Available online at www.sciencedirect.com
ScienceDirect
International Journal of Project Management xx (2016) xxx–xxx
International Journal of Project Management
www.elsevier.com/locate/ijproman

# Identifying and contextualising the motivations for BIM implementation in construction projects: An empirical study in China

Dongping Cao [a,b,*], Heng Li [a], Guangbin Wang [b], Ting Huang [a]

[a] *Department of Building and Real Estate, The Hong Kong Polytechnic University, Hong Kong, China*
[b] *Department of Construction Management and Real Estate, School of Economics and Management, Tongji University, Shanghai 200092, China*

Received 1 October 2015; received in revised form 18 January 2016; accepted 1 February 2016
Available online xxxx

**Abstract**

Grounded in institutional theory and the innovation diffusion literature, this paper identifies the motivations of designers and general contractors to implement BIM in construction projects, and investigates how different motivations are impacted by organisational BIM capability and other contextual factors. Results of factor analysis with survey data collected from China provide support for the theoretically developed motivation model which classifies BIM implementation motivations into four categories: *image motives*, *reactive motives*, *project-based economic motives*, *cross-project economic motives*. Hierarchical regression results suggest that although project participants will have stronger economic motivations to improve project performances as their BIM capability matures, this increase in economic motivations does not necessarily require a parallel decrease of desires to improve social image. Regression results also suggest that BIM implementation motivations relate to organisational ownership type and project characteristics. The findings contribute to a broadened understanding of the multi-dimensionality and dynamics of construction organisations' innovation implementation motivations.


*Keywords:* Building information modelling (BIM); Institutional theory; Innovation diffusion; Innovation implementation motivations; Construction projects

## 1. Introduction

In the past decade, building information modelling (BIM) has been increasingly regarded as one of the most promising innovations to address performance problems that have long plagued the construction industry (Eastman et al., 2011; Froese, 2010). Despite its great potential, the advancement of BIM in many countries is still in a relatively infant stage, with a relatively high percentage of construction projects still sitting on the sidelines of BIM implementation (Aibinu and Venkatesh, 2014; CCIA, 2013; Jensen and Jóhannesson, 2013; Samuelson and Björk, 2014). In order to leverage the potential of BIM to reshape the laggard construction industry, therefore, it is clearly important to develop a robust understanding of how project participants make BIM implementation decisions and how such decisions are impacted by related contextual factors.

Prior research on other innovations in the construction industry has already empirically probed the question of how construction organisations make innovation implementation decisions, but related research findings regarding the motivations or reasons for adopting and implementing innovations have been relatively discordant. While some studies (e.g., Toole, 1998) reveal that innovation implementation decisions are often accompanied by gathering information from external entities

* Corresponding author at: Department of Building and Real Estate, The Hong Kong Polytechnic University, Hong Kong, China. Tel.: +852 2766 5803; fax: +852 2364 9322.
*E-mail addresses:* dongping.cao@connect.polyu.hk (D. Cao), heng.li@polyu.edu.hk (H. Li), gb_wang@tongji.edu.cn (G. Wang), huang.ting@polyu.edu.hk (T. Huang).

http://dx.doi.org/10.1016/j.ijproman.2016.02.002
0263-7863/00 

such as trade partners and industry professionals, a stream of other research (e.g., Kale and Arditi, 2005; Esmaeili and Hallowell, 2012) suggests that innovation implementations are primarily driven by imitative motivations but less influenced by external requirements or suggestions, and still another (e.g., Nikas et al., 2007) controversially indicates that innovation usage has no significant association with environmental factors including the practices of peer organisations but is proactively driven by internal economic motivations such as seeking communication improvement and achieving cost reduction. Such discordance in the research results, together with the complexity of the BIM implementation decision-making process which may be caused by the unique characteristics of BIM as a relatively complex and influential innovation, will increase the difficulty in generalising extant research findings on other construction innovations to develop a theoretically rigorous understanding of how construction organisations are catalysed to implement BIM in construction projects.

Rogers's (1995) innovation diffusion model claims that perceived innovation characteristics, such as relative advantage and technological complexity, are important elements in the innovation diffusion process that impact whether an innovation is to be implemented. Consistent with this claim, much of extant BIM research has focused on exploring or validating how BIM could be beneficially implemented from a technical perspective (Cao et al., 2015), partly assuming that utilising related technological advantages of BIM to gain economic benefits will act as an important motivation for BIM implementation. In spite of its potential advantages, however, the implementation of BIM frequently involves a variety of process and organisational barriers (Dossick and Neff, 2010; Taylor, 2007) which may significantly influence organisational intentions to use BIM purely based on technical or economic motivations. Drawing on institutional theory (DiMaggio and Powell, 1983), recent studies claim that BIM implementation decisions could also be impacted by isomorphic pressures in external institutional environments and, therefore, potentially indicate that seeking social legitimacy is also an important motivation for construction organisations to engage in BIM initiatives (Cao et al., 2014; Succar and Kassem, 2015). However, while environmental pressures are seldom the only factors influencing innovation adoption and organisations may have complex and multi-dimensional motivations to implement innovations under the interplay of different contextual factors (Kennedy and Fiss, 2009; Martinez and Dacin, 1999), scant scholarly attention has been devoted to directly identifying the motivations for construction organisations to implement BIM in construction projects, and relatively little empirical evidence has been provided to explain how BIM implementation motivations might be impacted by related contextual factors such as organisational capability and project characteristics.

Grounded in institutional theory and the innovation diffusion literature, this study aims to identify and categorise the motivations of designers and general contractors to implement BIM in construction projects, and investigate how different motivations are impacted by organisational BIM capability as well as other related contextual factors. Empirical analyses in this study are based on project-based survey data collected from the Chinese mainland. The remainder of this paper is organised as follows. The next section develops the theoretical model of BIM implementation motivations and proposes the research hypotheses on the relationships between organisational BIM capability and BIM implementation motivations. Section 3 outlines the data and measurements used to test the model and hypotheses. This is followed by the presentation of the data analyses and results in Section 4. Section 5 discusses the findings and Section 6 summarises this paper.

## 2. Theoretical model and research hypotheses

### *2.1. Theoretical model of BIM implementation motivations*

Through viewing organisations as socially embedded systems subject to the impacts of external isomorphic pressures, institutional theory suggests that structural and behavioural changes in organisations are primarily triggered by the motivations of seeking social legitimacy (i.e., seeking to be socially accepted) (DiMaggio and Powell, 1983; Scott, 2001). As isomorphic pressures in institutional environments include both compelling pressures (such as coercive pressures) and less compelling pressures (such as mimetic and normative pressures) (Cao et al., 2014), the social motivations of project participants to implement BIM under the impacts of institutional isomorphic pressures could reflect not only their reactive needs to comply with the formal and informal requirements from the organisations upon which they are dependent (labelled as "reactive motives"), but also their intrinsic desires to proactively adapt to the industry expectations and technology development trends and thus to portray a good image of technological sophistication (labelled as "image motives"). Due to their relatively disadvantaged positions in project principal–agent relationships, designers and general contractors' reactive motives could be induced not only by the coercive pressures from regulatory agencies outside the project but also by the compelling influences from other project participants (such as clients/owners) strongly advocating BIM use.

