" approach was reformulated to a distinction between a "secondary market driver" and a "new market driver" strategy. The content of these revised constructs is described in detail in chapter 6.

Using the methodology described above, the boundaries and content of the original constructs were redrawn on the basis of the real world evidence found in the case studies analyzed. Once the categories and constructs had been revised in this manner and the causal relationships between variables and outcomes had been explored, deductive reasoning was used to check the internal validity of the revised theory. That is to say that whether the outcomes observed in the historical case studies flowed logically from the revised constructs and causal links was checked. Furthermore, the innovation literature was reviewed again to ensure that no better alternative explanations could account for the observed outcomes given the contexts.

As stated, this research has been based on a small sample to permit an in-depth analysis of the items in the sample. To ensure the external validity of the research findings (i.e. to make sure that the findings can be generalized beyond the cases included in the sample), efforts were made to include cases from a range of different industries. External validity refers to the notion that the relationships observed between phenomena in one context also hold in another context. Clayton Christensen (2006) argues that developing a set of comprehensive and mutually exclusive constructs and categories is an important way of ensuring external validity. He writes, "[m]utually exclusive categorization allows managers to say, ''I am in this circumstance and not any of those others.'' And collectively exhaustive categorization

would assure us that all situations in which managers might find themselves with respect to the phenomena and outcomes of interest are accounted for in the theory" (p. 53). Following Christensen's advice, this project has made sure that the constructs and categories it developed were comprehensive and mutually exclusive; one of its main outputs is a tree diagram that presents all ex-ante predictor variables identified. The variables are presented as questions and are all linked, with each node having at most two exits. Managers can use this diagram to check the probability of disruptive success of a particular project. The questions are comprehensive and the options are mutually exclusive which means that the diagram will lead managers to one specific outcome.

Selecting Focus Areas that are Useful for Forecasting

The aim of this research has been to clarify and simplify disruptive innovation theory while staying as close as possible to the established academic views on this phenomenon, in particular Christensen's ideas. Areas and attributes that were identified during the literature review but were found to have no ex-ante predictive value were dropped, e.g. the focus area "market positions". Furthermore, areas that are closely interlinked were merged: the three separate foci "market strategy", "business models" and "organizational competencies" were merged into "business models and organizational capabilities" and the two separate areas "technological trajectories" and "demand and product design" have been merged into "technology, product design and demand". The focus area "environment" was re-named "regulations, market conditions and industry standards" for greater clarity. Furthermore, a new focus area was added that had not been included in the original list, namely "value networks" as this area was found to have great ex-ante predictive

value as the case studies on electric vehicles and the rise and fall of Eastman Kodak, below, show.

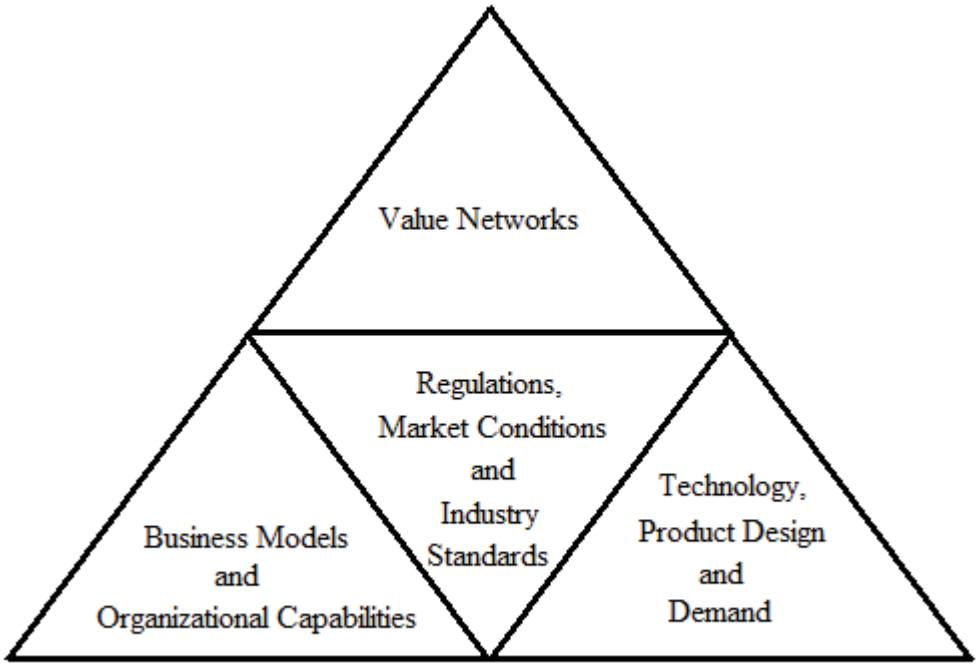


Figure 3 - The Key Foci of Disruption.

Adapted from Christensen, 2009

This revised set of foci also constitutes a better match with Clayton Christensen's approach to disruptive innovation (e.g. Christensen, 2009) than the set of areas identified during the literature review. The latter was based on the work of multiple experts whereas the sort list is more aligned with the vision of the theory's original creator.

Developing Measurable Indicators

At this this point in the study, a comprehensive and mutually exclusive set of constructs and categories had been developed and the theorized causal links between their key attributes and the outcomes observed in the historic case studies had been tested for internal validity. During the final stage of this research project the revised constructs were operationalized and the theorized causal relationships described with

clarity and detail. In other words, at this point all the groundwork had been completed for future quantitative analyses of the revised theory. In order to enable predictive modeling, this study has developed a comprehensive list of concrete predictor indicators against which data can be collected *before* disruption occurs and excluded variables that can only be used for post-hoc classification. The variables for each focus area have been amalgamated into a series of tree diagrams. These four tree diagrams have in turn been merged into one (very large) tree diagram which can be found in Appendix A. This figure takes the form of a decision tree with one or two exits for every node. It can be used as a decision making tool in and of itself or be used as the starting point for building a quantitative model for business forecasting. Future quantitative tests will be able to establish the predictive value of each suggested variable and eliminate those that contribute little to the predictive model. Suggestions for causal modeling are given in Chapter 6.

Ethical Considerations

This study analyzed and described actual historic innovation projects. It did not involve any research participants; only artifacts. No sensitive issues or affairs that might affect vulnerable individuals or groups were explored. Furthermore, this study only used data that was already available in the public domain. As such, this project did not carry any risk of affecting any individuals or groups in society in a negative manner. This project has respected the integrity and reputation of academia by contributing an original study based on transparent and verifiable methods for data collection and analysis.

Limitations and Solutions

This project's main limitation is inherent to all forms of qualitative research: qualitative studies do not use large-N samples or mechanical forms of randomization. Furthermore, qualitative data analysis involves direct interpretation of data rather than statistical analyses or formal modeling. As such, qualitative research findings are often regarded as subjective, non-generalizable and prone to bias. In addition, as Murmann (2012) points out, the historical method itself is regarded by many within the field of business strategy research as being "unsystematic and completely atheoretical" (p.91). However, most qualitative research projects are conducted in a systematic, theory-driven manner and produce findings that can be tested and verified. Furthermore, most qualitative projects that focus only on one single case study are exploratory in nature and make no claims to generalizability. As qualitative research results in theory-building which forms the basis for quantitative work, despite its inherent limitations, academia relies to some extent on qualitative work.

This project has followed a systematic approach to theory building consisting of the four concrete steps that have been described in this chapter. Furthermore, a clear set of criteria were used for evaluating the validity of empirical data. All findings are based on analyses of empirical data and logical deductions, both of which have been described in detail to facilitate evaluation by third parties. As stated, one of this project's main objectives has been to lay the groundwork for future quantitative studies. Its findings and outputs are intended to be tested through statistical and causal modeling. Furthermore, this project has endeavored to ensure the external validity of its findings. In order for its findings to be generalizable beyond the cases included in the sample, it has looked at innovation projects from a range of different industries. Furthermore, it has developed a set of constructs and categories that are both

comprehensive and mutually exclusive so cases can always be classified in a straightforward manner.

Chapter Five: The Key Ex-Ante Predictor Variables for Disruptive Innovation: Cases and Findings

This chapter will present the cases examined in this project and their findings. The relationship between these findings and this project's research questions will be discussed in detail in the next chapter, which also contemplates the relevance of this research to the business community and this paper's contribution to the wider academic literature.

This chapter will start with a brief recap of the research methods used, followed by an overview of the cases that have been selected and a rationale for their inclusion in this study. (The methods and methodology are described in detail in Chapters 3 and 4). This chapter will then present the selected case studies in the context of the four key domains of disruptive innovation: 1) business models and organizational capabilities; 2) value networks; 3) regulations, market conditions and industry standards; and 4) technology, product design and demand. Each section will start with a brief summary of the key points that are relevant to that domain. (The domains are described in detail in chapter 2).

The final section of this chapter lists, by domain, the ex-ante predictor variables for disruptive innovation identified in this study. These variables are presented in the format of tree diagrams. For the first three domains, this data is also presented in table format to enable the inclusion of more detail. The findings relating to the final domain, *technology, product design and demand*, were too complex to present in table format and are hence presented in a number of figures with

accompanying text. The validity, relevance and meaning of the findings presented in this chapter will be discussed in the next chapter.

The Case Studies

This section presents detail on the various trajectories of Christensen's theory necessary to evaluate the disruptive innovation capacity of a new product line. Full analyses of each case study, through the theoretical constructs provided at the beginning of this section, follow the theoretical presentation.

Business Models and Organizational Capabilities

Clayton Christensen considers the resources, processes, and values theory (RPV) one of the three core theories of innovation (Christensen, 2004). The other two are the value chain evolution theory (VCE), which will be discussed in the next section, and, obviously, disruptive innovation (DI) theory. Christensen has always treated RPV and VCE theory as integral to efforts to explain disruptive success and failure (e.g. 1997; 2003; 2004), and this research has taken the same approach. The reason for this approach is clear: although not strictly part of "core disruptive innovation theory", both VCE theory and RPV theory highlight important predictor variables for disruptive success. The case studies explored in this paper, in particular the case studies about electric vehicles and digital photography, confirm the ex-ante predictive value of value networks and business models, and organizational capabilities for forecasting disruption. This section will provide a brief overview of RPV theory.

Resources, Processes, and Values (RPV) Theory

A successful business model is based on a clear value proposition. This means that a good model has been designed to optimally perform a particular "job"

customers care about. The most powerful value-propositions are unique: they focus on different "jobs" than rival firms, or perform the same "jobs" in very different ways. Only a few firms can excel by aiming exclusively for operational effectiveness, that is, offering the maximum value possible at a given cost. There are firms that can effectively stop others from copying their products and practices, thus avoiding competitive convergence. An extensively integrated firm that completely dominates a highly interdependent system which has not been standardized will very likely be able to prevent copying. However, in order to be and remain successful, most firms will need to prioritize strategic positioning over achieving operational effectiveness.

A successful business model is marked by the perfect match between its value proposition, its cost structure and all its other activities. This means that a successful business makes trade-offs and that it does not pursue projects that undermine its value proposition (Porter, 1996). The firm's value proposition also needs to be perfectly aligned with its organizational capabilities, that is, its *resources, processes and values*. Resources are things or assets that are easily transferrable; processes are the established patterns through which an organization creates value; and values are the criteria by which an organization makes decisions about priorities. Organizational competencies shape and are shaped by the value network within which the firm operates, as will be discussed below (see also Chapter 2).

The founders of a new start-up play a central role in shaping the firm's processes and values. If the founders' methods are flawed the firm will likely fail. If the founders' actions and decisions are successful, they may come to mark the firm for a significant period of time: almost eight decades in the case of Eastman Kodak as will be shown below. Over time, as a firm grows and matures, the locus of its capabilities and disabilities shifts from its resources towards its processes and values

(that is, from visible and formal processes and values towards cultural processes and values) (Christensen, 1997). The case study about Apple Inc. below shows the impact of organizational culture on a firm's ability to successfully follow a disruptive strategy.

Case Study: Apple Inc.

Apple Inc. has successfully managed the commercialization of a number of disruptive innovation projects, i.e. the iPod, the iPhone and the iPad, from the very core of the established company. The firm is said to have "solved the innovator's dilemma" by prioritizing the development of well-designed products over financial performance in its business strategy. Steve Jobs has argued that Apple's problems during his absence from the firm stemmed from the fact that Sculley, the CEO at the time, followed the conventional approach of developing appealing products in order to maximize profit, whereas under Jobs these priorities were inverted: the firm managed it finances well in order to optimize product development. He said,

> My passion has been to build an enduring company where people were motivated to make great products. The products, not the profits, were the motivation. Sculley flipped these priorities to where the goal was to make money. It's a subtle difference, but it ends up meaning everything (Allworth, 2011).

This comment illustrates Jobs' priorities with his company.

During the past decade the firm's success has been based on the continuous development and carefully planned commercialization of a few, select, radically new products. Generally, firms are likely to reject new untested approaches in favor of historically successful strategies. This is known as *path dependency* and it constitutes one of the key factors that hold back incumbents from successfully developing and commercializing disruptive innovations. However, in the case of Apple Inc., the successful strategic decisions the firm had taken during its (recent) history have been

conducive to disruptive innovation. As such, the firm was not crippled by path dependency in the same way that another incumbent might be. Apple's "inverted" business strategy became an integral part of the firm's culture under the leadership of Steve Jobs, who always strongly emphasized the central importance of innovation and product design to the firm's business model. As a consequence, Apple has been less vulnerable to resource-dependency: its investors have so far been supportive of Apple's attempts at serial disruption, customers have come to expect it and employees were not rewarded, either directly or indirectly, for diverting funds away from disruptive initiatives to established successful projects.

Value Networks

Firms that seek to optimize performance and maximize value are faced with the strategic choice between integration and specialization. This is the focus of VCE theory. Integration refers to taking control of some or all stages of the value chain whereas specialization refers to the choice to focus on one specific component of the value chain. Specialization is only possible if an open market in component technologies has developed, which is by no means the case in all industries. An important precondition for specialization is the emergence of a dominant product design with a standard architecture. Furthermore, it must be possible to modularize the product – easier for some technologies than for others, as explained in the section on *technology and product design*. As a general rule, firms are advised to integrate those parts of the value chain that matter most to customers and outsource the rest to specialists (Christensen, 2004). Integration enables a firm to ensure that all relevant parts of the value chain support and strengthen the unique value proposition it offers to its customers. Integration further helps a firm ensure that all relevant parts of the value chain are compatible with an appropriate value network.

Value networks shape and are shaped by *demand patterns* within an industry. They reflect the order in which customers rank a product's performance attributes. This will vary according to the applications sought by different consumers. There can be distinct systems of use within one industry and hence distinct value networks. When products come to be used in new contexts, for example as a result of innovation or legislation, customers may change the order in which they rank their performance attributes, and new value networks may emerge. Value networks correspond with specific technological trajectories, that is, with specific patterns of solutions for problems and issues that are important to end-users (Christensen, 1995). Within a value network, the notion of "technological progress" is closely linked to end-users' unique rank ordering of the importance of various performance attributes. A value network encompasses one, several or all value chains within an industry and shapes the organizational capabilities of firms operating within it. That is to say that it determines these firms' priorities and shapes their processes of interaction, coordination, communication and decision-making (Christensen & Raynor, 2003). Successful firms ensure that they operate within a value network compatible with their unique customer value-proposition. They can do this by adapting themselves to an existing value network or by creating a new value network through extensive vertical and horizontal integration or through partnership and cooperation with other firms. This will be discussed in the case study on electric vehicles, below.

Case Study - Electric Vehicles

Christensen identified the electric vehicle (EV) as a potential disruptive technology in his seminal work the *Innovator's Dilemma* (1997). He contended that EVs underperformed in the areas that mainstream customers historically valued most (speed, acceleration time, driving range and a wide range of options and choices).

However, he also pointed out that the performance trajectory of the electric vehicle was steeper than the trajectory of performance demanded in the mainstream market, and that EVs would consequently eventually meet the minimum expectations of mainstream customers. This has indeed happened very recently: the two lines have crossed. We see, as a consequence, that in recent years the market share of plug-in electric passenger cars in the USA has begun to increase: from 0.14% in 2011, through 0.37% in 2012, to 0.53% of total new car sales during the first quarter of 2013 (Hybrid Cars, 2011, 2012, 2013). It is too early to say whether this trend will continue or whether growth rates will start to drop once the small niche market of technology enthusiasts and environmentalists has been fully catered to.

What is clear, however, is that to date, the EV has not yet disrupted the automobile market. This is in spite of the fact that Christensen already argued back in 1997 that incumbents were overshooting the mainstream market. He pointed out that there are practical (and legal) limits to the value of continued improvements in the areas of top speed and acceleration time. Furthermore, he held that consumers' ability to cope with ever-increasing numbers of choices and options is also finite (Christensen, 2007, p. 213).

Christensen argued at the time that EVs had the potential to disrupt the mainstream market from below because "they offer a set of attributes that is orthogonal to those that command attention in the gasoline-powered value network" (Christensen, 1997, p. 208): they were marked by simplicity, slow acceleration, and limited driving range (Christensen, 2007, p. 211). He held that firms producing EVs could gain a valuable foothold market from which to disrupt the mainstream *if they initially targeted EVs at customers who actually valued simple vehicles with a lower top speed and a lower driving range*. From this position EVs would then be able to

conquer the over-served mainstream market from below as cheap, basic, simple, convenient, no-frills vehicles.

Christensen stressed that it would be vital that the disruptive strategy be managed by an autonomous entity *whose business model, business partners and networks* (procurement, sales, distribution, supply, etc.) *matched the value package offered by the product.* That is, that car companies fail to bring EVs to market using the same internal teams and external partners and networks that also work on their established product lines (i.e. internal combustion engine powered cars), as these teams and networks have been optimized to bring products to market with a completely different performance package.

Christensen holds that modern mature industries tend to be modular in nature (1993, 2009) with heavily interdependent components slotting into a relatively fixed architecture. These architectures reflect the closely aligned business models of different firms within a value chain that have been fine-tuned to bring to market products offering a given performance package at a given profit margin. Mature and established value networks tend to be relatively rigid in nature because the product's components and architecture have evolved together towards an optimal fit in tandem with the system's routines and practices. This lack of flexibility is often made worse by path dependency (when historically successful decisions and strategies have become deeply ingrained unquestioned routines) and resource dependency (when the demands of current customers and investors are consistently prioritized over exploring and developing radically different products and new markets). *Given the relatively fixed nature of value networks, innovations can only become part of these systems if they adapt themselves to them*: the product's architecture with its closely interwoven components will not adapt to the potentially disruptive innovations, nor

will the system's interdependent routines and processes. If potentially disruptive innovations are "plugged into" established value networks, they will either be rejected or become co-opted; that is, they will be transformed into products that *sustain* the system and the product architecture. As a consequence, products that offered radically different performance package compared to the market standard are – if they are not rejected outright – amended so that they perform well against the dominant market drivers, *often at the expense of the product's original "disruptive" performance attributes*.

Since Christensen wrote about EVs in 1997, automobile incumbents have consistently sacrificed the attributes "simplicity" and "low-cost" in order to produce vehicles that met mainstream customers' expectations regarding top speed, acceleration, driving range and number of options and choices. As Christensen correctly predicted, they did not attempt to disrupt the mainstream market "from below" with cheap, simple and no-frills EVs. When encouraged (or forced) by government to develop and commercialize low and zero emission vehicles, they did so on the basis of their existing business models and value networks. As a consequence, the electric and hybrid vehicles they commercialized were designed in order to satisfy the dominant drivers in the mainstream market as much as possible given the constraints posed by electric propulsion. These vehicles offer (at best) an adequate performance against the performance dimensions mainstream customers have historically cared most about, but at a much higher price than comparable internal combustion engine-powered vehicles (due to the high cost of the car battery). This high purchase price renders the low fuel consumption of electric vehicles irrelevant as a cost saving method for individual consumers, even in the long run. At best, combined with generous government grants and subsidies, it means that electric

vehicles currently cost consumers about the same as their standard petrol or diesel powered equivalents. In spite of the high purchase price and government subsidies, incumbents GM Motors and Fiat/Chrysler sell their respective EVs (the Chevy Volt and the Fiat500e) at a significant loss (Eisenstein, 2013).

Christensen has called the most successful hybrid car to date, the Toyota Prius, *a sustaining innovation* (Christensen, 2012). The car does not offer a radically different performance package compared to mainstream cars and performs reasonably well against the mainstream market's dominant drivers. Models in the Prius family are characterized by low fuel consumption (similar to energy efficient diesel-powered vehicles) and are relatively affordable compared to other hybrids and EVs. The latter is due to the fact that models in the Prius family rely significantly less on their batteries for propulsion and more on their internal combustion engines compared to more expensive hybrids, such as the Chevrolet Volt, and pure EVs. The greater the car's dependency on its battery the higher its price, resulting in incumbents struggling to meet the sales targets of their plug-in hybrids and pure electric vehicles. *Toyota has succeeded at turning electric propulsion into a successful component technology that fits with the dominant product architecture and their existing value network.* Encouraged / forced by government legislation to produce low or zero emission vehicles - and failing to recognize the viability of a disruptive strategy - other incumbents are also attempting to turn electric propulsion into a sustaining innovation. However, perhaps because government pressure is distorting decision making, they are producing vehicles that perform adequately against the dominant market drivers but rely more heavily on electric propulsion than is economically viable (for a sustaining strategy), pricing their products out of the market.

The current designs of mass-produced hybrids and EVs do outperform standard internal combustion engine powered cars in a number of areas discussed below. However, Christensen's work suggests that none of these areas turn the current hybrids and EV models into potentially disruptive products. As discussed, he holds that incumbent car manufacturers are overshooting the market. He writes that once customers no longer value further improvements against the dominant market drivers, they start to prioritize convenience, speed and cost (Christensen, 2009) *in the context of jobs they need to get done*. That is to say that once mainstream consumers are no longer willing to pay extra for cars with a higher top speed, faster acceleration and a wider range of choices and options, they will switch to vehicles that make it easier, faster and cheaper to get the jobs done for which they have bought or hired a car. In Christensen's view, these product attributes are key to successful disruption.

Current mass-produced electric and hybrid vehicles outperform established cars in terms of noise and pollution levels and can help governments achieve national energy independence. As discussed, the high purchasing price of EVs renders their low fuel consumption irrelevant as a cost saving method for individual consumers. Speaking in Christensen's terms, from the perspective of the individual consumer this means therefore that electric vehicles can be bought or hired to fulfill the jobs "*(showing that I am) looking after the environment and/or the national interest"*. Enough drivers care about these jobs to have bought hybrid and electric vehicles and there is clearly a lucrative niche market for expensive hybrid and electrical cars. As discussed, especially the Toyota Prius has been a commercial success. However, most mainstream consumers buy or hire cars to fulfill different jobs. Owning a car that produces relatively low levels of noise and pollution, helps foreign policy, and consumes little fuel (but at a very high overall cost) is unlikely to make it easier,

faster and cheaper for mainstream customers to get their "jobs" done. It appears improbable therefore that mainstream customers will switch to the *current* value package offered by incumbent hybrid and electric vehicles, even if and when the cost of such EVs becomes comparable to that of combustion engine-powered cars.

