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A qualitative assessment of offsite construction awareness in the United Kingdom: construction industry experts' view

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ABSTRACT

The UK government is actively seeking to promote offsite construction (OSC) to improve housing and sustainability and achieve net-zero carbon targets. However, OSC adoption rates remain low. This qualitative study assessed OSC awareness through 12 interviews with experienced UK construction industry (UKCI) professionals. Its findings indicate that while OSC awareness exists, it is low among potential end users. Construction professionals are more aware, but general knowledge and adoption of OSC are still limited, and there are significant awareness–adoption gaps among industry stakeholders. These gaps are a major barrier to broader adoption. The study relies on a theoretical framework to propose with actionable strategies that will enhance OSC awareness and adoption. These recommendations provide a roadmap for increasing OSC uptake, offer insights for academic research, and highlight benefits for the construction industry, businesses and the environment. Additionally, they can be used to serve as a guide for other countries considering OSC adoption.

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KEYWORDS

Adoption; awareness; change management; construction industry stakeholders; offsite construction

Introduction

The construction industry (CI) is a complex and multi-disciplinary field characterized by diverse methodologies for executing various project types (Ahmad et al., 2019; Kale & Arditi, 2010). The industry is actively seeking ways to transition from its traditional practices to more efficient and advantageous approaches in order to meet rising demands (Osmani & O'Reilly, 2009; Rajanayagam et al., 2021). One such promising approach is Offsite Construction (OSC). OSC is a construction prefabrication concept that produces construction components in parts or as a whole off the construction site and transports these through various supply chain and logistics streams to the point of use (site) for assembly (Adeagbo & Anigbogu, 2020; Arif et al., 2017; Taylor, 2010; Wuni & Shen, 2020b). It was first introduced into the CI in the 16th century (Goulding et al., 2015; Thomas, 2006) before gaining traction in the 18th (Alonso-Zandari & Hashemi, 2017). The OSC approach was instrumental in resettling returning soldiers and their families shortly after Second World War (Alonso-Zandari & Hashemi, 2017; Goulding & Rahimian, 2019). It was also used to help combat the housing deficit caused by bombing in that war (Thomas, 2006). In recent times, OSC adoption has arguably facilitated the development of cost-effective

housing in the UK, where the shortage of homes is considered a significant challenge and has been a primary policy focus for several government regimes, including the new Labour government (Barton & Wilson, 2023; House of Lords, 2022; UK Parliament, 2019, 2024). Moreover, the adoption of OSC will bolster sustainability and promote the circular economy; this is important in the current business environment, where there is high stakeholder pressure to help create a sustainable society (Blismas & Wakefield, 2009; Garrett et al., 2021; Razkenari et al., 2020).

While OSC is advocated as a construction methodology because of its acclaimed environmental benefits, sustainability promotion and positive contributions to the circular economy (Razkenari et al., 2020), and because it is a cost-effective approach with great potential to improve profits for firms in the industry (Garrett et al., 2021), most UK houses are still built using traditional methods (Steinhardt & Manley, 2016). Recent estimates (Bain & Wilen, 2024; CITB, 2024a, 2024b) suggest that the United Kingdom's OSC sector accounts for only 7–9% of its total construction output. To date, the industry in total is estimated to be worth £1.5 billion to the economy. Reports have shown that greater OSC adoption has potential economic benefits (Oakley,

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2018). So why is its take-up so limited? Some scholars (for example, Steinhardt & Manley, 2016) have argued that limited OSC adoption is traceable to limited awareness. Indeed, product awareness is often considered a crucial first step before product adoption (Akpan et al., 2022; Colapinto et al., 2014). The existing studies in this area lack insight into how OSC awareness affects its adoption. Generally, Cai et al. (2023) noted that firms do not have a clear understanding of how to adopt OSC, which has hindered the process. It is, therefore, essential to conduct research to understand the impact of awareness on OSC adoption. This understanding will be vital in encouraging more CI stakeholders to adopt OSC.

Although a vast number of factors that play a role in OSC adoption have been identified in extant literatures (Agapiou, 2022; Alonso-Zandari & Hashemi, 2017; Arif et al., 2017; Feldmann et al., 2022; Liu et al., 2024; Saad et al., 2024; Schoenborn, 2012; Wuni & Shen, 2020a; Wusu et al., 2024; Young et al., 2020), the role of OSC awareness has been addressed in very few (Bendi, Rana, Arif, Goulding, and Sawhney, 2021; Chen et al., 2010; Goulding et al., 2015). To the authors' best knowledge, none of these looked specifically at how OSC awareness limits OSC adoption directly. While Zhou et al. (2018) examined how to improve awareness of green construction, the authors failed to explain the boundary conditions responsible for the current OSC awareness–adoption gap. The UKCI and the government, therefore, need to understand the role of awareness within the CI and among its diverse stakeholders, particularly in uncovering why OSC knowledge has not been sufficiently diffused to significantly impact adoption. Considering that the CI is wide -ranging and involving multiple stakeholders and end users, targeted awareness efforts are essential. Specifically, raising awareness among industry stakeholders – both direct customers and end users, not just industry practitioners – is critical to driving wider OSC adoption.

This study, therefore, seeks to explore how OSC awareness impacts OSC adoption and the boundary conditions that account for the current OSC awareness–adoption gaps. The study employs a qualitative research approach to gain insight into the views of UKCI professionals. It was decided that a qualitative perspective was most suitable for gaining an in-depth understanding of these issues and to learn from the rich experience of the UKCI professionals, as relatively few studies have examined the topic using such an approach. Most of the studies in the field (for example, Feldmann et al., 2022; Gusmao Brissi et al., 2021; Wuni, 2022) are review papers. Also, the majority of the published empirical works in CI research are based on quantitative methods (Blismas & Dainty, 2003). These quantitative studies in

the field (for example, (Agapiou, 2022; Luo et al., 2020; Nadim & Goulding, 2010; Wuni et al., 2022; Wuni & Shen, 2020)) examine general OSC adoption factors, highlighting awareness as one of them. Together, literature reviews and quantitative studies in the field are not sufficient to gaining an understanding of complex emerging research questions from the perspective of the research informants (Saunders et al., 2023).

Professionals from the UKCI were examined because the number of published articles reported from database searches indicated that the UK was a vital geographical location for gathering information about OSC (Miles, 2021; Raynor, 2021). This study, therefore, addresses the research questions listed below:

1. What underlying awareness issues impact OSC adoption as a choice of construction method?
2. How do the underlying awareness issues impact wider OSC adoption within the UKCI?
3. What strategies could be used to address the observed OSC awareness issues and enhance OSC adoption?

By answering the above research questions, this would be the first in-depth study to explore how awareness of OSC hinders and/or influences its adoption in depth and uncover the boundary conditions impacting the OSC awareness and adoption gap. In doing so, the study extends the literature in two major ways. First, it uncovers the varying levels of OSC awareness and adoption among different categories of CI stakeholders. The study sheds light on this as a boundary condition for wider adoption of OSC. Second, the study extends the extant literature by uncovering how multiple stakeholders in the UKCI could enhance OSC adoption and drive the desire for OSC usage through knowledge development exchanges and the provision of incentives in the form of green points and, thus, tax rebates. Finally, the study provides practical steps on how industry practitioners, policymakers and researchers could widen OSC adoption in the UK and other countries wishing to increase its use, an outcome that would be good for both OSC businesses and the environment.