While having provided important theoretical perspectives to explain the relationship between organisational activities and institutional environments, institutional theory has also been criticised for overemphasising the social logic underlying organisational activities but largely ignoring the role of economic or efficiency considerations (Martinez and Dacin, 1999; Roberts and Greenwood, 1997). As an attempt at applying institutional theory to explain the innovation diffusion process, the classic institutional diffusion model also separates social and economic motivations underlying innovation implementation activities and claims that the two types of motivations substitute for each other rather than working in a parallel logic (Tolbert and Zucker, 1983; Westphal et al., 1997). Although such a claim has a relatively long-standing tradition, it has recently drawn critical attention. Lounsbury (2007), for example, contends that segregating economic and social logics underlying innovation diffusion process is problematic, since economic mechanisms such as performance and efficiency are "institutionally embedded" rather than "decoupled from broader institutional beliefs" (p.302). Kennedy and Fiss (2009) similarly contend that economic and social motivations may coexist with rather than substitute for each other, and suggest that "the desire to appear legitimate should only conflict with a desire to improve performance when performance improvements themselves are illegitimate" (p.899).

As a fundamentally new way of creating, sharing, and utilising project life-cycle data (Eastman et al., 2011), BIM has been institutionally advocated because it has great potential to streamline project life-cycle processes and address performance problems in the construction industry (Francom and El Asmar, 2015; Love et al., 2013). As such, the motivations to appear socially legitimate through implementing BIM do not logically conflict with the motivations to realise economic performance improvement, and they may even reinforce each other. As a consequence, although the variety of BIM implementation barriers will increase the difficulties of gaining economic benefits from BIM and cause project participants to be more easily motivated by social reasons, the institutionalised BIM implementation process under the impacts of isomorphic pressures will probably be not completely isolated from the motivations to seek economic performance improvement. As for project-based organisations like design and construction enterprises, the improvement of economic performances is impacted not only by how they utilise technologies to enhance design and construction performances in a certain project in the short term but also by whether they could establish cross-project learning and capability building mechanisms to utilise current project activities to enhance the performances of future projects in the long term (Brady and Davies, 2004; Gann and Salter, 2000). When organisations move into a new technology or market base, cross-project learning and capability building will become more important to the improvement of long-term economic performances (Cao and Wang, 2014; Ruuska and Brady, 2011). As for innovative and complex technologies like BIM, therefore, economic motivations of designers and general contractors to implement technologies in a construction project should not only include the motives to improve short-term design and construction performances in the current project (labelled as "project-based economic motives"), but also involve the desires of conducting cross-project learning and capability building to gain long-term economic benefits in future projects (labelled as "cross-project economic motives").

Based on the above discussions, the motivations of designers and general contractors to implement BIM in construction projects are classified into four broad categories as shown in Fig. 1: image motives, reactive motives, project-based economic motives, and cross-project economic motives.

### 2.2. Research hypotheses on relationships between organisational BIM capability and BIM implementation motivations

Due to the project-based nature of design and construction organisations, the motivations of designers and general contractors to implement BIM in construction projects may be impacted by both organisational and project characteristics. As an organisational contextual factor directly hinging on BIM implementation processes, BIM capability of designers and general contractors is likely to be closely related to their motivations for implementing BIM in construction projects.

Impression management literature suggests that there are two primary tactics for an organisation to manage social image: protecting the organisation's established social image from degradation and improving the organisation's social image based on emerging opportunities (Rosenfeld et al., 1995). As such, as long as the utilisation of BIM in a certain project is in accordance with external institutional expectations on the project, participating organisations with different levels of BIM capability may both have motivations to regard the implementation of BIM in the project as an image management tactic. As for project-participating organisations with high BIM capability, they may need to conduct BIM implementation to exhibit their BIM capability, and thus to avoid their established image for embracing advanced technologies being contaminated. As for project-participating organisations with low BIM capability, they may need to conduct BIM implementation to improve or re-establish their social image for utilising the advanced BIM technology and to narrow the image gap for technology implementation between themselves and their counterparts. Therefore, organisational BIM capability may have no significant impact on the image motives of project participants to implement BIM in construction projects. With regard to reactive motives underlying technology implementation, project-participating organisations with such types of motivation are probably those coerced or unprepared users, as categorised by Iacovou et al. (1995), which are unaware of the potential benefits of BIM or unable to realise such benefits in the current project. Therefore, project participants possessing obvious reactive motives would be more likely to be those organisations without necessary experience or expertise on BIM technology. These lead to the following set of hypotheses

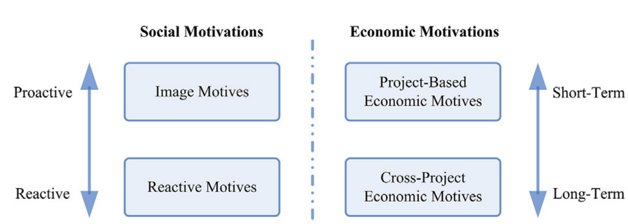


Fig. 1. Motivations for BIM implementation in construction projects.

Please cite this article as: D. Cao, et al., 2016. Identifying and contextualising the motivations for BIM implementation in construction projects: An empirical study in China, Int. J. Proj. Manag. http://dx.doi.org/10.1016/j.ijproman.2016.02.002

on the relationships between organisational BIM capability and the two types of social motivations:

**H1**. Project participants' BIM capability is not associated with their image motives for implementing BIM in a construction project.

**H2**. Project participants' BIM capability is negatively associated with their reactive motives for implementing BIM in a construction project.

According to the classification of construction innovations by Slaughter (1998), BIM is a typical systemic innovation. The effective implementation of this type of innovation generally requires an obvious change of traditional project processes and, therefore, also places newer requirements on the technical capability of related project participants. It has recently been reported in several developed countries that lack of BIM expertise has become a prominent factor inhibiting project participants from effectively gaining economic benefits from project BIM implementation activities (Eadie et al., 2013; Lee et al., 2012). In a developing country like China where the advancement of BIM is still in a relatively infant stage, the inhibiting effect of expertise insufficiency should be more obvious. As a consequence, as for project participants with higher BIM capability, they would be more capable of leveraging BIM to improve short-term design and construction performances and, therefore, have stronger project-based economic motivations while implementing BIM in a construction project. As for project participants with lower BIM capability, however, it would be more difficult for them to realise the short-term economic benefits of BIM in the current BIM-based construction project. As a result, they may put more emphasis on cross-project learning and capability building to better gain BIM benefits in future projects. The above considerations lead to the following set of hypotheses regarding the relationships between organisational BIM capability and the two types of economic motivations:

**H3**. Project participants' BIM capability is positively associated with their project-based economic motives for implementing BIM in a construction project.

**H4**. Project participants' BIM capability is negatively associated with their cross-project economic motives for implementing BIM in a construction project.

## 3. Measurements and data

### *3.1. Measurement development*

In order to empirically test the theoretical model and research hypotheses, a questionnaire survey was used as the method to collect data from participating organisations in BIM-based construction projects. The measurement items in the survey questionnaire were initially developed based on information gleaned from related literature as well as a semi-structured interview with four industry professionals conducted in September 2014. The four interviewed industry professionals included a project design director in an engineering and construction company in Shanghai, a vice general manager of a large construction consulting corporation in Shanghai, a project chief engineer in a construction group corporation in Shanghai, and a BIM technology director in a general contractor in Jiangsu. After the measurement items were initially developed, a pre-test involving 21 respondents from designers and general contractors was conducted via a Chinese online survey system (www.sojump.com) to identify ambiguous expressions and preliminarily test the validity of related constructs. Based on the feedback from these respondents, the expressions of some measurement items in the questionnaire were further revised. For example, the expression "economic benefits" in the motivation item "expecting that the economic benefits of BIM use will outweigh its costs in the project" was adjusted to "direct economic benefits."