So far this case study has shown that if potential disruptive innovations are plugged into existing dominant value networks, they will inevitably adapt to these systems and as a result lose their disruptive potential and become sustaining innovations. This case study also explores another key point, namely that disruption is greatly facilitated if key industry players take a leading role in creating a new value network that is appropriate for the value proposition offered by the disruptive product.

The influence and financial means required to create a new value network from scratch are significant. Shai Agassi, the former head of product development at the software giant SAP, founded an organization called A Better Place (2008). Agassi sought to overcome one of the main obstacles electric vehicles face in the market: their high purchase price. He aimed to do so by selling the cars and renting the batteries, as the latter account almost exclusively for the high cost of EVs. This business model is standard in the mobile phone industry but revolutionary in the automobile industry. At the heart of the model was a for-profit Electric Recharge Grid Operator (ERGO), which owned the batteries and managed the contracts with consumers, offering unlimited miles, a maximum of miles per month limit, and a pay-as-you-go option. The model was to be underpinned by a series of recharging stations as well as a network of automated battery swapping points (to enable longer journeys without lengthy recharging breaks in the middle). A Better Place worked in partnership with Renault, which provided a compatible EV car: the Renault Fluence

ZE. In 2011, prior to selling any cars, A Better Place had obtained $786M (CrunchBase, 2013) in funding, thanks to its impressive fundraising efforts. Some believed that A Better Place had the potential to disrupt the automobile market (e.g. Deutsche Bank, 2008; Barkenbus, 2009; Dijk et al., 2013)

A Better Place chose to roll out its project first in Denmark and Israel. These countries were selected because they are small and highly urbanized, making them especially suitable for electric mobility. Furthermore, the governments and populations of these nations are highly supportive of reducing oil consumption for environmental and national security reasons, respectively. A Better Place started selling its first vehicles and contracts in 2012. However less than 12 months later the company was forced to file bankruptcy. In July 2013 the company was sold for only $12M.

A Better Place's disruptive business models required the building of a network of battery swapping stations and recharging points. This network needed to be comprehensive to enable customers to drive around the country quickly and conveniently. A Better Place was faced with the chicken-and-egg situation faced by all aspiring disruptors who do not have the good fortune to find a suitable value network ready to go: so long as the infrastructure required to enable customers to use the product effectively was not in place, very few customers were willing to buy the product, thus depriving the aspiring disruptor of the funds needed to develop the required infrastructure. The construction of each automatic swapping station cost A Better Place $500,000 and in order for the system to work, dozens of such stations were needed, even in a small country like Israel (Woody, 2013). Using its substantial funding, A Better Place had started to build battery swapping stations and recharging points in both Denmark and Israel. However, so long as this network did not

adequately cover the country, customers still needed to make significant detours when driving around the country in order to swap their batteries, or take lengthy mid-journey breaks in order to recharge their cars. As a consequence, very few customers signed up. By the time A Better Place filed for bankruptcy only about 750 drivers had signed up in Israel (Woody, 2013).

The commercial failure of A Better Place can further be explained by the fact that the aspiring disruptor went to market targeting mainstream customers in Denmark and Israel rather than small niche markets. If A Better Place had initially targeted only, say, taxi fleets in Tel Aviv, public transport companies in Copenhagen or car rental firms in Jerusalem, it might have been able to build all the infrastructure required for these niche customers and then, having secured a reliable income stream, scaled-up from its foothold position. Starting small appears to be essential to aspiring disruptors who are not blessed by chance with a ready-to-go value network (as Sony was) and who cannot piggyback on the coordinating efforts of industry giants who can create extensive new value networks from scratch.

A potential alternative to leadership by an industry giant might be a consortium of aspiring disruptor firms with aligned business models who work together to coordinate the (rapid) development of the value network required to bring a disruptive product to market successfully. Furthermore, rolling out a product in a high-end foothold market may make it easier for aspiring disruptors to obtain the financial resources needed to build the infrastructure required to launch their product in the mainstream market because of this segment's higher profit margins. Examples of this type of "high-end disruption" are the mobile phone, which was initially only targeted at mobile business people, and the digital camera which was at first only used by professional journalists, as will be discussed below. It may be the case that

the expensive luxury electric cars produced by industry entrant Tesla Motors will help create the EV infrastructure needed to make the pure EV a viable mainstream car.

As discussed, incumbent car makers struggle to sell their electric vehicles because they target mainstream customers with products that offer an equivalent (or worse) performance against the dominant market drivers compared to their internal combustion engine-powered counterparts, are significantly more expensive to purchase and do not outperform standard cars in any secondary performance area that these customers are willing to pay for. Tesla motors, by contrast, does not target the mainstream. Instead, it focuses exclusively (for the moment) on electric vehicle enthusiasts within the luxury car sector. Unlike its incumbent competitors, Tesla is not struggling to make its sales targets because its niche customers actually value the performance package offered by the EV (for example because they are environmentalists or technology enthusiasts). Furthermore, the high price of Tesla's products is justified by their numerous luxury features: consumers are not buying an overpriced product. In areas where many customers are located, Tesla has started to build a network of recharging points and will complement this system with rapid battery swapping stations (Bullis, 2013). Unlike A Better Place, which needed to create a nation-wide network before its products became a viable option for its intended customers (mainstream drivers), Tesla is able to start with building just one swapping station in an area where its cars are popular. If this swapping station turns out to be a success, it can further build up its network from there. Tesla Motors has been compared to Apple and been called a "disruptive innovator" (Mihalache, 2012). This accolade is somewhat premature. In spite of the fact that the number of plug in electric vehicles has increased significantly over the past two years, only 0.53% of total new car sales during the first quarter of 2013 (Hybrid Cars, 2013) consisted of

plug in electric vehicles. Tesla Motors may remain a strategic differentiator and continue to focus only on its lucrative niche market. Thanks to its income stream from its niche customers, the firm may however be in a position to slowly build up the infrastructure required to make EVs eventually attractive to mainstream customers. Once a comprehensive network of recharging points and battery swapping stations has been put in place, Tesla, or another firm, might attempt disruption of the mainstream market using, for example, the business model developed by A Better Place.

Regulations, Market Conditions and Industry Standards

To date, governments around the world have done little to actively promote disruptive innovation. As a consequence, policies and legislation tend to hinder aspiring disruptors more than they help them. Government intervention in the private sector ranges from helping establish new industries to stabilizing and strengthening existing markets to encouraging competition and efficiency in sectors dominated by a few firms. Public funding of key scientific research is often central to the emergence of new markets. Furthermore, the government generally introduces performance regulations (such as minimum quality standards, permits and licenses) in order to protect consumers or, as in the case of electric vehicles, to bring about a socially desirable goal. However, it is important to highlight that vested interests are generally able to ensure that performance regulations protect the status quo (Christensen, 2009). This means that the political incentives to push through legislation that significantly harms the interests of powerful incumbents needs to be enormous for the policies to be adopted without delay or amendment.

Furthermore, as we have seen in the case study on electric vehicles above, the introduction of performance legislation that appears to promote a disruptive

technology does not always have this effect. In the case of EVs, performance regulations and government subsidies resulted in incumbents "cramming" the disruptive technology into sustainable products and developing financially unsustainable business models. It did not result in the disruption of the automobile market by an EV that offered a radically different value proposition compared to the market standard. Not being able to see beyond sustaining applications of the EV technology, automobile incumbents lobbied government repeatedly in order to get performance legislation amended or delayed. They were mostly successful, no doubt because their underwhelming performance lent credence to their argument that zero emission vehicles were not yet commercially viable.

Government intervention can unintentionally hinder disruptive innovation in a number of ways. Performance regulations such as minimum quality standards can have the side effect of denying market access to firms that offer a radically different value proposition. Furthermore, aspiring disruptors may be disadvantaged if they find themselves competing against established firms that have unsustainable business models but survive thanks to subsidies. (Credits, grants and subsidies may also result in firms "gaming" the system.) Governments sometimes introduce price caps or return rate regulation in an industry to ensure that an important product or service remains or becomes accessible to most people. Fixed return rates may render products that offer a radically different value proposition non-viable. Price caps have the side-effect of preventing incumbents from moving up-market to meet their growth needs and forcing them to "stand-their-ground" when rivals attempt to encroach from below, rendering low-end disruption a non-viable strategy. Christensen's recommendation for aspiring disruptors who find themselves blocked by policies and

regulations is to identify a space in the market that is covered by this legislation (Christensen, 2007).

Case Study: Minute Clinic

Minute Clinic was able to identify such a space in the market that is covered by legislation in the highly regulated US health care sector. Its story is a classic example of disruptive innovation "from below". When they were first introduced in 2000, Minute Clinic's walk-in clinics radically changed the US health care market for common family illnesses, basic health education and routine medical services. Prior to the emergence of the Minute Clinic, people were forced to make an appointment with a licensed family doctor for minor illnesses such as strep throat, ear infections or the treatment of minor wounds. Given the fixed costs family doctors and hospitals face in terms of training, obtaining licenses and meeting other regulations, their business models are not well suited to managing such minor jobs in a cost efficient manner. Some illnesses are still poorly understood by medical science and require trial and error style management by highly trained experts. Other illnesses, however, have been completely "solved" by medical research. When this is the case, a set of standardized routines is normally developed for diagnosis and treatment based on best practice.

Minute Clinic takes advantage of the fact that such standardized procedures can be carried out by medical professionals who have had less training and require easier to obtain licenses. Family doctors and hospitals often use the peanut butter method of pricing their services: they spread the different true costs of the different services they provide evenly over the prices they charge their customers. This enables them to provide medical services that require a lot of training and skill at below their actual cost, thus benefitting people with poorly understood conditions. However, this

approach constituted a great inconvenience to people who only required basic medical services for which standard routines had been established: they had to make an appointment, take time off work and pay a service fee that was much higher than the true cost of the service they received.

The story of the Minute Clinic is a classical case of disruptive innovation. Speaking in Christensen's terms, established service providers offered more expertise than certain customers required in order to get their "jobs" done, e.g. to get a common vaccination, or to get their sore throat treated, or to get a routine lab test done, or to get advice on how to quit smoking. These consumers did not need to be treated by a family practitioner (or at a hospital) and did not value the excess in expertise that was offered standard. Furthermore, being forced to attend an appointment, often during the day, meant that people had to take time off work and/or keep their children out of school. Minute Clinic noticed these over-served low-end customers and developed a low-cost business model offering a value-proposition that was targeted to their needs: walk-in clinics were placed in several convenient places. They are open seven days a week, during the day and during the evening, and no appointment is required. The clinics are staffed by nurse practitioners and physician assistants who are adequately trained and licensed (but no more than needed). As a consequence, Minute Clinic is able to offer its services at a much lower cost than either a family practitioner or a hospital can. The clinics were very successful and created a new sector in the Health Care industry: the convenient care clinics (CCCs). Currently there are 1450 CCCs located throughout the US. Although other firms have entered the market, Minute Clinic remains the market leader: in July 2013 the firm had 665 clinics and it plans to have increased this number to 1,060 by 2015 (Alexander, 2011).

Case Study – IBM

Until 1962, IBM was the only disk drive manufacturer in the world. IBM was a fully integrated firm that controlled both component research and the creation and rolling out of new architectural designs in the industry. However, as a result of the growth of the minicomputer market in the 1970s, the number of less vertically integrated computer manufacturers increased, creating a major market for independent disk drive manufacturers, mainly designers and producers of new architectures. When this happened, IBM could no longer control when the next design would be brought to market or what that design would be. This decoupling of component and architectural innovation significantly increased the power of IBM's most important customers. Being subjected to free market forces, IBM now let its key customers determine which of its many component innovations should be included in its new product architectures. Hence, as a consequence of the vertical disintegration of the industry, IBM became vulnerable to resource-dependency: its key customers and investors came to determine its product innovation strategy causing it to abandon designs that did not meet these stakeholders' expectations. This meant that innovations that deviated radically from the established performance trajectory, for example by having a much lower starting point, were likely to be rejected. Other firms benefitted greatly from the component innovations IBM developed but never used (or only used years after all other major players had already included them in their designs). Component innovations make it possible to improve existing architectures. IBM's competitors were hence able to radically improve the performance of their simpler architectures using "off the shelf" component innovations developed by IBM. It is important to note that IBM's innovations were not adequately protected by patents and that venture capitalists helped managers and

engineers from IBM break away from the mother firm and set up independent companies that produced the technologies and products IBM had sought to shelve due to a lack of interest from its main customers and investors.

Christensen points out that the disruption of the mainframe computer by the minicomputer took 30 years to complete because it wasn't coordinated by a central player. Instead, the start-up companies that developed the minicomputer were significantly held back in their growth until other start-up companies started to develop software that could run on minicomputers. These software-developing companies were in turn held back until other start-up companies started to develop 8 inch drives. The disruption of the minicomputer by the PC by contrast only took 10 years to complete because IBM orchestrated the creation of the entire PC value network. IBM used to be the key player in the computer mainframe market. It survived the rise of the minicomputer by setting up an autonomous business unit in Minnesota that had a very different business model -- one that enabled IBM to make money of products with a much lower profit margin. When the PC emerged, IBM repeated this move by creating yet another autonomous business unit in Florida, one fine-tuned to making money of PCs. However, IBM did more than this. A PC uses very different components compared to a minicomputer. For example, the logic circuit in a minicomputer is a printed wiring board whereas in a PC it is a microprocessor. IBM ensured the presence of the required component suppliers by investing heavily in Intel and by helping Microsoft and Seagate (two fledging companies at the time) launch themselves with generous long-term supply contracts. Furthermore, because PCs could not be sold directly to customers by factory salespeople (as had been the case with the mainframe and the minicomputer) IBM set up its own retail stores to bring PCs onto the market (Christensen, 2009).

Technology and Product Design

Disruptive products tend to be architectural innovations made from "off the shelf" component technologies. As such, the emergence of an open market in relevant component technologies greatly facilitates disruptive innovation as the case study about the disruption of IBM, below, shows. A pre-condition for the development of an open market is the emergence of a market standard and dominant product architecture as Figure 4 below illustrates.

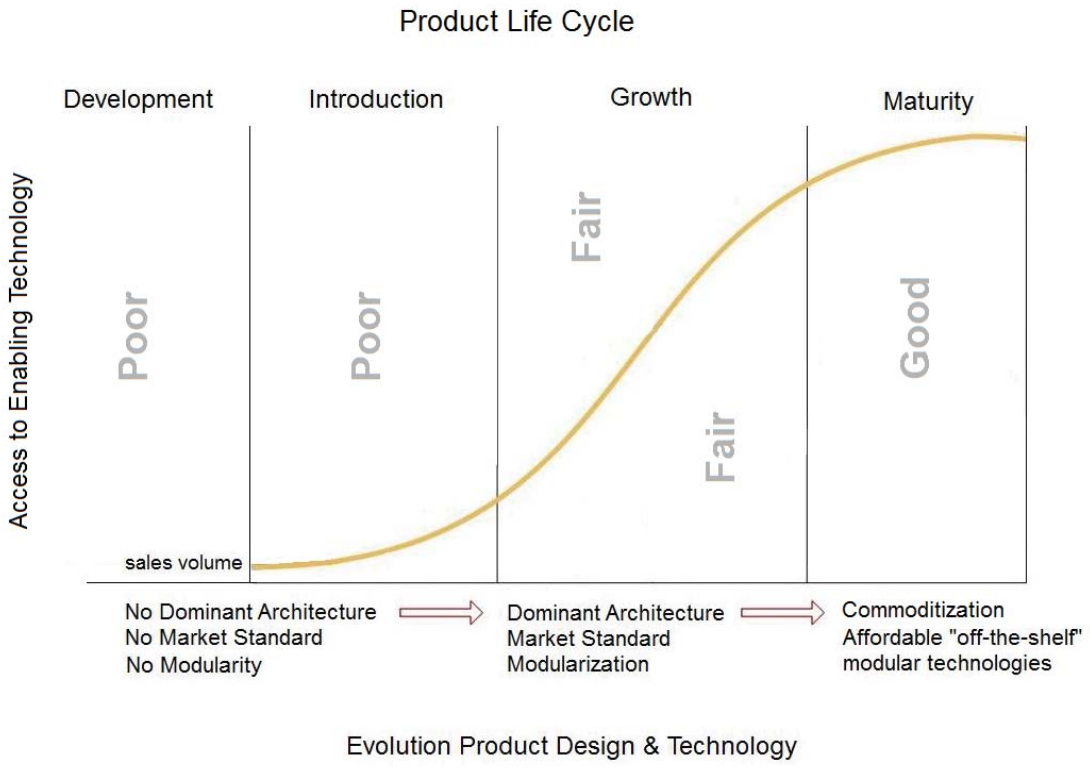


Figure 4 - Aspiring disruptors' ability to acquire key technologies at different stages in the product life cycle

The evolution from the product as a highly interdependent system to the product as a relatively fixed architecture into which standard components can be slotted makes modularization possible:. However, although this is a necessary precondition it is not a sufficient precondition as the case study about Eastman Kodak shows. Some technologies are harder to standardize than others: if one firm

dominates a series of highly interdependent analog systems, (partial) modularization may only be possible with this firm's explicit cooperation and leadership. Digital technologies are, comparatively speaking, easier to standardize and modularize and therefore copy. Modularization combined with the emergence of an open market in component level technologies can lead to fierce competition from firms with lower cost structures. This may result in price wars and commoditization: a shift in the focus of demand from performance to price. When this happens, component level products and services significantly drop in price, enabling entrants with relatively few resources to develop and commercialize architectural innovations.

In spite of significant business and government support, the aspiring disruptor had not been able to develop the required value network quickly enough to attract enough customers in order to be able to survive financially. An industry giant like IBM, by contrast, had been able to create a disruptive value network from scratch because of its resources and because of its alternative income streams. IBM's immediate financial survival did not depend on the PC and for this reason it had the time and financial independence needed to set up the infrastructure required to make the PC a disruptive success. Disruption is greatly facilitated if large integrated firms take a leading role in creating a new value network that is appropriate for the value proposition offered by the disruptive product.

Case Study – Kodak and Digital Photography

The Eastman Kodak Company started off as a classic disruptor. Before amateur photographer George Eastman founded the company in 1888, only a small number of highly skilled and relatively wealthy individuals were able to create photographic images. Taking pictures required not only a very bulky camera, but also developing plates, glass tanks, developing tents, chemicals, distilled water, tripod,

phosphoric flashes and photographic emulsions. Two methods for taking pictures existed at the time: wet plate, and dry plate. The wet plate method required the shortest exposure time, but photographers had to coat a developing plate with wet chemicals for every picture. In both methods, subjects had to sit prim and still for some seconds to allow for exposure (Genzlinger, 2000). Customers based their purchasing decisions primarily on performance differences in the area of primary functionality, or in Christensen's terminology, the main job for which customers hire the product: capturing memories in image format. However, most potential individual customers lacked the skill and money required to adopt photography as a hobby. A few individual photojournalists had used photography, before George Eastman set up his firm, to chronicle key events (e.g. the Crimean War and the American Civil War). However, it was beyond the means of most commercial enterprises, such as newspapers, to employ photojournalists on a regular basis because the sheer weight and volume of the required photography equipment made it extremely cumbersome and costly for photographers to travel.

First Step: The disruption of wet plate photography by improving the performance and reliability of dry plate photography.

George Eastman significantly improved upon the dry plate method, making it a viable alternative to the wet plate approach. He also invented a machine for coating large numbers of photographic plates. In 1880, he set up his first business, the Eastman Dry Plate Company, manufacturing pre-coated dry plates for sale. His inventions yielded better pictures and more reliability: his pre-coated dry plates required significantly less exposure time than the wet plate technology it replaced and did not require the photographer to apply wet chemicals in the dark. This meant that there was significantly less risk of the photographic subjects spoiling the picture by

not sitting still for long enough, or of the chemicals not being applied properly or the plates accidentally being exposed to the light prematurely.

Given that at this early point consumers primarily based their purchasing decisions on products' performance and reliability in terms of primary functionality (i.e. capturing memories in image format), Eastman's original success can, to a significant extent, be attributed to his careful efforts to construct a reputation for quality. He set out to create a strongly integrated firm, both vertically and horizontally. Eastman eventually became one of the first American industrialists to hire a full-time research scientist, recruited to help substitute the glass plates that Eastman's products used for roll film (Kadiyali, 1998, p.93). Eastman's obsession with quality and performance in terms of the products' primary functionality and reliability would become an integral part of his firm's organizational culture.

Second Step: the disruption of glass-plate photography through the introduction of more convenient technologies and supporting services: roll film, portable cameras and photo finishing.

From the very start, Eastman's goal was to make photography accessible to mainstream customers. Thus, his firm developed and commercialized roll film, which quickly became the market standard and remained in this position until the rise of digital photography. Eastman also developed a fully portable hand-held camera "the Kodak", in 1888. This invention was followed by a camera that could be loaded in daylight in 1891 and a pocket camera in 1895. Eastman rolled out these innovations on the basis of a radically new business model. The firm introduced its iconic Eastman Kodak camera in 1888 with the slogan: "You press the button - we do the rest." (Grant, 2005, p. 94). Taking pictures had now been simplified to pressing a button and sending the camera (later just the rolls of photographic film) to Kodak for

development. As a result of this radical simplification of the photographic process (for the consumer) the market expanded significantly. From now on, people who had previously lacked the skills required to take pictures were also able to adopt photography as a hobby.

Third Step: expanding the amateur photography market through selling equipment cheaply and making a profit from consumables.

The iconic Kodak camera was a commercial success in spite of its relatively high price of $25 ("About George Eastman", n.d.). It is important to highlight that this price was high compared to the budgets of mainstream customers, not compared to the other options available in the photography market at the time. In line with Eastman's stated aim to make photography accessible as a hobby to mainstream customers, the firm focused its R&D efforts on tools and manufacturing processes with an eye to lowering the cost of its products. The firm was able to learn by doing and quickly obtained the benefits of economies of scale: the firm manufactured its 100,000th Kodak camera in 1896. Around this time, Kodak also produced photographic paper and film at a rate of four hundred miles per month (Kodak, 1994). In addition to increasing efficiency and lowering costs, Eastman also further revised his business model with an eye to making photography genuinely affordable to mainstream customers. In 1900, Kodak introduced the Brownie model. This model sold for only $1, with film rolls costing only 15 cents. The introduction of this model marked the beginning of Kodak's highly successful "razor blade" business model. Like razor manufacturers who sell their razors cheaply in order to "lock" as many people as possible into buying their brand of blades, Kodak sold its cameras cheaply in order to obtain as many customers as possible for its rolls of film (Lucas & Goh, 2009, p.49). The success of the razor blade business model over time resulted in the

deeply ingrained organizational view that Kodak was first and foremost a photographic film company. This view served the firm well until the analog technology that underpinned its business model went into decline, as we will see.

