Article:

Jiang, H. and Payne, S. orcid.org/0000-0001-5289-5844 (2022) Examining regime complexity in China's green housing transition: a housing developers' perspective. Building Research & Information, 50 (3). pp. 291-307. ISSN 0961-3218

https://doi.org/10.1080/09613218.2021.1943644

Examining regime complexity in China's green housing transition: a housing developers perspective

Han Jiang[a]*, Sarah Payne[b]

[a] College of Architecture, Nanjing Tech University, 30 Puzhu S Rd, Pukou District, Nanjing, Jiangsu, China

Hjiang815@126.com

[b] Department of Urban Studies and Planning, University of Sheffield, Western Bank, Sheffield, United Kingdom, S10 2TN

Abstract

The housing sector has faced significant attention in global and national policy efforts to reduce carbon emissions. The result is that in many countries, green housing policies have been introduced as a means of regulating carbon emissions. China ranks second in building energy consumption worldwide (IEA, 2016) and buildings contribute some 26% of China's total carbon emissions (IEA, 2020). Existing studies reveal green housing development to be a complex, transitionary process, with many diverse factors - financial, market, policy and technological - shaping development outcomes. However, these dynamics remain empirically and conceptually understudied within the Chinese context. With only 28% of building projects being classified as green building in 2018 (MOHURD, 2019), little is known about how Chinese housing developers are responding to China's green building policies or what issues may be affecting them. To address this gap, this research adopts multi-level perspective theory to examine regime complexity in China's green housing transition, utilizing a large-scale quantitative survey of Chinese housing developers to examine their attitudes and motivations. In doing so, the findings reveal a complex set of factors within four sub-regimes that affect Chinese developer's capacity to act and elucidate the complexity and dynamics of China's ongoing green housing transition. Our findings indicate that any long-term shift towards normalizing green building practices will be driven more by changes in the policy and market regimes than in the financial or technological regimes, with implications for policy makers and market actors alike.

Keywords

Green housing development; housing developers; Chinese housing market; Socio-technical transitions; Built environment; multi-level perspective

1. Introduction

The building sector has faced criticisms across the globe as a main contributor - some 38% - of global energy-related carbon emissions (IEA, 2020). The housing sector, which accounts for 60.7% of the building sector (ibid.) has faced significant attention in global and national policy efforts to reduce carbon output. The result is that in many countries, the concept of 'green housing' has been introduced into technical and policy arenas and construction practices as a means of responding to these high carbon emission issues (Gabay et al., 2014; He et al., 2019). It is a housing type in which '…every phase of the building process (design, construction and operation) must incorporate environmental considerations such as energy and water efficiency, resource efficiency, indoor quality, waste and pollution control, house maintenance and the overall impact of the house on the environment' (Zainul Abidin et al., 2012, p.374). Many scholars argue the housing sector has the greatest potential to reduce carbon emissions and consider green housing transitions to yield an efficient building type to achieve carbon reduction goals (Wang, 2014; Ghaffarian Hoseini et al., 2013; Franco et al., 2021).

China's building sector is arguably at an even more critical stage. It ranks second in building energy consumption worldwide (IEA, 2016) and contributes 26% of China's total carbon emissions (IEA, 2020). China's engagement with mitigating climate change and realigning its energy sector suggests that the country is acknowledging the urgency of tackling the implications of its high emissions, translated in its national-level strategies (Zhang et al., 2018a; Shi et al., 2014). The growth rate of China's green building has shown a significantly accelerating trend over the last decade, from only 10 projects in 2008 to 10,139 projects at the end of 2018 (MOHURD, 2019). Nevertheless, these number are still low when compared with total new building projects completed in 2018, with only 28% considered green housing projects (ibid.). This rate of delivery indicates that the broader concept of green housing has not been sufficiently taken up and accepted by developers and the wider housing market and the delivery of green housing in China remains relatively low.

Previous studies have largely focused on investigating the drivers and challenges faced by industry practitioners in the development of green buildings. For example, Darko et al. (2017b) examined issues faced by US green building experts in adopting green building technologies; Pan and Pan (2021) explored drivers, barriers and strategies of high-rise, high-density zero carbon buildings in Hong Kong; and Singh et al. (2019) assessed barriers to adopting net zero energy housing in Canada. The literature reveals green housing development to be a complex, transitionary process, with many diverse factors – financial, market, policy and technological - constraining and driving building industry practitioners in their delivery of green buildings (Edmondson et al., 2019). However, these dynamics remain empirically and conceptually understudied within the Chinese context. Questions remain of our understanding of the complexity of the green housing transition in China and in particular, the issues facing housing developers when implementing state-led plans that seek to increase green building delivery.

In addressing this gap in knowledge, the main aim of this research is to examine the attitudes and motivations of developers in China's green housing transition by investigating what drivers and challenges they currently face and expect to face in the future, when delivering green housing. The study draws on multi-level perspective (MLP) theory to conceptualize the green housing transition as a socio-technical transition, and in doing so, emphasizes the nature and influence of sub-regimes on Chinese developers attitudes and motivations. In what follows, we review the existing literature on the drivers and challenges of the green housing transition, outline the conceptual and methodological approaches, present the results of the empirical research and discuss the findings and their implications.

2. Literature Review

2.1 Drivers and challenges of green housing development

Over the past decade, research has sought to examine the drivers and challenges of green building development across the globe (e.g. Darko et al., 2017a; O'Neill and Gibbs, 2014; Zhang et al., 2018a). Nguyen et al. (2017) argue, with reference to Vietnam, that although there are differences in green building development contexts between developed and developing markets, the adoption of green building practices in those two contexts generally face a set of similar drivers and challenges. We too seek to draw on research covering both developed and emerging economies in our review of the drivers and challenges of green housing development, suggesting it is an approach well placed to inform the conceptual framing of complexity within the Chinese transitionary context and the challenges facing Chinese developers in green building development.

2.1.1 Drivers

Financial drivers

Whether in Western economies or in China, the major motivation of developers is to seek profits (O'Neill and Gibbs, 2014; Qian et al., 2015; Zhang et al., 2018a, 2018b; Wang et al., 2021a;

Sandanayake et al., 2020). That is, they seek to accumulate profits by designing and constructing housing whose realised value is higher than the development costs by a sufficient margin to reflect the risks involved. It therefore follows that if the economic returns are high enough to offset incremental cost and risk, developers will be more likely to construct green building (Fuerst and McAllister, 2011; Zou et al., 2017). Capital returns depend mainly on the base economic returns of developing buildings and the potential price premium of green buildings (Juan et al., 2017). Existing research provides some evidence to show green buildings command a price premium. For example, Yoshida and Sugiura (2013) examined housing in Tokyo and reported that the price premium of green buildings was 10.3%. Fesselmeyer (2018) also found that in Singapore, green labels increased the price of building products by around 3%. Moreover, financial returns have been shown to drive the green building innovations and fundamentally improve building energy consumption of the structure in the long-term (Ji and Zhang, 2019).

Market drivers

The market prospects of green buildings are persuasive for developers focused on profit making (Nurul Diyana and Abidin, 2013). Green buildings have been shown to have greater market demand and a consumer willingness to pay for the perceived premium (Gou et al., 2013; Ofek and Portnov, 2020). Further, Ofek and Portnov (2020) reveal that enhanced corporate reputation can motivate developers to reposition their building activities towards developing green buildings. Indeed, in the face of stiff competition, establishing a positive corporate image and reputation has become a necessary condition for developers to survive (Andelin et al., 2015). Thus, a desire for a positive corporate image and reputation can influence developers' commitments to developing green housing, with research indicating some developers have already begun to incorporate green strategies into their businesses to secure a good reputation and gain competitive advantage (Zhang et al., 2011b).

Policy drivers

Government intervention is considered to be an influential factor in stimulating the adoption of green building development and supply (Qian and Chan, 2010; Murtagh et al., 2016; Wong and Abe, 2014; Song et al., 2021; Zhang et al., 2018b). Government intervention can be either mandatory (e.g. legal sanctions) or voluntary (e.g. incentives or policy support). For example, Fuerst et al.'s (2014) research showed the positive effects of compulsory requirements for LEED certification in the US commercial building sector. Zou et al. (2017) found that fiscal subsidies could stimulate Chinese green building development. Research by Udawatta et al. (2015) and Windapo (2014) indicated that developers do not always consider green building development unless they are required to comply with policy-driven green building evaluation standards. From the Chinese perspective, Song et al. (2021) revealed that mandatory policies have stronger influences to drive the green building development than incentive policies. In addition, government regulation can be considered not only as an external or top-down driver, but also as market-led or bottom-up driver because developers may seek opportunities to mitigate market-side risks related to future policy changes (Darko et al., 2017a).

Technological drivers

Green building or energy efficient technologies are another important driver for developers ~~to~~ in-building green housing (Wang et al., 2021a; Sparrevik et al., 2018) because they can reduce extra costs associated with green housing development, such as reducing the purchasing costs of green equipment or materials, or reducing maintenance costs (Zhang et al., 2018a; Fujii and Managi, 2019; Yin and Li, 2018; Kong and He, 2021). The application of energy efficiency technologies in green building has been shown to bring incremental economic benefits and environmental benefits (Liu et al., 2014). In addition, the more employees with green technology skills a developer has, the more likely they are to adopt green housing development practices, with green building experts placing much emphasis on motivation-driven capacity such as green skills (Hwang and Ng, 2013).