The revised questionnaire associated with this study was structured into two parts. The first part obtains general information such as project size and project type of the surveyed project, as well as ownership type of the surveyed project-participating organisation in which the respondent was employed. The second part evaluates motivations of the surveyed participating organisation (i.e., the designer or general contractor in which the respondent was employed) to implement BIM in the surveyed project, and BIM capability of the participating organisation at the time of implementing BIM in the surveyed project. Apart from project and organisational characteristic variables such as project size and organisational ownership type, a total of five core variables have been measured in the questionnaire: image motives (IMM), reactive motives (REM), project-based economic motives (PEM), cross-project economic motives (CEM), and BIM capability (BCA). These five variables were all operationalised as reflective constructs, and their detailed measurement items are shown in Table 1.

The two measurement items of IMM were adapted from Arevalo et al. (2013) and reworded to suit the context of BIM implementation in construction projects. The operationalisation of REM was partly based on Gavronski et al.'s (2008) work on the construct of "reactive motivations" in the context of ISO 14001 certification. According to the information further gleaned from the interviews and the pre-test, a total of three items were ultimately adopted to measure REM, namely, needing to comply with BIM use requirements from governments or other project participants, having to promise to use BIM to improve competitiveness in project bidding, and having to participate in using BIM as many other participants are using BIM in the project. The development of the measurement items of PEM was based on Grewal et al.'s (2001) similar study on the implementation of other types of information technology, but the detailed items were largely modified to fit the context of BIM implementation in construction projects. A total of three items were ultimately used to reflect PEM for BIM implementation from different aspects including solving process problems, improving project performances, and gaining instant positive ROI. The operationalisation of CEM was largely based on the information gleaned from the interviews with four industry professionals. The measurement items ultimately

Table 1
Measurement items for BIM implementation motivations and BIM capability.

| Construct | Code | Items | Mean | SD |
|---|---|---|---|---|
| Image motives (IMM) | IMM1 | To maintain a good image for using advanced technologies | 5.75 | 1.19 |
| | IMM2 | Not to lag behind industry counterparts in using BIM | 5.88 | 1.17 |
| Reactive motives (REM) | REM1 | Needing to comply with BIM use requirements from governments or other project participants | 4.19 | 1.55 |
| | REM2 | Having to promise to use BIM to improve our competitiveness in project bidding | 4.79 | 1.50 |
| | REM3 | Having to participate in using BIM as many other participants are using BIM in the project | 4.12 | 1.55 |
| Project-based economic motives (PEM) | PEM1 | Using BIM as a tool to solve related design and construction problems in the project | 5.66 | 1.03 |
| | PEM2 | Using BIM as a tool to improve cost and schedule performances in the project | 5.48 | 1.19 |
| | PEM3 | Expecting that the direct economic benefits of BIM use will outweigh its costs in the project | 5.45 | 1.24 |
| Cross-project economic motives (CEM) | CEM1 | To become more familiar with BIM implementation process through using BIM in the current project | 5.72 | 0.89 |
| | CEM2 | To foster BIM expertise of our team members through using BIM in the current project | 5.73 | 0.99 |
| | CEM3 | To better guide the use of BIM in future projects through using BIM in the current project | 5.87 | 0.93 |
| BIM capability (BCA) | BCA1 | Our team is experienced in implementing BIM | 4.03 | 1.59 |
| | BCA2 | Our team is capable to solve the possible technical problems of BIM | 4.14 | 1.44 |
| | BCA3 | Our team has the knowledge necessary for implementing BIM in such types of projects | 4.31 | 1.44 |

adopted include learning the BIM implementation process, fostering team members' BIM expertise, and guiding the use of BIM in future projects. Similar to the measurement of organisational motivations by other studies such as Brønn and Vidaver-Cohen (2009) and Grewal et al. (2001), the measurement items of the four motivation constructs were all rated by asking respondents to evaluate each motivation item as the reason of their organisation to implement BIM in the surveyed project on a seven-point Likert scale ranging from "1" (strongly disagree) to "7" (strongly agree). The items of BCA were adapted from the measures of "IT capability" developed by Grewal et al. (2001) and Son and Benbasat (2007) and reworded to suite the context of BIM implementation in construction projects. These items were also rated on a seven-point Likert scale anchored with "strongly disagree" to "strongly agree."

To isolate the variation in the four motivation constructs (i.e., IMM, REM, PEM, CEM) caused by organisational and project context, four control variables were included in the analyses on the relationship between BIM capability and BIM implementation motivations. As the first control variable, organisational ownership type was operationalised as a dummy variable reflecting whether the surveyed project-participating organisation was state-owned or not (0 = yes; 1 = no). With regard to three other control variables, project size was measured by investment value of the surveyed project (1 = below ¥50 million; 2 = between ¥50 and ¥200 million; 3 = between ¥200 and ¥1000 million; 4 = above ¥1000 million), project type was measured as a dummy variable indicating whether the surveyed project is residential type or not (0 = residential; 1 = non-residential), and project nature was operationalised as a dummy variable distinguishing public projects and private projects (0 = public; 1 = private).

### 3.2. Sampling and data collection

Only those well-informed senior and professional individuals directly involved in project BIM implementation activities on the Chinese mainland were considered as targeted respondents for the survey. As the use of BIM has been relatively rare in China, a completely random sampling method could not be used to elicit BIM-based projects and related project respondents from a specific project database. Instead, respondents for a wide variety of BIM-based projects were identified by several methods, including searching through related industry publications, requesting information from industry associations, and contacting professionals participating in four BIM industry seminars held by Tongji University between 2009 and 2014.

After being contacted through personal visits or network-based communications, respondents were asked to answer the survey questions based on their most recent BIM-based project which had already been accomplished or had already entered into the post-design construction stage. It was expected that asking the respondents to select their most recently involved project would not only enable them to have a clearer recollection of the project BIM implementation process but also help to reduce the possible response bias as many respondents might otherwise tend to select their most successful BIM-based project. As an attempt to mitigate the impact of confidentiality issues on the response rate, the respondents were not asked to report the name of the selected project. In order to minimise the possible overlap between the surveyed projects and thus improve the representativeness of the sample, it was attempted to distribute the questionnaire to diversified respondents which come from different organisations and participate in different projects in different regions in China.

Responses were collected from project designers and general contractors by means of personal visits and an online survey system from April to May 2015. Through the method of personal visits, about 75 respondents were contacted and 59 responses were collected; about 620 other respondents were invited through network-based channels such as emails and WeChat platform to participate in the online survey (www.sojump.com), and a total of 179 responses were collected. After the further omission of responses with incomplete information, a total of 188 valid responses were ultimately included in the analysis. Among the 188 valid responses, 81 were from project designers and 107 were from general contractors. Demographic characteristics of the surveyed projects and related participating

Please cite this article as: D. Cao, et al., 2016. Identifying and contextualising the motivations for BIM implementation in construction projects: An empirical study in China, Int. J. Proj. Manag. http://dx.doi.org/10.1016/j.ijproman.2016.02.002

organisations corresponding to the responses are shown in Table 2.