Eastman Kodak: A Near-Monopolist Incumbent

Kodak significantly delayed its rivals' attempts to enter the market by protecting all its product and process innovations through patents. As a result, Kodak was able to create an extensive cross-market value chain for its new goods and services before rivals were able to enter the market with competitive products. The processes and outputs of all firms within the value chain were selected or developed to fit with Kodak's business model, products and processes. Consequently, this industry-wide value network came to be fine-tuned to Kodak's way of doing things. This meant, for example, that Kodak's photofinishing process became the industry standard and that photo shops developed their processes in accordance. Rival brands struggled to develop products that were compatible with these standardized processes, (i.e. Kodak's processes). As a result, they tended to fare badly in a typical photo shop, even if their film produced high quality photographs if processed properly, according to that type of film's specific requirements as opposed to in "the standard way", which had come to mean Kodak's way (Gavetti, Henderson & Giorgi, 2005, p.2).

It quickly became clear that photographic film was at the heart of the industry (Kadiyali, 1998, p.89): any type of photographic film requires compatible cameras, compatible photofinishing services, compatible chemicals, paper, printing and processing equipment. Because Kodak completely dominated the photographic film market it was able to dictate technological standards in all connected markets: only cameras for which Kodak was willing to develop compatible film had any chance of commercial success. Only photo-finishers that could finish Kodak film to an

acceptable standard could remain in business. Rivals that did not develop Kodak-compatible products had little chance of commercial success.

It was a deliberate part of Kodak's market strategy to make it very hard for rivals to develop compatible products. Kodak would introduce radical design changes to its products without informing its rivals in advance. This, combined with Kodak's proactive patenting strategy, made it virtually impossible for rivals to develop compatible products on time without infringing any of Kodak's patents. Kodak would eventually license some of its proprietary technology in an effort to avoid antitrust lawsuits, but the firm never licensed its film.

Kodak had been able to control rivals and block entrants for decades because competing firms had not seen a way to bypass the industry-wide value network Kodak had created. The business and technological interdependencies that marked the imaging sector 'forced' rivals to make products that were compatible with the standards set by Kodak. The lock-in effect of these interdependencies was further strengthened by the fact that analog photography products were never fully standardized or modularized (Shih, 2013). Modularization refers to the process whereby products and processes are partitioned into discrete self-contained subunits with well-defined interfaces and with a clear set of design rules governing their assembly (Baldwin & Clark, 2000). If an open market in modular component technologies emerges, rivals can quickly improve and adapt their product architectures by buying the required component technologies "off-the-shelf". They can obtain years of research and development (often conducted by incumbent firms) simply by purchasing the relevant components, saving them high in-house R&D costs. Standardization and modularization gives rivals a clear blueprint to follow and enables firms with lower cost structures to create cheaper copies of existing products.

Alternatively, rivals can develop a radically different product architecture on the basis of existing component technologies and bypass the dominant value chain by introducing a radically different business model suited to their new product.

Some technologies are easier to standardize and modularize than others. Whereas digital technologies are comparatively easy to standardize and modularize, it is very difficult to do the same with analog technologies. When key products and processes in an industry are not fully standardized and modularized but coordinated and managed by one large integrated firm, rival innovation requires work at component, interface and architecture levels. The fact that analog photography was hard to modularize greatly strengthened the impact of Kodak's monopoly strategies. Rivals could not develop innovations that were purely architectural in nature, as disruptors tend to do, but were forced to revise and adapt component level technologies as well. However, component innovation tends to be slower and a lot costlier than architectural innovation. As a result, Kodak's ability to change market standards at will, combined with its patenting strategy that forced rivals to continuously "reinvent the wheel" in order to avoid copyright infringement, made the firm's position almost unassailable. Rivals generally lacked the funds and the flexibility to respond to Kodak's monopoly tactics. Furthermore, Kodak's economies of scale in terms of both supply and distribution made it difficult to compete with Kodak on cost, and they simply could not bear the huge R&D costs required for entry. As a consequence of the high barriers entrants faced, very few firms tried to enter the amateur photography market from the early 1960s onwards (Gavetti, Henderson & Giorgi, 2005, p.2).

Kodak's Downfall

Kodak went from holding a near monopoly position in photographic film and connected markets in 1978 to being forced to file for bankruptcy in 2012. What happened to Kodak during the intervening 34 years is considered to be a classic instance of disruptive innovation (Christensen & Euchner, 2011).

During the first decade of the 21st century digital photography almost completely replaced film-based photography. When this happened, amateur photographers began to consume photography in a completely different way. Consequently, the new technology came to be part of a different value network from the one Kodak dominated. Whereas before it had been necessary to print photographs in order to see the images, the ability to view images on a screen rendered printing optional. Kodak's control over the amateur photography market had been based on its near-monopoly position in photographic film, which used to be at the heart of the amateur photography market; however the shift to digital photography shifted film's position to the periphery.

Kodak could have established itself in a central position in the new digital value chain when it emerged. The firm invented the first digital camera in the late 1970s. It poured billions of dollars into digital imaging research during the 1980s (Grant, 2005, p. 97) and developed technologies that formed the basis upon which future digital imaging technologies were built. As a consequence, in the 1990s Kodak had a significant lead in digital photography R&D. It had also commercialized a respectable number of products related to digital photography. By 1999, Kodak was the second largest player in the US digital camera market, holding a 27% market share (Gavetti, Henderson & Giorgi, 2005).

However, in spite of these accomplishments in digital photography, Kodak's outdated business model became its downfall. It had understood from the very beginning that digital photography would eventually render film-based photography obsolete. However, the firm had been unwilling to actively contribute to the obsolescence of its historically highly successful business model. The firm had become used to the high margins found in the photographic consumables market and could not identify an equally lucrative opportunity in the emerging digital world. Developing a business model that ties in perfectly with an emerging value network is difficult as firms have to deal with a lot of unknowns. However, a first mover can to some extent shape the new value network to its own value-proposition and establish some control over (a section of) the nascent market. Kodak did this in the film-based amateur photography market and could have repeated this move in the digital world. The firm was however held back by its desire to keep film and other physical consumables relevant for as long as possible.

By the late 1970s Kodak had been an incumbent near-monopolist for decades. Because Kodak's business model had been very successful for a very long time the firm had developed a set of "procedures and policies to maintain the status quo" (Swasy, 1997). Kodak followed a sustaining R&D trajectory for many years, focusing primarily on improving the performance and reliability of photographic consumables. However, by the late 1970s we begin to see evidence that Kodak had met, and was beginning to exceed, low-end customers' demand for further performance upgrades in the areas of functionality and reliability. In Christensen's terms, consumers mainly "hired" Kodak's products in order to perform the following job: capturing memories in image format. To price-conscious consumers, Kodak products now performed this job as well, as reliably and as conveniently as they desired and they were hence not

motivated to pay for further improvements in these performance areas. As a consequence, for the first time in the history of photographic film, a rival was able to gain a significant foothold at the low-end of the USA market. Fuji film successfully established itself by selling cheaper photographic film of adequate quality. Kodak initially underestimated Fuji film, convinced that American customers would not want its unnaturally bright highly saturated colors (Kadiyali, 1998).

When the US photography market started to mature and customers began to make price their primary purchasing criterion, Kodak responded too late and too slowly to Fuji's threat. At this point Kodak could have introduced a product with radically different additional functionality that performed a related job customers valued and thus reset the focus of competition to performance in the area of functionality. However, Kodak failed to change the focus of demand back to performance through either innovation or marketing. Instead, Kodak ended up competing with Fuji on price. Both firms, for example, introduced cheap and convenient single-use cameras in the late 1980s. By the late 1990s, Kodak and Fuji had ended up in a price war that further reduced Kodak's share of the analog film market.

Kodak's advertising efforts also had the effect of increasing the overall market rather than taking market share back from Fuji. As a consequence, Fuji was able to increase its overall US sales without needing to invest too much in advertising itself, enabling the firm to keep its costs low. Having a higher cost structure, Kodak could not compete long term with Fuji's prices. In addition to Fuji's 15% lower cost to the consumer, Fuji also benefitted from a strong dollar by importing (Kadiyali, 1998). Importantly, Fuji was willing to trade huge profit margins for market share (Deutsch, 1997). The firm at times also used its strong position in Japan to subsidize its

products in the US in order to increase its sales volume. Because Kodak initially underestimated Fuji Film, Kodak made the significant strategic mistake of turning down the opportunity to become the official sponsor for the Los Angeles Olympics in 1984, allowing Fuji Film to take up the offer (Cowling, 2012). This event gave Fuji the brand recognition it had previously lacked in the US market. Between 1977 and 1990, Fuji's market share increased from 0 to 17.37% whereas Kodak's market share fell from 80% to 62.93% (Kadiyali, 1998). Kodak lost its near-monopoly position in the amateur photography market before digital photography replaced analog photography.

At the beginning of the 21st century amateur photographers began to base their purchasing decisions on how well products performed in the context of the job sharing memories in image format. At this point in time, all products on the market performed at least adequately in terms of capturing memories in image format and only the most demanding customers were still willing to pay for further improvements in this type of functionality. The first filmless cameras cost thousands of dollars and yielded inferior quality images compared to equivalent film-based products. The first adopters of these cameras were professional photojournalists who valued the new technology's ability to rapidly transfer images via telephone. The fact that the images were of low quality did not matter as they were intended for newspapers.

Two of Kodak's engineers, Gareth Lloyd and Steven Sasson, were awarded a patent for the first digital camera in 1978 (US patent no. 4,131,919). Classical disruptive innovation theory holds that incumbents get disrupted because they do not appreciate the potential of a new technology until it is too late. As a consequence, incumbents often invent the very technologies that will eventually disrupt them.

Kodak saw Lloyd and Sasson's 8-pound camera with digital cassette as a threat to its highly successful razor blade business model. The discovery of digital photography "sent fear through the company" and led to reactions such as "oh, my goodness, photography is dead" (Swasy, 1997). The inventor Steven Sasson recalls "My prototype was as big as a toaster, but the technical people loved it...but it was filmless photography, so management's reaction was, that's cute, but don't tell anyone about it" (Deutsch, 2008).

A few years later, in 1986, Kodak engineers invented the first megapixel electronic image sensor, which made it possible to print high quality 5x7 inch photographs using digital photography. This technology would form the basis upon which future digital imaging technologies were built. Kodak initially sought to "hide" its discoveries related to digital photography from the world because it (rightly) feared that filmless photography would destroy its established and highly lucrative business model. As a consequence, other firms introduced digital cameras onto the market before Kodak did.

This was not a problem in and of itself. The problem was that Kodak could not find an attractive business model that played to the strengths of the new technology. At the same time, the firm was unwilling to undermine its established and highly lucrative business model. Because Kodak was used to being able to control the introduction and obsolescence of products and services in the amateur photography market, Kodak believed that it could delay, control and very slowly phase-in digital photography. This strategy "worked" so long as no convenient alternative value network emerged that was highly compatible with digital photography.

Rather than continuing its practice of doing everything itself, Kodak now had to partner with IT firms to access the new technology (Chandler, 1986, p. 8). When

incumbents proactively engage in outside partnerships and use outsourcing for manufacturing and/or design, the relevant products and processes are out of necessity standardized and modularized (as far as is possible). It is important to highlight again in this context that digital technologies are much easier to fully modularize and standardize than analog technologies. When products are created and developed through cooperation between different firms, an open market in component technologies is likely to emerge. This, in turn, makes it easier for rivals and entrants to develop similar products by copying the standardized architecture and buying the required component technology "off the shelf". As a result, the digitization of an approach to a particular "job to be done" tends to expose incumbents to fierce competition and can relatively quickly lead to commoditization: the situation whereby customers base their purchasing decisions primarily on price because all products in the market perform (at least) adequately in terms of functionality, reliability and convenience.

Because Kodak could not identify an attractive business model suited to digital photography it opted instead for a controlled slow transition from analog to digital photography, in order to continue to profit from its dominant position in photographic film for as long as possible. In 1995, Kodak's CEO George Fisher said: "the future is not some harebrained scheme of the digital information highway or something. It is a step-by-step progression of enhancing photography using digital technology" (Maremont, 1995). Being used to controlling the introduction and obsolescence of products in the analog market, Kodak believed that the firm could control the industry's transition to digital at its own pace. However, the slow adoption rate of digital photography products in the 1990s was not the outcome of Kodak's deliberate control, but rather caused by the absence of a suitable alternative value

network that played to the strengths of the new technology. The year Fisher made his statement only 14% of Americans regularly used the internet. This figure had more than tripled by the year 2000 to 46%, rising further to 68% in 2005.

During the 21st century people started taking pictures with their digital cameras, uploading and storing them onto their computers and sharing them online through social media websites. Because people were now able to view and share pictures online, their need for physical printouts decreased dramatically. This rendered Kodak's film-based business model obsolete. By holding back, Kodak had passed up the opportunity to create an appropriate new value network that was fine-tuned to Kodak's products and processes. Given these circumstances, Kodak opted to form joint ventures and strategic alliances in order to commercialize its technology in the 1990s.

Apple provides an obvious example of how an established firm can create and then dominate a value network in the digital world: introduced in 2001, iTunes rapidly became one of the most important digital media player application on the market. The application is free to download and use and plays third party digital media including music, videos, television shows, movies, audio books and podcasts. The iTunes store also sells such media at affordable prices. The application can be downloaded onto computers running Apple's or Microsoft's operation systems (OS X and Windows) as well as Apple's portable devices: the iPod, iPad and iPhone. Using a business model that is the inverse of Kodak's razor-blade approach, Apple gives consumers access to consumables at a relatively low cost in order to 'lock' them into buying one of their relatively expensive pieces of equipment (the portable music players).

Kodak failed to firmly establish itself in the digital photography value chain by doing something similar to Apple. As a result of its unwillingness to undermine its established highly successful business model, Kodak wasted the advantage it had as a result of its head-start and dominant position in R&D. Kodak's perceived control over the pace at which the amateur photography market would transition from analog to digital was illusory: when the new digital value network had taken hold in the early 2000's, digital photography began to disrupt analog photography in markets around the world at a pace Kodak had not foreseen. When this happened, Kodak's profits started to decline rapidly because Kodak's respectable market position in the digital camera market in the late 1990's and early 2000's did not translate to profit. In 2001 Kodak lost $60 on every digital camera it sold (Gavetti, Henderson & Giorgi, 2005).

Having read Clayton Christensen's research, several people at Kodak contacted the Harvard professor for advice. Christensen told them that Kodak was indeed being disrupted and that the firm was making all the classic mistakes incumbents make. He advised the firm to separate the unit in charge of digital photography from the rest of the firm and to stop trying to develop digital cameras that could compete with analog cameras on the basis of image quality. "Don't do that, but rather use the digital technology to make it so affordable and simple that a whole new population can now own and use cameras" he advised (Christensen & Euchner, 2011, p.6). Following his advice, a low-end range of digital photography products, known as Easy-Share, was launched by a new separate business unit in 2001. The Easy-Share camera was distributed through Target and Wal-Mart. This range was very successful and Kodak became the market leader in the US digital camera market in 2004 (Bajaj, 2005). However, because digital technology is relatively easy to standardize and therefore copy, digital cameras rapidly became commodities.

Consequently, as the decade progressed, Kodak became exposed to ever-increasing competition from low-end competitors and ever-declining unit prices. Furthermore, when smart phones became widely adopted during the latter part of this decade, digital cameras themselves became disrupted by phones with in-built cameras. As Kodak was not able to make its digital camera business financially viable, in 2006 it outsourced the design, production and distribution of its digital cameras to Flextronics (Flextronics, 2006). 2007 was the last year Kodak turned a profit.

Chapter Six: Findings

The criteria by which customers choose one product or service over another evolve through four phases: in each phase, customers prioritize a different performance area as illustrated by Figure 5 below.

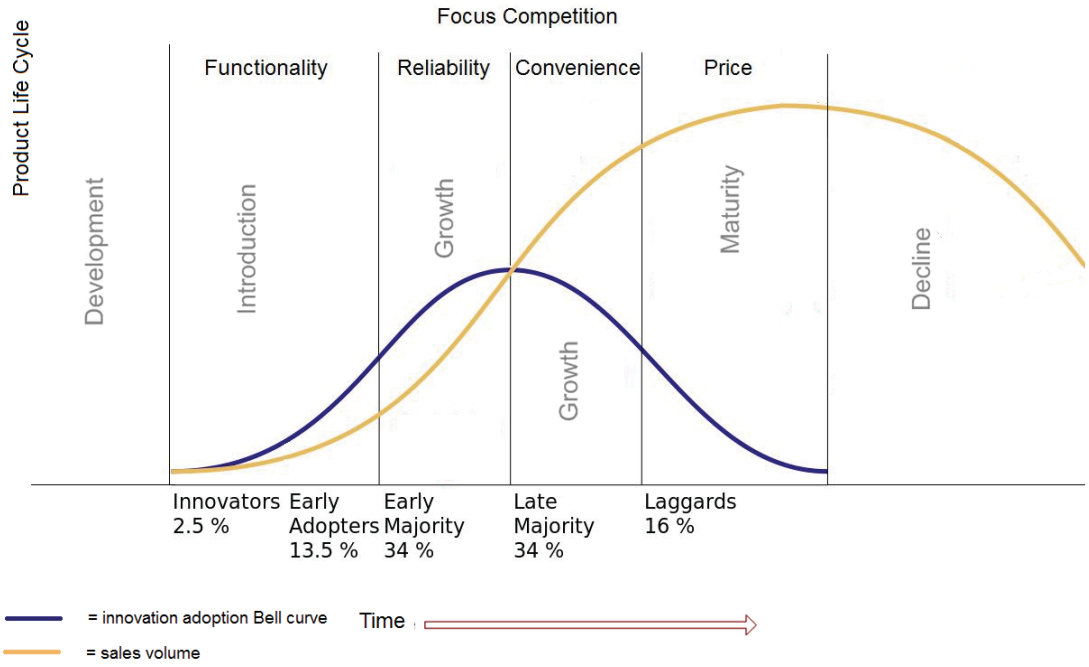


Figure 5 - The Innovation Diffusion Bell Curve, the Product Life Cycle & the Focus of Competition over Time

Once demand for further upgrades in functionality has been exceeded customers will start to base their purchasing decisions on performance in the area of reliability. And once demand for improvements in reliability has been exceeded customers will start to prioritize convenience. Finally, when customers no longer value further increases in convenience, commoditization occurs: performance differences between products are no longer valued and price becomes the sole focus of competition.

Whenever a market is characterized by performance oversupply in a particular area (functionality, reliability or convenience) a great opportunity presents itself for disruptive innovators who offer a product that outperforms the market standard in the next performance area (e.g. if mainstream customers are "over-served" in terms of performance in the areas of functionality and reliability, innovations that offer a superior performance in the area of convenience may quickly gain a significant market share). This is illustrated by Figure 6 below.

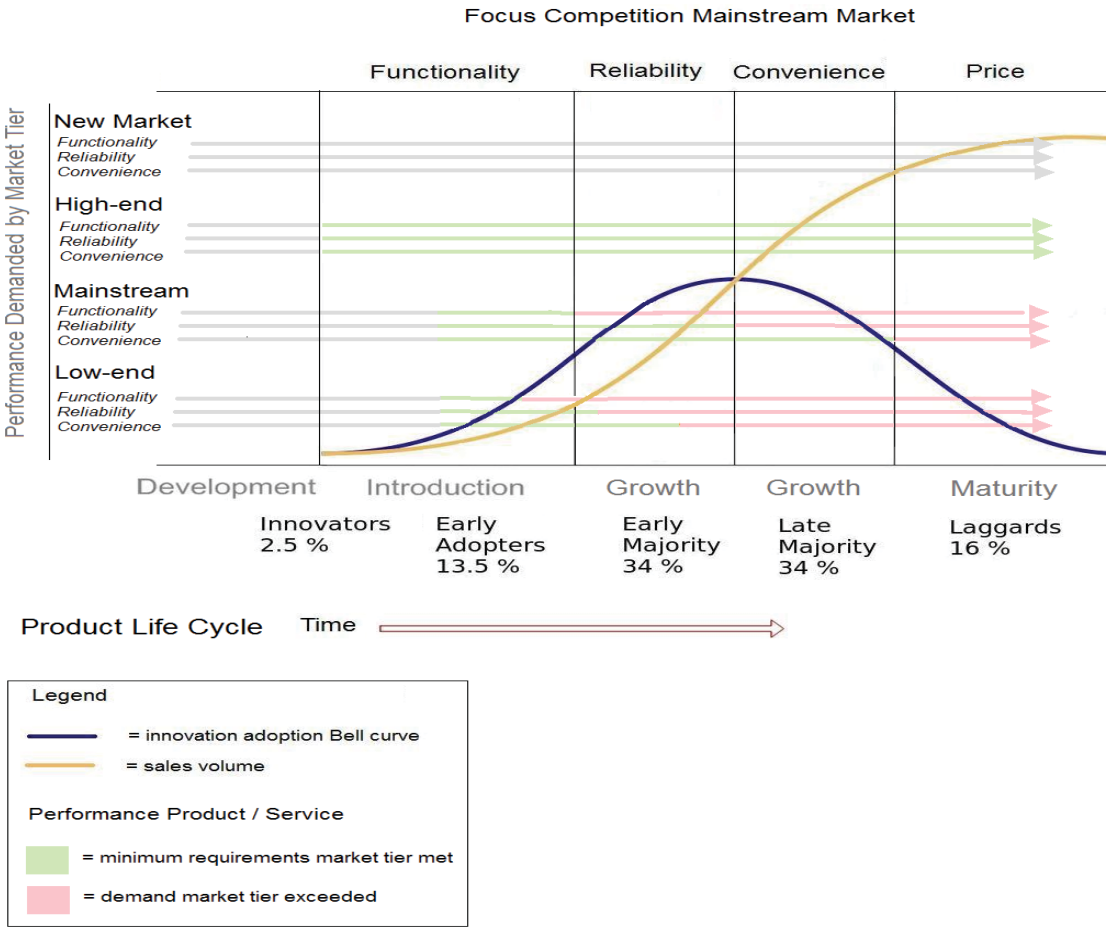


Figure 6 - Performance demanded by each market tier relative to the focus of competition in the mainstream market

Over time, customers' minimum and maximum requirements in a particular performance area are met and then exceeded by incumbent products based on the market standard. This happens tier by tier. High-end customers are the last tier to stop

valuing further upgrades in any given performance area. The minimum requirements of non-consumers will not be met by the market standard if they cannot use established products (in certain circumstances) because they require a fundamentally different type of (additional) functionality compared to what is offered.

