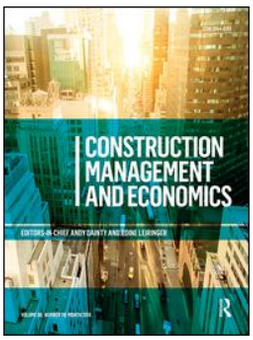

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Public clients ability to drive industry change: the case of implementing BIM

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ABSTRACT

Public clients are proposed as key actors in driving construction industry change towards a more sustainable, efficient and productive industry. Based on how they procure consultants and contractors, it is argued that public clients have the power and are in the position to act as "innovation supporters" and "change agents." However, the client's role as a driver of change and innovation is oversimplified and there is a need for further investigation into the client's ability to drive industry change. This paper presents a case study of a public client's initiative to drive industry change through the implementation of Building Information Modelling (BIM). We do this by investigating the process of intra-organisational change at the public client by mapping the client's absorptive capacity for change. The case study shows difficulties in turning the external knowledge into actual transformation when implementing a systemic innovation such as BIM. Findings contribute to the literature on public clients as drivers of change and innovation in construction and are relevant to research on public clients as drivers for industry change and innovation and to research on BIM as a game changer.

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KEYWORDS
industry change; innovation; client; project manager; absorptive capacity; building information modelling; procurement

Introduction

There is a major interest and discussion on the role of the construction client organisation in relation to construction industry change and innovation (e.g. Vennström and Eriksson 2010, Havenvid *et al.* 2016, Adam and Lindahl 2017). Compared to contractors, of whom much has been written in construction management research, the client organisation has been studied considerably less (Adam and Lindahl 2017). This is despite the fact that clients are in the position of the procurer and has the overall responsibility and power to manage construction projects (Adam and Lindahl 2017).

Unlike other actors in construction, the client is the actor with the impetus to initiate and transform (Winch 2010), and to govern construction projects (Eriksson and Laan 2007). Clients who act at the national or international level can therefore potentially influence many other actors when implementing change and innovation (Vennström and Eriksson 2010). Research on innovation in construction, for example Havenvid *et al.* (2016), Blayse and Manley (2004) and Hartmann *et al.* (2008), argue for the client as the actor able to initiate change towards a more sustainable, efficient and productive industry. In this context, clients are described as "innovation supporters" (Nam and Tatum 1997), "change agents" (Haugbölle *et al.* 2015) and "innovation champions" (Kulatunga *et al.* 2011).

Although there may be a commitment for change, major change initiatives are not easily implemented in construction (Bresnen *et al.* 2005). Previous research, for example Eriksson *et al.* (2008) and Bresnen *et al.* (2005), show that construction actors involved in change efforts may be both unwilling and unable to implement change. Additionally, Ivory (2005) found that clients are not always positive towards change and innovation, and how such negative clients can act as barriers to construction innovation. This is problematic in an industry in need of change since without positive and supportive clients, innovative solutions are likely to diminish (Hartmann *et al.* 2008). Nam and Tatum (1997) endorse the need for supportive clients for change and innovation in construction by showing how highly committed clients are of critical importance.

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Research on client driven change is increasingly focussing on change through the implementation of Building Information Modelling (BIM) (Succar 2009, Linderoth 2010, Wong *et al.* 2010, 2011, Vass and Karrbom Gustavsson 2017). A rationale behind the increased interest is that BIM is expected to address many of the construction industry's shortcomings; related to collaboration, design quality and life cycle perspectives on construction information (Eastman *et al.* 2008, Azhar 2011). BIM is presented as having the potential to influence the whole construction industry (Azhar 2011, Takim *et al.* 2013, Lee and Yu 2015), and consequently BIM is promoted as a "transformational game changer" that will transform the whole industry context by governmental strategies (Ciribini *et al.* 2016).

While some researchers assume or take for granted that clients have the ability to act as change agents in construction, other researchers take a more reflective position. Cherns and Bryant (1984), as well as Havenvid *et al.* (2016), argue that the client's role as driver for change and innovation in construction tends to be oversimplified as well as underexplored, and argue for further investigation into the client's role and ability for driving construction industry change. Recent research also found that the client's role as driver for industry change through the implementation of BIM is challenging (Bosch-Sijtsema *et al.* 2017, Vass and Karrbom Gustavsson 2017, Lindblad 2018). Hence, there is a need for additional studies analysing the impact or effect of public client's policy actions (Kassem and Succar 2017) and for exploring the client's ability to drive industry change.

The purpose in this paper is to investigate public clients' ability to drive industry change and innovation through the implementation of BIM. Through the concept of absorptive capacity (Cohen and Levinthal 1990), we explore clients' ability to *recognise* external BIM related knowledge, and their ability to *absorb* and *apply* this knowledge in order to drive industry change. Implications address the on-going discussion by Havenvid *et al.* (2016) and others on clients as drivers of change and innovation, and combine that with the discussion by Linderoth (2010), Lindblad (2018), (Bosch-Sijtsema *et al.* 2017), Vass and Karrbom Gustavsson (2017) and others on BIM as construction industry game changer.

The paper is structured as follows: The paper first gives an overview of the literature on client driven change and continues by describing BIM as a systemic innovation. We then present the absorptive capacity concept (Cohen and Levinthal 1990) and the extended model by Zahra and George (2002) which is the analytical model used. The paper follows by an outline of the research method and the characteristics of the chosen case before we present our findings and map findings to the absorptive capacity model. Finally, we discuss implications and give suggestions for future research.

Literature

Client driven change

Construction clients play an active role in shaping both the construction process and the final product (Hartmann *et al.* 2008). In research on construction innovation, Winch (1998) and Hobday *et al.* (2000) suggest that clients are in the position to exert direct or indirect influence on construction projects in order to generate innovative solutions. However, clients are not always positive to change and innovation. Ivory (2005) acknowledge that clients also can act as barriers to innovation in construction and when there is no positive and supportive client, innovative solutions are likely to diminish (Hartmann *et al.* 2008). However, innovation in construction is not only about the client's motivation or about willingness to change but also, as Nam and Tatum (1997) acknowledge, it is also important that clients have technical knowledge.