2.1.2 Challenges

Financial challenges

Within building industries across the globe, it is widely accepted that green building development is more expensive than conventional building development (Dwaikat and Ali, 2016; Rehm and Ade, 2013). The extra costs of green building development include higher initial costs (green materials and equipment costs); higher consulting costs to meet green building standards; and, higher costs for hiring skilled teams or employee practices (Ying et al., 2012; Marker et al., 2014). For example, Zhang et al's (2018a) research on the incremental costs of green building based on industrial reports and academic studies, found that the range of incremental costs for buildings with green certifications was from 0.4% to 11%, depending on the certification system and the buildings' rating level. Arguably, although green housing can offer cost savings for consumers in its operation stage (Kesidou and Sorrell, 2018), the concept of whole-life-cycle costing is often absent from the developers' point of view. In contrast, green building practices are usually considered to increase the cost of development due to the high upfront investment that disregards the whole lifecycle (Mousa, 2015).

Market challenges

Consumer awareness and attitudes towards green building products are crucial to the success of green building development (White and Gatersleben, 2011; Zhao et al., 2018; Juan et al., 2017). However, consumer attitudes can be difficult to change since '...society is often 'locked in' by ... unsustainable systems of consumption and production' (Lachman, 2013, p.269). For example, a survey of consumers' willingness-to-pay for green housing in Beijing found that 68.3% of the respondents had not heard about the official green building label (Zhang et al., 2016). In addition, green housing, which provides a more sustainable living environment, is often seen by consumers as a 'luxury good' that is more likely to be purchased by high-income groups (Hu et al., 2014; De Silva and Pownall, 2014). In contrast, previous studies show that ordinary house-buyers do not have the specialised knowledge to assess the 'greenness' of buildings (Eves and Kippes, 2010). Thus, the lack of consumers' knowledge on green housing and awareness to purchase green housing products means ultimately, there is little market-based incentives for developers to supply green housing (Davis and Metcalf, 2016).

Policy challenges

Some scholars argue that policy resistance is one of the most significant constrains when delivering green buildings (e.g. Darko and Chan, 2017; Chan et al., 2016; Ding et al., 2018). In terms of green housing development, incentives - usually provided by government - serve as important motivators for promoting market adoption (Olubunmi et al., 2016). Some governments, such as the UK, the US and Canada, provide various incentives to drive change toward green housing development, whereas studies have shown that China are still lacking clear incentives or regulations for green housing (Ding et al., 2018; Wu et al., 2019). Therefore, it is not surprising that developers' building practices are not always favourably regulated due to the lack of clear and consistent green housing policies or standards (Payne and Barker, 2018). In addition, in developing countries, although some developers are interested in utilising new green technologies, governments generally cannot afford to offer the necessary financial stimulus to overcome market regime constraints or skills gaps (Mousa, 2015). This limits the incentives available for developers to improve their knowledge and practices around green housing development. Indeed, much building activity may even be conducted without any official governmental monitoring (Mousa, 2015; Ding et al., 2018).

Technological challenges

Some research reveals that developers often face challenges in adopting green technologies, largely due to their lack of technical knowledge and expertise or the lack of available of green technologies that meet their specific development needs (Mousa, 2015; Wang et al., 2021a; Rashidi et al., 2018). In particular in developing countries, the existing technologies needed for green building development and green material applications appear to be inadequate (Mousa, 2015). The inability of developers to determine the potential performance of alternative green technologies when compared to their traditional development practices, increases uncertainty and risk (Zhang et al., 2011a), and this issue may even push developers back to traditional design and construction methods (Shi et al., 2013).

In addition, the lack of technologically astute employees is another barrier faced by developers (Wang, 2014; Wang et al., 2021b). The need for skilled employees not only refers to developers' employees, but also includes construction contractors and property managers. Compared with traditional housing development processes, green housing developers require greater interaction with their construction contractors to ensure effective communication and management in the more technically demanding green housing development process. However, challenges to these interactions include the low level of industrialisation of green construction methods, lack of coordination and lack of knowledge and trust (Alashwal et al., 2011; Menassa and Baer, 2014). Further, in the operation stage, insufficient knowledge, lack of skills training and qualified experts for green facility management are considered to be additionally significant problems for developers to consider when choosing to undertake green housing development projects (Deng et al., 2018).

Summary

Tables 1 and 2 provide a summary of the drivers and challenges discussed above. We have consolidated them into 17 specific factors within the four different types we used to frame our review. Our review has revealed a range of market, technological, policy and financial drivers and challenges facing green housing developers, from studies undertaken globally. It remains unknown the extent to which these drivers or challenges affect Chinese developers in adapting their development practices during China's green housing transition. We now move on to conceptualizing the green housing transition, drawing on MLP theory that characterizes sustainable transitions associated with the socio-technical changes (Köhler et al., 2019) before presenting the results of our empirical investigation.

Table 1

Drivers of green housing

Code	Type [a]	Driver factors	Key references
D01	M	Increases company reputation and competition ability	Zhang et al., 2018b; Nurul Diyana and Abidin, 2013; Andelin et al., 2015; Zhang et al., 2011b
D02	M	Increased customer demand	Zhao et al., 2018; Juan et al., 2017;Gou et al., 2013
D03	M	Easier to get land from biding	Zhang et al., 2018b
D04	P	Government mandatory regulations and policies	Feng et al., 2020; Fuerst et al., 2014; Udawatta et al., 2015; Windapo, 2014
D05	P	Government incentive regulations and policies	Alwisy et al., 2018; Fu et al., 2020; Feng et al., 2020; Zhang et al., 2018b; Zou et al., 2017
D06	F	Greater return on capital	Zhang et al., 2018b; Huang, 2017; Qian et al., 2015; O'Neill and Gibbs, 2014; Qian et al., 2015; Fuerst and McAllister, 2011
D07	F	Attract more investment	Darko et al., 2017a; Chan et al., 2016;
D08	T	Innovative greener technologies	Fujii and Managi, 2019; Yin and Li, 2018; Kong and He, 2021; Yang et al, 2019; Hassani et al, 2017;

[a] M=Market factor, T=Technological factor, P=Policy factor, F=Financial factor.

Table 2

Challenges of green housing

Code	Type [a]	Challenge factors	Key references
C01	M	Lack of household awareness	Huang, 2017; Feng et al., 2020; Zhao et al., 2018; He and Chen, 2021;Zhang et al., 2016; Hu et al., 2014; De Silva and Pownall, 2014; Eves and Kippes, 2010; Davis and Metcalf, 2016
C02	P	Unclear building regulations	Luthra et al., 2015; Häkkinen and Belloni, 2011; Serpell et al., 2013
C03	P	No uniform solution of green housing standard	Darko and Chan, 2017; Chan et al., 2016
C04	F	Higher costs for training employees	Dwaikat and Ali, 2016; Rehm and Ade, 2013; Ying et al., 2012; Marker et al., 2014
C05	F	Higher material costs	Dwaikat and Ali, 2016; Rehm and Ade, 2013; Ying et al., 2012; Marker et al., 2014; Zhang et al., 2018a; Mousa, 2015

Co6	F	Higher technology costs	Chan et al., 2016; Dwaikat and Ali, 2016; Rehm and Ade, 2013; Mousa, 2015
Co7	T	Insufficient technical knowledge and tools	Darko et al, 2017b; Wang et al., 2021b; Zhang et al., 2011a
Co8	T	Lack of availability of green technologies	Fujii and Managi, 2019; Kong and He, 2021;
Co9	T	Lack of skilled employees	Wang et al., 2021b; Hwang and Ng, 2013; Mousa, 2015; Alashwal et al., 2011; Menassa and Baer, 2014; Deng et al., 2018

[a] M=Market factor, T=Technological factor, P=Policy factor, F=Financial factor.

2.2 Conceptualising the Green Housing Transition

2.2.1 Multi-level perspective theory

This research adopts Geels's (2004) multi-level perspective (MLP) theory (Geels, 2010, 2011, 2018) which has become an agreed core framework to explain dynamic patterns in sustainable transitions associated with socio-technical changes (Köhler et al., 2019; Sovacool and Hess, 2017; Kanger, 2021). The MLP highlights interdependence at three levels: niche, regime and landscape (Geels, 2002). We have depicted the broad principles underlying MLP in Figure 1. As can be seen, niches in the base level provide innovations of green technologies which build internal motivation for transition (Geels, 2018). The regime level reflects the established and related principles and networks that strengthen existing socio-technical systems or create new changes (ibid.). It is in the regime where housing developers' building activities are principally located (Payne and Barker, 2018). The landscape level is usually considered as exogenous and represents the broader cultural values that affect the regime and niche levels (Geels, 2011). It is considered extremely difficult to make changes in the landscape level (Lachman, 2013).

