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Ernstsen, Sidsel Katrine; Maier, Anja; Larsen, Laurids Rolighed; Thuesen, Christian

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IS CONSTRUCTION RIPE FOR DISRUPTION?

Sidsel Katrine Ernstsén¹, Anja Maier², Laurids Rolighed Larsen³ and Christian Thuesen⁴

^{1, 2&4} *Department of Management Engineering, Technical University of Denmark, Produktionstorvet, Building 424, 2800 Kongens Lyngby, Denmark*

³ *NIRAS A/S, Sortemosevej 19, 3450 Allerød, Denmark*

The notion of ‘disruption’ and particularly that of ‘disruptive innovation’ is now widely used by researchers as well as management practitioners, and the construction industry is being described as ‘ripe for disruption’. By comparing this industry to healthcare (another massive, societally important industry also considered ripe for disruption), this paper applies the lens of disruption theory to analyse the current and anticipated status of the construction industry. To do so, we ask and answer three central questions: Why should construction be ripe for disruption? When will disruption potentially occur? How will disruption likely manifest? We find that both industries share a number of challenges, including a fragmented stakeholder network, complex incentive structures and a sense of being in a deadlock that makes change difficult. Furthermore, we find that in both industries the term ‘ripe for disruption’ describes a process rather than prescribe when disruption will occur. By applying central notions from disruption theory (disruptive technologies, low-end disruption, new-market disruption, and a focus on value creation), we identify several potential disruptors of the construction industry. To conclude, we discuss the benefits and limitations of applying disruption theory to the construction industry.

Keywords: disruption theory, disruptive innovation, healthcare, industry comparison

INTRODUCTION

“Disrupt - or be disrupted” has become a common catchphrase of today. Managers and scholars alike seek to understand the nature and potential impact of disruptive innovation. In 2003, Charitou and Markides (2003) identified 14 examples of industries having experienced disruptive strategic innovations. The list included industries as diverse as the steel industry, the airline industry and the life insurance industry - and since then, more industries could arguably qualify for the list.

Observing how disruptive innovation has upended competition in other industries, the notion of disruption has also reached the construction industry. In recent years, two comprehensive analysis reports have described the construction industry as being ripe for disruption (World Economic Forum, 2016; McKinsey Global Institute, 2017). Similar conclusions are found in other recent grey literature such as Fortune (Tobak, 2016) and Disruptor Daily (Rands, 2017), both listing construction as one of three to six industries which soon will be disrupted. Arguably, disruption has become a popular buzzword that attracts the attention of business managers. However, the term also forms the basis of scholarly theory (Christensen, 1997; Christensen and Raynor, 2003). In this paper, we

¹ sern@dtu.dk

will take the point of departure in the theory of disruption while seeking to answer the main research question: Is the construction industry indeed ripe for disruption?

Previous research has compared the construction industry's development, innovation and productivity to that of the manufacturing industry, as this industry has accomplished to benefit from several transformations during the last 100 years (Slaughter, 1998; Winch, 2003). However, this comparison is limited due to the distinctive features of construction, including a comprehensive regulatory environment, the need for on-site assembly, and long life expectancy requiring long-time testing (Slaughter, 1998). Consequently, Winch (2003) suggests learning from other industries that similarly to construction has a complex system production model, and Concept-to-Order (CtO) or Design-to-Order (DtO) production strategies.

The U.S healthcare sector is an example of such an industry. As we will show, this sector shares a number of characteristics with the construction industry - including a recent label of being 'ripe for disruption' (Christensen, Waldeck and Fogg, 2017). Seeking to understand whether construction is indeed ripe for disruption, we compare the two industries. The industry comparison is guided by three sub-questions:

- What makes us believe an industry is ripe for disruption - and in particular, why should construction be ripe for disruption?
- When will disruption potentially occur?
- How will disruption likely manifest?

We begin by reviewing the most important aspects of disruption theory. Next, we present the two industries and describe our method. The main body of the paper is shaped by the three questions above. For each question, we describe the status of the two industries separately, and identify similarities, differences and opportunities for learning. Finally, we discuss how disruption theory may contribute to construction and to which extent the construction industry can be characterised as ripe for disruption.