Public clients have been identified as being of particularly importance for driving change and innovation (Hartmann *et al.* 2008). By public clients are meant institutions on the national, regional and local level that procure consultants and contractors to provide public goods and services on a non-profit basis (Hartmann *et al.* 2008). The context for public and private clients differs, for example in relation to competition, interests, motivation, transparency and regulations. There is research that indicate that regulations such as the European Public Procurement Act may narrow the innovation scope (e.g. Pries and Janszen 1995, Halvorsen *et al.* 2005), there is also research on how public procurement strategies influence the performance of the industry because of the public sector's dominance in the construction industry (Hartmann *et al.* 2008).

It is important to acknowledge that client organisations are heterogeneous entities (Newcombe 2003, Sexton *et al.* 2008) and that they can be understood as representing "a complex web of inconsistent and conflicting demands of different interest groups that may be internal or external to the client's organization." (Hartmann *et al.* 2008, p. 437). Decisions are embedded in a context of "pluralistic views, goals and

motivations" (Hartmann *et al*. 2008, p. 437), which complicates change and the implementation of innovation. It is also recognised by, for example, Newcombe (2003) and Sexton *et al*. (2008), that professional (repetitive) clients have better innovation capabilities than occasional clients.

Professional clients, who repetitively carries out projects, gain a certain level of technical competence and experience that allows them to better formulate requirements on solutions in order to, minimise risks, evaluate solutions and acquire information (Hartmann *et al*. 2008). The innovation capability of professional clients has been found to be dependent upon their internal organisational structure, such as specialised units and individuals that engage in innovative activities throughout several projects (Hartmann *et al*. 2008). Industrial dynamics research on renewal in construction (e.g. Havenvid *et al*. 2016) argue that public clients are important drivers for innovation in the construction industry and that clients can trigger innovative behaviour through the specification of requirements in procurement. However, they also found that the development of procurement requirements cannot be formulated in isolation, but that requirements are a result of interaction in the project network. Hence, client procurement as a way of influencing innovation and driving change is dependent on how the requirements are understood and implemented across the network of actors, resources and activities (Havenvid *et al*. 2016).

BIM as construction industry game changer

Building Information Modelling (BIM) and its influence on change and innovation in the construction industry is increasingly addressed in construction research and industry practice (Succar 2009, Linderoth 2010, Wong *et al*. 2010, 2011, Vass and Karrbom Gustavsson 2017, Lindblad 2018). There are different definitions of BIM and one of the most commonly used definitions is provided by Succar (2009, p. 357). In his view, BIM can be understood as "a set of interacting policies, processes and technologies generating a methodology to manage the essential building design and project data in digital format throughout the building's life-cycle." BIM is further described as a typical "systemic innovation" (Cao *et al*. 2017), by which is meant "a situation where an innovation system goes beyond the boundaries of a single organization, and multiple innovations need to be co-ordinated" (Midgley and Lindhult 2017, p. 2). Seminal research on the characteristics of systemic innovation by Taylor and Levitt (2004) concluded that systemic innovation requires coordination between the actors linked to the system in which the implementation takes place. Consequently, the implementation of BIM requires substantial coordination and integration between many actors (Wong *et al*. 2010, 2011).

BIM implementation has been a frequently addressed issue for more than a decade. However, industry-wide implementation of BIM has been progressing slowly (Smith 2014, Khosrowshahi and Arayici 2012, Matarneh and Hamed 2017). A common explanation for the slow implementation is a lack of client demand (Chan 2014). It is argued that for BIM to be an industry game changer, public clients are needed as key actors (Wong *et al*. 2010, 2011). In particular, public clients are expected to take on the leading role and specify the extent and level of BIM to which the technology should be implemented in specific projects (Porwal and Hewage 2013).

It is also argued that public clients can influence the whole industry by establishing a BIM policy as a part of the client's procurement requirements (Bin Zakaria *et al*. 2013). When such a policy is at place, industry actors will change their focus from if BIM should be used, to how BIM can be used (Linderoth 2010). However, developing a BIM policy is a complex matter. Whyte and Hartmann (2017) present three issues of particular importance for BIM policy developers: First, acknowledging the firm's size and how smaller actors might lack motivation, materials or skills to align with policy. Secondly, the importance of maintaining flexibility in the policy to enable adaptation to the circumstances in the particular project. Thirdly, the need to resist the urge to use BIM technologies in an effort to simplify complex project contexts, instead developing policy that embrace project complexities to support creative engineering (Whyte and Hartmann 2017).

Not all researchers agree that clients are the main drivers for BIM implementation. Bosch-Sijtsema *et al*. (2017) presents a more reflective view and argue that it is not the lack of client demand that is the main obstacle to BIM implementation, but rather a lack of normative pressure. The individual's subjective positive or negative perception of BIM is a more influential factor than external pressure from clients (Bosch-Sijtsema *et al*. 2017). In particular, the BIM perception among project managers was found to be of importance since BIM implementation is argued to be dependent on project managers as early adopters (Mäki and Kerosuo 2015).

Public clients in Europe have worked with implementing BIM for many years and they have been involved in several BIM pilot projects (Ciribini et al. 2016). Several EU Member States have already implemented BIM in their procurement strategies in accordance with the European Union Directive 2014/24/EU on procurement (Ciribini *et al.* 2016). In the UK, direct actions are taken to increase BIM implementation and the UK was, in a study by Kassem and Succar (2017), found to have achieved the highest BIM maturity compared with other studied countries. There are also examples of public clients in other parts of the world implementing BIM with the intention to drive industry change. Two such examples are Hong Kong (HKCIC 2014) and the US (GSA 2007).

Absorptive capacity for implementing BIM

Absorptive capacity is important for enabling organisations to respond better to changing environments (Cohen and Levinthal 1990). This capacity enables organisations to extend and refine their current competences or to innovate and thereby facilitate organisational change (Leal-Rodriguez *et al.* 2014). The importance of absorptive capacity in the context of change has been addressed by for example Anumba *et al.* (2005). However, it is challenging to capture, transfer and apply knowledge in a project environment (Gann 2001).