It is evident from Table 2 that the surveyed projects are diverse in terms of project size, project type, and project nature. Among the 188 valid responses, 56 (29.79%) were collected through personal visits and 132 (70.21%) were collected by the online survey system. $\chi^2$ tests were conducted to compare the responses collected through the two different methods, and no statistically significant association between data collection method and sample characteristics was found (p-values for the analyses on organisational ownership type, project size, project type, and project nature are 0.889, 0.798, 0.556, and 0.271, respectively). Most respondents are senior and professional individuals with knowledge of the BIM implementation processes of their organisations in the surveyed projects, with 18.62% being project managers or chief project engineers, 14.89% BIM managers, 40.43% BIM engineers, and the remaining 26.06% being other types of engineers also directly involved in the use of BIM. In order to formally examine whether the responses were impacted by the positions of the respondents, the full sample was split into two groups: the group of BIM managers/BIM engineers (N = 104), and the group of project managers/non-BIM engineers (N = 84). A series of independent sample t-tests were then conducted to examine the differences in the values of the 14 measurement items listed in Table 1 between the groups, and no statistically significant difference was found for any measurement item (the p-values range from 0.067 to 0.898).

Table 2
Demographic information.

| Variable | Category | N | % |
|---|---|---|---|
| *Project demographics* | | | |
| Project size | Below ¥50 million | 42 | 22.34 |
| | ¥50–200 million | 59 | 31.38 |
| | ¥200–1000 million | 61 | 32.45 |
| | Above ¥1000 million | 26 | 13.83 |
| Project type | Residential | 40 | 21.28 |
| | Commercial | 72 | 38.30 |
| | Cultural | 10 | 5.32 |
| | Sporting | 5 | 2.66 |
| | Hospital | 11 | 5.85 |
| | Transportation | 16 | 8.51 |
| | Industrial | 16 | 8.51 |
| | Others | 18 | 9.57 |
| Project nature | Public | 106 | 56.38 |
| | Private | 82 | 43.62 |
| *Organisational demographics* | | | |
| Location [a] | North China | 20 | 10.64 |
| | Northeast China | 5 | 2.66 |
| | East China | 106 | 56.38 |
| | South Central China | 33 | 17.55 |
| | Southwest China | 11 | 5.85 |
| | Northwest China | 13 | 6.91 |
| Participating type | Designer | 81 | 43.09 |
| | General contractor | 107 | 56.91 |
| Ownership type | State owned | 90 | 47.87 |
| | Privately owned | 93 | 49.47 |
| | Foreign owned | 5 | 2.66 |

[a] Location of the respondent at the time of the survey, it might be different from the location of the project-participating organisation in which the respondent was employed.

## 4. Data analyses and results

### 4.1. Measurement model assessment

Using the collected survey data, three steps of data analyses were conducted to test the theoretical model and research hypotheses proposed in Section 2: assessment of the measurement model, descriptive and comparative analyses on BIM implementation motivations, and hierarchical regression analyses on the impacts of BIM capability and other contextual factors on BIM implementation motivations.

The measurement items of some motivation constructs were newly developed to suit the context of BIM implementation in construction projects. Following the process deployed by Fullerton et al. (2014) and Handley and Benton (2012) to assess measurement models with newly developed scales, both exploratory (EFA) and confirmatory factor analysis (CFA) were used to examine the reliability and validity of the measures. EFA was used to preliminarily assess item–construct relationships and to refine the scale measures, whereas CFA was used to further verify the results of EFA and systemically validate the measurement model. EFA was conducted in the SPSS Statistics programme 21.0 and CFA was conducted in Amos 20.0.

An EFA was first conducted to assess the underlying structure for the 11 motivation items listed in Table 1. The detailed analysis method was principal component analysis with varimax rotation. As expected, the analysis resulted in the extraction of four different factors reflecting the constructs of image motives, reactive motives, project-based economic motives, and cross-project economic motives. As shown in Table 3, the rotated loadings of the manifest items on their intended constructs are all above the recommended threshold of 0.4 (Nunnally, 1978) and larger than the loadings on other constructs. These results preliminarily validated the appropriateness of using the 11 listed motivation items to reflect the four proposed motivation constructs. As a result, no motivation item was removed from the measurement model according to the results of EFA.

CFA techniques based on the maximum likelihood (ML) approach were subsequently used to further verify the reliability and validity of the measurement model. Results suggested that the measurement model with all the five multi-item constructs (i.e., IMM, REM, PEM, CEM, and BCA) had acceptable fit level as judged by goodness-of-fit indicators ($\chi^2$/df = 1.325, NFI = 0.941, IFI = 0.985, CFI = 0.985, RMSEA = 0.042). As shown in Table 4, the composite reliability values of the examined multi-item constructs all exceed the recommended criterion of 0.70 (Fornell and Larcker, 1981). Convergent validity measures the extent to which the items underlying a particular construct actually refer to the same conceptual variable. The first evidence of convergent validity is provided by the indicator of AVE. As shown in Table 4, each AVE is above 0.5, indicating that at

Please cite this article as: D. Cao, et al., 2016. Identifying and contextualising the motivations for BIM implementation in construction projects: An empirical study in China, Int. J. Proj. Manag. http://dx.doi.org/10.1016/j.ijproman.2016.02.002

Table 3
Results of exploratory factor analysis.

| Measurement items | Factor loadings | | | |
|---|---|---|---|---|
| | Factor 1 | Factor 2 | Factor 3 | Factor 4 |
| IMM1 | 0.203 | 0.137 | 0.021 | **0.901** |
| IMM2 | 0.195 | 0.159 | 0.131 | **0.886** |
| REM1 | 0.066 | −0.109 | **0.733** | 0.151 |
| REM2 | 0.022 | 0.030 | **0.859** | 0.073 |
| REM3 | −0.096 | −0.020 | **0.831** | −0.078 |
| PEM1 | 0.232 | **0.851** | −0.057 | 0.099 |
| PEM2 | 0.150 | **0.892** | −0.031 | 0.123 |
| PEM3 | 0.119 | **0.851** | −0.026 | 0.110 |
| CEM1 | **0.885** | 0.187 | −0.040 | 0.138 |
| CEM2 | **0.868** | 0.170 | 0.030 | 0.239 |
| CEM3 | **0.898** | 0.161 | 0.006 | 0.108 |
| Eigenvalue | 2.525 | 2.392 | 1.990 | 1.755 |
| Variance explained (%) | 22.96 | 21.74 | 18.09 | 15.95 |
| Variance cumulatively explained (%) | 22.96 | 44.70 | 62.79 | 78.75 |

Note: Bold values represent the factor loadings of each measurement item on its intended construct.