DISRUPTION THEORY

The notion of disruption has intrigued business managers and scholars, since it was coined by Bower and Christensen in 1995. Disruption occurs as new innovations “bring to market a very different value proposition than had been available previously” (Christensen, 1997, xv), hereby changing the bases of competition in a market (Danneels, 2004). The theory on disruption is based on multiple case studies of technological development in e.g. the disk drive industry and the steel mill market. In these cases, disruption occurred because well-managed, established companies failed to recognise the disruptive characteristics of new technologies before it was too late. Dealing with disruptive technologies, the theory thus emphasizes the importance of first mover advantage and recommends incumbent to invest in disruptive technologies while they are still relatively immature (Christensen, 1997). Christensen and Raynor (2003) differentiate between low-end and new-market disruption. Low-end disruption happens when a low-cost and low-performance disruptive offering enters an existing market, and eventually overtake mainstream customer segments, as the performance of the disruptive offering improves. Opposed to this, new-market disruption targets current non-consumers and creates a new value-network.

Reviewing disruption theory, Danneels (2004) and Markides (2006) emphasised the lack of a clear-cut definition of disruptive technology and disruptive innovation and question the theory's ability to make ex-ante predictions. Nonetheless, the notion of disruption has been used increasingly often in the last few decades (Christensen, Raynor and McDonald,

2015), leading to a rather diluted understanding of the term. Correspondingly, much research has investigated how disruption should be defined, and if and how disruption may be predicted (e.g. Danneels, 2004; Markides, 2006; Yu and Hang, 2010).

The term "ripe for disruption" is not as often found in research literature. However, according to Yu and Hang (2010), Schmidt (2004) proposed that a market is ripe for disruption if it is characterised by customers that are overserved according to traditional attributes, and underserved according to secondary attributes. Analysing the U.S healthcare sector, Christensen *et al.*, (2017, 4) state that "High costs and uneven levels of access are typical hallmarks for an industry that is ripe for disruption". Consequently, we argue that to predict disruption we need to analyse the current status of an industry. Rather than focusing on specific technologies or a company setting, we will here apply the disruption lens in an industry context.

METHODOLOGY

The construction and healthcare are of course two very different industries. The main offerings of the healthcare system include diagnosing and treating patients, whereas the main offerings of construction are centred on designing and constructing physical structures. Where the primary outcome of healthcare is healthy people, the primary outcome of construction is a built environment. Despite their vast differences in offerings, the healthcare and construction industries share a number of characteristics. Both are quite large industries, given that each constitute 9-10 % of EU's gross domestic product (European Commission, 2016; Eurostat, 2016). The industries are of societal importance, depend on public investment, and have a complex ecosystem of actors with different roles, agendas and mandates. And perhaps most importantly, although both industries have been proclaimed ripe for disruption, both struggle with implementing disruptive changes at the same speed as other industries (World Economic Forum, 2016; Christensen, Waldeck and Fogg, 2017). The healthcare sector and the construction industry both score among the lowest when comparing the degree of digitalisation to other industries (Gandhi, Khanna and Ramaswamy, 2016), indicating that they experience a need for embracing the opportunities provided by new technologies and digital innovations.

We base the description of healthcare disruption on research material from the Christensen Institute (Christensen, Bohmer and Kenagy, 2000; Christensen, Waldeck and Fogg, 2017) as well as other academic articles on anticipated disruptive changes in the healthcare sector (e.g. Patou and Maier, 2017). The Christensen Institute analyses how disruption is happening in various industries with a special focus on the U.S healthcare sector. We will keep in mind that healthcare, like construction, is a very diverse industry on a global scale - and all the inherent mechanisms of the U.S healthcare sector may not be present in e.g. European equivalents.

The description on construction disruption is based on two rather recent industry analysis reports from McKinsey Global Institute (2017) and World Economic Forum (2016), and supplemented by academic articles on anticipated disruption of construction and construction innovation (e.g. Winch, 1998; Bock, 2015). We will consider construction as a global industry although we acknowledge that there are very large regional differences. We recognise that consultancy reports may be biased since consultancies arguably may benefit from claiming that an industry is ripe for disruption. However, the comprehensiveness of the analysis behind the reports as well as the anticipation of construction disruption from other, purely academic sources (e.g. Bock, 2015), make us include the reports as relevant sources.

Why Should Construction Be Ripe for Disruption?

Already in 2000, Christensen *et al.*, proclaimed that the U.S healthcare sector was ripe for disruption. This conclusion is based on a description of the sector as highly expensive, resistant to innovation, competing fiercely on price and delivering low-quality offerings. Further describing the challenges of healthcare, Christensen *et al.*, (2017) emphasized the high cost and uneven access to offerings as key reasons for why disruption should be anticipated.

McKinsey Global Institute (2017) describes construction as ripe for disruption based on a global analysis of the challenges and productivity of the industry. Based on studies of productivity in more than 30 industries, they argue that the productivity of construction is "remarkably poor" and could be improved by 50-60 percent. World Economic Forum (2016) argue that the large societal, economic and environmental impact of the construction industry makes the potential of digitally transforming the industry significant. They both point towards the opportunities in e.g. standardizing processes, rethinking contractual structures, changing regulations and adopting new technologies.