The Secondary Market Driver Strategy

This research has found that there are two distinct disruptive innovation strategies: the secondary market driver strategy and the new market driver strategy. This distinction contributes to the predictive power of the modified theory. The primary aim of the secondary market driver strategy is to grow an existing market by moving a product forward to the next demand phase. As discussed in the previous chapter, customers' purchasing priorities generally evolve from performance in the area of functionality, to performance in the area of reliability, to ease of use and, when all these demand criteria have been adequately met, and finally to price (see figure 7). This is obviously not a fixed pattern: it can be "reset" to an earlier demand phase for example through aggressive marketing campaigns or through *the new market driver strategy*, discussed below.

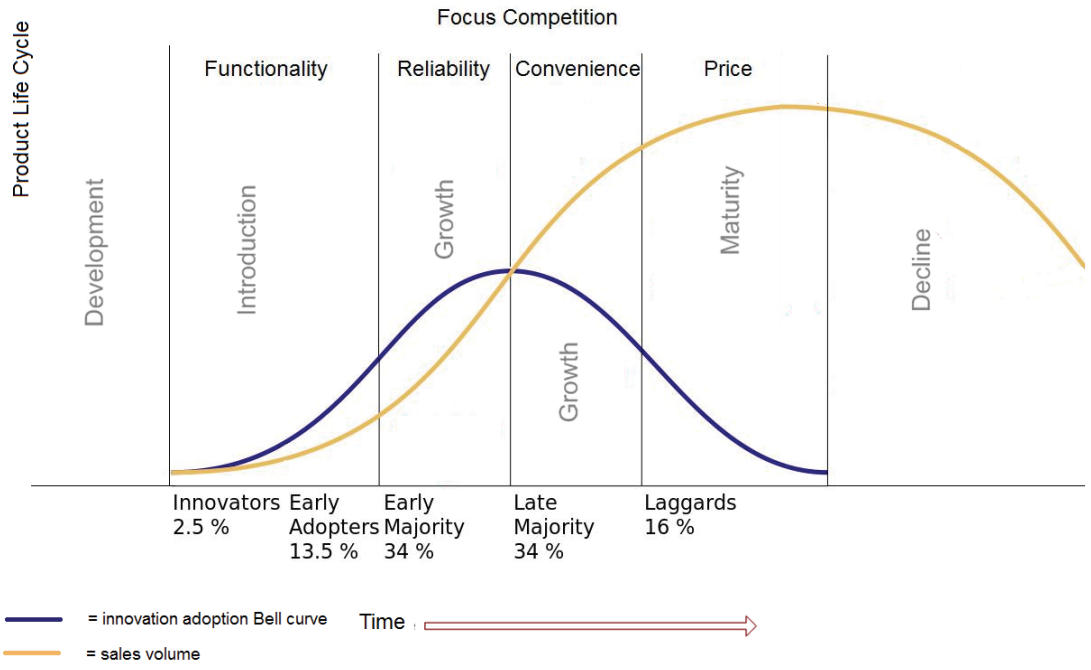


Figure 7 - The Innovation Diffusion Bell Curve, the Product Life Cycle & the Focus of Competition over Time

As Figure 7 above represents, in each phase, the demand criteria of lower-tier customers are met first, followed by those of mainstream customers. High-end demand is met last, if ever. Top-tier customers generally continue to value upgrades in all performance areas. Although they are generally among the first to switch when demand shifts to a new, radically different, additional type of functionality (the new market driver approach), their priorities tend to lag behind those of mainstream customers when it comes to following the pattern of demand phases outlined above. That is, they are the last to shift from prioritizing functionality to focusing on reliability, and they are the last to shift from focusing on reliability to prioritizing convenience. When the mainstream market has matured and most customers have made price their primary purchasing criterion, high-end customers are likely to continue to base their buying criteria on differences in product performance in the areas of functionality, reliability and convenience.

Disruptors following the secondary market driver strategy succeed by targeting over-served mainstream customers with a product that significantly outperforms the current market standard in terms of the market driver customers will prioritize next. Timing is central to this approach. Disruptors should aim to be ready to enter the mainstream market at the moment these customers are beginning to lose their willingness to pay for further upgrades in performance against the current market driver. Being ready entails having developed a flexible and scalable business model that is perfectly aligned with the emerging market driver as well as a product that 1) excels in performance against this new market driver and 2) meets the mainstream market's *minimum* performance criteria in all other areas. The firm should ensure that it can offer the product at a price mainstream customers are willing to accept.

The secondary market driver strategy can use either a low-end or a new-market approach. When using the low-end approach, aspiring disruptors monitor purchasing behavior at the low-end of the mainstream market in order to ascertain when the least demanding customers are starting to lose their willingness to pay for further upgrades in performance against the current market driver. When this happens, disruptors have the opportunity to establish a foothold in this market segment by targeting these over-served customers with basic products that significantly outperform the market standard in terms of what can be expected to be the next market driver (according to the common pattern in which the focus of demand changes, outlined above). This means, for example, that if low-end customers are being over-served in terms of functionality, the aspiring disruptor offers them a product that is more basic in terms of functionality but far superior in terms of reliability. This foothold strategy enables the aspiring disruptor to test whether over-

served customers are indeed shifting their priorities to the next phase in the established pattern, or whether they unexpectedly skip a phase, or whether they are no longer interested in products that (only) offer the type of functionality incumbent products specialize in. The latter may happen when another disruptor following *the new market driver strategy* has already targeted this segment with a product that offers (additional) radically different functionality. One can reasonably expect that once mainstream customers become over-served by incumbents they will shift their purchasing priorities to the same secondary market driver as the less demanding customers.

Firms following the new market secondary market driver strategy focus on current non-consumers of incumbent products. Through market research, firms can establish whether people are not using incumbent products (in certain circumstances) because of these products' inadequate performance versus what can be expected to be the next market driver. It may be the case, for example, that people are not using available products because they are not reliable enough or too difficult to use (in certain circumstances). If this is found to be the case, disruptors have the opportunity to establish a foothold in this market segment by targeting these non-consumers with products that through a radically different kind of additional functionality make their products more reliable or more convenient to use than incumbent products.

Whether using a low-end or a new market approach, establishing a foothold helps the aspiring disruptor develop a customer value-proposition that is fine-tuned to the new emerging market driver. It enables the firm to develop a business model and identify a value chain that is perfectly aligned with the emerging focus of demand. Furthermore, the foothold approach gives the disruptor the capital, know-how and experience needed to further improve its product through sustaining innovation.

However, as stated above, timing is central to the success of the secondary market driver strategy: if mainstream customers have already lost their willingness to pay for further upgrades in performance against the current market driver, it may be necessary to target these customers directly to prevent rival disruptors from setting the new market standard.

The secondary market driver strategy can only be successfully pursued if the current focus of demand in the mainstream market is based on performance in the areas of functionality, reliability or convenience. It is generally the case that demand for further upgrades against the primary and secondary market drivers has been adequately met once price becomes the primary focus of demand in the mainstream market. At this point, there is no longer any difference in terms of priorities or willingness to pay between the low-end and the mainstream: the segments have merged. Furthermore, because incumbents now compete on price, low-end foothold opportunities cease to exist: disruptors that enter the market with a cheap and basic product compete on the same market driver as incumbents in the context of a value network that incumbents dominate. Few disruptors survive direct competition against incumbents under such circumstances. It is still possible to disrupt a mature market but not by moving the focus of demand forward (there is no demand phase after "price") or by rolling out a cheap and basic product (because this involves entering in direct competition with incumbents). In actual fact, a market that has been overshot in all performance areas is extremely susceptible to disruption: disruptors that manage to identify a new, radically different, additional type of functionality that helps customers perform an additional "job" they genuinely value are likely to be successful, especially if their product is also cheaper in terms of either unit price or usage over time. The introduction of such an innovation is likely to rapidly move the

market standard on from its current stage in the product life cycle, *maturity*, to the next stage, *decline*. The approach of 1) growing an existing market by moving the focus of mainstream demand forward (the secondary market driver strategy) and 2) "resetting" the focus of mainstream demand to functionality (the new market driver strategy) the quickest variant of the *new market driver* approach, is shown by Figure 8 and 9 below.

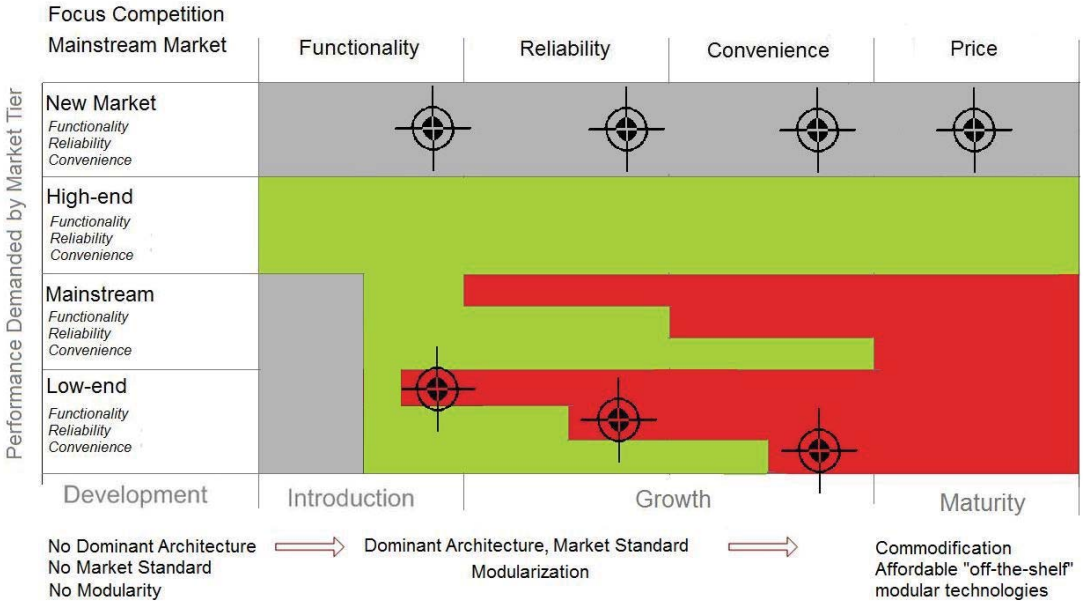


Figure 8 - Foothold opportunities over served low-end customers and people unable to consume established products (in certain circumstances)

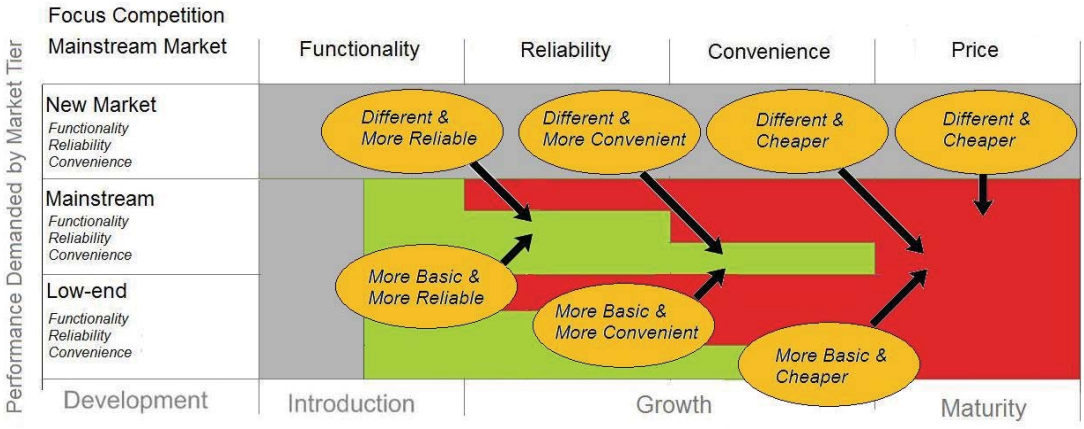
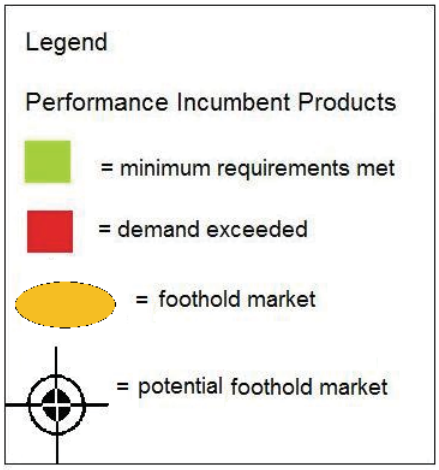


Figure 9 - From foothold to mainstream: the key performance cirteria that enable innovations to conquer the mainstream in each demand phase



The New Market Driver Strategy

New separate markets can be created with products that offer radically different (additional) functionality compared to the market standard, even if they are inferior to incumbent products in all other ways. In these distant new markets the new functionality offered by the new product becomes the key market driver. If successful, these new markets grow at the expensive of the old markets, eventually replacing them. The new market driver strategy starts, however, at zero. It shifts the focus of demand to functionality, resetting the product life cycle to its very beginning.

Innovations that are only just out of development tend to be inferior compared to products in the old established market in terms of primary functionality, reliability and ease of use. Furthermore, at this early stage in the product life cycle, firms do not yet benefit from any economies of scale, rendering first edition products comparatively expensive. As a consequence, the first adopters of this type of innovation tend to be highly skilled and highly resourced customers who have a specific need that no other product currently addresses better. Everett Rogers (1962/2003) refers to them as “innovators”. These high-end customers constitute the foothold market for firms following the new market driver strategy. This is shown in

figure 10 below: the potential new market footholds marked as "different" under *Functionality A* are the same as the "high-end" niche market under *Functionality B*.

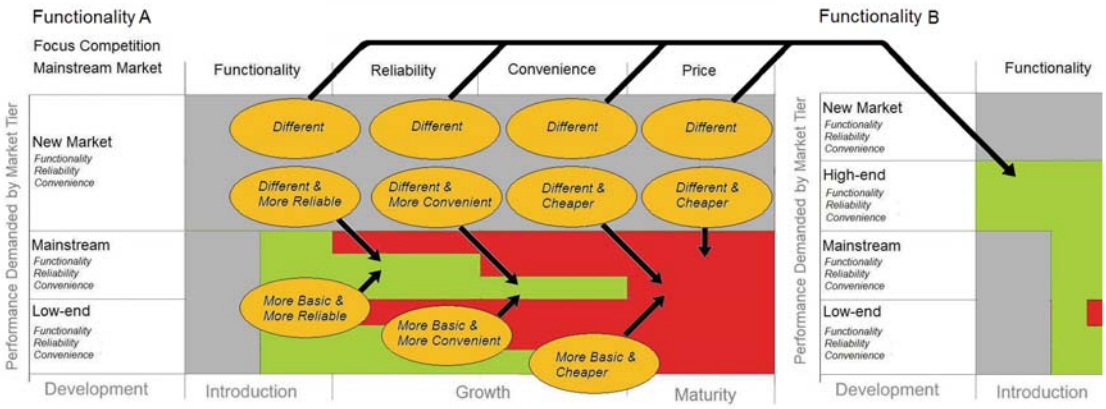


Figure 10 - Two distinct forms of new market disruptive innovation

As illustrated in Figure 10, starting out by setting up a separate niche market gives the disruptor the capital, know-how and experience needed to further improve its product through sustaining innovation. The disruptor can start targeting customers in the old market (based on functionality A) once his product meets these customers' minimum performance criteria. This might mean that the next segment to adopt the new product, after the high-end innovators, are the least demanding customers in the old market. An example of this is the cell phone: even though its first adopters were business professionals who could not use existing products while on the move, the next customer group to adopt this product as a replacement for landlines were teenagers, students and apartment dwellers; the low end of the old market.

New market driver disruptive innovation can also conquer the mainstream from above. As discussed earlier in this chapter, digital cameras were first adopted by professional photojournalists. The next group of consumers to adopt the new technology was the top of the middle tier, that is, the least price sensitive mainstream customers: people who valued the new market driver adopted the new product as

soon as it came within their price bracket. People did not adopt digital cameras because they had a cheaper unit price compared to analog cameras or because they were more cost efficient to use. When mainstream customers began to adopt the new technology in the late 1990s, digital cameras were still relatively expensive compared to film-based products.

It is important to point out that the product and business model that focus on "functionality B" are (or at least should be) perfectly aligned with the focus of demand and value network that characterize "market B". Naturally, a business model that has been optimized to deliver a value package suited to "functionality B" and related secondary market drivers cannot at the same time also optimally address demand in a market that prioritizes "functionality A" and related secondary market drivers. If a product that focuses on "functionality B" never meets the minimum requirements of customers in "market A", market B will remain separate from market A. There may be overlap in customers, but if so, these customers would use product A and product B in different circumstances and/or to perform different jobs. This also means that the new market driver strategy is very unlikely to succeed at disrupting another newly emerging market. When a new separate market is first created, demand will focus on functionality; the product's ability to perform the main job it has been hired to do. Until this demand is met, customers that value this job will not change their purchasing priorities, either to a secondary market driver or to a new market driver that focuses on a different type of (additional) functionality. Given that the disruptor's business model and product have been developed in order to function optimally in the context of demand for "functionality B", this disruptor can only address demand in emerging market A in a suboptimal manner. This means that s/he is very unlikely to defeat incumbents in emerging market A, most likely the creators

of the new market, in direct competition on the basis of functionality A. The two emerging markets are likely to remain separate at least until demand for primary functionality has been met in one of these markets.

There is likely to be asymmetry between the extent to which customers in market A value performance upgrades in functionality B and the extent to which customers in market B value performance upgrades in functionality A. If customers in market A value upgrades in functionality B more than customers in market B value upgrades in functionality A, product B is likely to disrupt market A and, as a result, product A is likely to go into decline (if the reverse is true, product A will disrupt market B). This asymmetry is linked to the nature of the two types of functionality (which will obviously vary on a case by case basis). However, the relative appeal of performance upgrades in each type of functionality can also be predicted on the basis of the respective maturity of the two markets. If customers in market A are over-served by incumbents in terms of functionality A (because the market is relatively mature) and customers in market B are still willing to pay premium prices for upgrades in functionality B (because the market is relatively young), customers in market A are likely to value upgrades in functionality B more than customers in market B will value upgrades in functionality A. Non-consumers in market A who cannot use product A (in certain circumstances) because product A lacks functionality B will be the first to switch to the new product. As discussed, they are likely to be high-end consumers. A firm following a *new market secondary market driver strategy* and one following a *new market driver strategy* both create products that introduce a radically different type of (additional) functionality (see Figure 11 and 12 below).

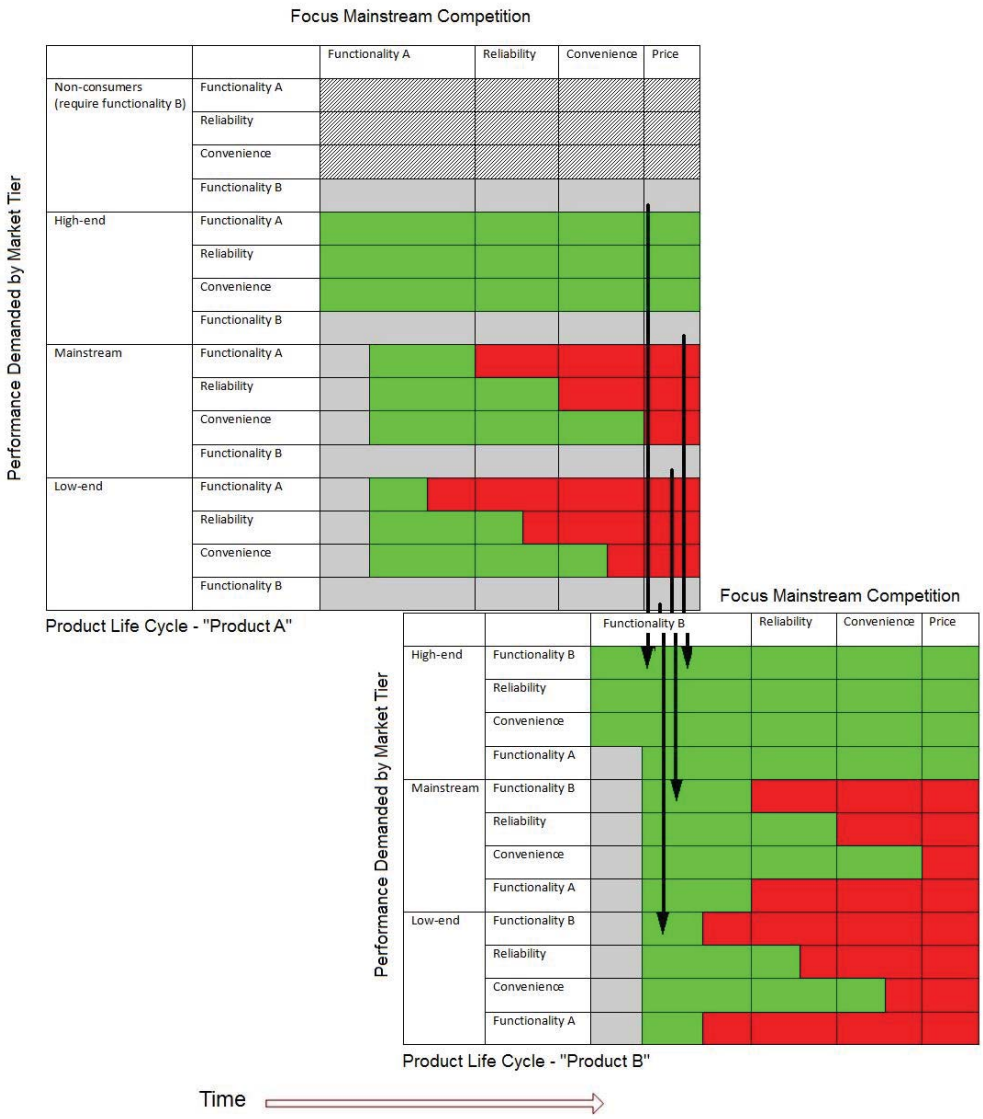


Figure 11 - The new market driver startegy: disrupting a mature market

Key: green indicates minimum requirements met, red indicates demand exceeded and grey indicates minimum requirements not yet met.