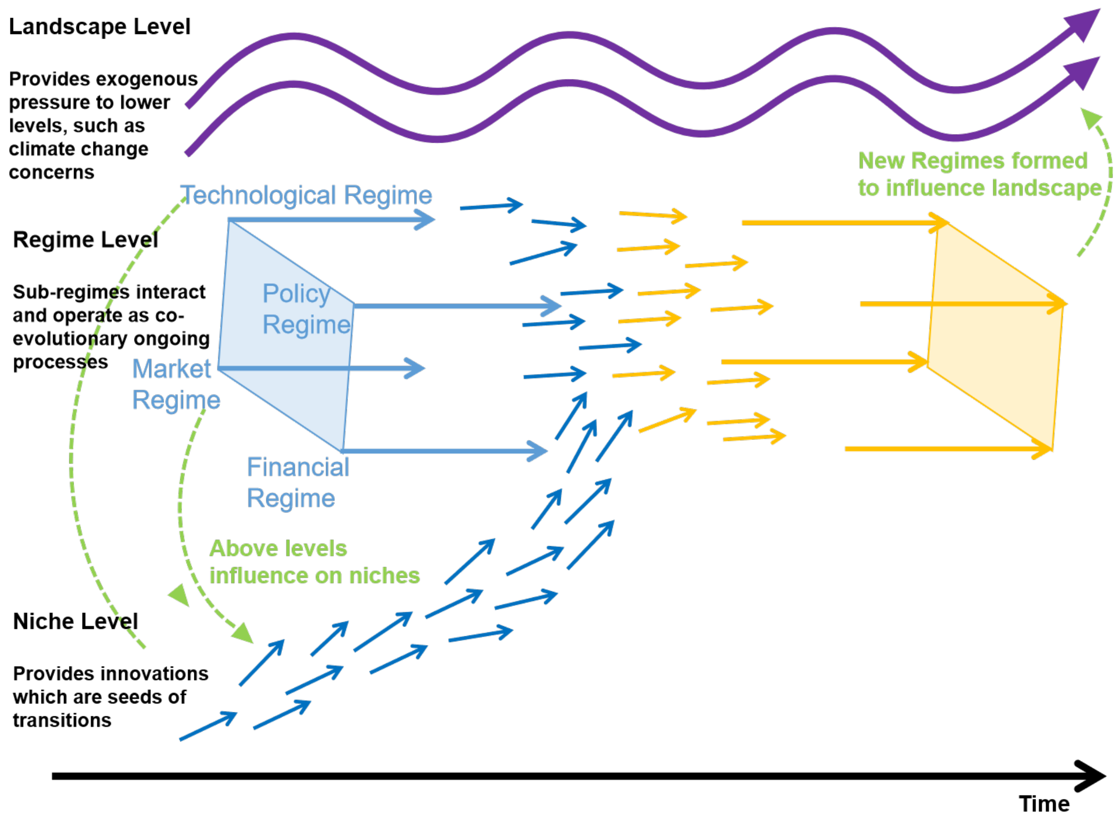

Fig. 1 The multi-level perspective on socio-technical transitions (Own illustration based on Geels, 2011).

Within MLP, two characteristics of socio-technical transitions can be summarized. First, socio-technical transitions are ongoing processes which contain a range of dynamic changes (Geels, 2019). They can be seen as long-term shifts between one socio-technical system to another (Kanger, 2021). Secondly, transitions contain multiple factors and all factors interact with each other (Geels, 2010, 2018). As Figure 1 depicts, the regime contains a range of sub-regimes in which transitions occur. These relate not just to technical factors, but also to political, market and financial factors. In other words, '…everything is interlocked, yet everything is changing in accordance with the interlockedness' Norgaard (1994, p.26). These lock-in mechanisms can exist within the regime level, indicating that although each of the sub-regimes operate under their own dynamics, they influence or can be influenced by other sub-regimes through causal interactions (Foxon, 2011). Therefore, both dynamically ongoing thinking and co-evolutionary thinking are brought in to assess socio-technical transitions when using the MLP perspective.

When applied to a housing development context, the green housing transition is conceived as a dynamic and ongoing process, shifting from a traditional housebuilding approach towards a greener approach (Home and Dalton, 2014; Geels, 2018). Through this process of adjustment and change, developers will be expected to face a range of complex and dynamic factors - beyond just the commonly emphasised technological issues - that encompass broader societal systems, such as culture, institutions and markets (Geels, 2010). A small number of studies have sought to utilize MLP in examining green building transitions. For instance, Nykamp's (2017) study on the green building transition in Norway; and the Finnish Environment Institute's (2019) assessment of the zero-energy building transition in Finland. In addition, Chinese scholars have also applied MLP, but more broadly to assess transitions towards sustainability, such as Rao's (2020) study on new energy vehicle transition and Zhang et al.'s (2020) work on the coal power transition in China. We seek to build on this fledging use of MLP to produce an original and novel examination of the green housing transition in China, with a particular focus on the attitudes and motivations of Chinese developers.

2.2.2 Developers and the green housing transition

The implicit idea that underpins conceptualizations of green housing transitions is that of state-market interactions (Rosenbloom, 2017). Green housing transitions are typically driven initially by significant shifts in national government policy seeking increases in the use of low or zero carbon technologies in market-led development practices (He et al., 2019). Only when large scale market acceptance of green building technologies occurs within the sub regimes - with associated technological, financial and market barriers overcome - are developers expected to fully reorientate their development practices to produce predominately green housing. This governance approach positions the housing market as having the greatest potential to reduce national carbon emissions and positions the state in the role of driving developers to adopt efficient green building technologies (Wang, 2014; Ghaffarian Hoseini et al., 2013; Franco et al., 2021). It is in these complex relations between state policy drives and market acceptance where the characteristics of MLP theory as dynamic ongoing processes of change (Geels, 2019) are revealed.

In China however, the green housing transition is regarded as a state-led transition (Zhang et al., 2018a) and many studies have focused on examining the governance of green housing development (e.g. Zhang et al., 2018a; Feng et al., 2020; Ding et al., 2018) within this planned economy setting. However, such an approach risks minimizing the role of Chinese developers in the green housing transition or underplaying the challenges or drivers they experience. Indeed, the growing importance of the housing market in China is well documented. As green housing transitions are complex and cannot be driven by the state alone, the important role and contribution of Chinese developers in the success of China's green housing transition cannot be understated.

However, research on Chinese developers has often been overlooked in popular studies of China's urban development (Dent et al., 2012-Wang et al., 2018; Ding et al., 2018). There is particularly a lack of research focused on investigating Chinese developers and their motivations or otherwise for delivering green housing. On this basis, the attitudes and motivations of developers and their perceived capacity to act on green housing policies and technologies in everyday development practice (Nykamp, 2017) is the key empirical focus of this research.

2.2.3 Conceptual Framework

As a middle range theory (Geels, 2019), MLP provides flexibility for scholars to choose their own entry points when using the theory. Figure 2 depicts the conceptual framework of the research and outlines how the theoretical positioning shapes the research approach. It outlines how we intend to examine the nature and influence of sub-regimes on China's green housing transition.

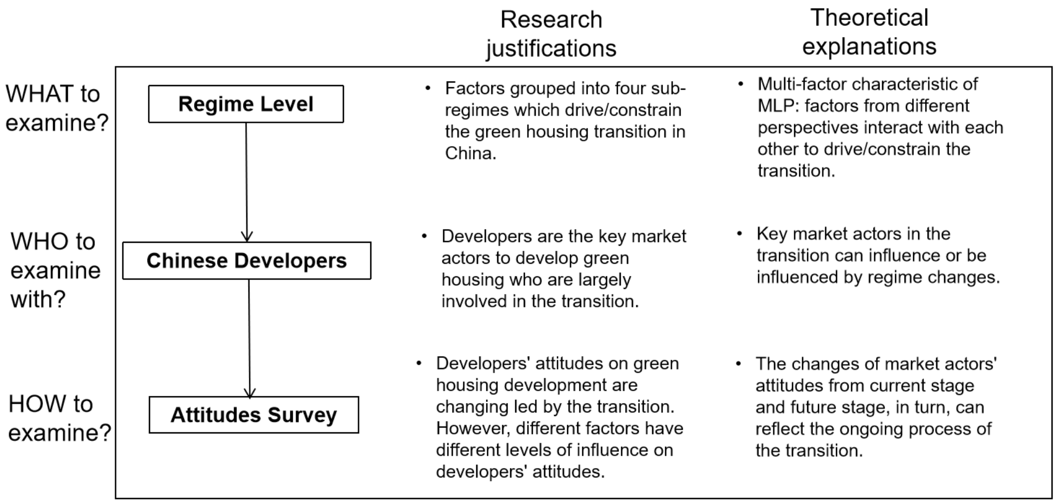

Fig. 2 Conceptual framework

As Figure 2 shows, the research focuses on activity in the regime level, where housing developers' building activities are principally located (Payne and Barker, 2018). When examining green housing transitions in the regime level, it becomes important to consider where different sub-regimes and their interactions have different levels of influence on developer attitudes and motivations (see Figure 1). As Chinese developers are the key market actors involved in the transition, their attitudes and motivations are considered to be highly representative of the market context of the transition, an area of research which has thus far been overlooked in China's transitions literature (Wang et al., 2018; Ding et al., 2018). An attitudes survey was therefore designed to gather attitudinal data from a large and broad cross section of Chinese developers, intended to provide a representative view of Chinese developers' attitudes and motivations towards green housing development. This approach to data collection addresses some of the significant empirical challenges associated with investigating such a large and geographically dispersed research subject (Bryman, 2016) like the Chinese housing industry.

Drawing on the above, MLP is applied to frame three research questions in this study: (1) What drivers and challenges influence Chinese developers in delivering green housing? (2) What are the interactions between different sub-regime factors? (3) What changes in developers' attitudes and motivations are there between the current situation and the perceived future situation? These three research questions will be addressed in the following sections in order to achieve our research aim of examining the attitudes and motivations of developers in China's green housing transition by investigating what drivers and challenges they currently face and expect to face in the future, when delivering green housing.

3. Research methodology

Given the bounding of the MLP (Geels, 2011), the methodological approach in this research needed to sufficiently elucidate the drivers and challenges in the green housing transition at the regime level by examining developers' attitudes and motivations in relation to their socio-technical network. A self-completion questionnaire survey was chosen as the most appropriate methodological tool for gathering a high level and representative perspective of Chinese developers' attitudes and motivations in respect of both drivers and challenges in the green housing transition.