Although both industries have identified the need for change, they are described as in a sort of deadlock that makes change difficult. In both industries, a large barrier to change stems from the complex network of actors with different objectives. Moreover, fierce competition makes it challenging for a single actor to break the deadlock - at least not without close coordination with others. The challenges that are used to characterise the industries as ripe for disruption are summarized in Table 1.

Table 1: Challenges used to characterise construction and healthcare as ripe for disruption

	Construction	U.S healthcare
Stakeholder network	Industry opaque and highly fragmented.	Powerful stakeholders interested in maintaining status-quo.
Incentive structures	Tenders or invoices according to time spent. Contractual structures and incentives misaligned.	Fee-for-service model. Difficult to calculate profitability per procedure. Focus on utilisation of assets.
Market dynamics	Fierce competition, slim margins. Informality and potential for corruption. Sub-optimal owner requirements.	Fierce competition between old institutions on price and accessibility. Uneven access to healthcare.
Quality of offerings	Poor project management and execution. Megaprojects surpass time and budget.	Reduced quality due to time pressure. This is dissatisfying to patients.
Skills vs. tasks	Low skill-level of workers. Need for training workers to use the latest equipment and digital tools.	High skill-level of doctors surpass most patients' needs.
Investment	Low degree of investment in digitalization and innovation.	Investments focus on treating difficult high-end diseases.

Although disruption theory does not provide specific parameters for assessing whether an industry is ripe for disruption, our comparison suggests six parameters that may characterise an industry as ripe for disruption. Moreover, it is shown that construction and healthcare experience quite similar challenges according to most parameters. The only major difference is the skill-level of professionals, which is claimed to be too low in construction and too high in healthcare.

Besides having similar challenges, both industries report that they experience that other industries have succeeded in benefiting more from a digital transformation, than they have (World Economic Forum, 2016; Christensen, Waldeck and Fogg, 2017; McKinsey Global Institute, 2017). Thus, disruption is anticipated due to an experience of missed opportunities rather than because current challenges constitute a burning platform.

When Will Disruption Potentially Occur?

The proclamation of a need for change in the construction industry is not new. Already in the late 1930s, Schumpeter argued that prefabricated housing would bring a “gale of creative destruction” to the construction industry, in the same way as mass production changed other industries (Winch, 1998). Winch (1998) argues that Schumpeter was wrong and that the industry has not yet experienced the cost reduction and quality improvements seen in other industries in last 100 years. So why should disruption occur in the construction industry just now?

A similar question is asked in the healthcare sector, where 17 years have passed since the sector was first described as ripe for disruption. Christensen *et al.*, (2017) suggest that characteristics of U.S healthcare make the sector impervious to change: End-users (i.e. patients) lack control of the design and buying decisions, new competitors experience high barriers to entry, and the fee-for-service reimbursement system fails to consider the quality of the care. Despite these forces repelling disruption, they persist in concluding that healthcare will be disrupted, although slower than initially expected.

In theory, disruption occurs at that exact point in time when the performance of a disruptive innovation surpasses the performance of mainstream offerings (Christensen, 1997). Thus, by mapping the performance trajectory of an expected disruptive innovation as well as mainstream offerings, one should be able to anticipate when disruption will occur. In practice, however, it is challenging to determine the disruption point before disruption has actually occurred (Danneels, 2004). One reason for this is that performance may be measured according to many different parameters - and that choosing the right parameter is not trivial. For example, for a group of customers in the construction industry the most important performance parameter could be "time from idea to finished building" or "life-time cost" or (most likely) something else. Even if one has identified the most important performance parameter for mainstream customers today, one should keep in mind that disruption may imply that this parameter is not the most important for customers tomorrow.

Thus, seeking to predict when disruption will occur in construction and healthcare is challenging. However, assuming that disruption will occur at some point, the challenge may be worth undertaking for construction companies to avoid being surprised by disruptors. Acknowledging the limitations of predicting the future, we believe companies in the construction industry may benefit from using e.g. foresight methods to identify potential disruptors. In the following, we identify some of the potentially disruptive technologies and innovations that should be analysed to be able to estimate when disruption could occur in construction.

How Will Disruption Likely Manifest?