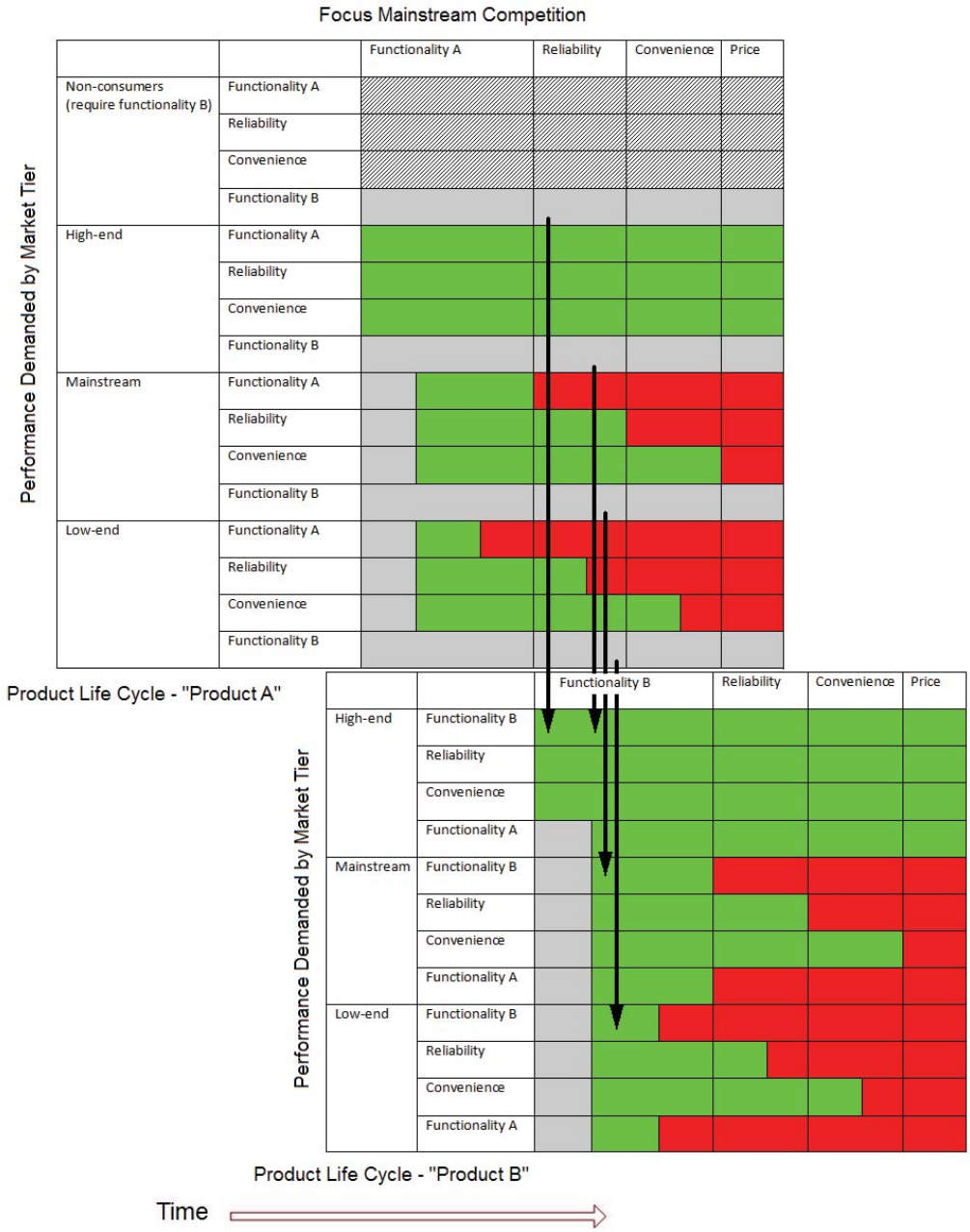


Figure 12 - The new market driver strategy: disrupting a growing market

Key: green indicates minimum requirements met, red indicates demand exceeded and grey indicates minimum requirements not yet met.

However, whereas the former aims to grow an existing market by moving the focus of demand on to the next phase, the latter aims to create an entirely new market based around the new type of functionality. If successful, this new market grows at the expense of the old market that was based around the old type of functionality and

eventually replaces it. The new market driver strategy is likely to take longer than the secondary market driver strategy. The reason for this is the fact that in the latter case the disruptor can build on the natural momentum of an existing market, whereas in the former case the disruptor has to grow a new market from infancy.

Using the Eastman Kodak case study as an example, the introduction of mass produced pre-coated dry plates was a new market secondary market driver strategy that moved the focus of demand in the analog photography market from functionality to reliability because it significantly reduced the risk of the photographic plates accidentally being spoiled. The introduction of digital photography, by contrast, led to the emergence of a market based around an entirely new type of additional functionality: sharing images. It emerged at the time when demand in the old market, which was still based on the primary functionality capturing images, had reached the "price" phase. As the case study shows, within twenty years of commercialization, the new product almost completely replaced the old product. So whereas a new market secondary market driver strategy moves demand forward to the next phase, a new market driver strategy "resets" it to functionality and whereas the former grows an existing market, the latter creates a new one.

Chapter Seven: Discussion and Conclusions

The goal of this project has been to clarify disruptive innovation theory and add the detail required to enable systematic forecasting of the phenomenon. This research has resulted in a comprehensive set of ex-ante predictor variables that are linked together in the format of a tree diagram and lead to a set of mutually exclusive outcomes (see appendix A). This set of variables and outcomes has been selected on the basis of a careful review of the academic literature and a detailed analysis of a series of case studies. The aim has been to construct a logically coherent and internally consistent theory that can account for both disruptive innovations that conquer the mainstream market "from below" and those that conquer the mainstream "from above": what Christensen terms "high-end anomalies".

This chapter starts with a discussion about high-end anomalies, arguing that this study's findings show that it is neither necessary nor accurate to restrict the term "disruptive innovation" to products that conquer the mainstream market from below. Next, this chapter will present a modified version of disruptive innovation theory based on the findings described in Chapter 5. This research has concluded that the academic literature and the case data indicate that there are two distinct disruptive innovation strategies: firstly, *the secondary market driver strategy* which can be based on either a low-end or a new-market approach, and secondly, *the new market driver strategy* that can only be implemented on the basis of a new-market approach. This research contends that this distinction clarifies the construct of disruptive innovation and adds to its predictive power. It has been the aim of this project to lay the

groundwork for future quantitative studies that wish to model the theory of disruptive innovation. The final section of this chapter has consequently been dedicated to providing a series of recommendations for future studies that aim to construct a quantitative predictive model of disruptive innovation.

Summary and Discussion of this Research

This study has focused on *disruptive innovation theory*, a theory developed by Harvard Professor Clayton Christensen (e.g. 1993; 1997). The theory is very popular because it offers fundamental insights into the "how and the why" of some of recent history's most impressive cases of company growth as well as its most shocking cases of company decline. The theory has enabled some innovation decision makers to develop highly lucrative innovation strategies (Christensen, 2006). However, to date it has not been possible to systematically forecast disruptive success or failure. Developing a disruptive business strategy has for this reason so far been an art rather than a science. In spite of its popularity and the numerous books and papers that have been written on this topic, until now the theory had not been sufficiently specified to enable quantitative analysts to build a predictive model to forecast disruptive success. Furthermore, the issue as to whether disruptive innovations always conquer the mainstream market 'from below' or whether they can also take over the mainstream 'from above' remained contested, with Christensen insisting on the former but others (e.g. Govindarajan & Kopalle, 2006b; Carr, 2005) arguing the latter.

This project involved undertaking an in-depth review of the disruptive innovation literature. It has also included analyzing a number of cases of disruptive innovation and potentially disruptive technologies that had been so classified by established disruptive innovation experts. These cases included what Christensen terms, 'high-end anomalies': expensive and technologically superior innovations that

are first adopted by high-tier customers but over time end up replacing the old market standard in the mainstream market.

This has been a qualitative research project that used the historical method to collect and analyze data. This study started by creating a clear and comprehensive overview of the constructs, categories and causal relationships that constitute disruptive innovation theory according to the academic literature. It then reviewed and revised these components of disruptive innovation theory through continuous iteration between analyzing historic case data and further developing theory. The project aimed to identify and resolve gaps and ambiguities through a process of aligning the historical case data with the constructs, categories and causal relationships that made up established disruptive innovation theory. The overarching goal of this research was to develop an internally consistent and externally valid theory that held ex-ante predictive power and could account for "high-end anomalies". To this end, this study removed variables comprising the current theory that could not be used for ex-ante prediction and those that did not apply to both 'regular' and 'high-end' forms of disruptive innovation.

Christensen's work on disruptive innovation draws heavily on *resources, processes, and values theory* (RPV) and the *value chain evolution theory* (VCE) as he himself acknowledges (Christensen, 2004). The current study found that the domains these theories cover, i.e. *business models* and *value networks*, contain a series of important ex-ante predictor variables for disruptive success. These variables consequently play a central role in the modified version of disruptive innovation theory this project developed. However, they also play a key role in Christensen's work so this does not constitute a deviation from the original theory, but merely a different emphasis. The revised theory completely preserves core disruptive

innovation theory's main premise, namely, that disruption is strongly correlated with incumbents exceeding demand in the old market, thereby enabling disruptors to attract these over-served customers with products that outperform incumbent products in a secondary or new performance area. The revised theory deviates from Christensen in that it does not contend that disruptors always target over-served customers with products that are simpler, cheaper and easier to use.

The literature and case study analyses conducted in this project found that disruptive success is to a large extent determined by the co-evolution between business models, value networks and product development. Again, this is no deviation from established theory. However, in order to make systemic ex-ante forecasting on the basis of this theory possible (and thus enable external validation) the theory's revision has linked these core components of Christensen's work to two old and well-established concepts from innovation theory that are not part of core disruptive innovation theory, namely the product life cycle and the technology adoption bell curve (Rogers, 1962/2003). This choice was made, tested and further developed through the before-mentioned process of continuously moving between theory and case data. This analytical process led to the identification of distinct patterns for each market tier early on, which, when further explored in the context of case data and the literature, were found central to ex-ante prediction. The analysis further led to the identification of two distinct disruptive innovation strategies, newly termed the *new market driver strategy* and *the secondary market driver* strategy. The probability of disruptive success in both cases is shaped by the compatibility between a firm's value proposition, the focus of demand, and the current phase of the product life cycle. Whereas the former strategy is aimed at creating a new market by introducing a radically different kind of (additional) functionality, the latter is aimed

at growing an existing market by moving the focus of demand on to a secondary market driver (i.e. not by introducing a new kind of functionality but by ensuring that products with the old kind of functionality are more reliable, convenient or cheaper to use). 'Functionality' refers in this context to a product's ability to perform a customer-defined "job" well.

Once this combination of factors had been developed into an internally coherent and logically consistent theory, a comprehensive set of measurable ex-ante predictor variables was developed and combined into a tree diagram (see appendix A). The variables in this diagram are presented as dichotomous questions, linked to each other by domain and all resulting in one of a number of mutually exclusive outcomes. This diagram can be used to systematically forecast the likelihood of disruptive success. The fact that this diagram has ex-ante predictive power but is not premised on a disruptive attack 'from below' shows that the 'from below' feature is not an essential component of disruptive innovation theory. The case studies included in this project naturally bear this out as they form the basis upon which the theory was modified.

A strength of an anomaly-driven research approach is that a hypothesis can be falsified on the basis of a small-N study. The example of Eastman Kodak alone demonstrates that Christensen is wrong to insist that disruption always happens 'from below'. What happened to Kodak is considered to be a classical case of disruptive innovation, even by Christensen himself (Christensen & Euchner, 2011). However, the fact is that digital cameras were first adopted by professional photojournalists, a 'high-end niche market', and later entered the mainstream 'from above' at a time when the film-based photography market was characterized by price wars. Digital cameras were not a simple, cheap and easier to use alternative to, for example, the

single use film-based cameras that dominated the low-end of the mainstream market at the time. They were adopted tier by tier by consumers who greatly valued the new functionality digital cameras offered and bought them as soon as the product came within their price bracket. Thus, it cannot be said that the digital camera disrupted 'from below'.

It has been the aim of this paper to further develop disruptive innovation theory so as to enable external validation through systematic forecasting. While it is straightforward to falsify a hypothesis on the basis of a small-N qualitative study, it is generally not possible to conclusively prove the general applicability of new theoretical insights that are based on only a few cases. Given that it was not within the scope of this project to establish the generalizability of its revision of disruptive innovation theory across a large number of cases, the goal of this research has been to do all the groundwork of that possibility for a future quantitative study. This is the first study to develop a comprehensive operationalized measure of disruptive innovation theory that can be used to systematically forecast the likelihood of a project's disruptive success on the basis of information that is available in public domain before market disruption occurs (if it occurs). This constitutes its main contribution to the academic literature and to the professional world of innovation management: the measure can be used as it is to evaluate the probability of disruptive success or it can be used as the basis for quantitative predictive modeling.

Can Disruptive Innovation Theory Account For "High-End Anomalies"?

Clayton Christensen has argued that expensive and/or technologically superior innovations that are first adopted by higher tier customers and conquer the mainstream from above should not be termed "high-end disruptive innovations", even if they do leave the previous market leader flat-footed and unable to respond

effectively (Christensen, 2006, pp. 50-51). According to his original theory, aspiring disruptors succeed because they remain under the radar long enough to build up the resources and momentum needed in order to rapidly conquer the mainstream from below once they embark on their "upmarket march". When this happens incumbents are caught off-guard and poorly prepared. Disruption consequently takes place because incumbent firms are too slow and too inflexible to respond in an adequate and timely manner to the new threat.

According to Christensen, the idea that incumbents do not value potential disruptive innovations *because their most important customers do not want them* is central to disruptive success. According to this view, incumbents are happy to cede low-end customers to disruptors because they do not perceive them as a threat. Instead of fighting over an unattractive segment with low-margins, incumbents choose to focus on the higher tiers in the market. Christensen argues therefore that aspiring disruptors can develop footholds in low-margin markets without too much fear of incumbent retaliation. However, he contends that incumbents would never let go off their most lucrative customers (the mainstream and higher tiers) without a fight. He holds that if these segments express an interest in an innovation, incumbents will not ignore the new product. As a consequence, he argues that if an aspiring disruptor were to attempt to create a foothold at the high end of the market on the basis of a product that high-end customers value, the firm would almost certainly quickly become the target of fierce incumbent retaliation. Given the power imbalance between incumbents and most aspiring disruptors, this is a fight the latter are unlikely to win. This is the reason why Christensen contends that disruptors always conquer the mainstream market "from below". He argues that conquering from below is a central part of his definition of "disruptive innovation", pointing out that if this

component were removed from the theory "disruption" merely becomes a description that can only be applied post-hoc (Christensen, 2007, p. 50).

The aim of this project has been to eliminate ambiguities from disruptive innovation theory and add the detail needed to enable validation through systematic forecasting. The goal has been to develop a diagram consisting of a comprehensive set of predictor variables and mutually exclusive outcomes able to predict disruptive success. The resulting tree diagram can be found in appendix A. The fact that a predictive model can be developed without the attack-from-below variable demonstrates that it is not an essential part of the definition of disruptive innovation. The case study on Eastman Kodak supports removal of this part of the current definition. What happened to Kodak has often been described as a classic case of disruption, even by Clayton Christensen himself (Christensen & Euchner, 2011). However, digital photography did not conquer the film-based market "from below". Like the first adopters of the cell phone, the first adopters of digital cameras were high-end professionals. They were photo journalists to whom the job "transmitting images quickly" held such great importance that they were willing to spend thousands of dollars on products whose performance in terms of the old market driver, *capturing memories in image format*, was inferior compared to significantly cheaper film-based cameras.

The digital camera did not conquer the mainstream "from below". As the case study on Eastman Kodak shows, the analog photography market had come to be marked by price wars and commodification by the late 1990s. Established incumbents fought each other on price and introduced cheap single-use film-based cameras in order to attract price-conscious customers. As a consequence, digital cameras were not cheaper or more affordable in usage compared to film-based cameras when

mainstream customers started to adopt them in the late 1990s. They had come down in price significantly since they were first introduced and this enabled their mass-adoption. They would come down in price even further during the first decade of the 21st century as a result of commoditization and eventually they would be disrupted by the smart phone. However, at the turn of the millennium they were not the low-cost option to go for if you were a price conscious amateur photographer. Digital photography is a well-established case of disruptive innovation, but digital cameras conquered the mainstream "from above".

The fact that digital photography constituted a "high-end disruption" may explain why Kodak immediately grasped the implications of the new technology for film-based photography when two of its engineers developed the world's first digital cameras in the late 1970s. The firm was the industry leader in digital photography R&D throughout the 1980s and 1990s and was among the first to commercialize digital cameras. As demonstrated in the case study, Kodak became disrupted by the rise of digital photography, not because the technology was off Kodak's radar, but because the firm could not identify a business model in the emerging world of digital photography that was as lucrative as its razor and blades business model had been in the film-based photography market. The firm's inability to find a business opportunity in the digital world that could support Kodak's existing cost structure and need for growth appears to have clouded the judgment of too many of its employees. It almost certainly contributed to the firm's mistaken estimate of the speed at which amateur photographers around the world would abandon film-based photography for digital photography. Furthermore, this purported misconception also accounts for the firm's unwillingness to harm its film-based business model in any way, in spite of the fact

that this made it significantly harder for Kodak to establish itself properly in the emerging digital world.

The case study of Eastman Kodak shows that an incumbent can become disrupted by a radically new technology under four circumstances: 1) even if the firm knows that higher tier customers value the new product; 2) even if the firm immediately understands that the new product is likely to radically alter the existing market; 3) even if the incumbent manages to gain a significant share of this emerging market; and 4) on the basis of a convenient and affordable product that is based on the new technology (e.g. Kodak's easy share range).

The case studies about the amateur photography market and the electric vehicle industry both deal with incumbents who proactively tried to commercialize a disruptive technology before aspiring disruptors even came on to the scene. Incumbents in both markets were motivated to commercialize a new technology at a time when mainstream customers did not express any interest in the innovation. In both cases, the first products were targeted at a small, high-end, niche market. Incumbents in both sectors undertook a large amount of R&D related to the new technology and incumbents in both industries managed to get significant market shares in the emerging markets. Nevertheless, no incumbent in either market was able to develop a product or a business model that was commercially viable. Kodak, consequently, went bankrupt and incumbents in the automobile market were forced to support their loss by making sales through public subsidies and profits made in their mainstream business.

The case studies show that the main reasons incumbents in both the electric vehicle and photographic industries failed at making their respective disruptive technologies a commercial success are, firstly the fact that they did not identify a

customer value proposition that played to the strengths of the new technology and secondly, the fact that they did not align their business models and value chains with a value network that was based on the strengths of the new technology. In both case studies, we find that incumbents attempted to develop and commercialize potentially disruptive technologies in the contexts of value networks that were aligned with the old established market rather than the new emerging one. Furthermore, they attempted to develop them on the basis of business models that had been fine-tuned to value propositions that were targeted at the old market driver.

The case studies highlight that the domains of business models, value chains and product development contain key ex-ante predictor variables for disruptive success. They show that the pattern of co-evolution between these domains (or lack thereof) determines disruptive success or failure. By linking this insight to established constructs in innovation theory, i.e. the product life cycle and the technology adoption bell curve, this research has further developed and operationalized disruptive innovation theory so that it can be used for systematic forecasting. This study found that an internally valid and consistent theory could be constructed without restricting the construct of "disruptive innovation" to market disruption "from below".

Recommendations for Further Study

Many have argued (e.g. Barney, 1997; Danneels, 2004) that the optimal way to test the validity of a theory is to build an accurate predictive model that adequately reflects its content, i.e. the set of theoretical constructs and the hypothesized relationships between them. As discussed, this project's aim has been to lay the groundwork for such predictive modeling. On the basis of a detailed analysis of documented historic innovation projects and the disruptive innovation literature, this research has identified and operationalized the key constructs, categories and causal

relationships that characterize disruptive innovation. By separating essential components of disruptive success from those that are merely ancillary, this research has clarified existing theory and shown that disruptive innovation theory can account for both disruptive innovations that take over the mainstream market from below and those who do so from above. On the basis of this project's findings and outputs, future researchers will be able to test and fine-tune the theory further using quantitative means.

Sampling and Data Collection

This research uses publicly available information about historic innovation projects for sampling and data collection. Modern technology makes it possible to analyze and compare information contained in various distinct databases simultaneously in an efficient and low-cost manner. Given that information relating to specific historic innovation projects may be stored in different locations, it would be necessary to identify all the relevant data sets in order to enable cross-analysis.

In order to avoid the criticism Clayton Christensen received regarding his data collection and sampling methods, namely that he sampled on the dependent variable and only included cases that supported his theory, the aim should be to select samples that are as random as possible given the circumstances. However, a study based exclusively on publicly available data faces some constraints. Firstly, failed innovation projects tend to go under-recorded which means that there is significantly less publicly available information about failed innovation projects than about successful ones. A truly random sample of the available data would therefore very probably result in a significant underrepresentation of failed projects.

This discrepancy can be rectified statistically during the data analysis phase. However, it would still be necessary to ensure that a minimum number of data points

be collected for each variable for these failed projects in order to ensure that statistical weighing does not result in distortion as a result of a small number of atypical failed projects that were included in the sample by chance. Secondly, it might be the case that for some of the predictor variables developed during this study little or no data is publicly available, in which case the variable would need to be excluded from analysis.

Therefore, while this study recommends taking advantage of the abundance of information that is available in the public domain and the ease with which this data can be accessed and analyzed using modern technology, it acknowledges that limiting the study to publicly available data imposes constraints on both the selection of indicators for modeling and the construction of the sample itself.

This research suggests that a diverse set of industries be included and that some overlap is ensured with industries studied by Clayton Christensen and other established disruptive innovation experts to enable theoretical comparison. To be selected for analysis, industries would need to be characterized (or historically have been characterized) by at least two products that each offers a radically different set of performance attributes so that disruption in that industry is at least a theoretical possibility. Furthermore, this study recommends selecting cases that have been well documented to avoid unnecessary gaps in the data.

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APPENDICIES

Appendix A: Predictor Variables and Tree Diagram (Consolidated)

The Appendix A consolidated ex-ante predictor variables identified for disruptive innovation that relate to regulations, market conditions and industry standards are shown in Figure 13 below. This tree diagram contains all ex-ante predictor variables found in this study. Appendix A enables business strategists and innovation planners to assess the likelihood of disruptive success of a product before its commercialization.