Table 4
Measurement validity and construct correlations.

| Construct | CR | AVE | Correlation matrix [a] | | | | |
|---|---|---|---|---|---|---|---|
| | | | IMM | REM | PBM | CBM | BCA |
| Image motives (IMM) | 0.85 | 0.74 | **0.86** | | | | |
| Reactive motives (REM) | 0.75 | 0.50 | 0.13 | **0.71** | | | |
| Project-based economic motives (PEM) | 0.87 | 0.69 | 0.31 | −0.07 | **0.83** | | |
| Cross-project economic motives (CEM) | 0.90 | 0.76 | 0.41 | 0.00 | 0.38 | **0.87** | |
| BIM capability (BCA) | 0.94 | 0.83 | 0.09 | 0.05 | 0.29 | −0.09 | **0.91** |

Note: CR = composite reliability; AVE = average variance extracted.
[a] Bold values on the diagonal represent the square root of AVE.

least 50% of the variance in the items can be accounted for by their respective construct. Further evidence of convergent validity is obtained by estimating the factor loadings of the measurement items. As shown in Table 5, the standardised factor loadings of the items on their respective constructs are all, with the sole exception of REM1, above the threshold of 0.7 and are significant. Although the loading of REM1 on REM (0.571) is lower than 0.7, it is still above the criterion of 0.5 recommended by Hair et al. (2010). Overall, the measurement model could be considered as having acceptable convergent validity. Also, it is shown that the square roots of the AVE (values on the diagonal of the correlation matrix in Table 4) are all greater than the absolute value of inter-construct correlations (off-diagonal values), suggesting that the constructs possess satisfactory discriminant validity.

### 4.2. Descriptive and comparative analyses

The measurement assessment results in the previous section have empirically validated the appropriateness of differentiating the four categories of BIM implementation motivations. Further descriptive analysis on the four motivation constructs reveals that image motives and cross-project economic motives have the highest mean values (as shown in Table 6), suggesting that these two categories of motivations are currently the strongest reasons for designers and general contractors to implement BIM in construction projects. The mean value of project-based economic motives is also at a relatively high level, suggesting that seeking instant economic benefits in the focal project is also an important motivation for project participants to involve in project-level BIM implementation activities.

It is also shown in Table 6 that compared with general contractors, designers generally possess more obvious reactive motives but slightly weaker image motives and project-based economic motives underlying their BIM implementation activities in the surveyed construction projects. Independent-sample T-tests, however, reveal that none of these differences are statistically significant at the 5% level (p-values range from 0.108 to 0.873). An independent-sample T-test for the variable

Table 5
Results of confirmatory factor analysis.

| Construct | Measurement items | Factor loadings | | | | | T-value |
|---|---|---|---|---|---|---|---|
| | | IMM | REM | PBM | CBM | BCA | |
| Image motives (IMM) | IMM1 | 0.866 | | | | | NA [a] |
| | IMM2 | 0.855 | | | | | 7.794 |
| Reactive motives (REM) | REM1 | | 0.571 | | | | NA [a] |
| | REM2 | | 0.826 | | | | 6.091 |
| | REM3 | | 0.707 | | | | 6.454 |
| Project-based economic motives (PEM) | PEM1 | | | 0.840 | | | NA [a] |
| | PEM2 | | | 0.888 | | | 13.257 |
| | PEM3 | | | 0.757 | | | 11.419 |
| Cross-project economic motives (CEM) | CEM1 | | | | 0.871 | | NA [a] |
| | CEM2 | | | | 0.885 | | 15.481 |
| | CEM3 | | | | 0.855 | | 14.806 |
| BIM capability (BCA) | BCA1 | | | | | 0.885 | NA [a] |
| | BCA2 | | | | | 0.934 | 19.336 |
| | BCA3 | | | | | 0.917 | 18.739 |

Note: Overall fit indices: $\chi^2$/df = 1.325, NFI = 0.941, IFI = 0.985, CFI = 0.985, RMSEA =0.042.
[a] Parameter that was fixed at 1.0.

Table 6
Results of descriptive and comparative analyses.

| Construct | Full sample | | Designers | | General contractors | | Independent sample T-test | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Difference | T-value | p-value |
| IMM | 5.81 | 1.10 | 5.76 | 1.09 | 5.86 | 1.11 | −0.10 | −0.593 | 0.554 |
| REM | 4.37 | 1.24 | 4.54 | 1.27 | 4.24 | 1.21 | 0.30 | 1.616 | 0.108 |
| PEM | 5.53 | 1.03 | 5.47 | 1.03 | 5.58 | 1.03 | −0.11 | −0.756 | 0.451 |
| CEM | 5.77 | 0.86 | 5.76 | 0.88 | 5.78 | 0.85 | −0.02 | −0.160 | 0.873 |
| BCA | 4.16 | 1.40 | 4.23 | 1.35 | 4.11 | 1.44 | 0.13 | 0.612 | 0.541 |

Note: IMM = image motives, REM = reactive motives, PEM = project-based economic motives, CEM = cross-project economic motives, BCA = BIM capability, SD = standard deviation.

of BIM capability further reveals that BIM capabilities of the surveyed designers and general contractors are not significantly different either. This result suggests that the non-significant difference in BIM implementation motivations between designers and general contractors is probably not caused by the non-equivalent BIM capabilities of the surveyed project-participating organisations.

With respect to the relationships among different categories of BIM implementation motivations, the Pearson correlation matrix in Table 4 illustrates that the correlation coefficients between reactive motives and three other motivation variables are all relatively low and not statistically significant at the 5% level. Distinctly different from their relationships with reactive motives, however, the three other categories of BIM implementation motivations are all highly significantly correlated with each other (p-values are all below 0.001), with the correlation coefficient between image motives and cross-project economic motives reaching a relatively high level of 0.41. These results provide evidence that project participants' social motivations to improve organisational image and their economic motivations to gain technical benefits could coexist rather than necessarily precluding each other during project-level BIM implementation processes. Together with the relatively high mean values of the motivation variables shown in Table 6, the results collectively suggest that project participants' motivations to implement BIM under the impacts of institutional environments are relatively complex and multi-dimensional, and that the BIM implementation process is often characterised with the coexistence of social image motives and economic motives (especially long-term economic motives), as well as the coexistence of project-based economic motives and cross-project economic motives.

### *4.3. Hierarchical regressions*

A hierarchical regression approach was used to test the hypotheses on the relationships between BIM implementation motivations and BIM capability. A total of four separate hierarchical regressions were performed, which employed the four categories of BIM implementation motivations as their dependent variables, respectively. For each of these regressions, the blocks of independent variables were entered individually, starting with control variables (including organisational ownership type, project size, project type, and project nature), and then the predicting variable BIM capability. Such a hierarchical regression process enables the incremental effects of BIM capability to be better examined by controlling for the effects of organisational and project characteristics. Since the independent-sample T-test results in Subsection 4.2 reveal that there is no significant difference in BIM implementation motivations and BIM capability between the surveyed designers and general contractors, all of the hierarchical regressions were performed using the full sample data from both designers and general contractors.[1] Variance inflation factors (VIFs) for the regression models are all within the desired low range from 1.07 to 1.19, suggesting that multicollinearity is not substantively influencing the regression estimates. Ordinary least squares (OLS) regression results of the hierarchical models are presented in Table 7.