In order to address the research aim, the questionnaire contained a range of sections with each section dealing with the following particular aspects of Chinese developers' attitudes and motivations toward the green housing transition: (1) Background information; (2) Trends of green housing development; (3) Key drivers of green housing development; (4) Key challenges for green housing development. In sections 3 and 4, questions were asked both in terms of the current situation and a future 10-year time horizon. This was in order to investigate possible future attitudinal changes toward green housing development in China to account for what Geels (2011) refers to as the ongoing and co-evolutionary process of socio-technical transitions.

The questionnaire included rating, multiple choice, and closed-end questions relating to facts, opinions and knowledge. Additional space was included at the end of each section for respondents to elaborate on their responses. The 5-point Likert Scale was used in section 3 and 4. It is commonly seen as a useful and effective method to elicit respondents' attitudes on the significance of different elements (Akintoye et al., 2000). Developers chose from 1 to 5 to show the extent of the effects caused by a particular driver/challenge on their attitudes to deliver green housing, where 1 means they thought it was not a driver/challenges at all, and vice versa.

The sample size required for the survey was calculated to be approximately 100 respondents according to Crano and Brewer's (2002) equations. Subsequently, 180 questionnaires were equally distributed (60-60-60) amongst the three different sizes[1] (large, medium and small) of developers in the Chinese housing industry, covering the whole country. Figure 3 shows the geographical distribution of respondents' operations in numbers, with a notable amount operating across all China's regions. The response rates for these three groups are illustrated in Table 3. Out of a total of 180, 96 questionnaires were returned and 4 were discounted due to being incomplete. Excluding the invalid questionnaires, the final response rate was 51.1% (92/180).

Table 3

Different sized companies and their response rates.

Company size	No. of questionnaires	No. of respondents	Response rate
Large size	60	35	58.3%
Medium size	60	26	43.3%
Small size	60	31	51.7%
Total	180	92	51.1%

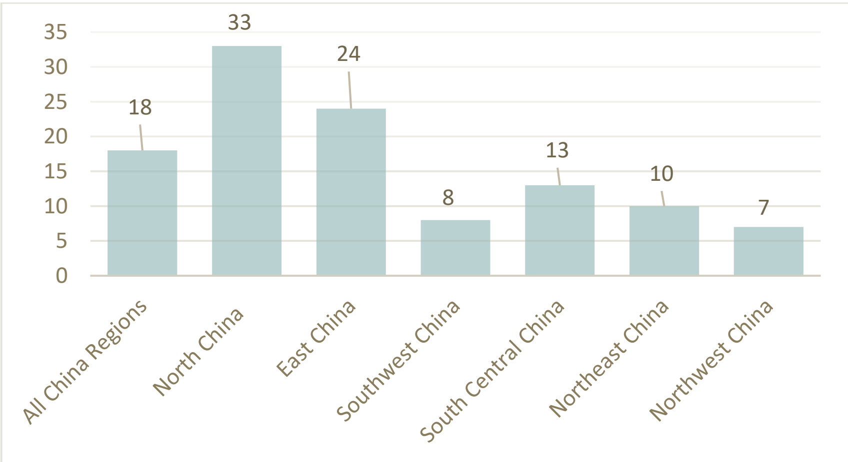

Fig. 3 Geographical distribution of respondents' operations in numbers.

The 92 responses were deemed adequate and the response rate was considered acceptable in being representative of the housing industry in China. It is considered more difficult to acquire data

[1] The Standard Regulation of Small and Medium-sized Enterprises (NBS, 2011) determine three size of companies in housing development and management sector by using both Annual Revenue (Y)l (Million Yuan) and Total Assets (Z) (Million Yuan). The companies need to meet both annual revenue and total assets targets to stay in a particular size category (ibid.). Large companies: Y≥200000, Z≥10000; Medium companies: 1000≤Y<200000, 5000≤Z<10000; Small companies: Y<1000, Z<5000.

for organisational research when compared with, for example, large-scale surveys of the public (Baruch and Holtom, 2008). In their research, Baruch and Holtom (2008) examined 490 different questionnaire surveys and found that the average response rate for organisational research was only 35.7%. This is largely due to the commercial sensitivity of the information discussed in market situations (Baruch and Holtom, 2008, Payne, 2020). Sample sizes in previous similar green building-related statistical research were 31 in Singapore (Hwang and Tan, 2012) or 33 in the US (Darko et al., 2017b). The details of all respondents, including the names of housing companies, were anonymized to maintain confidentiality and encourage the completion of questionnaires.

The survey data was statistically analysed with the Statistical Package for Social Science (SPSS) software. In order to test the reliability of the results, all the data were entered twice to check for any major inconsistencies with the original input. First, for the 5-point Likert Scale responses, the mean score ranking technique has been widely adopted in similar research to rank variables and to determine the key drivers/challenges (Darko et al., 2017b; Chan et al., 2009). If two or more factors got the same mean score, a standard deviation (SD) test was added to further assign the ranks (Darko et al., 2017b; Mao et al., 2015). The one-sample t-test was also used to test the significance of factors.

Secondly, a nonparametric test was conducted by using Kendall's W (i.e. Kendall's coefficient of concordance) ranges from 0 (no agreement) to 1 (totally agreement). It is widely used to assess agreement among rankings (Chan et al., 2009). The results of Kendall's W in this research were 0.067, 0.049, 0.034 and 0.017, respectively (Table 4-7). This indicates a strong agreement exists among the respondents regarding the rankings of the drivers/challenges.

Thirdly, to address the regime complexities of the green housing transition (Geels, 2011), correlation analysis between the four sub-regimes - technological, policy, market and financial - were also undertaken using bivariate Pearson Correlation. It is usually adopted to evaluate the significance of linear relationship between two continuous variables (Myers and Maria, 2004). Correlation analysis assessed the 'ongoing and co-evolutionary' changes of four sub-regimes between current and future stages. All the results of bivariate Pearson Correlation in this research were >0.05 or <-0.05 (Table 8 and 9), which indicates that the data were adequate for the further discussion.

4. Findings

This section presents the findings from the quantitative survey. The results are presented as they relate to current perceived drivers and challenges and anticipated future drivers and challenges. The results reveal an interesting set of sub-regime factors that highlight the complexity of China's green housing transition from the developers' perspective, with important insights for theory, policy and practice.

4.1 Drivers

The results of what developers consider to be the key drivers of the green housing transition in China, both currently and in the future are shown in Tables 4 and 5 respectively. As can be seen from Table 4, the top three current drivers of green housing development for developers were: D01 'Increases company reputation and competition ability' (market regime); D08 'Introduced greener technologies' (technological regime); and D02 'Increased customers' demand' (market regime). Table 5 shows the top three drivers of green housing development in the next 10 years as being: D01 'Increases company reputation and competition ability' (market regime); D05 'Government incentive regulations and policies' (policy regime) and D04 'Government mandatory regulations and policies' (policy regime).

Table 4

Current drivers for green housing development in China.

Code	Type	Frequency of responses					Mean	SD	Rank	Significance [a]
		1	2	3	4	5				
D01	M	1	13	15	27	36	3.91	1.106	1	0.000
D08	T	7	14	17	29	21	3.55	1.252	2	0.000
D02	M	9	15	16	25	27	3.50	1.330	3	0.001
D04	P	11	15	10	29	27	3.50	1.379	4	0.001
D05	P	12	13	22	21	24	3.35	1.354	5	0.016
D03	M	10	16	19	30	17	3.30	1.264	6	0.023
D06	F	14	15	20	20	23	3.25	1.396	7	0.089 *
D07	F	14	16	17	27	18	3.21	1.355	8	0.147 *
Kendall's W [b]	0.067									
Chi-square	49.480									
df	7									
Level of significance	0.000									

[a] (*) Data with insignificant results of one-sample t-test (p>0.05)(2-tailed).

[b] Kendall's Coefficient of Concordance test on the drivers among the developers.

Table 5

Drivers for green housing development in China in the next 10 years.

Code	Type	Frequency of responses					Mean	SD	Rank	Significance
		1	2	3	4	5				
D01	M	1	4	18	32	37	4.09	0.934	1	0.000
D05	P	0	7	18	31	36	4.04	0.948	2	0.000
D04	P	1	7	16	35	33	4.00	0.972	3	0.000
D08	T	1	7	20	31	33	3.96	0.994	4	0.000
D02	M	3	6	18	31	34	3.95	1.062	5	0.000
D06	F	4	15	13	32	28	3.71	1.191	6	0.000
D03	M	4	16	19	26	27	3.61	1.204	7	0.000
D07	F	7	11	23	27	24	3.54	1.217	8	0.000
Kendall's W [b]	0.049									
Chi-square	36.400									
df	7									
Level of significance	0.000									

[b] Kendall's Coefficient of Concordance test on the drivers among the developers.

The findings show that issues around company reputation and competitiveness were the most important driver for Chinese developers to develop green houses. This was anticipated to stay the same over the next 10 years. These findings indicate that Chinese developers consider establishing a 'green developer' image is an important aspect of improving their overall market competitiveness and being able to survive in the green housing transition. Moreover, compared with the current situation, policy regime factors appear to become increasingly important drivers in the future since D04 and D05 jumped from No.4 and 5 in Table 4 to No.3 and 2 in Table 5. This finding reflects the deep value accorded to 'planning' by the government in China (Wu et al., 2015) and indicates that, in the future, developers anticipate being driven more by changes in the policy regime. This will likely require additional regulatory support from policy makers through the introduction of mandatory and incentive regulations within the policy regime.