There are several recent studies on the implementation of BIM based on the absorptive capacity concept (e.g. Ahankoob *et al.* 2018, Buć and Divjak 2018; Chen *et al.* 2019). In their study on the implementation of BIM, Buć and Divjak (2018) focus on the influence of the organisation's environment on the ability of acquisition and assimilation of innovation in an organisation. They describe BIM as a systemic innovation, and they acknowledge a number of problems when implementing BIM. For example, lack of interoperability, insufficiently supported implementation of standards, lack of education and expertise, challenges of cooperation between stakeholders and cultural changes. They also reflect on the critical factors for the adoption of BIM and list the willingness to share information, master BIM model team/managers, effective collaboration between project actors, and organisational structure to support BIM as such factors (Buć and Divjak 2018). Lastly, Buc' and Divjak (2018) mentions critical factor of political influence. The example is the European countries in which governments are said to be the main promotors of the adoption of BIM through the public projects they launch.

In a study by Ahankoob *et al.* (2018), they acknowledge that there is a high expectation that higher BIM proficiency can lead to higher business performance. However, they also reflect on research that shows that the influence of BIM on business performance may be limited (e.g. Smits *et al.* 2016) and that there is an overoptimistic understanding about the influence of BIM on business performance improvement (e.g. Kelly and Ilozor 2016). Based on their empirical findings, Ahankoob *et al.* (2018) list the following barriers to BIM implementation: organisational cultural values that highlight traditions and institutional norms, lack of training courses and public guidelines that highlight the important role of government, and funding and BIM-related costs that highlight the importance of having a strong business case.

Based on a study of the Chinese construction industry, Chen *et al.* (2019) address factors that influence the adoption of BIM and they develop a model that integrates the critical success factors related to the technology of BIM with the organisation and the environment. While the relative advantage of BIM was found to be an enabling factor, the complexity of BIM was found to be an inhibiter. Findings also indicate that young organisations are more likely to adopt BIM. The ability to adopt BIM thus vary between organisations.

Analytical framework

The concept of absorptive capacity (ACAP) establish a link between external and internal knowledge. Cohen and Levinthal (1990) developed the concept and they argue that a company's capability to innovate is dependent on its ability to recognise the value of new, external knowledge and its ability to assimilate and apply it to commercial use in terms of business opportunities. ACAP is a process that includes several successive stages, it can be understood as a combination of organisational routines, and strategic processes; by which organisations acquire, assimilate, transform, and exploit knowledge with the intention of creating a value (Zahra and George 2002). As such, ACAP includes both the assimilation of external knowledge and the creation of new knowledge.

The "gate" through which external knowledge enter the organisation is constituted by the human capital (the employees) and their experience obtained through international networks (Onkelink *et al.* 2016). The employees are therefore of major importance for ACAP to develop. There are, however, also other important factors such as capabilities of internal

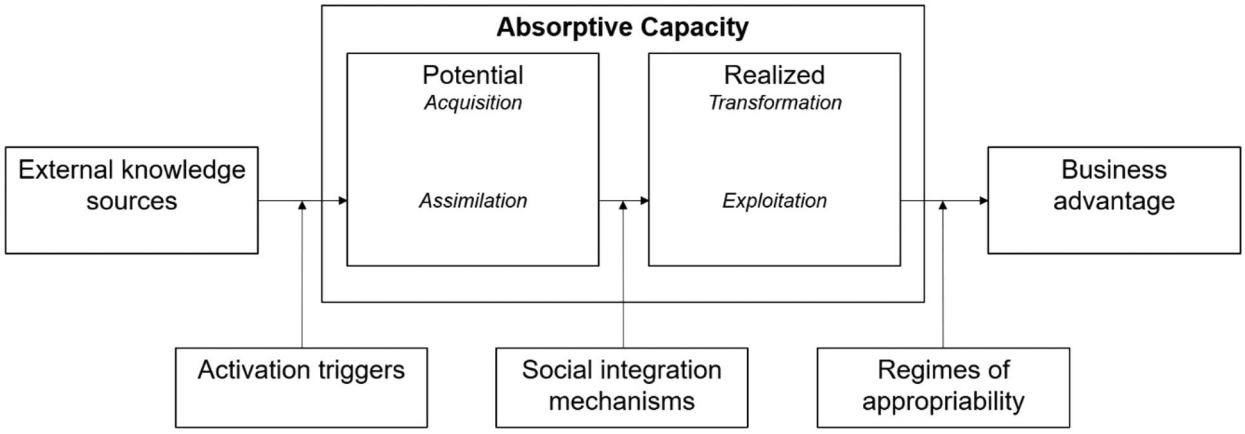

Figure 1. Absorptive capacity, based on Zahra and George (2002).

creation of knowledge from external knowledge, the information management systems and the practices for social integration (Lev *et al.* 2009, Kostopoulus *et al.* 2011, Roberts *et al.* 2012).

Based on the research on ACAP by Cohen and Levinthal (1990), Zahra and George (2002) developed a model that connects antecedents, moderators and outcomes with the multidimensional construct of absorptive capacity (Figure 1).

According to the model by Zahra and George (2002), external knowledge sources and experience are not enough to create development of absorptive capacity within an organisation. Instead, they suggest that the development lies in *activation triggers*, i.e. events that force an organisation to pay attention to new ideas instead of protecting existing practice. Examples of such events are organisational crisis, performance failures, radical technology shifts or changes in governmental policy.

Zahra and George (2002) divides absorptive capacity into two interdependent subsets, potential absorptive capacity (PACAP) and realised absorptive capacity (RACAP). PACAP involves *acquisition* and *assimilation* of external knowledge, where acquisition concerns an organisation's ability to identify and acknowledge externally generated knowledge that is critical, while assimilation concerns the organisation's routines and processes including analysis, interpretation and understanding of the information obtained.