While BIM capability is not included in the regression models, as shown in Table 7 (Model 1, Model 3, Model 5, Model 7), the four control variables in total could explain 9.8%, 9.9%, 6.8% of the variances in IMM, PEM, and CEM respectively, but could only explain 0.9% of the variance in REM. With respect to the separate effects of the control variables, organisational ownership type is revealed to have significant negative relationships both with IMM ($\beta = -0.230$, $p < 0.01$) and with CEM ($\beta = -0.256$, $p < 0.001$). This result provides clear evidence that compared with project-participating organisations from privately owned and foreign-owned corporations, state-owned designers and general contractors generally have more obvious image motives and cross-project economic motives for undertaking project-level BIM implementation activities. Project type ($\beta = 0.201$, $p < 0.01$) and project nature ($\beta = -0.170$, $p < 0.05$) are further illustrated to be positively and negatively associated with PEM, suggesting that designers and general contractors generally have more obvious motivations to gain instant economic benefits from BIM implementation activities in non-residential and public projects.

After BIM capability is added as an independent variable (Model 2, Model 4, Model 6, Model 8), the variance in PEM explained by the regression model significantly increases from 0.099 to 0.145 ($F = 9.826$), but the increases of the explained variances in three other motivation variables (i.e., IMM, REM,

[1] Equivalent hierarchical regressions were also performed using the sub-sample data from designers (N = 81) and from general contractors (N = 107) separately; the results are essentially identical with those based on the full sample data.

Table 7
Results of OLS regression models predicting motivations for BIM implementation.

| Independent variables | IMM | | REM | | PEM | | CEM | |
|---|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
| Ownership type | −0.230 ** | −0.242 ** | 0.030 | 0.022 | 0.039 | 0.001 | −0.256 *** | −0.246 ** |
| Project size | 0.120 | 0.104 | −0.055 | −0.066 | 0.103 | 0.048 | 0.002 | 0.016 |
| Project type | 0.104 | 0.094 | 0.077 | 0.070 | 0.201 ** | 0.168 * | −0.080 | −0.071 |
| Project nature | 0.032 | 0.038 | 0.000 | 0.005 | −0.170 * | −0.148 * | 0.025 | 0.019 |
| BIM capability | | 0.068 | | 0.046 | | 0.228 ** | | −0.058 |
| $R^2$ | 0.098 | 0.102 | 0.009 | 0.010 | 0.099 | 0.145 | 0.068 | 0.071 |
| F-value | 4.985 *** | 4.153 *** | 0.395 | 0.385 | 5.044 *** | 6.195 *** | 3.318 * | 2.767 ** |
| $\Delta R^2$ | | 0.004 | | 0.002 | | 0.046 | | 0.003 |
| F-value (change) | | 0.842 | | 0.352 | | 9.826 ** | | 0.594 |

Note: IMM = image motives, REM = reactive motives, PEM = project-based economic motives, CEM = cross-project economic motives; Standardised regression coefficients (β) are reported.
* P < 0.05.
** P < 0.01.
*** P < 0.001.

CEM) are all non-significant at the 5% level (F-values range from 0.352 to 0.842). The regression coefficients in Table 7 similarly reveal that only the relationship between BIM capability and PEM is statistically significant ($\beta = 0.228$, $p < 0.01$), and that the relationships between BIM capability and three other motivation variables are all non-significant at the 5% level. A noteworthy observation is that BIM capability is positively rather than negatively associated with REM ($\beta = 0.046$, $p > 0.05$), suggesting that the relationship between the two variables might be more intricate than a priori hypothesised. To sum up, with respect to the hypotheses on the relationships between BIM capability and BIM implementation motivations, H1 and H3 are supported while H2 and H4 are not.

## 5. Discussions

### 5.1. Categories of BIM implementation motivations

Through the categorisation of BIM implementation motivations as well as the characterisation of relationships among different motivation categories, the findings in this study could help to further reveal the underlying logic for BIM implementation in the laggard construction industry. While previous research (e.g., Cao et al., 2014) has provided evidence that project BIM implementation activities are closely associated with external institutional environments and could be driven by social motivations, the present study further illustrates that the motivations of project participants to implement BIM are relatively complex and multi-dimensional and that the implementation process could be characterised not only with the coexistence of social image motives and economic motives but also with the confluence of project-based economic motives and cross-project economic motives. These results suggest that for influential and complex innovations like BIM, innovation implementation activities are not simply or invariably reflected as passive conformity to external institutional pressures without economic rationality. Instead, organisational responses to external institutional environment, which are characterised with the desires of not only seeking social legitimacy but also maintaining economic efficiency, could be relatively strategic.

Although some organisational theorists (e.g., Oliver, 1991; Pfeffer, 1982) have already underlined the strategic responses of organisations to external environments, the literature using institutional theory to explain innovation implementation activities has a long tradition of decoupling economic efficiency mechanisms from institutionalisation processes, contending that motivations to seek social recognitions in institutional environments and motivations to gain economic benefits generally substitute for each other rather than working in a parallel logic (Tolbert and Zucker, 1983; Westphal et al., 1997). However, the empirical study in this paper provides evidence that although socially reactive motivations seldom coexist with efficiency-related economic motivations, social motivations of image improvement do not necessarily preclude economic motivations in all situations. Together with recent findings of Kennedy and Fiss (2009) and Lounsbury (2007) in other industries, this result could help to prompt rethinking of the conventional wisdom on the relationships between social and economic motivations in institutionalisation processes. As extant research on other innovations in the construction industry has presented relatively discordant findings on the motivations or reasons for innovation adoption and implementation (e.g., Esmaeili and Hallowell, 2012; Nikas et al., 2007), the findings of this study on the coexistence of different innovation implementation motivations could also help to partly reconcile the discordant findings in the extant construction innovation literature and to enrich our understanding of the complex innovation diffusion process in the construction industry.

### 5.2. Impacts of BIM capability on BIM implementation motivations

Based on the categorisation of BIM implementation motivations, this study has further investigated the impacts of BIM capability and other contextual factors on the categorised motivations. The results from hierarchical regression analyses support the hypotheses on the positive association between project-based economic motives and BIM capability, and on the non-significant association between image motives and BIM capability. These results suggest that although project-participating organisations (i.e., designers and general contractors) will have stronger economic motivations to improve short-term project performances as their BIM capability matures, such an increase in economic motivations does not necessarily require a parallel decrease of desires to improve social image. As such, these results could provide further evidence that social motivations and economic motivations could coexist rather than necessarily precluding each other during institutionalisation processes.

With regard to reactive motives and cross-project economic motives, however, their hypothesised relationships with organisational BIM capability both fail to be supported by the hierarchical regression results. A noteworthy result is that reactive motives are found to have a slightly positive association with BIM capability, which is surprisingly different from the a priori hypothesised negative association between the two variables. Such an unexpected result could be attributed to two aspects of reasons. First, as shown in Table 6, the mean values of image motives and cross-project economic motives are much higher than that of reactive motives. Such a distinct difference suggest that for many designers and general contractors with relatively low BIM capability, their BIM implementation activities could primarily stem from image motives or cross-project economic motives rather than necessarily deriving from reactive motives at present. Therefore, it is illustrated that low BIM capability of the surveyed project-participating organisations is not necessarily connected with high reactive motives. Second, in those construction projects where designers and general contractors implement BIM primarily out of reactive motives, the compelling pressures on BIM implementation may be often reflected as or accompanied by the tendency of project clients/owners to select organisations with high BIM capability as design and construction service providers. As a result, although high reactive motives of designers and general contractors are probably not inherently induced by their high BIM capability, the two variables are still statistically illustrated to be positively associated with each other.