To understand how disruption may be anticipated in construction, we will take point of departure in four recommendations found in disruption theory:

- Disruptive technologies: Invest early as a first mover advantage is essential
- Low-end disruption: Identify overserved customers
- New-market disruption: Identify current non-consumers
- Focus on creating value for the customer

Disruptive technologies: Invest early as a first mover advantage is essential

Technological progress is often brought forward as a reason to anticipate disruption. However, in the analyses of healthcare disruption, new technologies are merely mentioned as an enabler of disruption, alongside with new innovative business models and a changed value network (Christensen, Waldeck and Fogg, 2017).

According to McKinsey Global Institute (2017), the largest potential for productivity improvement of the construction industry stem from the implementation of new technologies. Especially the anticipated disruptive potential of Building Information Modelling (BIM) has long been studied by construction researchers (e.g. Morgan, 2017). World Economic Forum (2016) conducted a survey about the perceived potential of construction technologies among industry experts, and here integrated BIM was rated as extremely likely and anticipated to have an extremely high impact. BIM is arguably a critical driver of disruption in construction since digitalisation of data makes several other new value propositions possible. Another important group of potentially disruptive technologies is found in automated construction technologies such as 3D printing and construction robotics (Bock, 2015). Bock (2015) argues that automated construction technologies will speed up construction processes, change the way buildings are designed, and eventually pervasive robotics (e.g. service robots) will be an integrated part of the built environment. Considering these examples of technological progress in both the virtual and physical dimensions of construction, we expect disruptive changes to affect the entire value-chain of construction.

When companies have identified supposedly disruptive technologies, they should, according to theory, act as first movers in maturing the technologies to avoid being disrupted. This recommendation, however, contrasts the description of construction and healthcare as being in a deadlock where stakeholders need to act simultaneous for change to occur. In construction, for example, multiple companies have invested heavily in BIM to gain a first mover advantage. However, BIM seems to gain grounds through a coordinated effort (including legislative action) rather than through a strategic first move. As disruption theory focuses on the actions of a single company, it does not provide recommendations for coordinating disruptive initiatives across an industry.

Low-end disruption: Identifying over-served customers

According to disruption theory, incumbent companies may prepare for disruption by identifying current customers that are currently over-served. Christensen *et al.*, (2017) argue that on one hand, the U.S healthcare system delivers dissatisfying services to patients due to e.g. time constraints on consultations. On the other hand, the healthcare offerings overshoot the needs of the majority of patients, as highly educated doctors attend all patients without differentiating between minor and major health issues. Thus, the recommendations for healthcare include creating a system where the skill level of the health professional corresponds to the difficulty of the medical issue (Christensen, Bohmer and Kenagy, 2000).

Translating this line of thoughts to construction, we find that construction, like healthcare, defines its offerings based on professional disciplines rather than complexity of the offerings. For example, larger companies in the construction industry are typically differentiated by profession (e.g. architect or engineer) rather than by the nature of assignments (e.g. school building or landscape planning). In this regard, disruption theory recommends taking the point of departure in the customers' jobs to be done and look for over-served customers. Over-served customers may be customers that currently buy relatively low-cost offerings (e.g. expansions of an office building) without actually

needing the high-end offerings that the company is capable of providing (e.g. specialised knowledge used for designing hospitals).

An example of a low-end disruptor of construction is Altan.dk, a specialized company that delivers customized balconies including customer service, installation and life-time support (Kudsk *et al.*, 2013). Altan.dk has succeeded in identifying a customer group that needs "only" the services related to designing and establishing balconies on existing buildings. Although the balconies are customized, they are designed using a product configuration system of standardised components, enabling Altan.dk to deliver a low-cost product that is valuable to a specific group of customers.

As the case of Altan.dk demonstrates, low-end disruption of construction does happen. Disruption theory may therefore contribute to construction through its emphasis on the (often over-looked) potential of low-cost, low-performance offerings that improve over time. Correspondingly, construction companies may benefit from identifying low complexity tasks that 1) could be bundled as a low-cost offering, and 2) may develop to a high-end product over time as technology improves.

New-market disruption: Identifying current non-consumers

Another type of disruption, which might be anticipated in construction, is new-market disruption. According to theory, this kind of disruption may be found by identifying current non-consumers. An example from healthcare is that of doctors prescribing patients to change their lifestyle, e.g. exercising more, losing weight and/or eating healthier to prevent e.g. diabetes or depression (Christensen, Waldeck and Fogg, 2017). These patients can be seen as non-consumers since they are expected to make lifestyle changes between the occasional doctor's appointments without the support from health professionals. Identifying this gap in the market, a pilot study in Boston, successfully introduced non-clinically trained health coaches. The health coaches meet with the patients before and after clinical consultations, act as the patients' advocate and support the patients in their health journey. Since the focus is on prevention rather than treatment, the investment in health coaches is shown to pay off.