The interrelation between an organisation's potential and realised capacity is dependent on well-functioning *social integration mechanisms* that facilitate information sharing and the sharing and exploitation of knowledge. Zahra and George (2002) argue that an organisation also need routines that allow the combination of new knowledge and already existing knowledge and transform it for use in the known context. This is described as a process of *bisocation,* the combination of two different and incompatible frames of reference. Hence, Zahra and George (2002) suggest that an organisation's RACAP involves both *transformation*, which is an organisation's ability to develop and refine routines to combine existing knowledge with the newly required knowledge and assimilated knowledge and create new insights, and *exploitation*, which reflects an organisation's ability to incorporate new knowledge into their operations and practices.

The third moderator for innovation, as suggested by Zahra and George (2002), is the *regime of appropriability*. By regime of appropriability is meant the institutional and industrial dynamics that affect the organisation's ability to protect the advantages of new product and processes. Such regimes can concern for example technological and organisational barriers as well as market, policy and legislative barriers.

Method

Research methodology

In this paper, we investigate a public client's ability to drive industry change through the implementation of BIM. We do this through an "abductive" approach where empirics and existing theory are considered in tandem (Alvesson and Kärreman 2007). The empirics this paper is based upon are collected in a single case study (Eisenhardt 1989). A case study is recommended when the aim is to understand a complex issue because " … the case study produces the type of context-dependent knowledge that research on learning shows to be necessary to allow people to develop from rule-based beginners to virtuoso experts" (Flyvbjerg 2006, p. 221). The case study, including the interest for developing knowledge of what happens in the industry, is further recommended by Flyvbjerg

Table 1. Respondents.

Interview no.	Interviewee's role	Organisational unit	Duration
1	Project manager	BIM implementation project	1h
2	Technical manager	large project	1,5h
3	Member	BIM implementation project	1h
4	Project manager	large project	1,5h
5	Assistant Subproject manager	large project	1h (phone)
6	Member	BIM implementation project	2h
7	Project manager, previously from the investment department	BIM implementation project	2,5h
8	Specialist Data coordinator	investment	1h
9	Project manager, from the large project department	BIM implementation project	1h
10	Project manager	investment	1h
11	Project manager	investment	1h

(2006) who state, "predictive theories and universals cannot be found in the study of human affairs. Concrete, context-dependent knowledge is, therefore, more valuable than the vain research for predictive theories and universals" (Flyvbjerg 2006, p. 224).

Research setting (case description)

The public client organisation studied here is the largest infrastructure client in Sweden, the Swedish Transport Administration (STA). The STA is a state agency and is assigned to development, procurement and maintenance of national roads and railways. The construction industry, with its fragmented, project-based and highly regulated characteristics, is a suitable setting for exploring public client's ability in driving change and innovation through systemic innovation such as BIM.

At the time of our data collection (2014–2017), the STA implemented BIM to their organisation. The decision to implement BIM at the STA was taken by the general director in 2013. This decision was influenced by a governmental BIM initiative (SOU 2012:39), which in turn was based on an overall governmental directive to increase productivity and innovation in the construction industry (Dir. 2009:92 2009). A BIM implementation project was initiated at the STA in 2013. Any particular organisational unit did not govern this project; instead, it was assigned to the whole client organisation and managed by team of BIM experts. The strategy was to establish a BIM policy that would guide procurement and the formulation of procurement requirements specifying the delivery of a coordinated BIM-model for all procured projects.

At this time, the STA included five units and a number of smaller sub-units and support-units. The large project department and the investment department were the two largest units and they were responsible for developing, procuring, managing and controlling investments in infrastructure projects. While the large project department was responsible for the largest (in terms of budget and scope) and most complex projects, the investment department was responsible for the main bulk of investment projects. The STA, with its units, sub-units and support-units, is heterogeneous and fragmented, and there are different organisational cultures and traditions in different parts of the organisation, partly based on a merger ten years ago between the rail and road administrations.

Collecting data

As a part of the longitudinal case study, data was collected from interviews, observations and document analysis. A longitudinal perspective enables the study of change processes and related mechanisms (Pettigrew 1985). The data is qualitative and includes experiences from a variety of perspectives. The data consist of around 80 hours of observations of meetings and workshops performed by the first author. The first author had access to premises, Intranet and (some) databases at the STA and could observe formal and informal meetings, workshops and hallway discussions. During observations, the first author took careful notes that were categorised chronologically.

The data also includes 11 semi-structured interviews with representatives working at different units at STA. The first author also performed all of the interviews. The respondents were identified and selected based on their interaction with, expertise, or special interest of, the BIM Implementation. In order to get a more holistic understanding of the BIM implementation, the respondents represent different units of the STA. Some interviews were recorded and transcribed and when not recorded (as per the interviewees' request), careful notes were taken. All interviews were performed at the time of the BIM implementation process. Five of the respondents represented the BIM implementation project, while six represented the large project department and the investment department (Table 1). Each interview lasted between one and two hours in general and the questions focussed