Literature review and theoretical underpinning

Literature review

Offsite construction is a prefabrication and assembling technique used to achieve rapid construction. It was initially used to produce prefab houses using timber as the major construction element. While such prefab buildings gained relatively wide usage in the early 1800s, their

popularity was short-lived due to their poor material quality and structural strength, their propensity to exhibit mould growth, and their short life cycle, among other reasons (Arif et al., 2017; Gan, Chang, Zuo, et al., 2018). Most of these failures were attributable to the use of timber-frame structures. This prompted calls for a more sustainable and structurally stable approach to producing such buildings quickly. To address these shortcomings, timber components of the 1800s were replaced with more durable composite materials (CITB, 2019; Farmer, 2016; Hamzeh et al., 2017), leading to the development of materials that can cope with today's industrial, policy and societal demands.

Thus, despite the shortfalls of the earlier prefabricated building attempts in the 1800s, the industry still sees viable potential in OSC concepts that use newer approaches and improved alternative materials (Hamzeh et al., 2017). As a result, major industry players and governments have invested heavily in promoting OSC. For instance, the UK government has prioritized OSC adoption, after recognizing its potential to help it achieve net-zero carbon emissions and mitigate climate change (Jin et al., 2022; Zhang et al., 2019). If widely adopted, OSC offers a credible alternative to the industry's current resource-intensive and environmentally harmful construction methods by reducing waste, lowering carbon emissions, conserving natural resources and supporting a strained global economy (Babalola et al., 2019; Chen & Lu, 2018). But how much awareness-raising needs to be done for OSC to be more widely adopted?

Recent studies have shown that despite government efforts to enhance OSC use by promoting the sustainability benefits associated with it, its overall rate of usage is still very low (Barton & Wilson, 2023; Brown, 2024). Notably, OSC adoption declined after the failings of timber prefabs became more widely known, and research has shown that publicity aimed at updating and redefining awareness can enhance usage (Razkenari et al., 2020). Understanding and addressing these awareness gaps will, thus, be essential if OSC is to be more widely adopted and its full potential realized.

Many authors have examined the factors that have influenced OSC adoption in different regions and countries (Agapiou, 2021; Schoenborn, 2012; Wuni & Shen, 2020b, 2019), including India (Bendi, Rana, Arif, Goulding, and Kaushik, 2021), Australia (Blismas & Wakefield, 2009), Ethiopia (Daget & Zhang, 2019), the United States (Gusmao Brissi et al., 2021), Honk Kong (Jaillon & Poon, 2010), China (Jiang et al., 2020), Nigeria (Wusu et al., 2024) and the UK (Alonso-Zandari & Hashemi, 2017; Flynn, 2023; Nadim & Goulding, 2009, 2010; Ofori-Kuragu et al.,

2022). One particularly salient yet scarcely reported factor is awareness (Bendi, Rana, Arif, Goulding, & Kaushik, 2021; Goulding et al., 2015). Taken together, these studies suggest that the following factors lead to low adoption of OSC: whole life energy (Bras et al., 2020), supply chain management (Luo et al., 2020), economic values and design potential (Nyemba et al., 2017), cost factor (Pan & Sidwell, 2011), project management practices (Robichaud & Anantatmula, 2011), design (Shang et al., 2020), a combination of buffer-space hedging, multi-period hedging, and hedging in production lead-time and coordination (Zhai et al., 2017, 2018, 2019) and awareness issues (Bendi, Rana, Arif, Goulding, & Kaushik, 2021; Goulding et al., 2015). While these factors have been identified in the literature as barriers, some of these, such as costs, design, and supply chain management, have also functioned as drivers of OSC (Ayinla et al., 2019; Heptonstall & Jenkins, 2022; Pan & Sidwell, 2011).

Interestingly, out of the several studies (98 articles) reviewed on OSC adoption factors, only a few (Ahmad et al., 2019; Bendi, Rana, Arif, Goulding, & Sawhney, 2021; Goulding et al., 2015; Wuni & Shen, 2022) highlighted awareness as a factor that inhibits OSC adoption, but they failed to expatiate on how it does so. Also, none addressed the OSC awareness issues influencing adoption in either a global or UK context. In line with the extant studies in marketing and product development and growth (see Amutha, 2016; Galati et al., 2019), which show that product awareness is often considered a crucial first step before product adoption, this study argues that the desired increase in OSC adoption cannot proceed without intensified awareness. Thus, this lack of understanding of how awareness hinders OSC adoption and the boundary conditions responsible for this situation is a massive gap in the literature that needs to be examined (Cai et al., 2023; Wusu et al., 2024).

General product awareness

Awareness can be defined as having knowledge about the existence of a product or service, while adoption is defined as deciding to use or employ that product or item to address a problem or carry out a task (Hussain et al., 2014). Promoting awareness takes the form of a sensitive, informative and emotional appeal to potential users about the usefulness of a new or improved existing product with the intent of raising its visibility within the market, sustaining its use or preventing its utter decline (Clinton & Chatrath, 2022).

To achieve this, organizations target those groups in the general public (Colapinto et al., 2014) where potential users are most likely to be found. Generally,

communication plays a critical role as it allows participants to share information about the product or service, fostering knowledge and positive perceptions. More often, essential features such as the price and quality of the product or service are communicated during this process to potential end users to enhance product knowledge level and perception. Arguably, knowledge of the product's benefits, cost, and utility compared to those of rival products encourages the adoption of the advertised product. Some estimates suggest that social media has become a major communication platform which facilitates communication with potential end users of a product or service. The use of social media platforms is usually very cheap and is free in some cases.

Penetrating an established and running market without creating strong awareness could negatively impact the product image and shorten its lifecycle. While it must be admitted that creating awareness does not guarantee automatic adoption of the product, a strong correlation is found to exist between the rate of its adoption and the amount of awareness created around the product, its function, and its benefits (Mujuka et al., 2021). For example, Clinton and Chatrath (2022) noted that creating strong awareness creates consumer confidence, which could positively impact how potential users relate to products, a finding also supported by Larney and van Aardt (2010). Studies with similar findings have looked at the fields of digital non-financial services (Shaikh et al. (2020), EV cars (Jin & Slowik, 2017) and recycling (Larney & van Aardt, 2010)).

Offsite construction awareness and adoption

OSC is a construction methodology that is being reintroduced to the construction market. Its initialization phase (development and introduction) has passed, and it is now in the growth stage; however, it is struggling, and its outlook for potential market saturation looks bleak. Notably, its reintroduction has encountered its fair share of awareness challenges. While organizations in many sectors have used awareness to drive wider adoption of their products, this has not been well explored within the CI. Although, as we have seen, awareness does not translate into adoption in all cases, it has been proven to increase the adoption rate as well as user knowledge of a product's benefits (Mujuka et al., 2021). For example, product end users can become product co-creators through their reviews, input, and feedback if they are taken into cognisance during product development (Akpan et al., 2022; Gan, Chang, and Wen, 2018; London & Pablo, 2017). Their contribution refines the product and in turn leads to greater awareness and adoption rates (Ginigaddara et al., 2022; Shaikh et al., 2020).