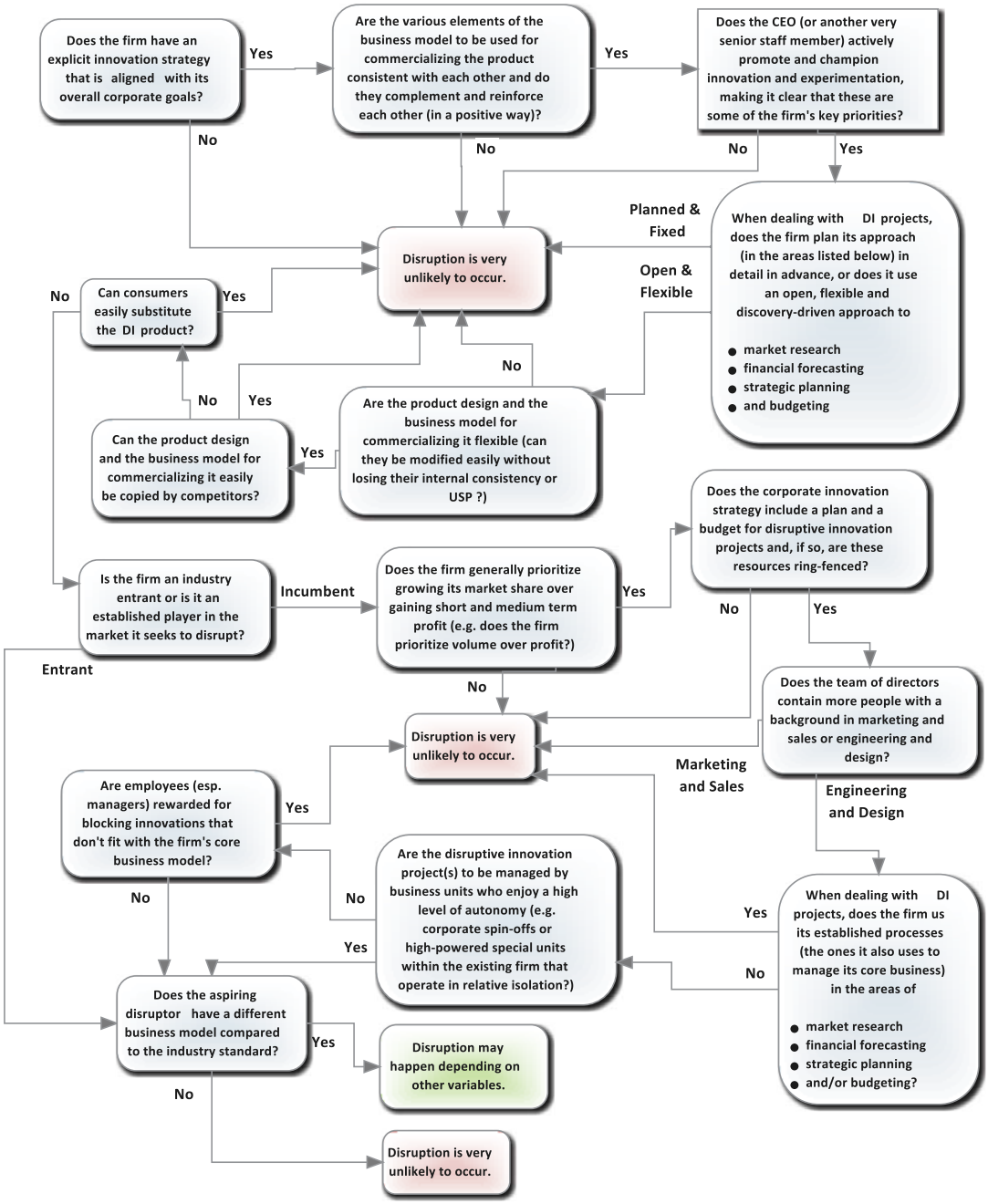

Figure 13 - Decision Paths; Part One

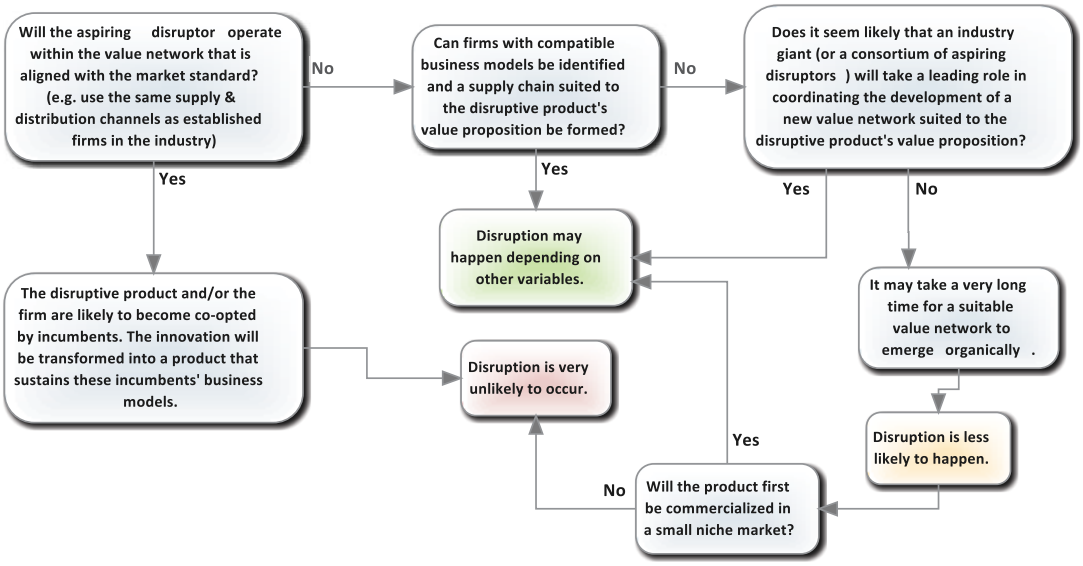

Figure 14 - Decision Paths; Part Two

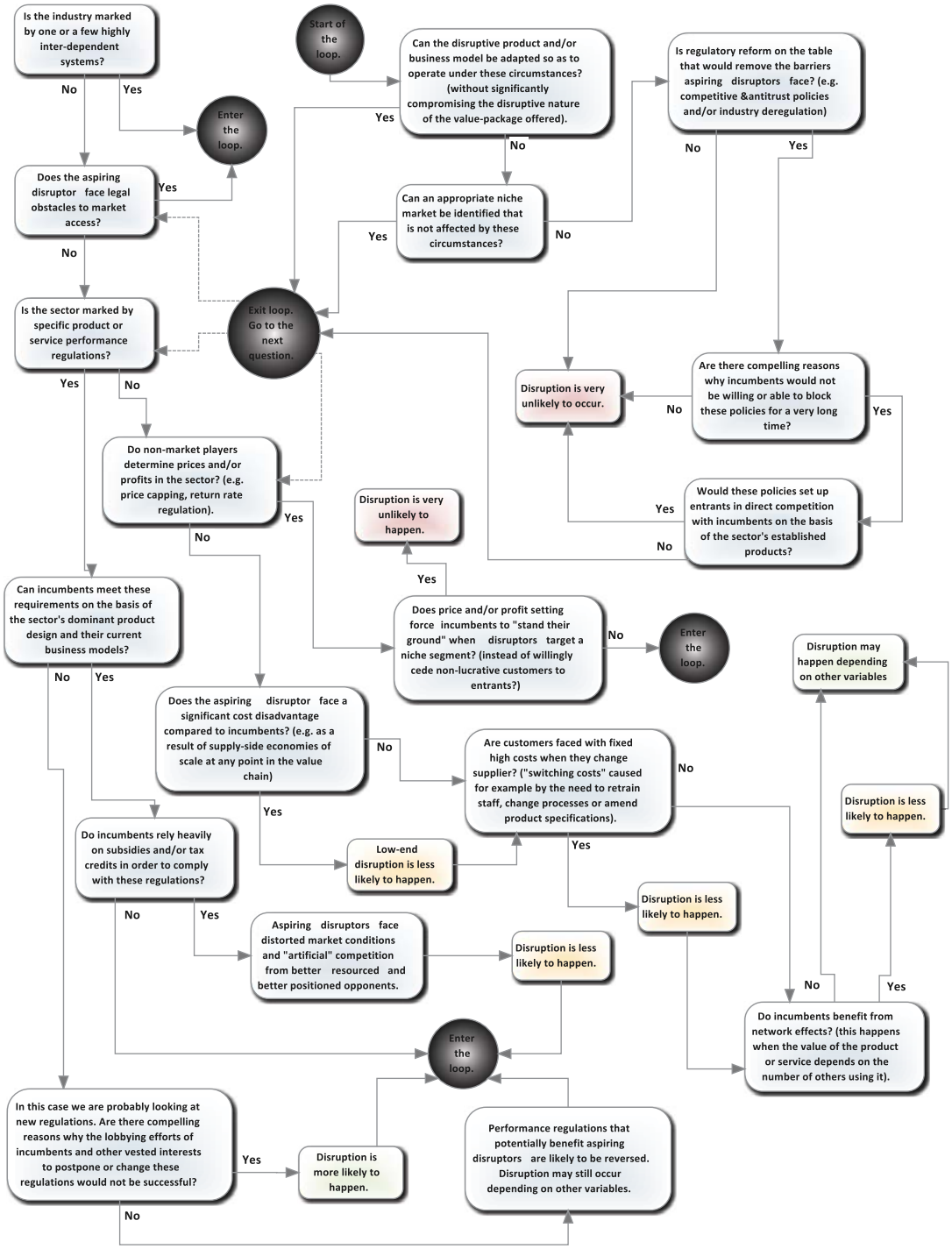

Figure 15 - Decision Paths; Part Three

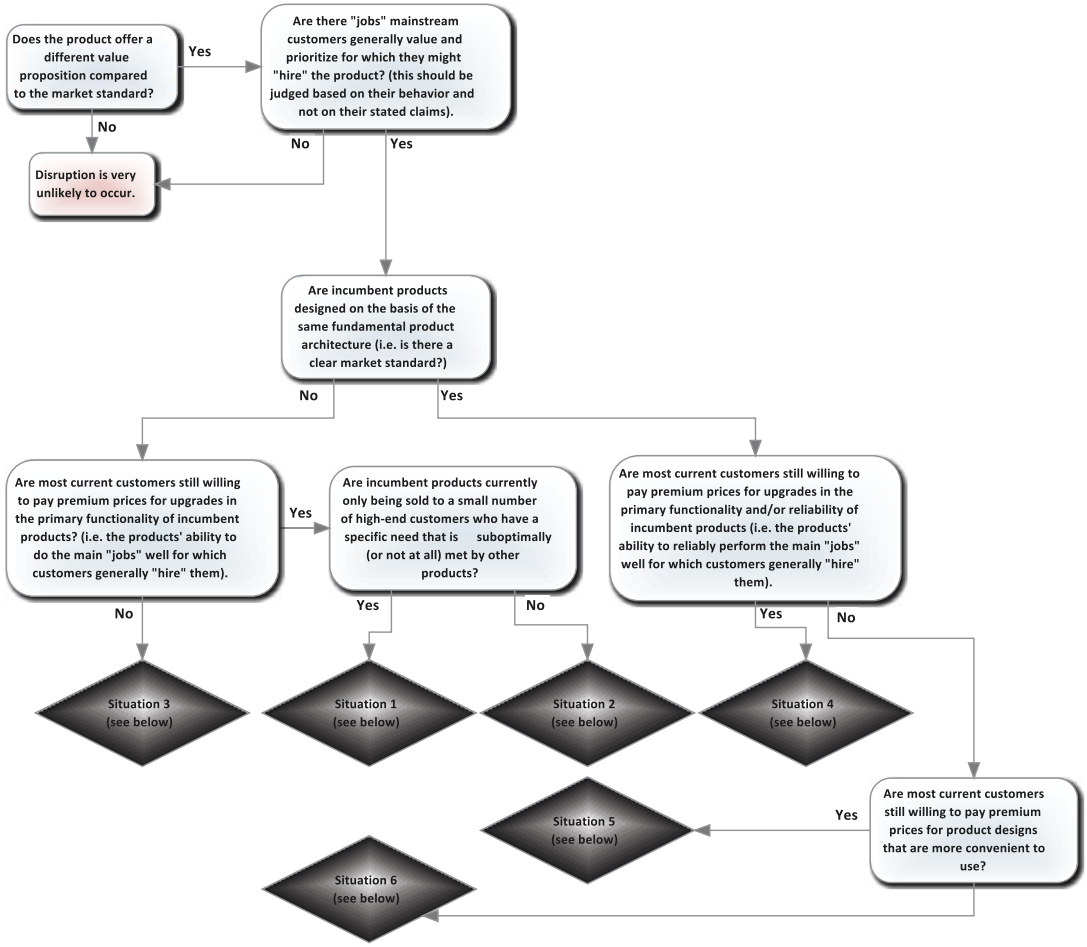

Figure 16 - Decision Paths; Part Four

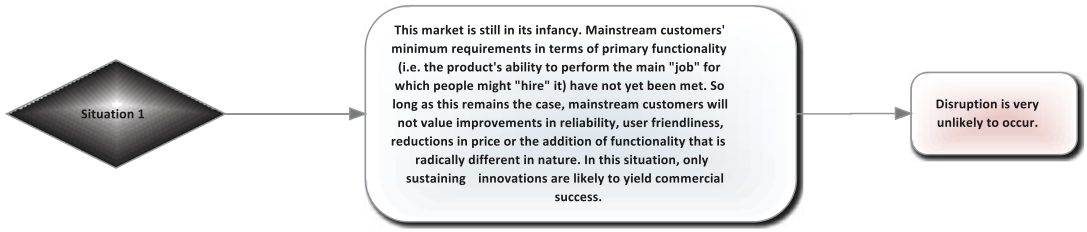

Figure 17 - Decision Paths; Situation One

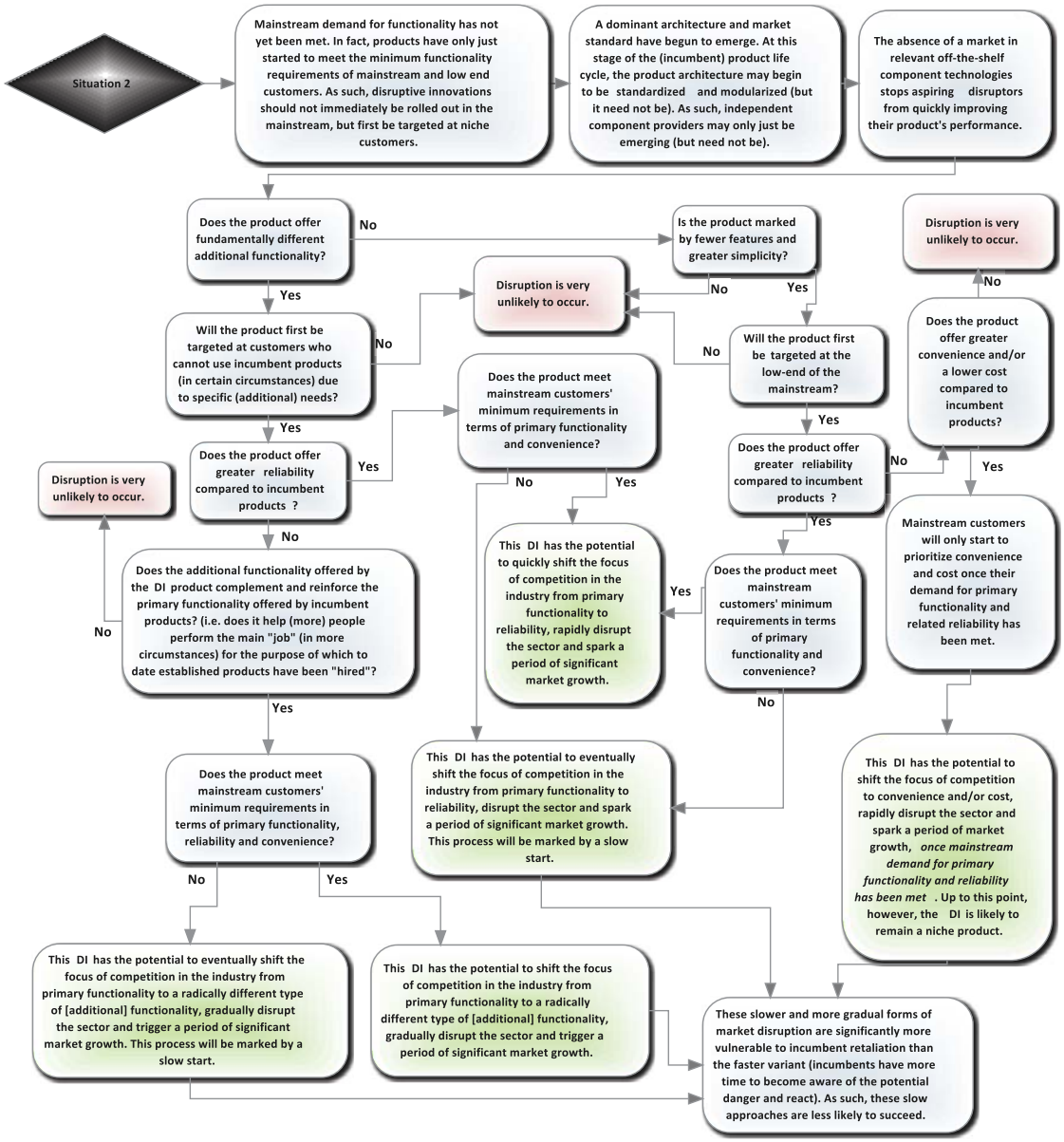

Figure 18 - Decision Paths; Situation Two

Figure 19 - Decision Paths; Situation Three

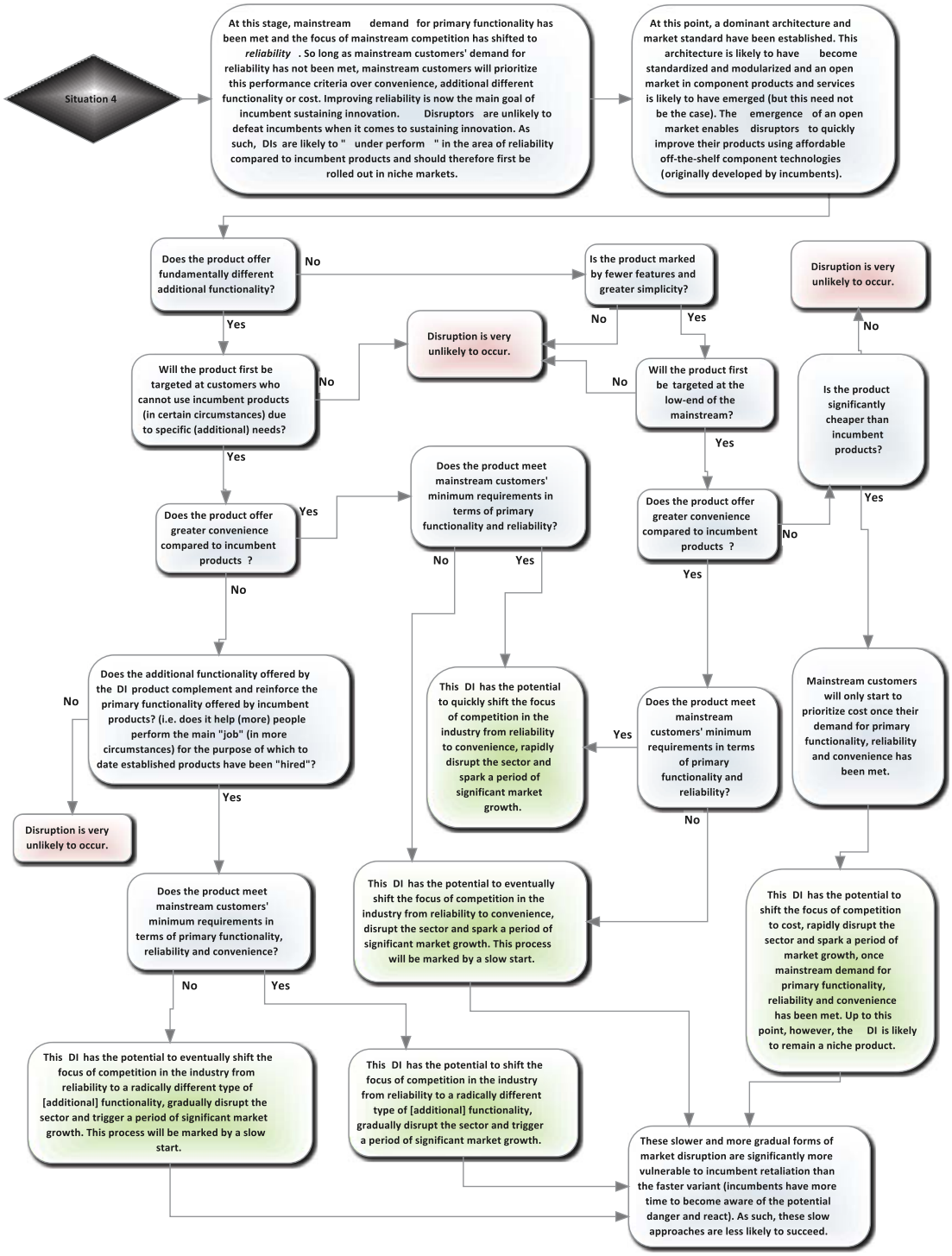

Figure 20 - Decision Paths; Situation Four

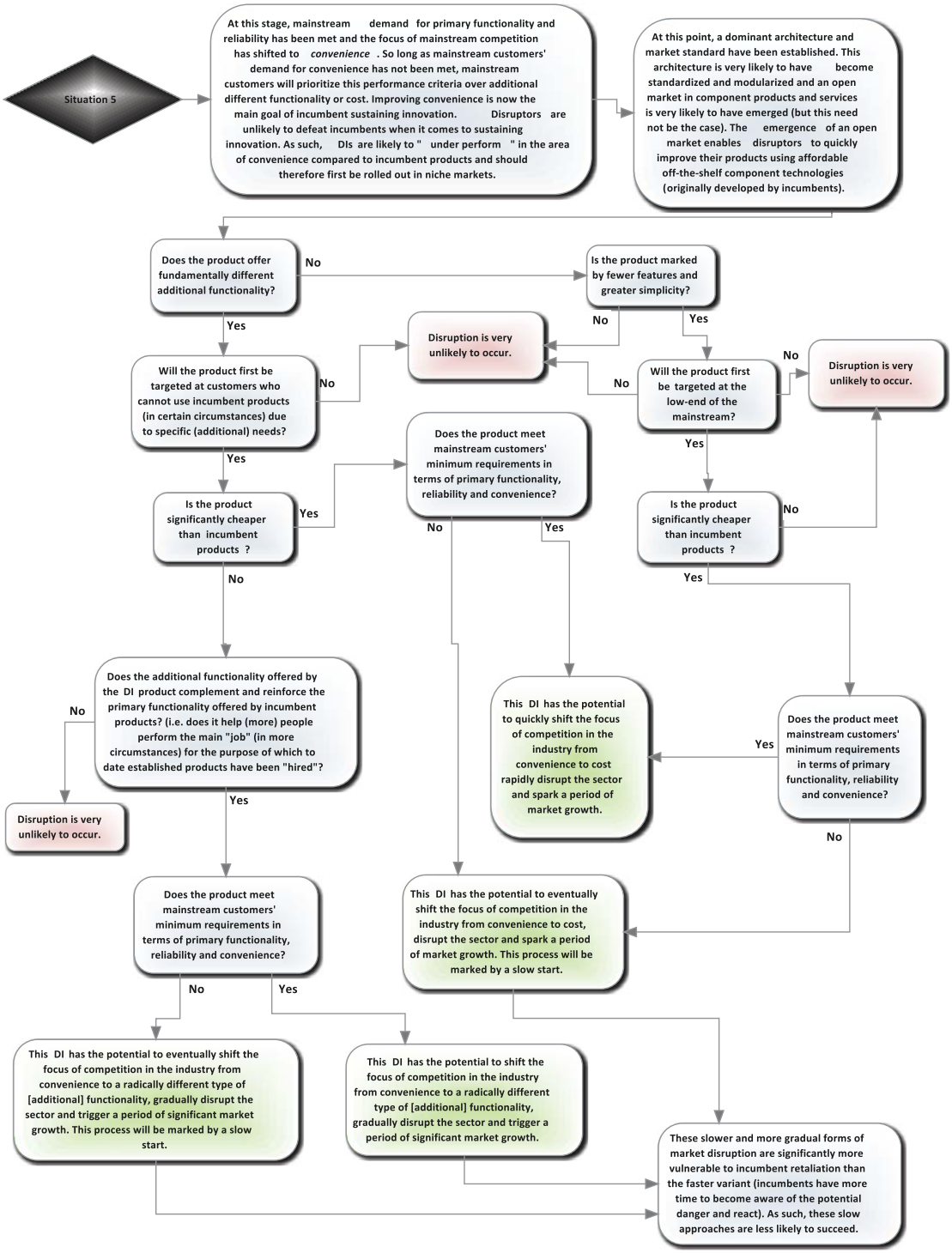

Figure 21 - Decision Paths; Situation Five

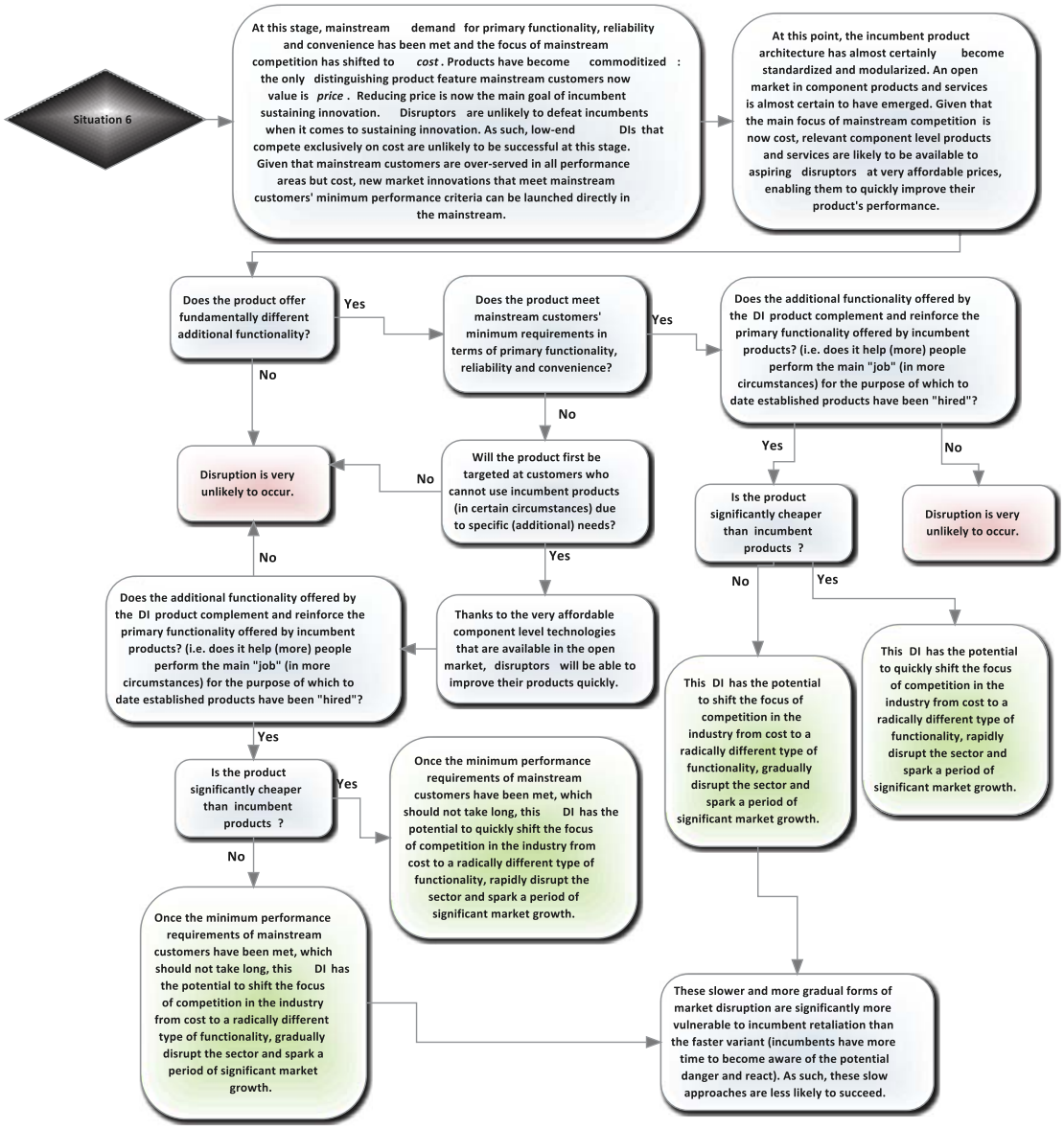

Figure 22 - Decision Paths; Situation Six

Appendix B: Predictor Variables and Tree Diagram (Scenarios)

The ex-ante predictor variables identified for disruptive innovation that relate to regulations, market conditions and industry standards are shown in Figure 23 below.

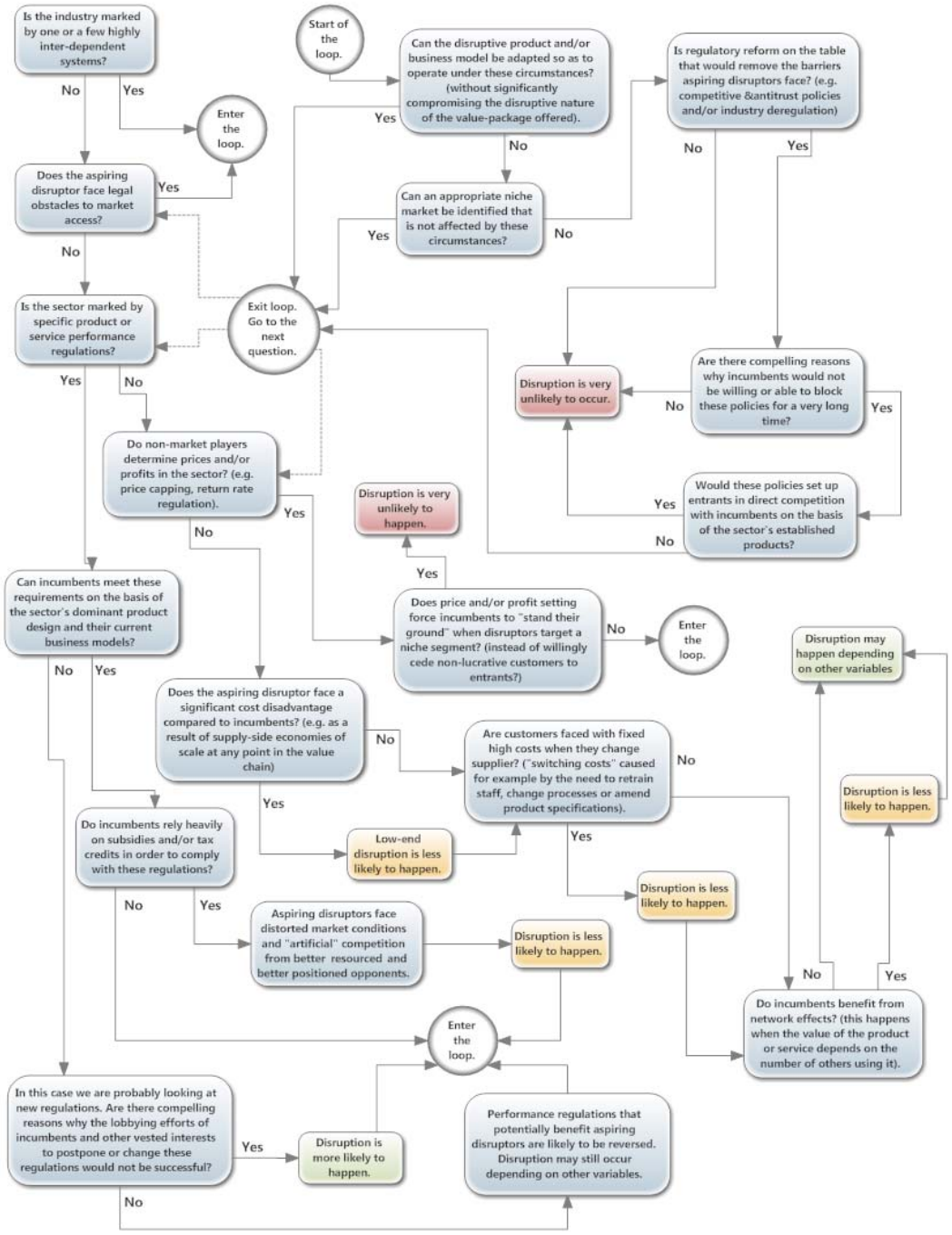

Figure 23 - Regulations, Market Conditions and Industry Standards: Ex-Ante Predictor Variables for Disruptive Innovation

The indicators are presented in the form of a tree diagram. This tree diagram form part of the larger tree diagram presented in Appendix A, which contains all ex-ante predictor variables found in this study.

Technology, Product Design, Demand: Predictor Variables & Tree Diagram

The ex-ante predictor variables identified for disruptive innovation that relate to technology, product design and demand are shown in Figures 24 to 28 below.

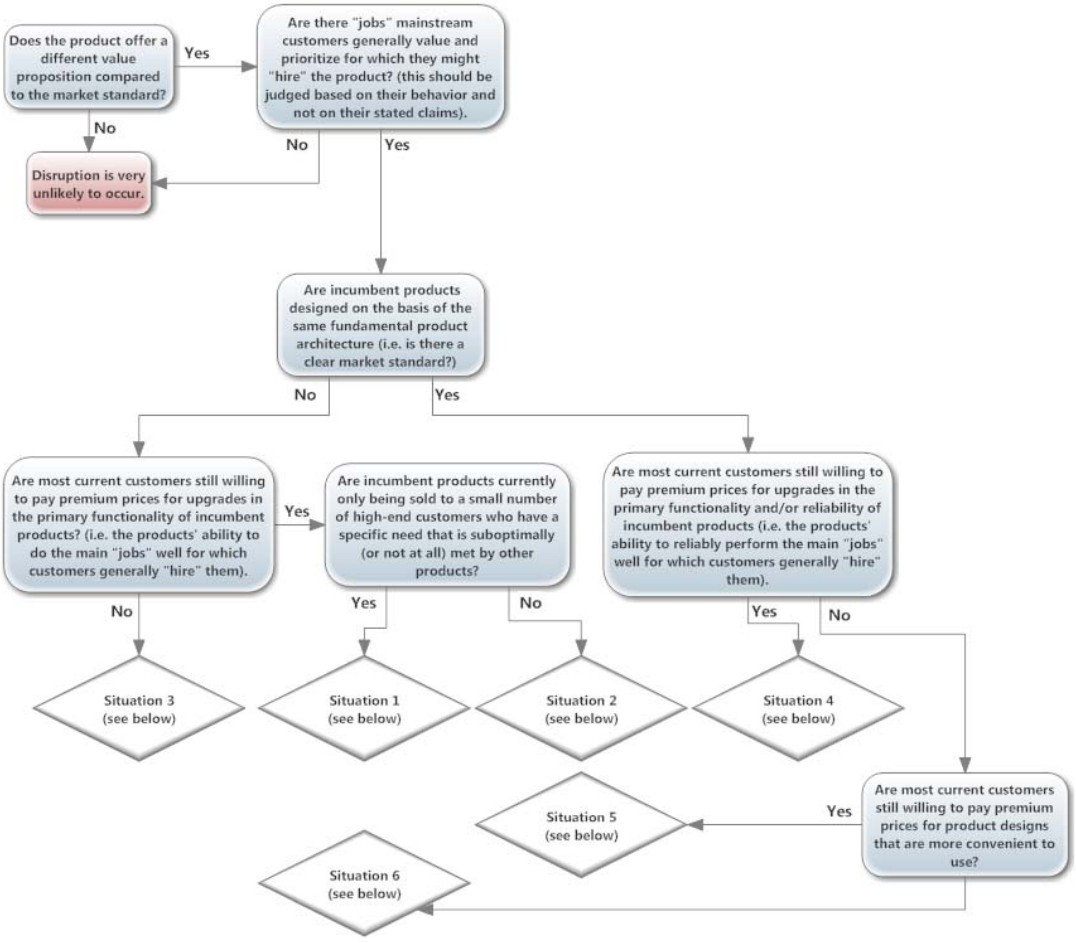

Figure 24 - Technology, Product Design and Demand: Ex-Ante Predictor Variables for Disruptive Innovation

Tree diagrams reflect these indicators and comprise a smaller part the larger tree diagram presented in Appendix A., which contains all ex-ante predictor variables found in this study. Appendix A enables business strategists and innovation planners

to assess the likelihood of disruptive success of a product before its commercialization.

Any Situation

At any point during the product life cycle, aspiring disruptors can "reset" the focus of mainstream competition to *functionality* by introducing a product that offers radically different (additional) functionality ("functionality B"). In this dissertation, I refer to this strategy as the *new market driver approach*. For a discussion of this approach, see Chapter 6.Its success in other situations depends on:

1. Whether the new product meets the minimum performance requirements of customers in the original market in terms of "functionality A", reliability and convenience.
2. The relative appeal of "functionality B" to customers who primarily buy a product because of "functionality A" (and vice versa).
3. The extent to which customers in the original market are "over-served" by incumbents in terms of "functionality A", reliability and convenience.

This strategy is very unlikely to succeed in a newly emerging market (Situation 1, see below).

Situation 1

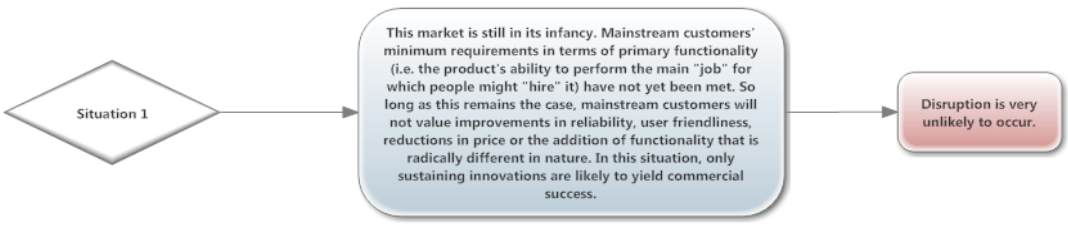

Figure 25 - Tree Diagram Situation 1

In Situation 1, the product is still in its infancy and sales volumes are low. (Figure 25 reflects Situation 1 and illustrates a product in its infancy.) The product does not yet meet mainstream customers' minimum requirements for functionality (ability to get a specific job done) and as a consequence few people have adopted it. In Christensen's terms: a small number of customers are "hiring" the product in spite of its suboptimal performance because they are very motivated to get a specific "job" done – and there are no better products on the market to perform this job. In terms of customer segmentation: at this stage only high-end customers are buying the product (in his 1962 work *Diffusion of Innovations*, Everett Rogers refers to these early customers as "innovators"; they account for about 2.5% of the total market). Innovators tend to be well educated and wealthy. People who lack the required skills or funds will be deterred from early adoption and will continue to use outdated and inferior methods to get the specific job done.

Mainstream customers will not value improvements in reliability, user friendliness, reductions in price or the addition of functionality that is radically different in nature so long as the product does not meet their minimum needs in terms of ability to get the main job done for which they intend to "hire" the product. Furthermore, *until products or services start to exceed customers' demand for functionality, customers will base their buying decisions primarily on this criterion*. Therefore, in this phase, only innovations that improve products' ability to get their main job done (functionality A) are likely to be commercially successful. Products offering radically different functionality may create new separate markets, but will not disrupt this particular infant industry – unless they also meet customers' minimum requirements in terms of the main functionality products in this market offer (which