In contrast, the three least important drivers of green housing development perceived by Chinese developers, both currently and in the next 10 years, were situated in the financial and market regimes (Table 4 and 5). These findings imply a limitation in the ability of market-based processes alone to deliver green housing in China, both currently and in the future. The findings also reveal the relatively minor importance of financial drivers to developers in delivering green housing - Chinese developers do not see green housing projects as securing a greater return on capital (D06) or attracting more investment (D07). This is likely because of the higher upfront costs for developers in developing green housing (Mousa, 2015), as well as the investment and financing platform imperfections, as no investment and financing platform directly targets green housing projects in the Chinese housing market (Li and Shui, 2015). In addition, developers did not consider that green housing development could help them to acquire land for development (D03), implying that the influential factors for acquiring land are complex and building 'green' is not a key factor for securing land by bidding.

Also worthy of note is how 'Innovative greener technologies' (D08) shifted from a second to a fifth ranked driver and 'increased customer demand' (D02) shifted from a third to a sixth rank as drivers over the next 10 years. For developers, these two factors were relegated in perceived importance as drivers for green housing in the future, giving some indication of developers' perceptions over the relative importance of the technical aspects of, and consumer interest in, green housing demand. It also implies that developers may be expecting a greater public acceptance of green housing products, as supply chains mature and green housing becomes more normalised.

4.2 Challenges

The results of what developers consider to be the key challenges of the green housing transition in China, both current and future stage are shown in Table 6 and 7 respectively. Table 6 shows that currently, the top three most serious challenges to green housing development in China were all financial regime factors: C06 'higher technology costs', C05 'higher material costs' and C04 'higher costs to training employees'. These findings correlate with the key drivers for green housing, where financial factors were perceived as the least significant drivers (Table 4). The research therefore indicates that developers are currently experiencing financial pressures when developing green housing in China, and these financial pressures are likely further exacerbated by the lack of capital return. However, in the next 10 years, financial factors are shown to become less important, likely due to the expected development of further green technologies and the lowering costs of green materials associated with developing green technologies (Zhang et al., 2018a). For example, as can be seen from Table 7, C06 declined in ranking from first to third; C05 declined from second to seventh; and C04 shifted from third to sixth. This implies that developers expect the cost of production to decrease over time, which may ease the burden of the current financial challenges they face.

Table 6

Current challenges to green housing development in China.

Code	Type	Frequency of responses					Mean	SD	Rank	Significance [a]
		1	2	3	4	5				

C06	F	3	12	18	31	28	3.75	1.125	1	0.000
C05	F	4	14	16	30	28	3.70	1.184	2	0.000
C04	F	2	15	20	34	21	3.62	1.078	3	0.000
C09	T	3	16	20	35	18	3.53	1.094	4	0.000
C03	P	6	16	13	37	20	3.53	1.199	4	0.000
C08	T	2	15	23	38	14	3.51	1.011	6	0.000
C07	T	3	16	26	33	14	3.42	1.051	7	0.000
C02	P	6	23	18	30	15	3.27	1.196	8	0.032
C01	M	9	17	25	31	10	3.17	1.154	9	0.152*
Kendall's W [b]	0.034									
Chi-square	28.440									
df	8									
Level of significance	0.000									

[a] (*) Data with insignificant results of one-sample t-test (p>0.05)(2-tailed).

[b] Kendall's Coefficient of Concordance test on the challenges among the developers.

Table 7

Challenges to green housing development in China in the next 10 years.

Code	Type	Frequency of responses					Mean	SD	Rank	Significance [a]
		1	2	3	4	5				
C03	P	8	11	18	40	15	3.47	1.162	1	0.000
C02	P	9	15	15	39	14	3.37	1.211	2	0.004
C06	F	12	11	18	33	18	3.37	1.290	3	0.007
C07	T	6	17	21	35	13	3.35	1.133	4	0.004
C04	F	9	15	20	35	13	3.30	1.193	5	0.016
C05	F	14	12	18	30	18	3.28	1.337	6	0.046
C01	M	14	12	15	42	9	3.22	1.248	7	0.098*
C08	T	8	19	19	34	12	3.25	1.183	8	0.046
C09	T	10	14	21	35	12	3.27	1.196	9	0.032
Kendall's W [b]	0.017									
Chi-square	14.050									
df	8									
Level of significance	0.000									

[a] (*) Data with insignificant results of one-sample t-test (p>0.05)(2-tailed).

[b] Kendall's Coefficient of Concordance test on the challenges among the developers.

Table 7 shows that, from the developers' point of view, the three most serious challenges to green housing development in the next 10 years are: C03 'no uniform solution of green housing standard' (policy regime); C02 'unclear building regulations' (policy regime); and C06 'higher technology costs' (financial regime). Two policy regime factors shifted to the top three challenges in the future, when compared to current day. This implies developers may have less confidence in policy makers in the future or that current green housing standards and regulations may not be clear or uniform enough for market actors to implement.

The least serious challenge revealed by the research was 'lack of household awareness' (market regime). This perspective stayed consistent for both current and future views of developers on the housing market. Compared with the key drivers shown in Tables 4 and 5, 'increased customer demand' was in the middle-to-upper ranking at third and fifth respectively. Interestingly, this implies that greater consumer demand may be seen as a driver for Chinese developers towards green housing but that a lack of consumer demand is not currently perceived as a challenge by developers. This finding seems vague, but it likely reflects the fact that green housing development is still in the exploration stage in China and is not a mainstream feature of the housing market. Indeed, developers are more constrained by financial regime factors in the short term and policy regime factors in the long term.

4.3 Correlations between the four sub-regimes

Table 8 and 9 represent the results of the bivariate Pearson Correlation test. Factors were grouped into four sub-regimes - market regime, policy regime, financial regime and technological regime - to further evaluate co-evolutionary relationships in regime level. The co-evolutionary relationships were assessed by the correlations between sub-regime changes. For example, to what extent can changes in the market regime currently to the next 10 years affect changes in the policy regime from current day to the future? Both of these changes were continuous variables that can be used to test the correlation.

Table 8

Correlations of the ongoing changes between four sub-regime drivers.

	Market regime	Policy regime	Financial regime	Technological regime
Market regime	1			
Policy regime	0.677	1		
Financial regime	0.330	0.768	1	
Technological regime	0.561	0.855	0.945*	1

*Correlation is significant at the 0.01 level(2-tailed)

Table 9

Correlations of the ongoing changes between four sub-regime challenges.

	Market regime	Policy regime	Financial regime	Technological regime
Market regime	1			
Policy regime	0.987**	1		
Financial regime	0.822	0.888*	1	
Technological regime	-0.226	-0.340	-0.505	1

*Correlation is significant at the 0.01 level(2-tailed)

**Correlation is significant at the 0.05 level(2-tailed)

It can be seen from Table 8 that the correlation of the ongoing changes between financial regime drivers and technological regime drivers is 0.945 which significantly correlates at the 0.01 level (2-tailed). It indicates that financial regime drivers and technological regime drivers have a stronger co-evolutionary relationship in China's green housing transition. Similarly, Table 9 shows the correlations of the ongoing changes between policy regime challenges and market regime challenges is 0.987; while this number is 0.888 between policy regime challenges and financial regime challenges. It reveals that policy challenges have greater influences on market and financial regimes. Further discussion of these findings is provided in the next section.

4. Discussion

By adopting a socio-technical transition framework, this research has revealed a set of market, financial, policy and technological regime factors that have been shown, to varying degrees, to influence Chinese developers' attitudes and motivations towards green housing development. Some regime factors have been shown to have larger influence than others in driving or challenging Chinese developers. Moreover, the extent to which these regime factors influence developers is likely to dynamically change during the green housing transition, where policy and market factors become more significant, and technological and financial factors become less significant, as the transition process evolves. We now draw further on our conceptual framework to discuss the complexity underpinning this regime-level analysis, where we emphasize the dynamic and ongoing changes within the sub-regimes, and their differing levels of correlation, as core characteristics of China's green housing transition.

5.1 Regime complexity in China's green housing transition

From the perspective of the market regime, Chinese developers are most driven to develop green housing by seeking 'increased company reputation and competition ability' both currently and in the future. These findings support existing literature that a positive image and reputation affects a company's commitment to green housing (Andelin et al., 2015; Zhang et al., 2018a). Interestingly, the findings also reveal the more limited role consumer demand plays in driving the green housing transition in the Chinese context, both currently and as perceived in the next 10 years. These findings reveal an interesting paradox - the primacy of market competitiveness as a driver of green housing sits alongside the more limited role consumers play in driving or constraining green housing market outcomes. Whilst Chinese developers appear to be driven by their reputations, they seem unconcerned by the impact that consumers may have as regards the marketability and saleability of the green housing they produce.

One explanation for this may be found in the policy regime, where mandatory regulations and policies featured as a fairly significant driver both currently and in the future. The expectation therefore that the Chinese government will mandate the production of green housing through regulation may act to suppress the influence of consumer behaviour by virtue of limiting alternative forms of housing. In this sense, Chinese developer's attitudes appears to be strongly influenced by their ability to compete against one another to establish a positive image and reputation (Andelin et al., 2015; Zhang et al., 2018a) and capture market share in what could become an increasingly homogenised market setting. This may also explain the financial regime challenges around material, technology and training costs, which reflect Chinese developers' struggles to deliver green housing in a cost effective and therefore competitive manner.