Agile methodologies emphasize the prioritization of users in product development outcomes, as meeting user needs in terms of quality and functionality is deemed essential for product viability (Franklin, 2021; Manager & Lockhart, 2023). Understanding users' needs through awareness creation exercises is thus crucial in driving innovation (product) adoption and improvement (Hoyer et al., 2010). For example, Amutha (2016) observes that the introduction of e-banking failed in Tuticorin, India, due to customers' unfamiliarity with the product. Kelley and Sánchez (2005) further highlight that variations in user preferences require awareness and education to foster product adoption. Therefore, customer-centric products are more likely to succeed in the market. Donaldson and Preston (1995) and Harrison et al. (2015) argued that users develop loyalty to familiar products and those that meet their needs, thereby ensuring continued patronage. Thus, neglecting the user's role in product design and development risks creating products without corresponding adoption or consumption. This is particularly relevant to OSC as, for example, 25% of UK construction projects is expected to be OSC, but less than 10% is actually OSC (CLC, 2020).

Awareness and adoption among construction industry stakeholders

In product development, the role of stakeholders in product creation and adoption is essential with particular attention given to users in this context, as they play a significant role in a product's life cycle and adoption success (Hines et al., 2006). A stakeholder is defined as anyone with any type of vested interest in a business or enterprise and its outcomes (Akpan et al., 2022; Gan, Chang, & Wen, 2018; London & Pablo, 2017). For this study, CI stakeholders are defined as the different groups of tradespeople (professional or not) involved at all stages of the construction process, from ideation through execution to post-construction activities. Gan, Chang, and Wen (2018) list the following as stakeholders: developers, supervisors, designers, manufacturers, government, contractors, researchers, financial institutions, higher education institutions, consultants, the public, suppliers of material and equipment, logistics enterprises, retailers and media. Hamzeh et al. (2017) categorized CI stakeholders as general contractors (GC), architects/engineers (A/E), and precast manufacturers (M). Building on the works of both Gan, Chang, and Wen (2018) and Hamzeh et al. (2017), for the purposes of this study, CI stakeholders are classified in three groups: as professionals (engineers, architects, planners, quantity surveyors, etc.), allied professionals (manufacturers, contractors, academics, consultants,

etc.), and the public (government, clients, end users, media, etc.). Studies suggest that the interests of these different stakeholders differ depending on the project. For example, in an OSC project, the government and community may seek rapid housing provision and sustainability promotion; builders seek ease of construction and profit; the client and manufacturers seek profit and ROI; and the users seek durable houses that represent value for money.

As the analyses by Gan, Chang, and Wen (2018) and Ngoc Nguyen et al. (2020) have shown, the extant studies do not provide enough information to help us identify each stakeholder group's awareness level regarding OSC technology. However, Goulding and Pour Rahimian (2019) noted that industry professionals lack awareness of OSC's sustainability benefits, while design professionals lack awareness of the Design for Manufacture and Assembly (DfMA) approach (Tavares et al., 2021). Similarly, Wusu et al. (2024) submit that in Nigeria, OSC awareness is lacking in government agencies regulating building constructions, schools, and among construction workers. Nadim and Goulding (2009) note that there are OSC awareness challenges in the UK higher education sector in relation to construction-related courses, so, judging by academic awareness, the UK academics cannot evaluate whether OSC has a promising future or not. Thus, it is not surprising that only 10% of UK construction projects in 2020 used OSC; globally the figure was less than 5%, and overall improvement within the CI globally that year stood at less than 1% (CLC, 2020). The authors of this article recommend raising client awareness of the benefits of OSC and ensuring that design development teams are kept informed of the latest assembly techniques.

An examination of the grey literature within the CI supported this view: although few articles addressed the issue of OSC awareness, almost all of those that did cite lack of awareness as a limitation to wider OSC adoption (CITB, 2019, 2024b; CLC, 2020; Milbank Architects, 2022); however, they failed to provide insight into the factors influencing this in the UK and the boundary conditions responsible, thus underlining the importance of identifying these. The current study, thus, argues that a key strategy in enhancing the adoption of OSC and similar innovations will be that of 'loud', targeted marketing and advertising campaigns that educate consumers on OSC's potential benefits. Owing to the multifaceted nature of the CI, strong synergy, understanding and collaboration between its different stakeholders are essential for the successful delivery of projects on time and on budget (Akpan et al., 2022). For these collaborative partnerships to work as expected, the different stakeholders' understandings of OSC need

to be appraised. Hence, the need for this research and its focus on stakeholder awareness.

Theoretical underpinnings

Several theories have been applied to improve our understanding of adoption of technology innovations across industries including IT and construction. These theories include Roger's Innovation Diffusion Theory (IDT), the United Theory of Acceptance of Use of Technology (UTAUT) (Munir, 2003; Ragozzino, 2006), Technology Adoption Models (TAM 1, TAM 2, and TAM 3), the Concerns-Based Adoption Theory (C-BAM) (Momani et al., 2017; Shang et al., 2021; Wusu et al., 2024), and ADKAR (Garrison, 2023), among others. Individually, all of these theories (apart from ADKAR) have shortcomings, and they are therefore not particularly suitable for understanding how awareness influences adoption (Ajibade, 2018; Momani et al., 2017). For example, Momani et al. (2017) note that IDT, one of the earliest theories that covers general views on adoption does not explain how awareness facilitates change in potential users' perceptions to bolster adoption. Moreover, it fails to account for the individual and social support that end users require to adopt a technology. TAM models, such as the one proposed by Davis in 1989, have a limited focus when it comes to adoption (Munir, 2003), concentrating on users' perceptions of and attitudes towards new technology (Momani et al., 2017), and failing to highlight how awareness is created. Though some extensions of TAM have gone on to assess factors such as perceived ease of use and perceived usefulness in predicting technology adoption (Lee et al., 2003), the models still do not 'provide any feedback on some factors that may enhance adoption like integration, flexibility, completeness of information, and information currency and they do not predict the user's behaviour within culture' (Momani et al., 2017). UTAUT was built on eight adoption models including IDT and TAM, and it strengthened the limitations of those models by adding four constructs: namely performance expectancy, effort expectancy, social influence, and facilitating conditions. However, studies have shown that UTAUT demonstrates low exploratory power in its approach to business intelligence. It does not exhibit reliable outcomes across different geographical locations. Also, it demonstrates a limited capacity to unravel the complex relationships among its constructs (Alshammari & Rosli, 2020; Williams et al., 2011, 2015). Owing to its inability to address concerns about adoption and user feedback, it was considered not suitable for use in this study. Though C-BAM addresses user concerns, it was

also considered unsuitable for our purposes because it does not address how to create awareness.