As for the negative association between cross-project economic motives and BIM capability, the non-significant result may be due to the relative immaturity of BIM development in the Chinese construction industry. At present, the problem of lacking BIM expertise is still relatively pervasive in the construction industry in China, and most industry organisations still lack knowledge on how to adjust traditional design and construction processes to meet the requirements of BIM implementation according to their specific organisational and project characteristics (CCIA, 2013). Even for those organisations relatively experienced in implementing BIM, their project teams are generally composed of professional BIM technicians and traditional design and construction engineers, with many team members evidently lacking BIM expertise. Besides the above problems, BIM implementation by designers or general contractors in construction projects also frequently involves other technical and organisational barriers such as interoperability problems and non-collaboration of other project participants. As a consequence, even for those designers and general contractors with higher BIM capability than their counterparts, it might still be not easy for them to fully realise the value of BIM in the short term, and they could still have strong cross-project economic motives of learning BIM implementation process, fostering team members' BIM expertise and guiding the use of BIM in future projects.

### *5.3. Impacts of contextual factors on BIM implementation motivations*

Apart from organisational BIM capability, project type and project nature are also found to have significant impacts on project-based economic motives of designers and general contractors to implement BIM in a construction project. While the result of the impact of project type is probably due to the difference in the complexities of building structure and construction process between residential and non-residential projects, the result of the impact of project nature could be partly attributed to the difference in client/owner support for BIM implementation between public and private projects. As illustrated in Cao et al. (2015), compared with their counterparts in private projects, clients/owners in public projects in China generally provide more support for BIM implementation such as championing BIM and driving project participants to collaboratively implement BIM. With the support from clients/owners, therefore, designers and general contractors in public projects may be more capable of overcoming related organisational and process barriers of BIM implementation and thus have stronger motivations to gain instant project benefits from BIM implementation.

It is also illustrated in this study that organisational ownership type is significantly associated with both image motives and cross-project economic motives for BIM implementation. These results could largely be explained by the differences in social responsibility and organisational size between state-owned and non-state-owned corporations in the Chinese construction industry. Compared with their privately owned and foreign-owned counterparts, state-owned corporations in China are generally expected to assume more social responsibility by responding to public appeals and leading industry development while seeking economic benefits. Facing the long-existing criticisms on their operational inefficiency as well as the increasing industry expectations on BIM technology, therefore, state-owned designers and general contractors would have strong motivations to implement BIM in their participated projects to exhibit good social images of deploying innovative technologies and leading industry development trends. Apart from their difference in the assumed social responsibility, state-owned and non-state-owned corporations in the Chinese construction industry are also substantially different in corporation size, with the average output value of state-owned corporations (¥567.86 million) being 2.20 times higher than that of non-state-owned corporations (¥177.72 million) in 2013 (NBSC, 2014). The larger corporation size would probably cause state-owned corporations to have more slack resources and more intensive needs to establish cross-project capability building mechanisms and, therefore, have stronger cross-project economic motives for BIM implementation.

### 5.4. Limitations and future research directions

Interpretation of the findings of this study should be made in light of several limitations. First, with an intrinsic advantage of allowing replicability and thus enabling structured comparisons across different projects, questionnaire survey was deployed as the main method to collect perceptual data from project respondents. This may generate potential response biases related to subjectivity and social desirability. As such, Harman's one-factor test was conducted on the five primary variables including IMM, REM, PEM, CEM, and BCA to examine possible effects (Podsakoff and Organ, 1986). The test showed that no single dominant factor emerged and the largest factor only accounted for 28.76% of the total variances in the measurements, suggesting that the common method bias is unlikely to be a substantial contaminant of the results. Second, this study was conducted in a specific cultural and market context in the Chinese construction industry. This may limit the generalisability of the related results to other cultural and market contexts. As such, a natural extension of the present study would be to conduct related cross-cultural and cross-national research in the future, and validate the applicability of the analysis results in different cultural and market contexts.

## 6. Conclusions

Grounded in institutional theory and the innovation diffusion literature, this paper developed and tested a model categorising the motivations of designers and general contractors to implement BIM in construction projects, and investigated how different categories of motivations are associated with organisational BIM capability as well as other contextual factors. The results of factor analysis with project-based survey data collected from 188 designers and general contractors on the Chinese mainland provide clear support for the theoretically developed motivation model, in which motivations for implementing BIM in construction projects are classified into four categories: *image motives*, *reactive motives*, *project-based economic motives*, and *cross-project economic motives*. Comparisons of the categorised motivations suggest that image motives and cross-project economic motives are currently the strongest reasons for designers and general contractors to implement BIM in construction projects, and that social motivations and economic motivations underlying BIM implementation do not necessarily preclude each other as conventional wisdom might indicate. Results of hierarchical regressions support the hypotheses on the positive association between project-based economic motives and BIM capability, and on the non-significant association between image motives and BIM capability. However, hypotheses on the associations between BIM capability and the two other motivation variables are not supported. While illustrating no significant difference in BIM implementation motivations between designers and general contractors, hierarchical regression results further reveal that both project type and nature are significantly associated with project-based economic motives, and that project organisations from state-owned corporations generally have stronger image motives and cross-project economic motives to implement BIM than their counterparts from other types of corporations. The findings could help to develop a more comprehensive understanding of the reasons why construction organisations implement BIM in construction projects and provide a more dynamic picture of how BIM implementation motivations may vary as organisational contexts change. Through providing evidence that the motivations of project participants to implement BIM under the impacts of institutional pressures are distinctly multi-dimensional and dynamic, the findings could also help to partly reconcile the discordant findings on innovation implementation reasons in the extant construction innovation literature and to deepen the understanding of the complex relationship between innovation implementation activities and external institutional environments.

## Conflict of interest

There is no conflict of interest.

## Acknowledgements

This research has been financially supported by the National Natural Science Foundation of China (grant no. 71272046) and the Public Policy Research Funding Scheme in Hong Kong (grant no. 2014.A6.054.15B). The authors would like to acknowledge the respondents for their participation in this empirical study, as well as Dan Tan and Yuqing Hu at Tongji University for their assistance in data collection.

## References

Aibinu, A., Venkatesh, S., 2014. Status of BIM adoption and the BIM experience of cost consultants in Australia. J. Prof. Issues Eng. Educ. Pract. 140 (3), 04013021.

Arevalo, J.A., Aravind, D., Ayuso, S., Roca, M., 2013. The global compact: an analysis of the motivations of adoption in the Spanish context. Bus. Ethics: Eur. Rev. 22 (1), 1–15.

Brady, T., Davies, A., 2004. Building project capabilities: from exploratory to exploitative learning. Organ. Stud. 25 (9), 1601–1621.

Brønn, P.S., Vidaver-Cohen, D., 2009. Corporate motives for social initiative: legitimacy, sustainability, or the bottom line? J. Bus. Ethics 87 (1), 91–109.

Cao, D., Wang, G., 2014. Contractor-subcontractor relationships with the implementation of emerging interorganizational technologies: roles of cross-project learning and pre-contractual opportunism. Int. J. Constr. Educ. Res. 10 (4), 268–284.

Cao, D., Li, H., Wang, G., 2014. Impacts of isomorphic pressures on BIM adoption in construction projects. J. Constr. Eng. Manag. 140 (12), 04014056.