Correspondingly, we may identify current non-consumers in construction to anticipate how new-market disruption may manifest here. Although a lot of stakeholders are generally involved in construction projects, there are also rather significant groups of stakeholders that are typically not involved. This may for example include the expected users of a new bike path, the neighbours of a new subway station or the future cleaning personnel of a new school. New technologies such as virtual and augmented reality make it easier to involve users in the construction design at an early stage of the project. Likewise, new-market disruption may be expected to empower the users. Perhaps crowdfunding platforms can involve users in prioritizing new construction projects, or allow the future users to vote about design-related decisions during the project.

Today, many construction companies deliver a customized solution for each customer i.e. they deal with markets of one (Gilmore and Pine, 2000; Thuesen, Jensen and Gottlieb, 2009). In contrast, disruption theory presupposes a mass market where companies target customer segments with different offerings. This discrepancy between practice and theory challenges the relevance of speaking of new-market disruption in construction. Supposing that a market consists of one customer, identifying new-market disruption in construction would mean identifying just one new customer. Supposing, in contrast, that construction may be a mass market, new-market disruption entails developing standardised solutions for construction.

Focusing on Creating Customer Value

Describing how disruption will occur in U.S. healthcare, Christensen *et al.*, (2017) argue for changing the incentive structures from a fee-for-service to a value-based system. Healthcare practitioners could for example be reimbursed on account of the general health of their community opposed to on account of number of consultations. Furthermore, a value-based incentive system would entail an increased focus on prevention rather than treatment. Technological progress could support this focus on the preventive value of healthcare, as it enables continuous monitoring of peoples' health, behaviour and environment (Patou and Maier, 2017).

In construction, focusing on long-term value may mean measuring the indoor work environment and its effect on the users of the building, or utilizing measures of life-time environmental impact in the design of new structures. If companies in the construction industry start focusing on prevention rather than "treatment", facility management may likely play a bigger role in the design and construction phases. Furthermore, an increased focus on value would entail rethinking the contractual structures to align risk and reward and forming e.g. strategic collaborations.

In both healthcare and construction, it is difficult to change incentive structures and value networks. Especially because shifting to an incentive system that is based on long-term value typically will induce bad financial performance in the short run. Christensen *et al.*, (2017) prescribe that legislators, providers and payers need to coordinate their actions in order to create sustaining changes. Although this is highly difficult, the benefits of disrupting the industry appear to be worth it.

DISCUSSION AND CONCLUDING REMARKS

Comparing healthcare and construction, a number of similar challenges and opportunities were identified. Both industries are characterised by a complex stakeholder network, misaligned incentive structures, improvement potential in the quality of offerings and limited investments in disruptive innovations. Assuming that the healthcare sector is indeed ripe for disruption, this comparison would suggest that construction is similarly ripe for disruption.

However, the identified similarities between healthcare and construction may also support another conclusion: that the construction industry, just like healthcare, is "impervious to even the strongest forces of disruption" (Christensen, Waldeck and Fogg, 2017, 4). Or perhaps more likely: disruption theory may not be the most appropriate theory for explaining the complex industrial dynamics of construction and healthcare.

This view is supported by Geels (2018) who has analysed the transformation of energy-related sectors to low-carbon energy systems. He argues that disruption theory's focus on single (conquering) innovations and price/performance competition makes the theory less suitable for studying system transitions, where e.g. social and political dimensions play a large role in creating change.

Correspondingly, we find that the strengths of disruption theory does not lie in its ability to predict when disruption will occur, but rather in its recommendations for envisaging how disruption could likely manifest. Taking point of departure in four recommendations from disruption theory, we have shown to which extent the lens of disruption may aid construction companies in anticipating changes.

As for the question of when disruption might occur, disruption theory falls short of an answer. Different industries have different trajectories of technological development,

meaning, for example, that it took 40 years before mini mills had disrupted the steel industry (Christensen, Raynor and McDonald, 2015). Arguably, this may deflate the prescriptive value of speaking of ripeness for disruption. Although the industry is claimed to be ripe for disruption today, the lack of a specified timeframe makes it possible that the industry is still (or again) ripe for disruption in 15 years from now.

Not knowing when disruption will occur in construction (and assuming that it will), construction companies may benefit from following both market and technology development closely. Foresight methods may be helpful for imagining possible future, and technology management methods may aid the companies in identifying and assessing the potential of new technologies. As a part of our future research, we aim to combine the advantages of foresight and technology management and investigate new ways of assessing the disruptive potential of new technologies.

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