The current study, therefore, relies on ADKAR to explain how awareness creation can bolster OSC adoption. ADKAR is a change management and adoption model which has been used by studies to understand awareness and adoption challenges across various industries. ADKAR stands for awareness, desire, knowledge, ability, and reinforcement. It provides guidance for organizations on how to change from one form of work model to another, especially in the context of a complex and disruptive technology transition. For example, Microsoft used ADKAR to diagnose and address blockers to customer success, thereby improving its customer service management and increasing customer buy-in (Stephen, 2024). ADKAR is thus suitable for managing a complex change like transitioning from a slow and environmentally unfriendly construction method to a sustainable, quick and growth-oriented one like OSC. Through awareness creation, the ADKAR model provides insight into the change process, thus creating the requisite knowledge needed to drive the desire for change and, consequently, adoption among different potential end users. According to this model, awareness provides users with reasons to adopt the new product and enables them to ask questions and find clarity on the need for change (Creasey, 2020; Hiatt, 2006). ADKAR measures adoption advancements in a linear progression of stages promoting awareness. While the public's perception of OSC has become more negative (Agapiou, 2022; Pan et al., 2007), and efforts to revive it have met with conservatism and protectionism (Looby et al., 2022; NHBC, 2016), perhaps due to a limited understanding of how the product has been improved (Razkenari et al., 2020). Key OSC stakeholders can leverage its inherent benefits (Ajayi et al., 2019) to counter this and to drive knowledge, reinforce acceptance and boost adoption. This approach provides the potential for OSC adoption to pursue the desired path of continual progression, which continues beyond its final stage, 'reinforcement'. Figure 1 sets out the phases of ADKAR.

Methodology

While previous studies on OSC adoption and construction management have deployed quantitative research approaches (Blismas & Dainty, 2003) to identify the different factors responsible for low OSC adoption, these studies have failed to provide a rich contextual account of lack of awareness as one of the key factors nor the boundary conditions accountable for the awareness – adoption gap. According to Queirós et al. (2017),

this is unsurprising as the quantitative approach is unsuitable as a means of creating in-depth understanding of an emerging research phenomenon in its context because it does not answer 'how' and 'what' questions. In Cai et al.'s (2023) account, CI firms have not had a clear understanding of how to adopt OSC, which has thus hindered further adoption. A qualitative research perspective may therefore be needed as this study has done (Cai et al., 2023). This study, therefore, employed a qualitative approach to unpacking how OSC awareness influences OSC adoption in the UKCI by questioning CI experts. Additionally, a qualitative approach is more suitable for answering the 'what' and 'how' research questions the current study tries to answer (Yin, 2015).

Before data gathering commenced, the University of Hertfordshire Social Sciences, Arts and Humanities Ethics Committee with Delegated Authority (SSAH ECDA) approved the study interview call with the Protocol Number BUS/PGR/UH/05327.

Sampling technique

Given the study's exploratory nature, a purposive sampling technique was employed, consistent with a qualitative research design (Saunders et al., 2015). A purposive sampling technique allows researchers to select knowledgeable participants capable of providing the relevant data. In this case, data on OSC from CI professionals provided answers to the study's research questions (Rahimian et al., 2017). While such a sampling strategy enhances internal validity, it may limit external validity (Andrade, 2021). Through the first and second authors' industry networks, 45 experts in different professional areas within the CI were contacted through emails, text messages and social media platforms such as LinkedIn and Facebook. Of the 45 people contacted, eight agreed to participate in the study. Through snowball sampling (Darlow et al., 2022), the interviewer was put in touch with four more of their colleagues with relevant knowledge on the subject, making 12 participants in total. The participants included architects, civil/structural engineers, clients, investors, potential end users, etc. See Table 1.

Data collection

Twelve semi-structured interviews were conducted using the Zoom and MS Teams video-call applications. The semi-structured interview is a discussion format that allows researchers to gather specific and rich data that are helpful in answering her/his research questions. Moreover, interviews allow the researcher the flexibility to reflect on and analyse interviewees' voices, body

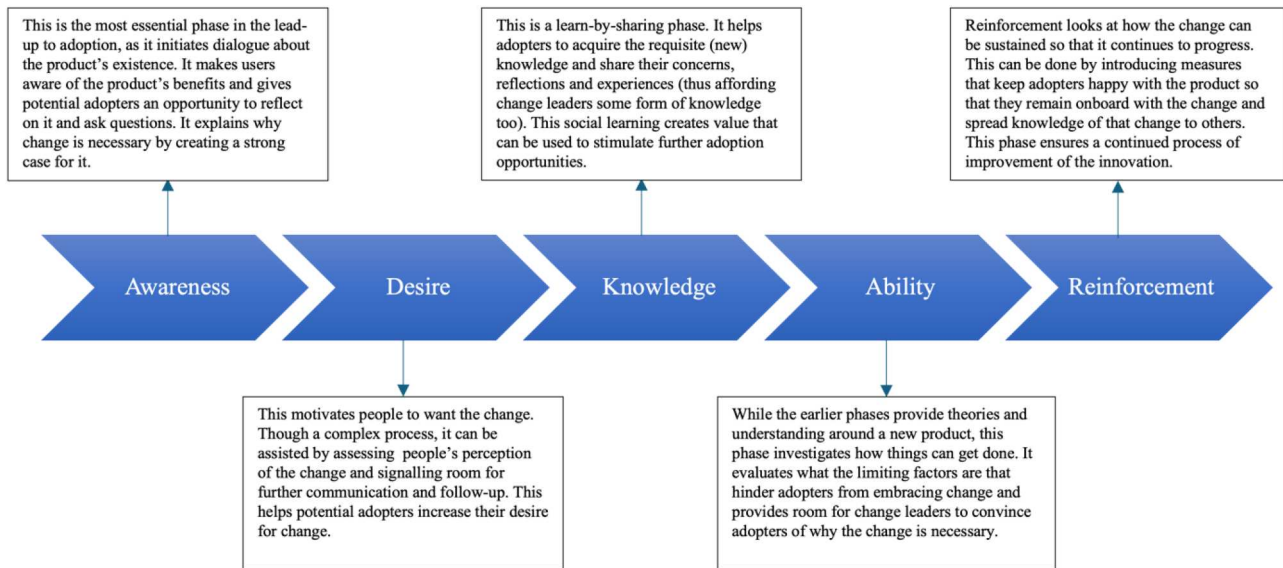


Figure 1. Theoretical ADKAR model for awareness–adoption improvement. Source: Authors’ own work, inspired by Prosci (2020).

language and emotions (Saunders et al., 2015). The interview schedule was developed after an extensive literature review to ensure that valid interview questions were asked. To enhance construct validity, before the interviews began, pilot interviews were conducted with three people: an academic who ensured they satisfied academic research requirements; an industry professional who ensured they covered emerging issues relating to OSC within the industry; and a potential end user, who provided insights from the perspective of potential adopters (Wusu et al., 2024). With the consent of the interviewees, interviews were recorded for analysis. The first group of questions addressed the interviewee’s demographic profiles (see Table 1). In the second section, open-ended questions were deployed requesting interviewees to discuss their experiences of UK projects involving OSC adoption. The questions asked included the following:

How has the UK construction industry been evolving with the traditional and offsite construction methods?
How does awareness promote/inhibit the wider adoption of OSC within the UK construction industry?

How can construction industry players/stakeholders promote awareness of OSC as a viable construction method?

To offset any limitations of the interview process, follow-up questions were asked on specific issues that emerged during the interviews. These included the following:

1. *What do you think is/are the different end users’ experience(s) of OSC?*
2. *What steps can be taken to address awareness issues?*
3. *Do you think the schools/institutions are preparing students for the offsite construction shift in the construction industry? Are there modules/courses dedicated to offsite construction?*

Table 1. Profile of interview respondents.