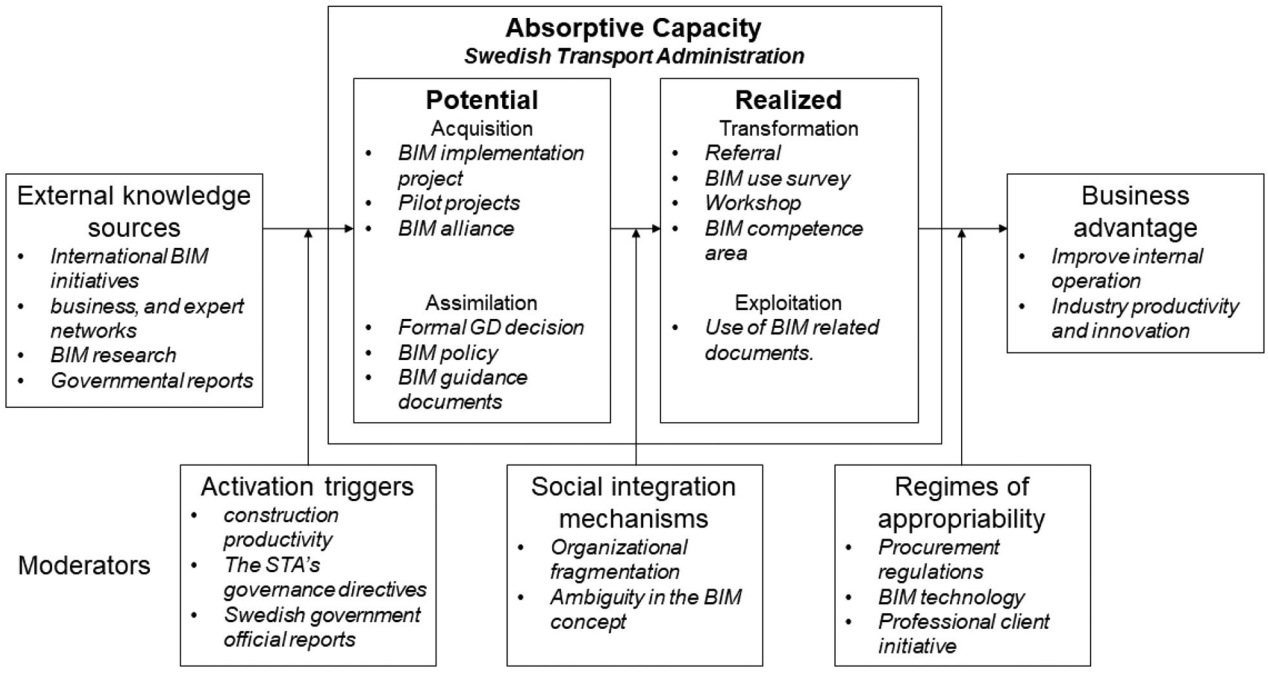

Figure 2. The STA's BIM implementation, mapped to the model of absorptive capacity by Zahra and George (2002).

on how the respondents were influenced by the actions taken during the BIM implementation and what their perceptions of the BIM implementation process were.

In addition, internal policy documents such as directives have also been analysed, all of which are related to BIM implementation at the STA. The documents present an insight into the BIM policy and procurement guidelines devised by the BIM implementation project to influence other projects.

Analysing data

When analysing the data, we were first focussing on how the BIM implementation process took place, i.e. what did the different actors do and who did what when implementing BIM internally at the STA. The analysis, with interview transcripts and documents, followed an interpretative and exploring process rather than confirming (compare with Eisenhardt and Graebner 2007). First, we studied the actions chronologically in order to gain a comprehensive understanding of the implementation process. Based on emerging patterns (Hansson 1958, Weick 1995) we structured the continuous chronology in four themes: decision to implement BIM, implementation project, competence area and follow-up workshop. By this structure, the chronology in studied case was subdivided into four consecutive themes. The themes were then mapped to the concepts from the Zahra and George model (2002) (Figure 2).

Findings

Formal decision (2013)

The formal BIM implementation process started in 2013 when the General Director of the STA signed a decision to work towards "a coordinated and controlled implementation of BIM, Building Information Modelling/Model, in the whole STA organization". The decision was based on a governmental directive that the STA should work for increased productivity and innovation in the construction industry (SOU 2012:39). At this time, BIM had already been tested in a few selected infrastructure projects (e.g. BIM pilot projects) managed by the STA, and thus BIM was not an entirely new concept at the STA. The major change this decision presented was therefore a formal starting point for how the client organisation was now expected to always require BIM when procuring projects by external actors (e.g. contractors and consultants). At this time, there was an intense international discussion on public initiatives to drive change through the implementation of BIM and a governmental BIM initiative in the UK had influence on the BIM implementation at the STA. Documents and experiences from the UK served as a direct inspiration and influenced actions taken at the STA.

The wider construction industry context included construction project actors (consultants, contractors, suppliers etc.), business, and expert networks, such as BIM Alliance and Building SMART. These business, and expert networks, among others, were promoting BIM to be implemented in all national public client organisations in order to increase efficiency and productivity in the construction industry. This resulted in a national initiative called "BIM in the Government" (authors' translation) that was published in 2013 (BIM Alliance 2018). At this time, many actors viewed BIM as the ultimate solution to the construction industry's well-known problems, including how to limit time delays, cost overruns and how to increase quality and productivity.

Implementation project (2013–2014)

The decision by the General Director resulted in the initiation of a BIM implementation project at the STA. The project team included a project manager and 13 BIM experts from different units at the STA. This project team was expected to work across all units at the STA, and they began with outlining objectives for BIM use (both internal objects and objectives that concerned the whole construction industry). The objectives were later summarised in a project specification stating that BIM shall be used to some extent in all procured infrastructure projects from 2015 and onwards. The specification also said that BIM shall make the STA more efficient, that BIM will support the establishment of the organisation as a professional client, and that BIM shall be included as a requirement when procuring both design and construction.

The BIM implementation project then continued by outlining a BIM strategy to meet the objectives. The BIM strategy defined BIM as *"the use of information models in a linked information flow through the work processes relating to buildings and other facilities"* (TDOK 2013:0688, p. 1). Further, the strategy specified maturity levels of BIM-use including a base level to which BIM shall be procured in all future projects managed by the large project department and the investment department. The strategy also specified the expected output from working with BIM centric work practices. This output was described as *"increased efficiency in internal processes and project practices"* (TDOK 2013:0688, p. 1). Besides objectives and strategies, the BIM implementation project also specified BIM-enabled tools aimed at design or construction, e.g. model based planning and evaluation of design alternatives. Following the development of objectives, BIM strategy and tools, the BIM implementation team finalised BIM guidance documents.

The BIM guidance documents, which became the main deliverable of the BIM implementation project, were based on experiences from BIM pilot projects performed mainly by the large project department. In these pilot projects, BIM were tested on a relatively extensive level by devoted teams with high BIM competence. The documents were developed to guide project managers in the procurement of design services and construction projects. More specifically, the documents were aimed at supporting the formulation of BIM requirements in procurements, which was something new for most project managers. The guidance documents also included specifications on how to use BIM at the STA, i.e. they were specifying internal processes. Consequently, the BIM guidance documents were directed both towards the requirements when procuring, i.e. how external industry actors such as consultants and contractors shall work with BIM and towards the internal processes defining how the client itself should work with BIM.