Looking at the financial regime, the empirical results in this research point to the complex and oppositional nature of the financial regime in the Chinese green housing transition. On the one hand, financial factors are the greatest challenge currently facing Chinese developers and will continue to be in the coming years. On the other hand, they are the least influential driver under current and perceived future market conditions. These findings are significant as they indicate the limited role the financial regime may have in driving developers' capacity to act in the green housing transition. They also highlight the financial tensions developers face in adjusting to greater levels of green housing development. The limits of the financial regime arguably position market and policy regimes (see below) as more likely spaces for driving change in the green housing transition or where government intervention or other transition shaping mechanisms may have greater influence.

Turning to the policy regime, it has been shown in the research to have a mixed influence on developers' attitudes in China's green housing transition. Whereas under the current situation, policy factors were spread amongst other regime factors, the perceived future importance of policy factors increased, both as drivers and challenges to the green housing transition. The growing importance of policy regime factors in the next 10 years shows that developers perceive State action as becoming more significant, overtaking technological factors and financial factors respectively. Unclear building regulations and uniform green housing standards were perceived by developers as significant challenges to be expected in the coming ten years. Government incentives showed to be an increasingly important driver in the future, indicating that developers may expect the state to absorb financial regime issues around the extra costs associated with green housing development. Nonetheless, it is clear that, from the developers' perspective, an interventionist policy paradigm is necessary in the Chinese housing market, with the Chinese State adopting a leading role in supporting the green housing transition.

Finally, for the technological regime, the research revealed that innovative green technologies were perceived as a significant current driver by developers (Figure 4). However, the perceived future importance of technological regime factors decreased, with policy and market regime factors becoming comparatively more important to developers in the coming ten years. It is expected that the development of innovations at the niche level (Geels, 2011) may gradually permeate to regime level to mainstream currently innovative technologies or indeed form a new technological regime, reducing the difficulties faced by developers in utilising green technologies. In this sense, developers may simply move to utilise once innovative green technologies, rather than being driven by them.

5.2 Reframing China's green housing transition

By adopting an MLP perspective, our research has revealed a number of co-evolutionary interactions between the different sub-regimes associated with China's green housing transition. This approach has elucidated the complexity and dynamics of the ongoing transition from the developer's perspective and highlighted the differing influence of the various regimes on developers' attitudes and motivations towards the green housing transition. The research has revealed that changes between the technological regime drivers and financial regime drivers are complementary - when green housing technologies or equipment are developed, developers' costs in adopting them decline. Further, the policy regime has been shown to have the greatest effect in influencing co-evolutionary interactions (Table 8 and 9), revealing that state-led green housing policies have a strong influence on market or technology changes during the transition. Whilst these findings do reflect the non-fully market-oriented characteristic of the Chinese housing market (Wu et al., 2015), they reveal the central and dominant role of the policy regime in China's green housing transition.

Ultimately, conceptualizing the shift towards green building practices as a socio-technical transition reframes the process as one of long-term adaptation, where many dynamic and co-evolutionary changes need to be considered when assessing the feasibility and market-based delivery of state-led policy ambitions. Indeed, our research on developer attitudes and motivations in China has revealed that any long-term shift towards normalizing green building practices will be driven more by changes in the policy and market regimes. The financial and technological regimes are expected to become less important in driving the transition. This trend will need to be reflexively considered by policy makers to adapt to the changing conditions of China's green housing transition.

5. Conclusion

Overall, this research has examined the attitudes and motivations of developers in China's green housing transition by investigating what drivers and challenges they currently face and expect to face in the future, when delivering green housing. In doing so, it has uncovered notable regime complexity in China's green housing transition. The research has revealed that developers recognised green housing as a mainstream trend in the future Chinese housing market. However, whilst developers were driven by a series of regime factors in making the transition towards green housing development, a set of regime challenges were identified by them which constrain their choices and actions. The research also revealed an ongoing and dynamically shifting process, with differences between drivers and challenges in the current and anticipated future contexts.

Our research has provided a number of original research contributions to the green housing literature, multi-level perspective literature, and innovative methodological design. First, our research has focused on the role of market actors in green housing development in non-western and non-liberal contexts. It contributes to knowledge that, although the Chinese green housing transition is facing similar drivers and challenges as with other developed economies, the impact of those drivers and challenges are different based on China's unique institutional environment and development stage. Second, although MLP theory has been utilised for analysing socio-techinical transitions in other countries or sectors, our research is the first of its kind to introduce this conceptual framework into China's green housing context. The empirical findings in our research support existing conceptualizations that posit socio-technical transitions as a complex, ongoing process, where different sub-regime factors operate co-evolutionary and dynamically interact with each other (Geels, 2004, 2011). Our research has particularly emphasized the benefit of utilizing MLP theory to investigate complexity, constraint and opportunity in green housing development and carbon regulation research more broadly. Third, our research has been conducted using a score ranking technique which is widely used to show key drivers/challenges in similar research. However, an original bivariate Pearson Correlation test to investigate the co-evolutionary interactions between different sub-regimes was used this research, showing the feasibility of this data analysis approach and providing a methodological contribution for shaping future similar research. Finally, our research helps policymakers better understand the market conditions of China's green housing transition by revealing insights into the policy regime. These findings will enable policymakers to further consider what kind of new or additional policies or regulations might be required to address the challenges.

Despite these original contributions to knowledge, our research does face some limitations. Because our focus was on gathering high level quantitative data that was representative of the Chinese housing industry as a whole, it overlooked what could arguably be considered as equally important qualitative explanations of developer motivations towards green housing. Further, whilst we argued the regime-level, and sub-regime level in particular, was the most important area of conceptual focus, this risks downplaying the interactions between all three key levels of Geels (2004, 2011) multi-level perspective. In addition, as our empirical investigation focused on Chinese developers alone, we were unable to capture the attitudes and motivations of other important stakeholders, who also operate within the regime alongside developers. Indeed, a reading of the drivers and constraints indicate that consumers, construction contractors and suppliers have significant roles to play in China's green housing transition.

In light of the varying responses of Chinese developers towards the green housing transition, and the limitations we identify of our own research, the following important research gaps remain unresolved and require further academic and policy attention: (1) Where addressing multi-actor characters of socio-technical transitions, additional work should examine other key stakeholders' interests, such as consumers, construction contractors and suppliers, and the interactions between different stakeholders across the regimes; (2) In addressing the multi-level character of socio-technical transitions, addition work should focus on examining the niche level and the landscape level, to explore how these different levels influence or are influenced by the wider green housing transition and the impacts on developers.

Acknowledgments

The authors would like to express their deepest appreciation to all the respondents who kindly participated in this research and the reviewers for the helpful and constructive feedback.

References

Abidin, N.Z., Yusof, N. and Awang, H., 2012. A foresight into green housing industry in Malaysia. International Journal of Mechanical and Industrial Engineering, 6(7), p.373-381.

Akintoye, A., McIntosh, G. and Fitzgerald, E., 2000. A survey of supply chain collaboration and management in the UK construction industry. European journal of purchasing & supply management, 6(3-4), p.159-168.

Alashwal, A.M., Rahman, H.A. and Beksin, A.M., 2011. Knowledge sharing in a fragmented construction industry: On the hindsight. Scientific Research and Essays, 6(7), p.1530-1536.

Alwisy, A., BuHamdan, S., & Gül, M., 2018. Criteria-based ranking of green building design factors according to leading rating systems. Energy and Buildings, 178, 347-359.

Andelin, M., Sarasoja, A.L., Ventovuori, T. and Junnila, S., 2015. Breaking the circle of blame for sustainable buildings–evidence from Nordic countries. Journal of Corporate Real Estate, 17(1), p.26-45.

Barton, J., Davies, L., Dooley, B., Foxon, T.J., Galloway, S., Hammond, G.P., O'Grady, Á., Robertson, E. and Thomson, M., 2018. Transition pathways for a UK low-carbon electricity system: Comparing scenarios and technology implications. Renewable and Sustainable Energy Reviews, 82, p.2779-2790.

Baruch, Y. and Holtom, B.C., 2008. Survey response rate levels and trends in organizational research. Human relations, 61(8), p.1139-1160.

Chan, A.P., Darko, A., Ameyaw, E.E. and Owusu-Manu, D.G., 2016. Barriers affecting the adoption of green building technologies. Journal of Management in Engineering, 33(3), p.04016057.

Chan, E.H., Qian, Q.K. and Lam, P.T., 2009. The market for green building in developed Asian cities—the perspectives of building designers. Energy Policy, 37(8), p.3061-3070.

Crano, W.D. and Brewer, M.B., 2002. Content analysis. Principles and Methods of Social Research. Lawrence Erlbaum Associated, Publishers, Mahwah, New Jersey, p.245-263.

Darko, A. and Chan, A.P., 2017. Review of barriers to green building adoption. Sustainable Development, 25(3), p.167-179.

Darko, A., Chan, A.P.C., Ameyaw, E.E., He, B.J. and Olanipekun, A.O., 2017a. Examining issues influencing green building technologies adoption: The United States green building experts' perspectives. Energy and Buildings, 144, p.320-332.

Darko, A., Zhang, C. and Chan, A.P., 2017b. Drivers for green building: A review of empirical studies. Habitat international, 60, p.34-49.

Davis, L.W. and Metcalf, G.E., 2016. Does better information lead to better choices? Evidence from energy-efficiency labels. Journal of the Association of Environmental and Resource Economists, 3(3), p.589-625.