would mean outperforming the firms who introduced the product). See Chapter 6 for a full discussion of this topic.

Given that no market standard has yet emerged, no standardization is possible and no open market in relevant component products and services exists yet. This constitutes a significant obstacle for aspiring disruptors, as disruptive innovations tend to be architectural innovations made from "off-the-shelf" component technologies. Component level R&D tends to be significantly more costly than architectural R&D and is beyond the reach of many aspiring disruptors.

Situation 2

At the point reflected in Situation 2, a dominant architecture and market standard begin to emerge and products start to meet the minimum functionality requirements of mainstream and low-end customers. As a consequence, total product adoption rises to about 15% of the total market. Once a particular architectural design starts to dominate the market, component standardization and product modularization become possible (but by no means inevitable). If an open market in component products and services emerges, aspiring disruptors may be able to meet target customers' minimum expectations regarding functionality without needing to make prohibitively expensive investments in component innovation R&D. The latter is significantly more costly than architectural innovation R&D and constitutes a specific strength of large incumbent firms (not of small entrants with low cost structures).

Figure 26 below illustrates Situation 2. This reflects the likelihood of a shift in the focus of competition in the industry from *functionality* to *reliability* being triggered and a period of significant market growth being sparked.

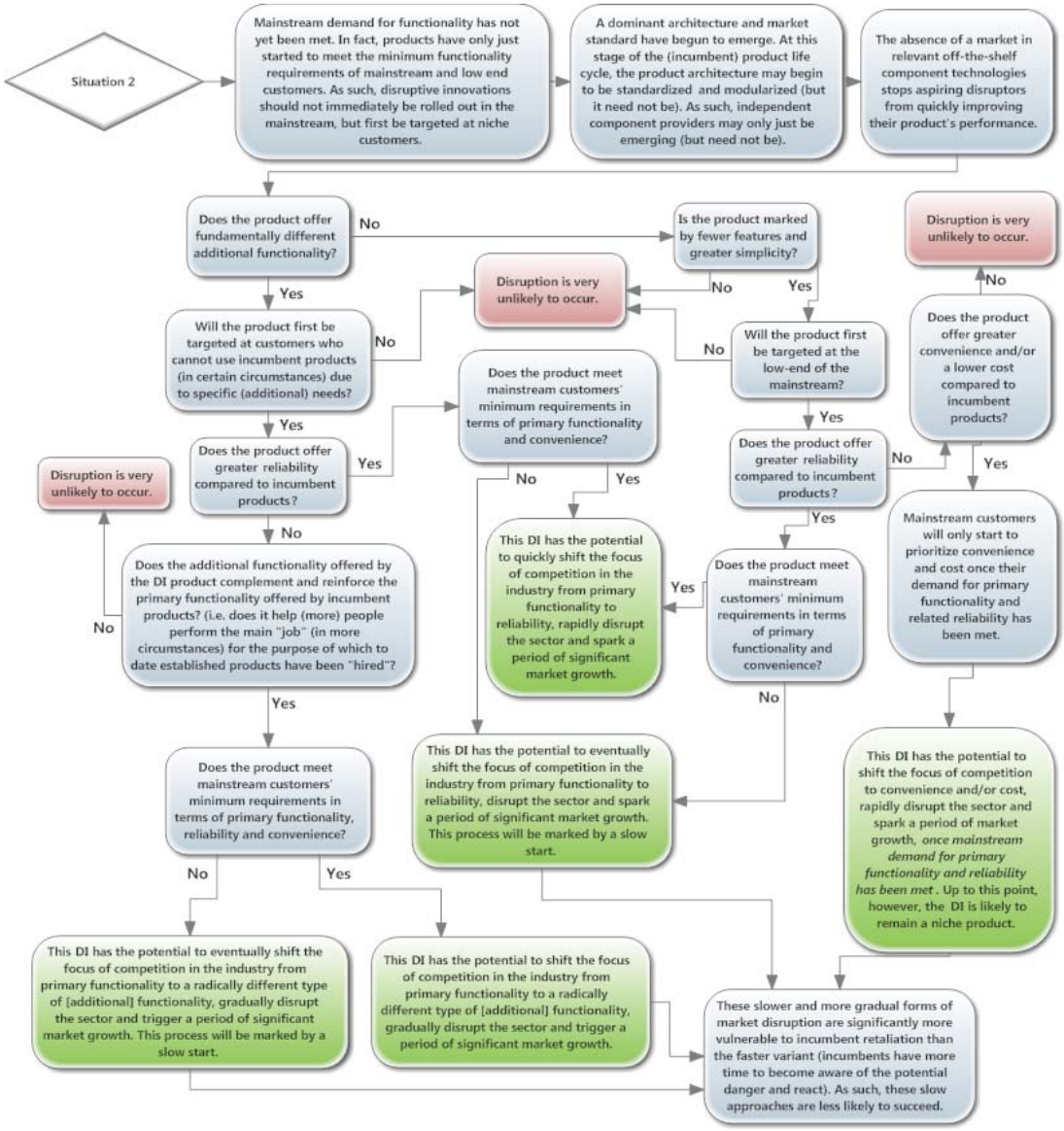

Figure 26 - Tree Diagram Situation 2

Being less wealthy and less skilled than the products' initial adopters, mainstream and low end customers tend to require higher levels of performance before they can effectively use a product. The minimum performance requirements of high-end customers are therefore *lower* than those of mainstream or low-end customers. High-end customers are, however, the last segment to stop valuing further sustaining upgrades in any given performance area. Demand for further performance improvements in the area of functionality is first met in the low end of the mainstream. Once this demand has been met (which will happen during this phase)

low-end customers will start to prioritize performance in the area of *reliability*. During this phase, there are also still a significant number of non-consumers: people who do not or cannot use mainstream products (in certain circumstances) because they lack the required skills or resources to use the product or service effectively.

In this situation, rapid industry disruption and significant market growth may be brought about by products that meet the following four conditions:

1. They meet mainstream customers' minimum requirements in terms of primary *functionality* and *convenience* (i.e. ability to perform the main task for which customers intend to "hire" the product – and to do so in a convenient manner).

2. They offer either:

   - fundamentally different (additional) functionality and *greater reliability*; or
   - fewer features (greater simplicity) and *greater reliability*

3. They are first rolled out in appropriate foothold markets (and not directly in the mainstream). Products offering additional functionality should first be rolled out in a *new market* foothold: gaining initial customers among people who cannot use incumbent products (in certain circumstances) due to specific (additional) needs. Products offering fewer features and greater simplicity should initially be targeted at the *low end* of the mainstream: gaining initial customers among people who are over-served by incumbent products in terms of product functionality.

4. They are introduced into the mainstream market when mainstream customers start to lose their willingness to pay premium prices for further upgrades in terms of incumbent products' primary functionality.

If these conditions are met, the introduction of the new product into the mainstream market is likely to trigger a shift in the focus of competition in the

industry from *functionality* to *reliability* and spark a period of significant market growth.