At the time of BIM implementation, there were several other ongoing change initiatives at the STA aimed at increasing productivity by driving change and innovation to the construction industry. One such example was the "professional client initiative" that also developed objectives, strategies and guidance documents. The professional client initiative was based on a marketisation strategy, where more responsibilities were delegated to suppliers, limiting the direct client influence. With larger degrees of freedom, this initiative aimed at opening up for innovative solutions by suppliers. The professional client initiative had four main purposes, to increase innovation, productivity, and competition on the market, and, to clarify the role of the STA (as a client) and its suppliers. On several occasions, however, it was found that different internal policy documents were in conflict with each other causing frustration and uncertainty among employees at the STA and among industry actors. One such example is related to the level of details when formulating requirements when procuring consultants and contractors. While the professional client initiative suggested a lower level of details when formulating procurement requirements, the BIM implementation initiative suggested mandatory and more specific procurement requirements.

In order to evaluate the BIM guidance documents applicability in different units at the STA, the guidance documents were sent on an internal referral procedure before being finalised and implemented. In this

referral, several issues were raised, both from technical and organisational perspectives. This referral collected 333 individual comments, of which 120 were directly addressed, 110 were forwarded to later development and around 100 were discarded.

When the BIM implementation project was closed in 2014, the STA's work with implementing BIM continued, albeit in a different organisational form and under a different label. From 2015 onwards, the group of BIM experts working with implementing BIM at the STA formed a BIM competence area. This way, the BIM implementation work changed from being a temporary project to become a permanent competence area, the revised guidance documents were implemented to the STA's management system in 2015 and when being in use, revisions were continuously made to handle feedback.

Competence area (2015–)

While the main task of the BIM implementation project team had been to develop objectives, strategy, tools and guidelines, the objective for the BIM experts working at the BIM competence area (of which many were the same persons) was to promote and increase the use of BIM; both internally at the STA and externally among actors in the construction industry. The overall objective was to change the work practices by influencing the process of procuring design services and construction projects. However, the BIM competence area also developed a BIM strategy that served to influence work practices which was included in the guidance documents as requirements on coordinated information models. By requiring coordinated models when procuring, all project actors were incentivised to work jointly with BIM. The guidance documents also specified that the client's project managers were responsible for ensuring that BIM centric work practices were carried out and documented in all construction projects which also pinpointed the client's project managers as having the key role for insuring and fulfilling the implementation and wider use of BIM.

In order to follow up and assess the BIM implementation process, an external consultant was contracted. The consultant performed two surveys directed towards the STA and external actors. The surveys took place at the end of 2015 and at the end of 2016, and the results showed a slight downward trend in the satisfaction of working with BIM, in particular among the client's project managers. To follow up on these results, the BIM competence area initiated a workshop in May 2017 with representatives from the large project department and the investment department. The aim of the workshop was to identify the most problematic issues of working with BIM and find ways to address them.

Follow-up workshop (May 2017)

At the workshop it was communicated that project managers were still unfamiliar with BIM and that they had difficulties understanding the survey questions when filling in the survey. According to one BIM expert working at the investment department, several project managers had therefore forwarded the survey to him and asked him to respond instead of them because they did not have time or competence to answer the questions themselves.

Further, concerns were raised about how the BIM models were used in various projects. Concerns regarding the responsibility for model information in inter-organisational model use were pinpointed as of particular importance. However, representatives from the investment department said that they didn't work this way. Instead, most project at the STA were using BIM to a much more limited degree. Thus, at the current stage barriers linked to inter-organisational use of models were not seen as one of the most problematic issues.

The workshop also pinpointed uncertainties regarding the degree to which the STA's project managers had direct use of and benefits from the BIM models. Project managers from the investment department said they had limited contact with the models and therefore they had little use of them. A representative from the large project department commented upon this saying that if the project managers and project teams did not use the models, there was no point in having them. Other difficulties in the use of models were also pinpointed, for example related to the European public procurement act. It was said that due to software neutral procurement, the STA had to be able to use seven different viewer programmes for models. The client's project managers also expressed uncertainty in regard to the specifics of BIM use in projects. Specifically, the project managers expressed ambiguity on what was expected to be included in the models and not.

To summarise, the BIM implementation at the STA was ongoing for several years. It began with external influence from national and international examples, continuing with a temporary and top-down initiated BIM implementation project, before a permanent BIM competence area was established. In May 2017, the BIM implementation project was followed-up in a

workshop, revealing a number of inter- and intra-organisational challenges still to be handled.

Mapping BIM implementation

To explore the STA's ability to drive industry change through the implementation of BIM, the BIM implementation process at the STA is mapped in relation to the model of absorptive capacity (Zahra and George 2002) (Figure 2).

External knowledge sources

The external knowledge that influenced the STA came from different sources. One such source was the BIM implementation initiatives in other countries that served as inspiration and role models. For example, the BIM strategy developed in the BIM implementation project directly refers to different BIM maturity levels defined in the UK maturity model. Business, and expert networks such as BIM Alliance was also influencing the STA. Such networks had the role as communication channels and knowledge sharing platforms between the BIM initiative at the STA and other BIM-related initiatives in industry, society and academia. The networks served as nodes between academic knowledge, industry experience, international role models and public clients nationally and internationally. In addition to networks, governmental reports served as knowledge sources that influenced the STA. To summarise, external knowledge sources comprised of for example, national and international BIM initiatives, industry network and governmental reports.

Business advantage

As a public client, the STA is not driven by the pursuit of establishing a business advantage. Instead, the organisation aims at fulfilling its governmental directive. Among others, this directive state that the STA *"should, in its role as a client, act for increased productivity, innovation and efficiency on the markets for investment, operation and maintenance"* (SFS 2014:362). Thus, the BIM initiative's objective has been the fulfilment of this goal rather than establishing a specific business or competitive advantage. Instead, the STA is working towards establishing change and innovation in the construction industry at large as well as improving its internal operation.