De Silva, D.G. and Pownall, R.A., 2014. Going green: does it depend on education, gender or income?. Applied Economics, 46(5), p.573-586.

Deng, W., Yang, T., Tang, L. and Tang, Y.T., 2018. Barriers and policy recommendations for developing green buildings from local government perspective: a case study of Ningbo China. Intelligent Buildings International, 10(2), p.61-77.

Dent, P., Patrick, M. and Ye, X., 2012. Real estate: property markets and sustainable behaviour. Routledge.

Ding, Z., Fan, Z., Tam, V. W., Bian, Y., Li, S., Illankoon, I. C. S., & Moon, S., 2018. Green building evaluation system implementation. Building and Environment, 133, 32-40.

Dwaikat, L.N. and Ali, K.N., 2016. Green buildings cost premium: A review of empirical evidence. Energy and Buildings, 110, p.396-403.

Edmondson, D.L., Kern, F. and Rogge, K.S., 2019. The co-evolution of policy mixes and socio-technical systems: Towards a conceptual framework of policy mix feedback in sustainability transitions. Research Policy, 48(10), p.103555.

Eves, C. and Kippes, S., 2010. Public awareness of "green" and "energy efficient" residential property: An empirical survey based on data from New Zealand. Property Management, 28(3), p.193-208.

Feng, Q., Chen, H., Shi, X., & Wei, J., 2020. Stakeholder games in the evolution and development of green buildings in China: Government-led perspective. Journal of Cleaner Production, 275, 122895.

Fesselmeyer, E., 2018. The value of green certification in the Singapore housing market. Economics Letters, 163, p.36-39.

Fowler, K.M., Rauch, E.M., Henderson, J.W. and Kora, A.R., 2010. Re-assessing green building performance: A post occupancy evaluation of 22 GSA buildings (No. PNNL-19369). Pacific Northwest National Lab (PNNL), Richland, WA (United States).

Foxon, T.J., 2011. A coevolutionary framework for analysing a transition to a sustainable low carbon economy. Ecological Economics, 70(12), p.2258-2267.

Franco, M. A. J. Q., Pawar, P., & Wu, X., 2021. Green building policies in cities: A comparative assessment and analysis. Energy and Buildings, 231, 110561.0.

Fu, Y., Dong, N., Ge, Q., Xiong, F., & Gong, C., 2020. Driving-paths of green buildings industry (GBI) from stakeholders' green behavior based on the network analysis. Journal of Cleaner Production, 273, 122883.

Fuerst, F. and McAllister, P., 2011. Eco-labeling in commercial office markets: Do LEED and Energy Star offices obtain multiple premiums? Ecological Economics, 70(6), p.1220-1230.

Fuerst, F., Kontokosta, C. and McAllister, P., 2014. Determinants of green building adoption. Environment and Planning B: Planning and Design, 41(3), p.551-570.

Fujii, H., & Managi, S., 2019. Decomposition analysis of sustainable green technology inventions in China. Technological Forecasting and Social Change, 139, 10-16.

Gabay, H., Meir, I.A., Schwartz, M. and Werzberger, E., 2014. Cost-benefit analysis of green buildings: An Israeli office buildings case study. Energy and buildings, 76, p.558-564.

Geels, F.W. and Schot, J., 2007. Typology of sociotechnical transition pathways. Research policy, 36(3), p.399-417.

Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. Research policy, 31(8-9), p.1257-1274.

Geels, F.W., 2010. Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. Research policy, 39(4), p.495-510.

Geels, F.W., 2011. The multi-level perspective on sustainability transitions: Responses to seven criticisms. Environmental innovation and societal transitions, 1(1), p.24-40.

Geels, F.W., 2018. Disruption and low-carbon system transformation: progress and new challenges in socio-technical transitions research and the multi-level perspective. Energy Research & Social Science, 37, p.224-231.

GhaffarianHoseini, A., Dahlan, N.D., Berardi, U., GhaffarianHoseini, A., Makaremi, N. and GhaffarianHoseini, M., 2013. Sustainable energy performances of green buildings: A review of current theories, implementations and challenges. Renewable and Sustainable Energy Reviews, 25, p.1-17.

Gou, Z., Lau, S.S.Y. and Prasad, D., 2013. Market readiness and policy implications for green buildings: case study from Hong Kong. Journal of Green Building, 8(2), p.162-173.

Hassani, H., Silva, E. S., & Al Kaabi, A. M., 2017. The role of innovation and technology in sustaining the petroleum and petrochemical industry. Technological Forecasting and Social Change, 119, 1-17.

He, C., Yu, S., Han, Q. and de Vries, B., 2019. How to attract customers to buy green housing? Their heterogeneous willingness to pay for different attributes. Journal of Cleaner Production, 230, p.709-719.

He, L., & Chen, L., 2021. The incentive effects of different government subsidy policies on green buildings. Renewable and Sustainable Energy Reviews, 135, 110123.

Hu, H., Geertman, S. and Hooimeijer, P., 2014. The willingness to pay for green apartments: The case of Nanjing, China. Urban Studies, 51(16), p.3459-3478.

Huang D.X., 2017. Evolutionary game analysis of green building demand side based on profit risk. China Civil Engineering Journal.

Hwang, B.G. and Ng, W.J., 2013. Project management knowledge and skills for green construction: Overcoming challenges. International Journal of Project Management, 31(2), p.272-284.

Hwang, B.G. and Tan, J.S., 2012. Green building project management: obstacles and solutions for sustainable development, Sustain. Dev. 20 (5) (2012) 335–349.

IEA, 2016. Towards a zero-emission, efficient, and resilient buildings. Global Status Report 2016. Available at: https://www.worldgbc.org/sites/default/files/GABC_Global_Status_Report_V09_november_FINAL.pdf [Assessed on 27th January 2020].

IEA, 2020. Towards a zero-emission, efficient, and resilient buildings and construction sector. Global Status Report 2020. Available at: https://globalabc.org/sites/default/files/inline-files/2020%20Buildings%20GSR_FULL%20REPORT.pdf [Assessed on 16th May 2021].

Ji, Q., & Zhang, D., 2019. How much does financial development contribute to renewable energy growth and upgrading of energy structure in China?. Energy Policy, 128, 114-124.

Jiang, H. and Payne, S., 2019. Green housing transition in the Chinese housing market: a behavioural analysis of real estate enterprises. Journal of Cleaner Production, p.118381.

Juan, Y.K., Hsu, Y.H. and Xie, X., 2017. Identifying customer behavioral factors and price premiums of green building purchasing. Industrial Marketing Management, 64, p.36-43.

Kanger, L., 2021. Rethinking the Multi-level Perspective for energy transitions: From regime life-cycle to explanatory typology of transition pathways. Energy R esearch & Social Science, 71, 101829.

Kern, F., 2012. Using the multi-level perspective on socio-technical transitions to assess innovation policy. Technological Forecasting and Social Change, 79(2), p.298-310.

Kesidou, S.L. and Sorrell, S., 2018. Low-carbon innovation in non-domestic buildings: The importance of supply chain integration. Energy Research & Social Science, 45, p.195-213.

Kibert, C.J., 2016. Sustainable construction: green building design and delivery. John Wiley & Sons.

Köhler, J., Geels, F. W., Kern, F., Markard, J., Onsongo, E., Wieczorek, A., ... & Wells, P., 2019. An agenda for sustainability transitions research: State of the art and future directions. Environmental Innovation and Societal Transitions, 31, 1-32.

Kong, F., & He, L., 2021. Impacts of supply-sided and demand-sided policies on innovation in green building technologies: A case study of China. Journal of Cleaner Production, 294, 126279.

Lachman, D.A., 2013. A survey and review of approaches to study transitions. Energy Policy, 58, p.269-276.

Li, J. and Shui, B., 2015. A comprehensive analysis of building energy efficiency policies in China: status quo and development perspective. Journal of Cleaner Production, 90, p.326-344.

Liu, Y., Guo, X. and Hu, F., 2014. Cost-benefit analysis on green building energy efficiency technology application: A case in China. Energy and Buildings, 82, p.37-46.

Ma, X., Gong, W., Song, L., 2014. Collection of green building policies in China during 2013. Constr. Sci. Technol. 6, p.36–44.

Marker, A.W., Mason, S.G. and Morrow, P., 2014. Change factors influencing the diffusion and adoption of green building practices. Performance Improvement Quarterly, 26(4), p.5-24.

McGraw-Hill Construction, 2013. World green building trends: Business benefits driving new and retrofit market opportunities in over 60 countries. Bedford Massachusetts: Smart Market Report.

Menassa, C.C. and Baer, B., 2014. A framework to assess the role of stakeholders in sustainable building retrofit decisions. Sustainable Cities and Society, 10, p.207-221.

MOHURD, 2019. Statistics of green building numbers in China. Available at: http://cngb.org.cn/index.action?sid=402888b74f68e52e014f696c7643000c [Accessed on16th May 2021].

Moradi, A. and Vagnoni, E., 2018. A multi-level perspective analysis of urban mobility system dynamics: What are the future transition pathways?. Technological Forecasting and Social Change, 126, p.231-243.

Mousa, A., 2015. A Business approach for transformation to sustainable construction: an implementation on a developing country. Resources, Conservation and Recycling, 101, p.9-19.

Murtagh, N., Roberts, A. and Hind, R., 2016. The relationship between motivations of architectural designers and environmentally sustainable construction design. Construction Management and Economics, 34(1), p.61-75.