Situation 3

The following diagram represents Situation 3, in which aspiring disruptors should enter the mainstream market directly.

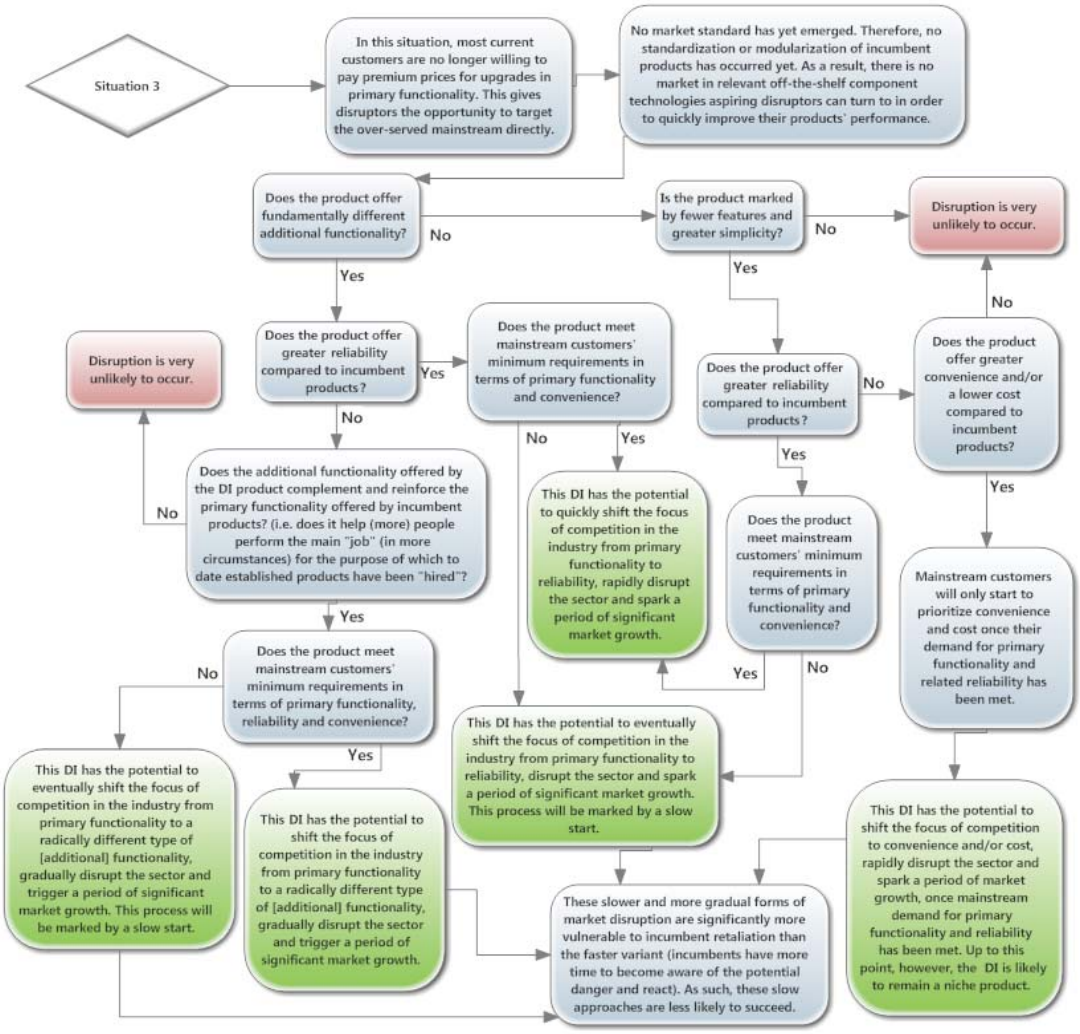

Figure 27 - Tree Diagram Situation 3

As Figure 27 illustrates, in Situation 3 most current customers are no longer willing to pay premium prices for upgrades in *functionality*, yet no market standard has emerged. This suggests that the "job" for which customers "hire" this product can easily be performed in a number of equally viable ways – or that the product has been developed to perform a "job" customers do not value or prioritize. If the latter is

the case, the market offers little prospect for significant growth. If the former is true, *rapid industry disruption and significant market growth may be brought about by products that meet all of the following four conditions:*

1. They meet mainstream customers' minimum requirements in terms of primary *functionality* and *convenience* (i.e. ability to perform the main task for which customers intend to "hire" the product – and to do so in a convenient manner).

2. They offer either:

   - fundamentally different (additional) functionality and greater reliability, or
   - fewer features (greater simplicity) and greater reliability

Given that established products are already "overshooting" mainstream customers in terms of primary functionality, aspiring disruptors should enter the mainstream market directly.

Situation 4

Figure 28 below represents the options for Situation 4. In this situation, a shift in the focus of competition in the industry from *reliability* to *convenience* is triggered and a period of significant market growth occurs.

As indicated in Figure 19, in Situation 4 the market is characterized by *performance oversupply* in terms of functionality: incumbent products offer a higher level of performance in this area than mainstream customers can use or value. Only high-end customers still value improvements in functionality. The related shift in mainstream demand from a focus on functionality to a focus on reliability (possibly triggered by a disruptive product) will probably lead to significant market growth: during this phase total product adoption is likely to rise to about 50% of the total market. In Rogers' terms, the product has now been adopted by the following population segments: *innovators*, *early adopters* and *the early majority* (Rogers, 1962/2003).

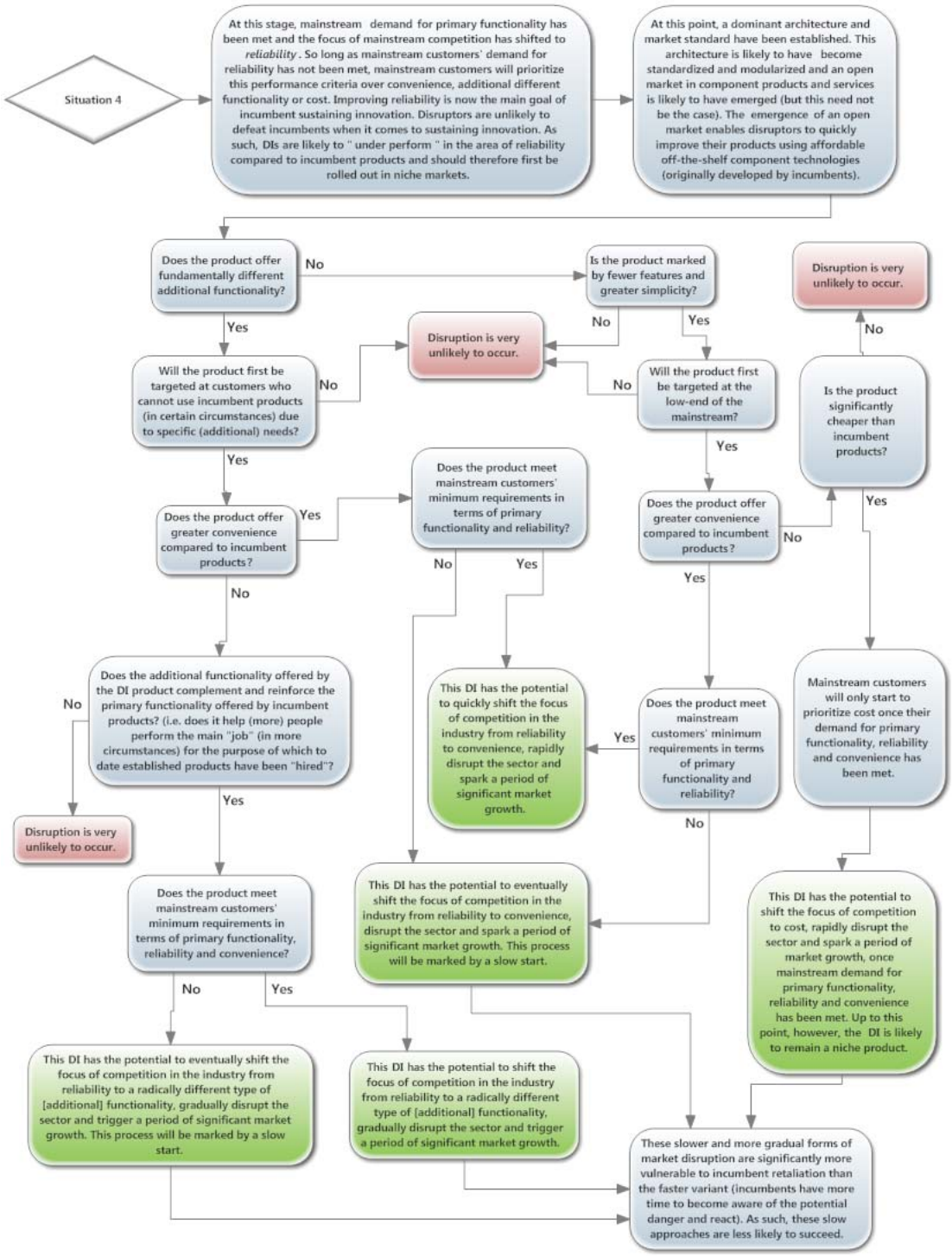

Figure 28 - Tree Diagram Situation 4

There are however still a significant number of non-consumers: people who do not or cannot use mainstream products, or who do not or cannot use mainstream products in certain circumstances because they lack the required skills or resources. In addition, the "early adopters" tier may include a significant number of low-end

customers who are content with lower levels of functionality and reliability than mainstream customers. Once products satisfy their (relatively low) requirements in these areas they will start to base their purchasing decisions on performance in the areas of *convenience* and *price*. Non-consumers and low-end consumers constitute a viable foothold market for aspiring disruptors whose products meet the groups' respective minimum requirements regarding functionality and reliability and who offer a superior performance in terms of convenience and/or a lower price. If an open market in relevant component technologies has emerged, aspiring disruptors may now be able to meet target customers' minimum expectations regarding product performance using "off-the-shelf" component innovations developed by incumbents.

In Situation 4, rapid industry disruption and significant market growth may be brought about by products that meet all of the following four conditions:

1. They meet mainstream customers' minimum requirements in terms of *functionality* and *reliability* (i.e. ability to perform a specific task well and to do so reliably)

2. They offer either:

   - fundamentally different (additional) functionality and more convenience, or
   - fewer features (greater simplicity) and more convenience

3. They are first rolled out in appropriate foothold markets (and not directly in the mainstream). Products offering additional functionality should first be rolled out in a *new market* foothold: gaining initial customers among people who cannot use incumbent products (in certain circumstances) due to specific (additional) needs. Products offering fewer features and greater simplicity should initially be targeted at the *low end* of the mainstream: gaining initial customers among people who are over-served by incumbent products in terms of product functionality and reliability.

4. They are introduced into the mainstream market when mainstream customers start to lose their willingness to pay premium prices for further upgrades in terms of incumbent products' reliability.

If all of these conditions are met, the introduction of the new product into the mainstream market is likely to trigger a shift in the focus of competition in the industry from *reliability* to *convenience* and spark a period of significant market growth.

Situation 5

Figure 29 below illustrates Situation 5. Situation 5 illustrates the likelihood of a shift in the focus of competition in the industry from *convenience* to *price*. As represented in Figure 29, in Situation 5 the market is characterized by *performance oversupply* in terms of functionality and reliability: incumbent products offer a higher level of performance in these areas than mainstream customers can use or value. Only high-end customers still value improvements in functionality and reliability. The related shift in mainstream demand from a focus on reliability to a focus on convenience (possibly triggered by a disruptive product) will probably lead to significant market growth: during this phase total product adoption is likely to rise 85% of the total market. There are still people, who Rogers terms the *laggards* (Rogers, 1962/2003), who do not or cannot use mainstream products or who do not or cannot use mainstream products in certain circumstances. Low-end customers are content with lower levels of functionality, reliability and convenience than mainstream customers. Once products satisfy their (relatively low) requirements in these areas they will start to base their purchasing decisions solely on *price*. If an open market in relevant component technologies has emerged, aspiring disruptors may now be able to meet target customers' minimum expectations regarding

functionality and reliability using "off-the-shelf" component innovations developed by incumbents.

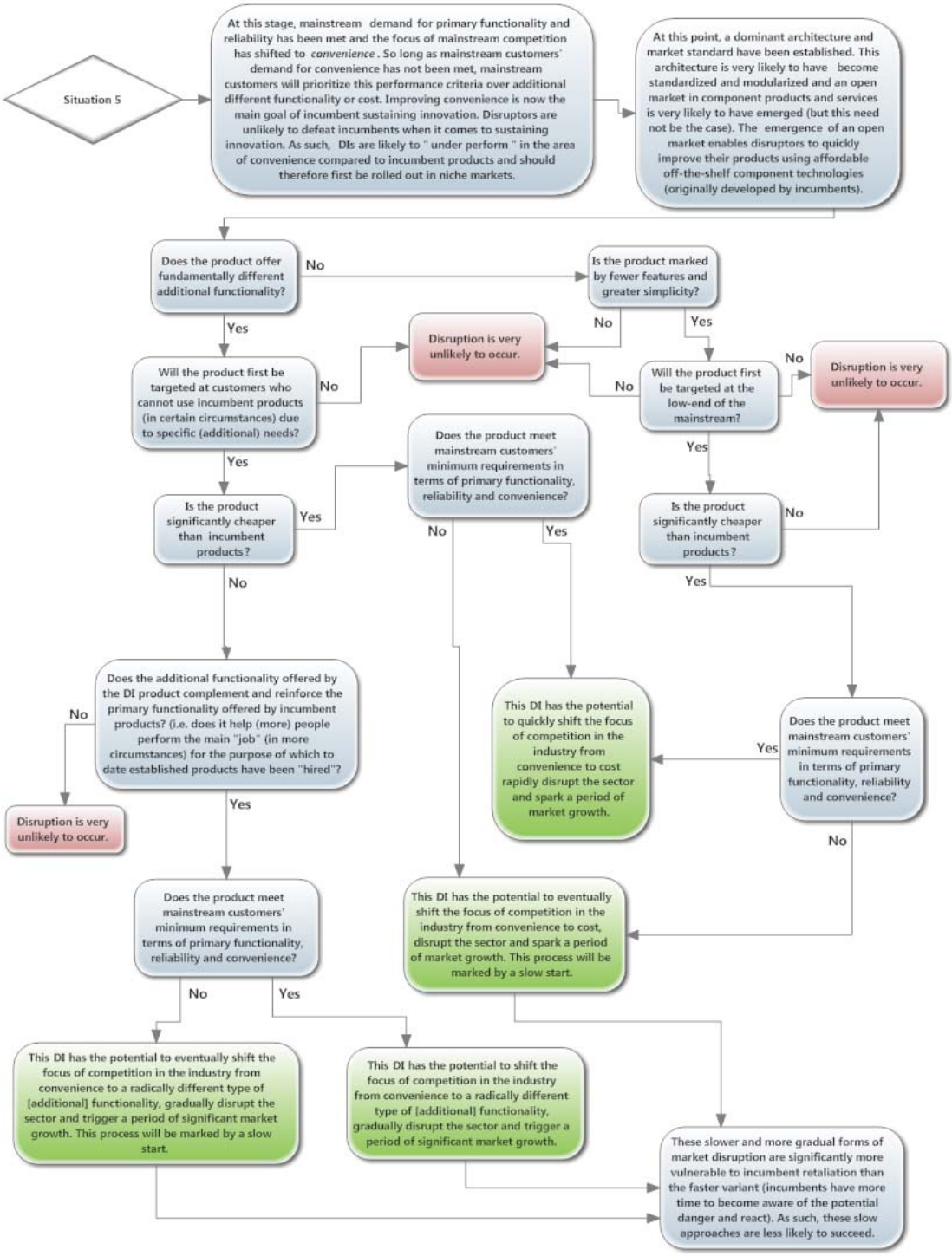

Figure 29 - Tree Diagram Situation 5

In Situation 5, rapid industry disruption and significant market growth may be brought about by products that meet all of the following four conditions:

1. They meet mainstream customers' minimum requirements in terms of *functionality*, *reliability* and *convenience* (i.e. ability to perform a specific task well and to do so reliably and in a convenient manner)

2. They offer either:

   - fundamentally different (additional) functionality and a lower price, or
   - fewer features (greater simplicity) and a lower price

3. They are first rolled out in appropriate foothold markets (and not directly in the mainstream). Products offering additional functionality should first be rolled out in a *new market* foothold: gaining initial customers among people who cannot use incumbent products (in certain circumstances) due to specific (additional) needs. Products offering fewer features and greater simplicity should initially be targeted at the *low end* of the mainstream: gaining initial customers among people who are over-served by incumbent products in terms of product functionality, reliability and convenience.

4. They are introduced into the mainstream market when mainstream customers start to lose their willingness to pay premium prices for further upgrades in terms of incumbent products' convenience.

If all of these conditions are met, the introduction of the new product into the mainstream market is likely to trigger a shift in the focus of competition in the industry from *convenience* to *price*. This is likely to trigger a period of some growth.

Situation 6

In Situation 6 illustrated by Figure 30, the market is characterized by *performance oversupply* in terms of functionality, reliability and convenience: incumbent products offer a higher level of performance in these areas than

mainstream customers can use or value. Only high-end customers still value improvements in functionality, reliability and convenience. The related shift in mainstream demand from a focus on convenience to a focus on price (possibly triggered by a disruptive product) will probably lead to some final market growth: during this phase total product adoption is likely to rise to close to 100% of the total market. (Nevertheless, there will still be people unable to use established products *in certain circumstances*). In this phase products have become commoditized: performance differences between products are no longer valued and *price* becomes the sole focus of competition.

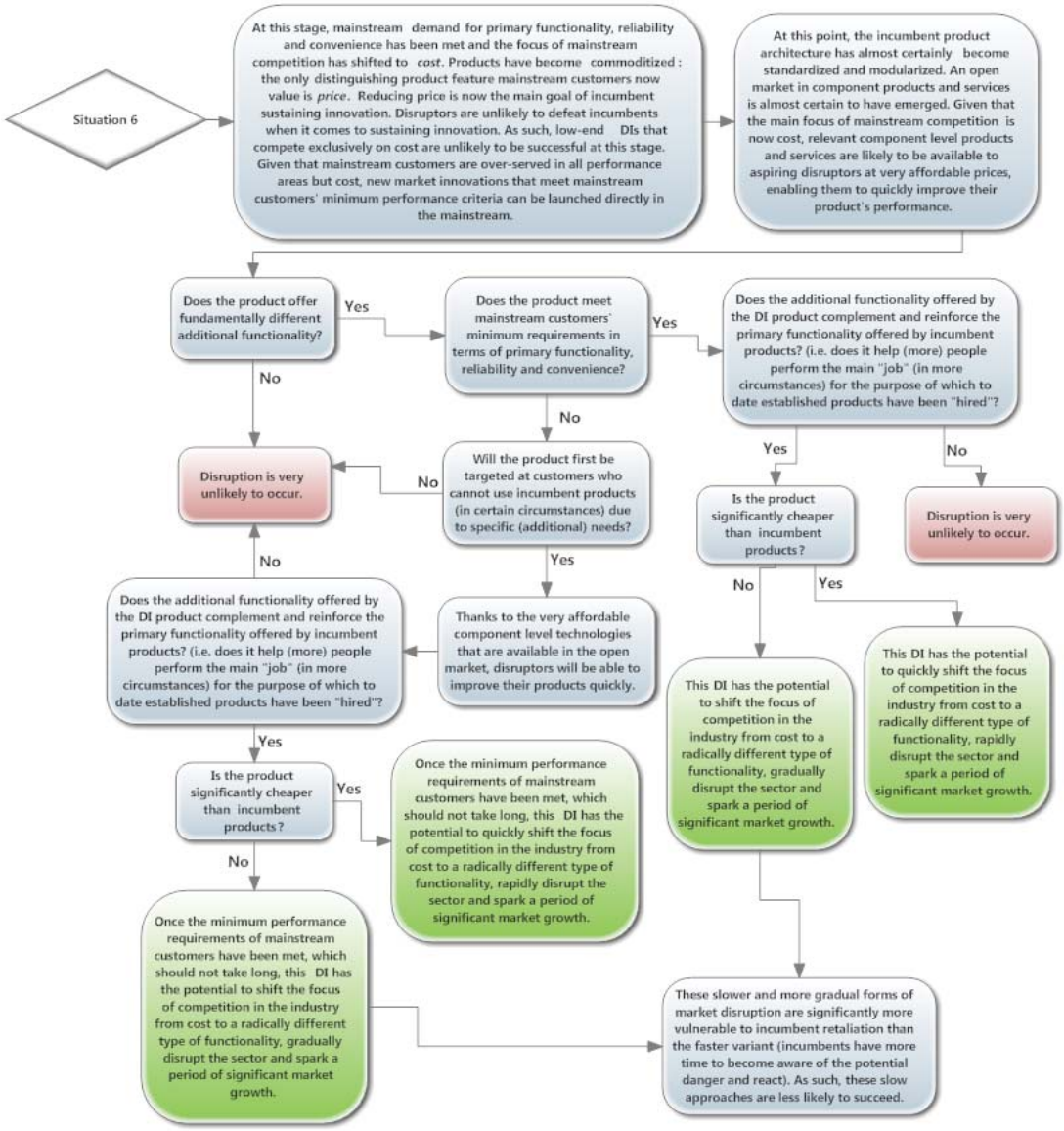

Figure 30 - Tree Diagram Situation 6

Once the focus of competition shifts to price, the difference between the low end and the mainstream in terms of demand will disappear. As a consequence, the low-end of the mainstream market no longer provides a safe foothold incumbents do not value and therefore do not defend. Those incumbents who have not fled up-market (for example as a result of government price setting) are motivated to compete on price against entrants. Even though they are held back by outdated business models that are characterized by high cost structures, the incumbents left to fight in the mainstream market will be strongly motivated to address this. (The optimal time

to start the process of disrupting the market with *more basic and cheaper* products is, hence, the previous demand phase, when such products can still be launched in an unchallenged low-end foothold market).

In Situation 6, rapid industry disruption (but very limited market growth) may be brought about by products that meet both of the following conditions:

1. They meet mainstream customers' minimum requirements in terms of *functionality*, *reliability* and *convenience* (i.e. ability to perform a specific task well and to do so reliably and in a convenient manner).
2. They offer fewer features (greater simplicity) and *a lower price*

These products can be launched directly in the mainstream market. Their success depends heavily however on incumbents' (lack of) ability to overcome the significant challenges related to restructuring old and established processes and routines for making money. If incumbents overcome these challenges on time (they may not) low-end disruptors are likely to fail as they are unlikely to be able to take on better resourced and better connected incumbent firms that are on the ball and motivated to fight. In this situation, significant market growth can only be brought about through new market disruptive innovation. That is, through "resetting" the focus of mainstream competition to *functionality* by introducing a product that offers radically different (additional) functionality ("functionality B").