Cao, D., Wang, G., Li, H., Skitmore, M., Huang, T., Zhang, W., 2015. Practices and effectiveness of building information modelling in construction projects in China. Autom. Constr. 49, 113–122.

China Construction Industry Association (CCIA), 2013. Use of BIM in Construction Enterprises. *China* Building Industry Press, Beijing (in Chinese).

DiMaggio, P.J., Powell, W.W., 1983. The iron cage revisited: institutional isomorphism and collective rationality in organizational fields. Am. Sociol. Rev. 48 (2), 147–160.

Dossick, C.S., Neff, G., 2010. Organizational divisions in BIM-enabled commercial construction. J. Constr. Eng. Manag. 136 (4), 459–467.

Eadie, R., Browne, M., Odeyinka, H., McKeown, C., McNiff, S., 2013. BIM implementation throughout the UK construction project lifecycle: an analysis. Autom. Constr. 36, 145–151.

Eastman, C., Teicholz, P., Sacks, R., Liston, K., 2011. BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors. second ed. John Wiley and Sons, Hoboken, NJ.

Esmaeili, B., Hallowell, M., 2012. Diffusion of safety innovations in the construction industry. J. Constr. Eng. Manag. 138 (8), 955–963.

Fornell, C., Larcker, D.F., 1981. Evaluating structural equation models with unobservable variables and measurement error. J. Mark. Res. 1981 (18), 39–50.

Francom, T.C., El Asmar, M., 2015. Project quality and change performance differences associated with the use of building information modeling in design and construction projects. univariate and multivariate analyses. J. Constr. Eng. Manag. 141 (9), 04015028.

Froese, T.M., 2010. The impact of emerging information technology on project management for construction. Autom. Constr. 19 (5), 531–538.

Fullerton, R.R., Kennedy, F.A., Widener, S.K., 2014. Lean manufacturing and firm performance: the incremental contribution of lean management accounting practices. J. Oper. Manag. 32 (7), 414–428.

Gann, D.M., Salter, A.J., 2000. Innovation in project-based, service-enhanced firms: the construction of complex products and systems. Res. Policy 29 (4), 955–972.

Gavronski, I., Ferrer, G., Paiva, E.L., 2008. ISO 14001 certification in Brazil: motivations and benefits. J. Clean. Prod. 16 (1), 87–94.

Grewal, R., Comer, J.M., Mehta, R., 2001. An investigation into the antecedents of organizational participation in business-to-business electronic markets. J. Mark. 65 (3), 17–33.

Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E., 2010. Multivariate Data Analysis. seventh ed. Prentice Hall, Upper Saddle River, NJ.

Handley, S.M., Benton, W.C., 2012. Mediated power and outsourcing relationships. J. Oper. Manag. 30 (3), 253–267.

Iacovou, C.L., Benbasat, I., Dexter, A.S., 1995. Electronic data interchange and small organizations: adoption and impact of technology. MIS Q. 19 (4), 465–485.

Jensen, P.A., Jóhannesson, E.I., 2013. Building information modelling in Denmark and Iceland. Eng. Constr. Archit. Manag. 20 (1), 99–110.

Kale, S., Arditi, D., 2005. Diffusion of computer aided design technology in architectural design practice. J. Constr. Eng. Manag. 131 (10), 1135–1141.

Kennedy, M.T., Fiss, P.C., 2009. Institutionalization, framing, and diffusion: the logic of TQM adoption and implementation decisions among US hospitals. Acad. Manag. J. 52 (5), 897–918.

Lee, G., Lee, J., Jones, S.A., 2012. The Business Value of BIM in South Korea: How Building Information Modeling Is Driving Positive Change in the South Korean Construction Industry. McGraw Hill Construction, Bedford, MA.

Lounsbury, M., 2007. A tale of two cities: competing logics and practice variation in the professionalizing of mutual funds. Acad. Manag. J. 50 (2), 289–307.

Love, P.E.D., Simpson, I., Hill, A., Standing, C., 2013. From justification to evaluation: building information modeling for asset owners. Autom. Constr. 35, 208–216.

Martinez, R.J., Dacin, M.T., 1999. Efficiency motives and normative forces: combining transactions costs and institutional logic. J. Manag. 25 (1), 75–96.

National Bureau of Statistics of China (NBSC), 2014. China Statistical Yearbook 2014. China Statistics Press, Beijing (in Chinese).

Nikas, A., Poulymenakou, A., Kriaris, P., 2007. Investigating antecedents and drivers affecting the adoption of collaboration technologies in the construction industry. Autom. Constr. 16 (5), 632–641.

Nunnally, J.C., 1978. Psychometric Theory. second ed. McGraw-Hill, New York.

Oliver, C., 1991. Strategic responses to institutional processes. Acad. Manag. Rev. 16 (1), 145–179.

Pfeffer, J., 1982. Organization and Organizational Theory. Pitman, Boston, MA.

Podsakoff, P.M., Organ, D.W., 1986. Self-reports in organizational research: problems and prospects. J. Manag. 12 (4), 531–544.

Roberts, P.W., Greenwood, R., 1997. Integrating transaction cost and institutional theories: toward a constrained-efficiency framework for understanding organizational design adoption. Acad. Manag. Rev. 22 (2), 346–373.

Rogers, E.M., 1995. Diffusion of Innovations. fourth ed. Free Press, New York.

Rosenfeld, P., Giacalone, R.A., Riordan, C.A., 1995. Impression Management in Organizations: Theory, Measurement, Practice. Routledge, London.

Ruuska, I., Brady, T., 2011. Implementing the replication strategy in uncertain and complex investment projects. Int. J. Proj. Manag. 29 (4), 422–431.

Samuelson, O., Björk, B.C., 2014. A longitudinal study of the adoption of IT technology in the Swedish building sector. Autom. Constr. 37, 182–190.

Scott, W.R., 2001. Institutions and Organizations: Ideas, Interests and Identities. second ed. Sage Publications, Thousand Oaks, CA.

Slaughter, E.S., 1998. Models of construction innovation. J. Constr. Eng. Manag. 124 (3), 226–231.

Son, J.Y., Benbasat, I., 2007. Organizational buyers' adoption and use of B2B electronic marketplaces: efficiency- and legitimacy-oriented perspectives. J. Manag. Inf. Syst. 24 (1), 55–99.

Succar, B., Kassem, M., 2015. Macro-BIM adoption: conceptual structures. Autom. Constr. 57, 64–79.

Taylor, J., 2007. Antecedents of successful three-dimensional computer-aided design implementation in design and construction networks. J. Constr. Eng. Manag. 133 (12), 993–1002.

Tolbert, P.S., Zucker, L.G., 1983. Institutional sources of change in the formal structure of organizations: the diffusion of civil service reform, 1880–1935. Adm. Sci. Q. 28 (1), 22–39.

Toole, T., 1998. Uncertainty and home builders' adoption of technological innovations. J. Constr. Eng. Manag. 124 (4), 323–332.

Westphal, J., Gulati, R., Shortell, S., 1997. Customization or conformity? An institutional and network perspective on the content and consequences of TQM adoption. Adm. Sci. Q. 42 (2), 366–392.

Please cite this article as: D. Cao, et al., 2016. Identifying and contextualising the motivations for BIM implementation in construction projects: An empirical study in China, Int. J. Proj. Manag. http://dx.doi.org/10.1016/j.ijproman.2016.02.002