S/No	Qualification/Experience	Years of experience	Years of experience in OSC within the UK
R1	Architectural technology and house building	About 45 years	Over 30 years in DfMA designs
R2	Architecture	28 years	Very experienced
R3	Manager, construction technology, PhD (in construction skills)	Over 10 years	4 years
R4	Architecture	Over 30 years	Very experienced
R5	Construction management	Over 10 years	More than 5 years
R6	Architectural technology, OSC consultant	Over 40 years’ experience	21 years in OSC
R7	Architecture	25 years	Very experienced in all other forms of DfMA, apart from volumetric
R8	Architecture	5 years	4 years
R9	General practice, chartered surveyor	25 years	Very experienced
R10	Architecture	Very experienced	Very experienced
R11	Architecture, project manager, site agent	13 years	5 years
R12	Senior lecturer (Construction Management), operations manager, geo-technique officer	Over 10 years	Over 7 years

The average interview time was 50 min. It is considered necessary to achieve data saturation in qualitative research (Patton, 2002). This helps researchers to determine whether the available data are relevant to answering the study's research question and reaching conclusions (Saunders et al., 2015). After 10 interviews, the authors reached a point of theoretical saturation as no new information was emerging (Bell et al., 2022). With the addition of two further interviews, no new issues were observed; the respondents simply emphasized the issues that had already been mentioned concerning OSC awareness and adoption.

Data analysis

The study employed thematic analysis for qualitative data analysis (Braun & Clarke, 2006). This approach allowed for a comprehensive and nuanced examination of the data, yielding valuable insights into the research questions. First, the authors familiarized themselves with the data by repeatedly reading the interview transcripts and listening to the audiovisual recordings (Braun & Clarke, 2006). Second, the authors developed initial codes and relevant text excerpts for each code from reading the transcripts and the notes they had made from them. Consistent with thematic analysis, codes were developed based on a review of prior literature (Braun & Clarke, 2006). The study also utilized information and insights from a word pool, created using Word Cloud. See Figure 2.

Codes such as awareness and adoption levels, knowledge, recreation and strategies for offsite construction were identified at this stage. Third, broad themes were developed after reading through the relevant text segments of the collated text associated with each code (Braun & Clarke, 2006). Finally, these narrow themes were merged into broader ones that could encapsulate the recurrent issues in the data. At this final stage, further themes were developed: these included varying awareness levels, the awareness situation, awareness and OSC knowledge, awareness and adoption, and recreating awareness were developed. See Table 2 on data categorization and theme development.

The first and third authors analysed the data in a joint coding process. The overall percentage of agreement between the two coders was 76%, above the suggested threshold of 70% by Cohen (1960). A further meeting was held with the interviewees to validate the outcome of this analysis process. Only six of the twelve interviewees could attend the validation exercise, and because of individual schedules, the meetings were one-on-one as opposed to the targeted focus group meeting. These meetings were held 18 months after the initial interview

exercise. All six interviewees confirmed the findings of the research as reported.

Findings

In line with the study's research questions, the thematic analysis identified three major insights around OSC awareness: varying OSC awareness levels, varying degrees of OSC knowledge among stakeholders, and historical perceptions. These themes are discussed in the following section.

Varying OSC awareness and adoption levels among stakeholders

This study uncovered varying and lopsided OSC awareness levels among OSC stakeholders as a major OSC awareness concern, as reported by interviewees. This issue varies in terms of its impact on stakeholders' level of adoption. While existing literature (Goulding et al., 2015; Wusu et al., 2024) suggests limited awareness, it does not specify which stakeholders are aware of OSC or what the awareness boundary issues are.

High OSC awareness level among professionals

It emerged that some interviewees believe there is a high awareness level among professionals and, consequently, high OSC usage among these professionals within the UK.

I would say there's a lot of awareness ... There are a lot of conferences. There's a lot of discussion ... Several companies have established modern methods of construction departments and divisions within their companies, and so in terms of awareness, I think there is a large awareness that exists. – R6

It [the construction industry] is getting a lot of information, and a lot of publication[s] out there ... Currently, I can say that a lot of information is out there. – R5

I think offsite construction is becoming a more noticeable idea; more people (professionals) are aware of it ... I think nowadays it is a far more common solution ... – R2

While industry professionals seem to be aware of OSC, it emerged that the awareness level is low among other stakeholders.

Low OSC awareness level among end users (customers)

In contrast, some other interviewees believe OSC awareness is low. Their responses included the following:

In terms of awareness, probably low ... and 2/10 at the very best – R1

Table 2. Data categorization and theme development.

S/ No	Respondents' quotation	Codes	Total no of codes	Subthemes	Themes
1.	'OK, I mean the level of awareness is relatively low. You know that's why I said for 4/10.'	Low Awareness	6	Varying OSC Awareness Level	Varying OSC Awareness and Adoption levels
2.	'Yeah, I say it's quite high, so maybe seven or eight or something like that.'	High Awareness Level	12		
3.	'... I'm not sure that it's kind of getting to everybody, and maybe it is getting to the 95% but they just choose not to use it. They think they're quite happily doing things in traditional ways.'	Adoption	7	Varying OSC Adoption Level	
4.	'Half of the adoption, maybe less to be honest, but I don't know. But it's quite low. The adoption is quite low.'	Adoption Level	5		
5.	'I think offsite construction is becoming a more noticeable idea, more people are aware of it. And even in the 10–15 years since I was working extensively and designing offsite solutions, I think nowadays it [is a] far more common solution ...'	Existing Awareness	6	Awareness and Adoption Knowledge	Inherent Opportunities in OSC State
6.	'I think there is [sic] plenty of efforts going on to make awareness of offsite construction, whether everybody listens to it is another matter.'	Awareness, not adoption	3		
7.	'Probably a lack of knowledge generally across the industry, so we need to raise the knowledge across the whole construction sector ...'	Paucity of knowledge			
7.	'I'm not sure that my friends that are not in the construction industry have much awareness of modern methods of construction, I'm not sure my circle of friends who are not in the construction industry have a true awareness of how things are done.'	Professional Awareness	4	OSC Current State	
8.	'... let's reflect on what I said at the beginning about when they go to conferences, you tend to see the same kind of people all the time. Would they invite [a] person not in houses in? I don't know. Maybe, maybe not.'	Awareness and adoption lie among majority industry stakeholders	6		
9.	'I think it is evolving, but as I mentioned before, I think it's only evolving in pockets. Because of that sort of 5–10% market share.'	Increasing Awareness	5	Increasing OSC Awareness and Adoption	Strategies for Increasing OSC adoption
10.	'I believe that the best way to make this industry change is to showcase examples of success through innovation or change ... And I think once we can demonstrate really good examples of successful innovation, that's how the industry will change. So for me this is an amazing opportunity.'	Recreating Awareness	5		

... They think they're quite happily doing things in traditional ways. So, it's not an easy question to answer. – R4

Examining the opinion of the interviewees on the level of OSC adoption within the UK, most respondents rated the adoption level below 5 on a scale of 10, as shown in these examples:

Half of the adoption, maybe less, to be honest, but I don't know. But it's quite low. The adoption is quite low. – R7

Yeah, adoption maybe three or four (out of 10). – R10

... I think that's ... 4 out of 10. – R11

On a scale of 1–10, I would say OSC is probably on about 4 / 10 ... that's what I give you. I think there's still a lot to be learned ... – R12

Inherent opportunities in current OSC state

Despite the aforementioned issues around OSC awareness and adoption in the UK, the respondents acknowledged

the present efforts geared towards increasing the visibility of OSC by its champions. They noted that:

This is getting better. People (in the industry) are beginning to understand it, ... awareness is growing. I think the actual level of offsite construction is higher than perhaps anticipated. – R1

... and the barriers ... I think they're slowly dissipating [...] really like more and more people are realizing that we need to use modern methods of construction ... – R11

R7 noted that government and CI policies have been helping to increase OSC awareness and consequently support its adoption.