Activation triggers

The argument that the construction industry is lagging behind other industries in terms of productivity was a strong argument and worked as a major driver for implementing BIM at the STA. An example of this is the specification for the BIM implementation project that directly linked the implementation of BIM to increased industry productivity. This activation trigger is further strengthened by the governance directives for the STA that states that the STA, in their role as client, should work towards increasing productivity, innovation and efficiency on the markets of investments in and maintenance of infrastructure (SFS 2014:362). The Swedish government official report (SOU 2012:39) also directly linked BIM to the goal of improving efficiency in infrastructure construction. This report was also specifically referred to in the project specification for the BIM implementation project. To summarise, examples of activation triggers for gathering external knowledge of BIM were construction productivity, the STA's governance directives and Swedish government official reports.

Acquisition and assimilation

At the STA, there were three interlinked channels through which external BIM knowledge were acquired. The main channel for knowledge acquisition was the BIM implementation project and most of the project team members had personal BIM knowledge and previous experience from BIM pilot projects. Some BIM pilot projects continued after the BIM implementation project began in 2013 and they served as a knowledge base for the BIM implementation project to draw lessons learned. Further, the STA maintained active membership in the industry expert network BIM Alliance which linked the team members of the BIM implementation project to other actors of with a special interest in BIM. Industry networks thus served as a complementary channel to BIM knowledge.

The assimilation of acquired BIM knowledge and experience was conducted in a series of activities. The GD's formal decision to implement BIM at the STA represent the start of a structured and formalised BIM implementation process. This decision initiated the BIM implementation project that was responsible for facilitating assimilation activities. As examples of outcomes, the BIM implementation project produced an internal BIM policy and internal BIM guidelines. Because of the establishment of the BIM policy, BIM was dictated as a natural part of procurement at the STA and there were detailed guidelines of BIM use specified in the guidance documents.

Transformation and exploitation

The BIM policy and the guidance documents aimed at influencing and directing project managers how to procure and manage their construction projects. Thus, the assimilated knowledge was used to establish a transformation of the project procurement process at the STA. However, there were difficulties in realising this transformation. For example, project managers reported that they had difficulties in understanding the new documents and that they found the guidelines to be in conflict with other initiatives, in particular the professional client initiative. During the follow up workshop, project managers expressed how *"We do not work that way"*, as a reaction to the proposed use of coordinated models. Further, project managers are expressing how they are avoiding BIM in their projects stating, "*We have chosen not to go into BIM, and once again it is a matter of resources. I have not enough BIM knowledge and did not know how we could use it"* (No.11).

To facilitate transformation, the BIM implementation project arranged activities to revise and improve the BIM documents and thereby better adapt the external BIM knowledge to the local context and practice at the STA. The referral process of BIM guidance documents, the BIM survey and the workshop are three examples of such activities. The results of these activities were later evaluated and incorporated into the new and more permanent organisation that was established and which was labelled BIM competence area. By reorganising the BIM implementation work from a temporary initiative to a more permanent organisation, the STA established a long-term perspective transformation of BIM.

Exploitation of the acquired BIM knowledge would require that project managers at the STA actually used and followed the new BIM policy and the BIM guidance documents when procuring and managing their construction projects. This would also include an actual incorporation of requirements for BIM in the procurement templates. However, since the project managers found it difficult to follow the new guidelines and use the new templates the exploitation of BIM knowledge at STA became problematic.

Social integration mechanisms

The mechanisms by which project managers are influenced in their actions as procurers of construction projects are mainly through a series of policy and guidance documents. The documents collects demands, which project managers incorporates in the procurement process, thus influencing the construction industry. By establishing new BIM guidance documents as a part of the portfolio of demands was the mechanism by which the BIM initiative aimed at influencing the procurement process at the STA. However, the STA, including its multitude of units, subunits and support units experienced intra-organisational fragmentation in relation to BIM implementation. Different units applied different guidelines and different objectives, and different units prioritised BIM differently, which made STA act as a heterogeneous organisation. The professional client initiative provided what was perceived as contradictory directives to the BIM implementation initiative. Further, project managers did not view BIM implementation as the obvious path to achieve higher productivity and increased innovation.

There were difficulties in adapting the current ways of working to the new external BIM knowledge. For example, projects managers were not aware of how BIM could be used in their projects, or what the benefits would be, which made BIM become a cognitive barrier. For example, a project manager for the BIM implementation at the investment department stated that *"Project managers do not understand for what they should use BIM, therefore they exclude demands for BIM when procuring"* (interview No. 7). There was also ambiguity among project managers around what BIM would include and what BIM might entail. The difficulties for project managers to establish BIM use in projects was shown in, for example, the referral, the survey and at the workshop, indicating that there was a lack of social integration mechanisms.

Regimes of appropriability

Several external factors had an impact on the STA's ability to absorb external BIM knowledge. The BIM technology was continually developed and some of the barriers to BIM implementation were directly linked to technical limitations. For example, there were challenges with problematic interoperability, lack of well-established and accepted standards and varying BIM maturity among actors. Additionally, the public procurement legislation created barriers to BIM implementation at STA, for example when project managers were not allowed to specify file format neutral demands which resulted in the use of several different viewer programmes for models.

Discussion

The presented case is an empirical example of a public client organisation's initiative to drive industry change thorough the implementation of BIM. For the

implementation of a systemic innovation such as BIM to lead to industry change, the client has to accept the change (i.e. establish intra-organisational acceptance for change) before they may exert their influence on external actors (i.e. drive inter-organisational change) (compare with Hartmann *et al.* 2008, Ivory 2005). For clients to be successful in driving inter-organisational change, and thereby influence the industry actors, the client has to have the ability to absorb BIM knowledge. To better understand this process, we have applied the model of absorptive capacity by Zahra and George (2002).

A lack of client demand for BIM is argued to be an explanation for the slow implementation of BIM in the construction industry (Chan 2014). From an absorptive capacity perspective, this can be understood as a lack of activation triggers for clients to absorb BIM knowledge. Beyond the need for activation triggers, BIM also requires coordination between industry actors because of its systemic nature (compare with Taylor and Levitt 2004). Case study findings show how these two factors (i.e. a need for activation triggers and coordination between actors) represent external knowledge that have influenced the BIM implementation process at STA and thus the BIM implementation project worked to establish a demand for BIM in the procurement requirements and a support for BIM use in projects.