Myers, L. and Sirois, M.J., 2004. S pearman Correlation Coefficients, Differences between. Encyclopedia of statistical sciences.

NBS, 2011. National Bureau of Statistics China Yearbook 2011. The National Bureau of Statistics of the People's Republic of China, Beijing.

NDRC, 2016. The 13th Five-Year-Plan for Economic and Social Development of People's Republic of China (2016-2020) Available at: http://en.ndrc.gov.cn/newsrelease/201612/P020161207645765233498.pdf [Accessed 15 June 2019]

Nguyen, H.T., Skitmore, M., Gray, M., Zhang, X. and Olanipekun, A.O., 2017. Will green building development take off? An exploratory study of barriers to green building in Vietnam. Resources, Conservation and Recycling, 127, p.8-20.

Norgaard, R.B., 1994. Development betrayed: The end of progress and a co-evolutionary revisioning of the future, London: Routledge.

Nurul Diyana, A. and Abidin, N.Z., 2013. Motivation and expectation of developers on green construction: a conceptual view. In Proceedings of World Academy of Science, Engineering and Technology (No. 76, p. 247).

Nykamp, H., 2017. A transition to green buildings in Norway. Environmental Innovation and Societal Transitions, 24, p.83-93.

O'Neill, K.J. and Gibbs, D.C., 2014. Towards a sustainable economy? Socio-technical transitions in the green building sector. Local Environment, 19(6), p.572-590.

Ofek, S., & Portnov, B. A., 2020. Differential effect of knowledge on stakeholders' willingness to pay green building price premium: Implications for cleaner production. Journal of Cleaner Production, 251, 119575.

Olubunmi, O.A., Xia, P.B. and Skitmore, M., 2016. Green building incentives: A review. Renewable and Sustainable Energy Reviews, 59, p.1611-1621.

Payne, S. and Barker, A., 2018. Carbon regulation and pathways for institutional transition in market-led housing systems: A case study of English housebuilders and zero carbon housing policy. Environment and Planning E: Nature and Space, 1(4), p.470-493.

Qian, Q.K. and Chan, E.H., 2010. Government measures needed to promote building energy efficiency (BEE) in China. Facilities, 28(11/12), p.564-589.

Qian, Q.K., Chan, E.H., Visscher, H. and Lehmann, S., 2015. Modelling the green building (GB) investment decisions of developers and end-users with transaction costs (TCs) considerations. Journal of cleaner production, 109, p.315-325.

Rashidi, S., Esfahani, J. A., & Karimi, N., 2018. Porous materials in building energy technologies—A review of the applications, modelling and experiments. Renewable and Sustainable Energy Reviews, 91, 229-247.

Rehm, M. and Ade, R., 2013. Construction costs comparison between 'green' and conventional office buildings. Building Research & Information, 41(2), p.198-208.

Rosenbloom, D., 2017. Pathways: An emerging concept for the theory and governance of low-carbon transitions. Global Environmental Change, 43, p.37-50.

Sandanayake, M., Gunasekara, C., Law, D., Zhang, G., Setunge, S., & Wanijuru, D., 2020. Sustainable criterion selection framework for green building materials–An optimisation based study of fly-ash Geopolymer concrete. Sustainable Materials and Technologies, 25, e00178.

Schot, J. and Geels, F.W., 2008. Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy. Technology analysis & strategic management, 20(5), p.537-554.

Shi, Q., Zuo, J., Huang, R., Huang, J. and Pullen, S., 2013. Identifying the critical factors for green construction–an empirical study in China. Habitat international, 40, p.1-8.

Song, Y., Li, C., Zhou, L., Huang, X., Chen, Y., & Zhang, H., 2021. Factors affecting green building development at the municipal level: A cross-sectional study in China. Energy and Buildings, 231, 110560.

Sovacool, B. K., & Hess, D. J., 2017. Ordering theories: Typologies and conceptual frameworks for sociotechnical change. Social studies of science, 47(5), 703-750.

Sparrevik, M., Wangen, H. F., Fet, A. M., & De Boer, L., 2018. Green public procurement–A case study of an innovative building project in Norway. Journal of Cleaner Production, 188, 879-887.

Udawatta, N., Zuo, J., Chiveralls, K. and Zillante, G., 2015. Attitudinal and behavioural approaches to improving waste management on construction projects in Australia: benefits and limitations. International Journal of Construction Management, 15(2), p.137-147.

Wang, G., Li, Y., Zuo, J., Hu, W., Nie, Q., & Lei, H., 2021b. Who drives green innovations? Characteristics and policy implications for green building collaborative innovation networks in China. Renewable and Sustainable Energy Reviews, 143, 110875.

Wang, N., 2014. The role of the construction industry in China's sustainable urban development. Habitat International, 44, p.442-450.

Wang, W., Tian, Z., Xi, W., Tan, Y. R., & Deng, Y., 2021a. The influencing factors of China's green building development: An analysis using RBF-WINGS method. Building and Environment, 188, 107425.

White, E.V. and Gatersleben, B., 2011. Greenery on residential buildings: Does it affect preferences and perceptions of beauty? Journal of environmental psychology, 31(1), p.89-98.

Windapo, A.O., 2014. Examination of green building drivers in the South African construction industry: Economics versus ecology. Sustainability, 6(9), p.6088-6106.

Wong, S.C. and Abe, N., 2014. Stakeholders' perspectives of a building environmental assessment method: The case of CASBEE. Building and Environment, 82, p.502-516.

Wu, F., Zhang, F. and Wang, Z., 2015. Planning China’s Future: How planners contribute to growth and development. RTPI: mediation of space–making of place.

Wu, Z., Jiang, M., Cai, Y., Wang, H., & Li, S., 2019. What hinders the development of green building? An investigation of China. International journal of environmental research and public health, 16(17), 3140.

Yang, X., Zhang, J., Shen, G. Q., & Yan, Y., 2019. Incentives for green retrofits: An evolutionary game analysis on Public-Private-Partnership reconstruction of buildings. Journal of cleaner production, 232, 1076-1092.

Yin, S., & Li, B., 2018. Transferring green building technologies from academic research institutes to building enterprises in the development of urban green building: a stochastic differential game approach. Sustainable Cities and Society, 39, 631-638.

Ying Liu, J., Pheng Low, S. and He, X., 2012. Green practices in the Chinese building industry: drivers and impediments. Journal of technology management in China, 7(1), p.50-63.

Yoshida, J. and Sugiura, A., 2015. The effects of multiple green factors on condominium prices. The Journal of Real Estate Finance and Economics, 50(3), p.412-437.

Zhang, L., Sun, C., Liu, H. and Zheng, S., 2016. The role of public information in increasing homebuyers' willingness-to-pay for green housing: Evidence from Beijing. Ecological Economics, 129, p.40-49.

Zhang, L., Wu, J. and Liu, H., 2018a. Turning green into gold: A review on the economics of green buildings. Journal of Cleaner Production, 172, p.2234-2245.

Zhang, L., Wu, J., & Liu, H., 2018b. Policies to enhance the drivers of green housing development in China. Energy Policy, 121, 225-235.

Zhang, X., Platten, A. and Shen, L., 2011a. Green property development practice in China: costs and barriers. Building and environment, 46(11), p.2153-2160.

Zhang, X., Shen, L. and Wu, Y., 2011b. Green strategy for gaining competitive advantage in housing development: a China study. Journal of Cleaner Production, 19(2-3), p.157-167.

Zhao, S., Zhu, Q., & Cui, L., 2018. A decision-making model for remanufacturers: Considering both consumers’ environmental preference and the government subsidy policy. Resources, Conservation and Recycling, 128, 176-186.

Zhou, Y., 2015. State power and environmental initiatives in China: Analysing China’s green building program through an ecological modernization perspective. Geoforum, 61, p.1-12.

Zou, Y., Zhao, W. and Zhong, R., 2017. The spatial distribution of green buildings in China: Regional imbalance, economic fundamentals, and policy incentives. Applied Geography, 88, p.38-47.

Singh, R., Walsh, P., & Mazza, C., 2019. Sustainable Housing: Understanding the Barriers to Adopting Net Zero Energy Homes in Ontario, Canada. Sustainability, 11(22), 6236.

Horne, R., & Dalton, T., 2014. Transition to low carbon? An analysis of socio-technical change in housing renovation. Urban Studies, 51(16), 3445-3458.

Geels, F. W., 2019. Socio-technical transitions to sustainability: a review of criticisms and elaborations of the Multi-Level Perspective. Current Opinion in Environmental Sustainability, 39, 187-201.

Finnish Environment Institute, 2019. Transition Towards Zero Energy Buildings: Insights on Emerging Business Ecosystems, New Business Models and Energy Efficiency Policy in Finland. SYKE Publications.

Rao, Y. (2020). New energy vehicles and sustainability of energy development: Construction and application of the Multi-Level Perspective framework in China. Sustainable Computing: Informatics and Systems, 27, 100396.

Zhang, H., Zhang, X., & Yuan, J., 2020. Coal power in China: A multi-level perspective review. Wiley Interdisciplinary Reviews: Energy and Environment, 9(6), e386.

Seeliger, L., & Turok, I., 2015. Green-sighted but city-blind: Developer attitudes to sustainable urban transformation. In Urban Forum. Vol. 26, No. 3, pp. 321-341.

Wang, W., Zhang, S., Su, Y., & Deng, X., 2018. Key factors to green building technologies adoption in developing countries: the perspective of Chinese designers. Sustainability, 10(11), 4135.