They have come up with a statement in the press that they're looking for at least 50% of the apartment blocks they build going forward to be built with offsite construction. So, as these major builders start to adopt offsite construction, then the awareness grows. – R7

However, according to various industry and academic reports, the identified improvements are still not at all

close to the desired 25% use of OSC within the CI (Flynn, 2023; Miles, 2021). Thus, OSC awareness and knowledge varies across CI stakeholders, and adoption is reportedly low compared to the UK government target. The awareness gap between industry professionals and other CI stakeholders, particularly potential end users, could be the missing link to achieving the wider adoption that is desired. The interview findings provided hope, however, as interviewees pointed out inherent opportunities in OSC's current state that could be leveraged to pursue wider adoption, and they suggested strategies for achieving the same.

Strategies to increase OSC adoption

Some interviewees noted that the awareness that has been created around the use of OSC within the UKCI is insufficient to drive the desired adoption level. R12 and R5 explained:

We really need more awareness within the industry for offsite construction. – R12

... and we are looking at passing this information, not just to increase ... but to [...] improve ...'. – R5

The measures identified to achieve this are described below.

Wider engagement and participation

The study revealed the need for intra-synergy among CI professionals and inter-synergy with non-professional stakeholders. Interviewees proposed renewing awareness among industry professionals and increasing it among the general populace through better stakeholder engagement. Strategies to achieve this might include publicizing successful OSC projects and creating more training programmes to better communicate OSC methodology to construction and other workers. One interviewee noted:

I believe that the best way to make this industry change is to showcase examples of success through innovation or change ... I think once we can demonstrate really good examples of successful innovation, that's how the industry will change. – R2

R5 added:

'... the training providers I belong to ... , we are looking at passing this information, not just to increase ... but to [...] improve ... so we have a task force going to colleges, talking to them about modern method of construction.' – R5

R5 further noted that a reorientation of workers mindsets, driven by a top-to-bottom approach, would allay the resistance and reluctance within the industry and

combat the historical negative perceptions of OSC among the general public.

We need to get people's mindset to change, and that's the challenge. How do we get people's mindsets to change? And I genuinely believe that can only come from the top of the businesses. – R7

OSC education and knowledge development

Another important strategy worth exploring is that of bringing awareness of OSC to people outside the CI. One interview noted:

So, I think you can overcome that by ... , expanding knowledge about offsite; we need to help people understand offsite so they can engage more comprehensively in that. – R3

Given these comments on the need for information to be diffused more widely, there may need to be a more pragmatic approach to its dissemination. Professionals need to implement their knowledge and apply it by adopting OSC, thus inspiring confidence in the technology to grow outside the CI. The approach to achieving wider adoption needs to be redesigned to ensure that 'talking' and 'knowing' become 'doing', in order to address the fears and concerns of potential adopters, as pointed out by R6 and R9.

And I would say, ... I would say people (industry professionals) are aware of OSC but are scared to make the decision to use them until it is a contractor-led decision ... – R9

Whether there's enough pragmatism about how you can apply it is another question ... – R6

Refined support policy and pragmatic implementation approach

This pragmatic approach has the potential to address the fears and hesitation of potential adopters through the practical demonstration of successful OSC projects.

I believe that the best way to make this industry change is to showcase examples of success ... And I think once we can demonstrate really good examples of successful innovation, that's how the industry will change. – R2

Further, government and regulatory bodies should improve and broaden the range of existing policies that support take-up, such as incentives, tax reductions, green credits, OSC training and scholarships to encourage greater OSC adoption.

Product advocacy and promotion

Marketing is what sustains products. So, for a product to remain relevant, strong advocacy and promotion are required, in addition to continuous development and

integration. Interviewees suggested providing information about the advantages of OSC compared to traditional methods as an option to explore.

... I'm not sure that it's kind of getting to everybody, and maybe it is getting to the 95% but they just choose not to use it. – R4

Discussion

This study has explored the role of awareness in wider OSC adoption and the boundary conditions impacting the awareness and adoption gap. First, it emerged that industry professionals have varying OSC awareness levels, and that these are among the boundary conditions responsible for that gap. Extant studies (for example, Gan, Chang, & Wen, 2018) highlight uneven levels of awareness as a significant adoption limiting factor but fail to elucidate how it actually affects adoption. Building on this, the current study found that the majority of direct users of OSC have very little or no understanding of it; although awareness levels are high among industry professionals, these account only for a minority of users. Although the study's findings must be interpreted with caution due to the small sample size, arguably these findings suggest that the knowledge of manufacturers and industry professionals alone is insufficient to drive OSC adoption (Galati et al., 2019). The market space needs a large number of consumers (volume) to drive the growth and usage of a product. Thus, the general public's lack of knowledge and understanding of OSC has a strong negative influence on the product's prospects for survival (Clinton & Chatrath, 2022). According to Batty (1976), 'We need to do many things, and the most important [thing] is with decision makers and people who will use these tools'; this highlights the significance of product stakeholders, especially product users, in the OSC adoption chain.

Second, consistent with the extant studies by Hamzeh et al. (2017) and Farmer (2016), our findings uncovered those negative historical perceptions of earlier OSC adoption also accounted for low take-up. It seems that earlier negative experiences have remained with some users, leading to a lack of confidence and interest in the rejuvenated form of OSC we see today. Thus, preconceived notions around the OSC concept may have informed a cultural gap hindering wider adoption within the UK. Third, also consistent with extant studies (Bain & Wilen, 2024), we found that despite the improvements reported in OSC usage, overall adoption is still very low. While the study's findings align with industry reports on low adoption levels, it also uncovered that adoption levels are increasing, although mostly

among industry professionals. Conversely, the level of growth reported by our study's participants is not in sync with what is reported in Hosseini et al. (2018). According to Hosseini et al. (2018), OSC usage by UK construction companies tripled between 2004 and 2006. Consistent with industry reports (Bain & Wilen, 2024; CITB, 2024a, 2024b), we found that in 2020 OSC accounted for around 7–9% of all construction industry projects (CLC, 2020). In addition, this finding implies that current efforts to market OSC have not had much result, as this level of progress is not even close to the UK government's 25% OSC usage target (Oakley, 2018). Despite the low sample size, the reported improvements indicate promising opportunities that could be maximized still further.