However, the case study findings indicate that there were difficulties in establishing an absorptive capacity for the external BIM knowledge at the STA. For example, during the workshop in May 2017, there were project managers expressing how they did not work according to the BIM guidelines. This indicate a lack in the STA's transformation ability. Specifically, situations are found in the case where construction project managers perceived that the external BIM knowledge was in conflict with the existing routines at the STA. From an absorptive capacity perspective, this indicates that the process of bisocation (Zahra and George 2002) between external BIM knowledge and existing project work practices were not complete.

Public clients are constituted of a multitude of complex networks of formal and informal relationships and interdependencies (Newcombe 2003, Sexton *et al.* 2008) which add challenges to establishing transformation. Driving change in such an organisational context requires acceptance, collaboration and alignment from a multitude of actors (Harty 2008). From an absorptive capacity perspective, there has to be strong social integration mechanisms supporting the absorption of external knowledge. However, case findings show that such mechanisms were not in place. Instead, there were several barriers to absorption. For example, there were structural barriers in terms of the fragmentation between units and there were cognitive barriers in terms of the lack of understanding of BIM use among project managers.

Difficulties in transforming work practices at the STA indicate challenges in turning the potential absorptive capacity into realised absorptive capacity. The members in the BIM implementation project, in which the acquisition and assimilation of external BIM knowledge was conducted, were early adopters of BIM. These individuals generally possessed extensive BIM experience and competence. The construction project managers, however, who were the main target for the transformation, did not possess this experience or competence and they faced difficulties that were not identified in the acquisition.

In terms of external motivators, the regimes of appropriability limited project managers' ability to use the assimilated BIM knowledge at STA. Factors, such as the public procurement legislation directly influence the degree to which project managers at the STA are able to influence projects, hindered the bisocation process of making BIM a part of the project process at the STA. The external knowledge were mainly acquired in BIM pilot projects or other examples of early stage implementation. Thus, there was a lack of external knowledge sources from widespread BIM use and no clear benefits from actual BIM use. Indications of potential hype around BIM (Fox 2014; Dainty *et al.* 2015) can be found among the BIM experts at STA when developing guidelines directing project managers to require BIM. However, project managers at the STA questioned the usefulness of transforming their work practices. Without empirical evidence of the direct usefulness of BIM, which may persuade project managers to actually change their work practices, regimes of appropriability will hinder the transformation among project managers.

BIM is one of many initiatives that address productivity in construction. Currently there are also other initiatives following other rationales of how construction productivity could be improved. The BIM initiative, following a technological imperative, was contested by the professional client initiative, following a marketisation imperative. These rationales have different answers to the industry's challenges and argue for different change initiatives. They also require different prerequisites in order to be successful.

Conclusion

As discussed in the introduction, prior research emphasise the role clients as needed change agents in driving construction industry change. There is also a strong emphasis on BIM as game changer in the construction industry. However, for industry change to take place, intra-organisational change at client organisations has to be established. There is a tendency to forget (or neglect) the client's ability to drive change and innovation to the construction industry.

During the implementation of BIM studied in this paper, there were difficulties in the transition from recognition of external knowledge to the absorption and application of said knowledge i.e. the transition between potential to realised absorptive capacity. In this process, the absorption of external BIM knowledge needs to extend beyond a limited group of early adopters. Due to a lack of social integration mechanisms and hindering regimes of appropriability, the transformation was unsuccessful. Findings thus argue for the importance of establishing acceptance for change internally at the client organisation first, in order for the client organisation to have the ability to influence the inter-organisational network (i.e. the wider construction industry). By applying the model of absorptive capacity, this paper meets the recent call for further elaboration on the client's role as driver for industry change (Havenvid *et al.* 2016). We show how the client's ability to drive industry change in the studied case was insufficient due to a lack of absorptive capacity.

The framework of absorptive capacity (Zahra and George 2002), describes how three distinct moderators influence the absorption of external knowledge. We found that the moderator of activation triggers has been over emphasised in relation to BIM implementation while simultaneously disregarding difficulties in establishing supportive social integration mechanisms and regimes of appropriability. This calls for more research on the internal change processes at client organisations and the need for a reminder of the fact that clients are often fragmented and heterogeneous. Research on client driven change and innovation in construction often pinpoint the client's power and possibility to initiate change to a wider industry context when setting procurement requirements (e.g. Hartmann *et al.* 2008). However, the client's project managers first have to be convinced of the merits of new technology in order to require it. Hence, BIM implementation requires a negotiation processes, convincing project managers of the value and usefulness of BIM (compare with Harty 2008). Thus, the advocates of BIM as a game changer in construction have to take the intra-organisational change process into account (e.g. Azhar 2011, Lee and Yu 2015, Takim *et al.* 2013, Ciribini *et al.* 2016). Top-down, expert-led implementation of systemic innovations such as BIM in public client organisations face major challenges and is dependent on the client's absorptive capacity. While some work is based on the technological imperative, other work uses the rationale of a marketisation imperative. This is especially important to acknowledge in relation to, procurement (Haugbölle *et al.* 2015) which in the case of driving change through BIM, requires a combination of imperatives. It is also important to remember the need for client competence in order to drive innovation and change trough the implementation of new technology (Nam and Tatum 1997). Consequently, the client's ability to drive industry change towards BIM is not merely a matter of technical development or improved procurement strategies, but must instead be understood in terms of the client's absorptive capacity.

To conclude, findings contribute with an investigation of the client as a driver for change and innovation that acknowledge the fragmentation and heterogeneity of the client organisation. We contribute to the debate on clients as drivers of change and innovation and the discussion on BIM as an industry game changer. Findings also provide managerial advice for how client organisations can improve their ability to drive industry change and innovation through the implementation of BIM. The ability is dependent on managing all three moderators influencing the four dimensions of absorptive capacity. However, further research is needed to explore each dimension more in-depth, and the ways in which the moderators influence the dimensions. Due to empirical limitations, this paper only address intra-organisational change, which can be understood as the first stage in a two-stage process of client driven change. The second stage, the inter-organisational change, will take the perspective of external industry actors and networks into account and needs to be studied in future works.

Disclosure statement

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