Finally, the following key strategies emerged for increasing OSC adoption: drawing and building on the ADKAR model; knowledge development and promotion among end users; and training for industry professionals, which should be supported by the government's regulatory and awareness capacity-building policies to drive adoption. As a first step, creating stronger awareness is a proactive measure to ensure a product's acceptance and create a line of defence against (end) users' resistance or even rejection of the concept (Dickinson & Shaver, 1982). OSC knowledge should be promoted widely and advocated for by both government and industry professionals. Clinton and Chatrath (2022) emphasize the pivotal role of product awareness and knowledge on the part of (end) users in ensuring successful market penetration. Identifying user awareness and knowledge gaps and devising ethical approaches to bridge these gaps is crucial for any product's success. Awareness promotion messages should highlight the environmental benefits of OSC adoption while countering the effect of negative historical perceptions. For a product such as OSC, which has previously suffered such perceptions and is in competition with well-established construction methodologies, rebranding and industry professional knowledge may not be enough to drive its adoption far (Ayinla et al., 2019). To establish it in the saturated construction market will require a strong marketing effort to bring it to the attention of the general public. If this is done, awareness and adoption levels will increase among users and industry professionals.

Alongside uncovering the need for promotion, the study also revealed that adequate training for industry professionals so that they are equipped to educate end users. Additionally, governments should reinforce OSC adoption through housing policies that offer incentives, such as tax reductions and green credits; these should be available not only to construction

professionals, like contractors, architects, engineers, etc., but also to all other stakeholders, including end users. This will encourage wider participation and sustained reinforcement. Moreover, bridging the awareness–adoption gap through promotion, knowledge development and government intervention through policy development will position OSC alongside other sustainable, green and eco-friendly technologies, fostering an alignment between OSC use, the attainment of Sustainable Development Goals (Hussain et al., 2014), and economic advantage. The theoretical model below summarizes the above findings.

Theoretical implications

This study's findings make two theoretical contributions to knowledge. First, while extant studies (Bendi, Rana, Arif, Goulding, & Sawhney, 2021; Chen et al., 2010; Goulding et al., 2015) confirm that a lack of awareness is limiting the broader adoption of OSC, this study extends the literature by identifying how the awareness gap among CI stakeholders serves as a boundary condition for understanding the OSC awareness and adoption gap within the UKCI. Second, the study extends the ADKAR model, a linear change model, to $ADKAR \Rightarrow A$, by uncovering how multiple stakeholders in the UKCI can use the ADKAR reinforcement to enhance OSC adoption, thus creating awareness to promote adoption (see Figure 3). This can be achieved by showcasing successful OSC projects, knowledge development and sharing information about the incentives OSC usage affords (like tax rebates and green points).

Industry implications

Goulding and Rahimian (2019) identified people, processes and technology (PPT) as integral pillars of change management, but underscored the pivotal role of people, particularly users, in the technology transition. This suggestion, which emphasizes the importance of reaching end users and enhancing their understanding of the benefits OSC offers, does not yet seem to have been adequately explored. This study thus encourages industry practitioners on OSC to shift their focus from industry professionals as driving the process and its technology to promoting OSC among the people (end users) through awareness; this is also in line with Ofori-Kuragu and Osei-Kyei's (2021) call to enhance innovation awareness within the CI among client groups. Further, the study has identified opportunities to bring this about, for example by bringing more non-professional CI stakeholders to events (workshops, conferences, expos, seminars, etc.) where OSC is

discussed. What is more, cooperation between CI leaders and government or parastatal bodies to help push the benefits of increased OSC use would also build on the progress made so far, as would the provision of tax incentives and green points.

Policy implications

The study's findings also have implications for policymakers seeking to identify strategic policy interventions to improve OSC adoption as it presents core areas where they should concentrate their efforts. The study urges OSC policymakers to explore end-user and allied professionals' perspectives for widespread adoption. Although there was a recent call in the House of Lords for scrutiny of the amount of money expended on the pursuit of OSC adoption, with a view to withdrawing that support (UK Parliament, 2024), our findings suggest this would be unwise. This is due not only to the inherent benefits associated with OSC adoption, but also a reflection of the positive improvements that have taken place in take-up of OSC, although it does not yet account for the expected figure of 25% of all construction projects. This article encourages Parliament to question the proposition that OSC research is a waste of taxpayers' money (Ridings, 2024). This study upholds the view that OSC is an excellent tool for achieving the net-zero carbon target, as it has the potential to significantly reduce the CI's carbon footprint. Therefore, it behoves the government to extend the green point advantage and other OSC-driving incentives to potential adopters of all kinds, not just to CI professionals or OSC manufacturers. The government can also incentivize academics and students to explore OSC in their research, in addition to encouraging schools and apprenticeship and training programmes to include more information about OSC in their curricula (CITB, 2024b).

Governments and stakeholders in countries with similar characteristics to the UK seeking to encourage wider adoption of OSC can also draw on these ideas to promote OSC adoption in their regions. Similarly, other regions can leverage the insights in this study to either introduce OSC or increase its adoption rate of OSC. However, the authors point out that this should be done with caution, and that the small sample size of the current study should be borne in mind.

This study's limitation lies in its focus on industry professionals majorly, its lack of end-user perspectives, as well as the small sample size, which limits generalization of the study's findings. Therefore, the authors call for an in-depth examination of OSC awareness factors among end users in order to concretise or negate this

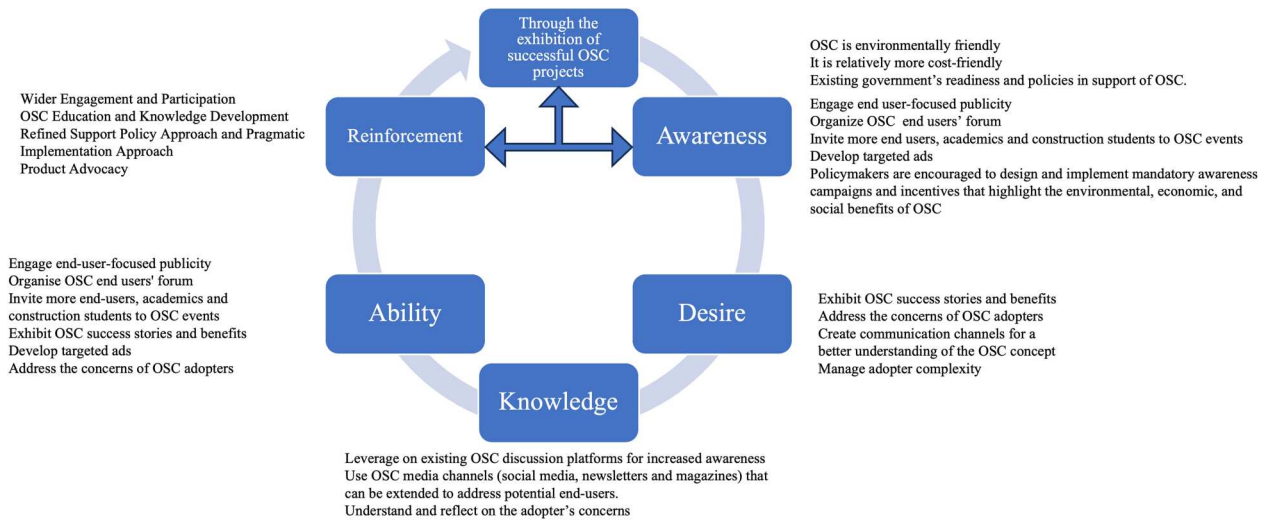


Figure 3. Proposed framework for wider OSC awareness and adoption. Source: Authors' own work, inspired by Prosci (2020).

study's claims. Additionally, exploring data on offsite construction demand among house seekers by researching diverse user groups like real estate agents, developers and housing associations, could provide more insight into customers' awareness of, and interest in, acquiring or renting OSC buildings. Such an analysis, with its broader sample size, would provide a more comprehensive understanding of OSC adoption dynamics and would have greater potential in terms of generalizing its findings beyond the UK.

Conclusions

This study's findings concur with those of earlier works, which noted that poor OSC awareness was a factor that limited its wider adoption (Moradibistouni et al., 2019). Also, the study aligns with existing research that emphasizes a lack of OSC knowledge in general (Gan, Chang, & Wen, 2018). Both of these gaps have resulted in a situation whereby the general populace, particularly potential users of OSC (Saad et al., 2024), have not been able to access the social and other benefits of its adoption: these include reduced negative environmental impacts, reduced depletion of natural resources and construction waste, increased energy efficiency and general improvements to the construction sector (Sutrisna et al., 2018). Furthermore, the study has pointed to the underlying issues that contribute to the awareness gap. The study's findings lead us to the following conclusions.

OSC awareness does exist to some extent: the level of awareness is not as low as extant reports had suggested, though the majority of it is found among CI professionals and their allied partners. It is also noted that efforts have been made to advance awareness of OSC.

However, its adoption level is still very low, though this has improved slightly in recent years. Perception is still a significant factor influencing take-up, but the level of acceptance is encouraging. Overall, the qualitative assessment reveals that the most decisive awareness factors influencing wider OSC adoption may be more external than internal (in that they largely affect end users rather than construction workers).

Despite these observed issues and encouraging benefits, the study acknowledges the need for swift action. The potential for growth exists if OSC awareness issues, particularly awareness among potential users, are promptly addressed (Osmani & O'Reilly, 2009). This study thus provides a foundation for future research on increasing OSC adoption by shedding light on the existing awareness dynamics and emphasizing the critical role of external perceptions in shaping the trajectory of OSC within the UKCI.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

Owing to ethical agreements on data usage, ongoing research works, and journal article development using interview data, the research data cannot be made public at this time; however, it is available on request.

References

- Adeagbo, D. O., & Anigbogu, N. A. (2020). *An industrialised building system approach to housing development in Nigeria*. Centre for Advanced Research & Development.

- <https://casirmediapublishing.com/2020/01/09/an-industrialised-building-system-approach-to-housing-development-in-nigeria/>
- Agapiou, A. (2021). *Increasing the prevalence of offsite construction in housing association developments: Conceptual and pragmatic challenges*. <https://doi.org/10.20944/preprints202112.0168.v1>
- Agapiou, A. (2022). Barriers to offsite construction adoption: A quantitative study among housing associations in England. *Buildings*, 12(3), 283. <https://doi.org/10.3390/buildings12030283>
- Ahmad, S., Soetanto, R., & Goodier, C. (2019). Lean approach in precast concrete component production. *Built Environment Project and Asset Management*, 9(3), 457–470. <https://doi.org/10.1108/BEPAM-02-2018-0051>
- Ajayi, S., Brinlow-Harris, J., Alaka, H., & Dauda, J. (2019). *Managing the benefits and impediments to offsite construction in the UK Construction Industry*. Proceedings of the 35th Annual ARCOM Conference, 2–4 September 2019 (pp. 577–586).
- Ajibade, P. (2018). Technology acceptance model limitations and criticisms: Exploring the practical applications and use in technology-related studies, mixed-method, and qualitative researches. *Library Philosophy and Practice (e-journal)*. 1941. <http://digitalcommons.unl.edu/libphilprac/194>. Retrieved April 29, 2025, from https://www.researchgate.net/publication/329308172_Technology_Acceptance_Model_Limitations_and_Criticisms_Exploring_the_Practical_Applications_and_Use_in_Technology-related_Studies_Mixed-method_and_Qualitative_Researches
- Akpan, I. J., Udoh, E. A. P., & Adebisi, B. (2022). Small business awareness and adoption of state-of-the-art technologies in emerging and developing markets, and lessons from the COVID-19 pandemic. *Journal of Small Business & Entrepreneurship*, 34(2), 123–140. <https://doi.org/10.1080/08276331.2020.1820185>
- Alonso-Zandari, S., & Hashemi, A. (2017). *Prefabrication in the UK housing construction industry*. pp. 347–360. ZEMCH 2016 International Conference Proceedings, 5th International Conference on Zero Energy Mass Customised Housing - ZEMCH 2016, Kuala Lumpur, Malaysia, 20–23 December 2016. http://zemch.org/zemch_conference_proceedings
- Alshammari, S., & Rosli, M. S. (2020). A review of technology acceptance models and theories. *Innovative Teaching and Learning Journal*, 4(2), 12–22.
- Amutha, D. (2016). A study of consumer awareness towards e-banking. *International Journal of Economics & Management Sciences*, 5(4), 350–353. <https://doi.org/10.4172/2162-6359.1000350>
- Andrade, C. (2021). The inconvenient truth about convenience and purposive samples. *Indian Journal of Psychological Medicine*, 43(1), 86–88. <https://doi.org/10.1177/0253717620977000>
- Arif, M., Killian, P., Goulding, J., Wood, G., & Kaushik, A. (2017). *Barriers and challenges for offsite construction in UK housing sector*. pp. 854–861. University of Salford. <http://usir.salford.ac.uk/44058/>
- Ayinla, K., Cheung, F., & Tawil, A.-R. H. (2019). Demystifying the concept of offsite manufacturing method: Towards a robust definition and classification system. *Construction Innovation*, 20(2), 223–246. <https://doi.org/10.1108/CI-07-2019-0064>
- Babalola, O., Ibem, E. O., & Ezema, I. C. (2019). Implementation of lean practices in the construction industry: A systematic review. *Building and Environment*, 148, 34–43. <https://doi.org/10.1016/j.buildenv.2018.10.051>
- Bain, D., & Wilen, A. (2024, March 11). Despite the setbacks, MMC and offsite construction are still growing [NBS]. *Construction News*. <https://www.constructionnews.co.uk/cn-intelligence/despite-the-setbacks-mmc-and-offsite-construction-are-still-growing-11-03-2024/>
- Barton, C., & Wilson, W. (2023). *Tackling the under-supply of housing in England*. <https://commonslibrary.parliament.uk/research-briefings/cbp-7671/>
- Batty, M. (1976). *Urban modelling: Algorithms, calibrations, predictions*. Cambridge University Press.
- Bell, E., Harley, B., & Bryman, A. (2022). *Business research methods*. Oxford University Press.
- Bendi, D., Rana, M. Q., Arif, M., Goulding, J. S., & Kaushik, A. K. (2021). Understanding off-site readiness in Indian construction organisations. *Construction Innovation*, 21(1), 105–122. <https://doi.org/10.1108/CI-02-2020-0016>
- Bendi, D., Rana, M. Q., Arif, M., Goulding, J. S., & Sawhney, A. (2021). An off-site construction readiness maturity model for the Indian construction sector. *Construction Innovation*, 21(1), 123–142. <https://doi.org/10.1108/CI-07-2020-0121>
- Blismas, N. G., & Dainty, A. R. J. (2003). Computer-aided qualitative data analysis: Panacea or paradox? *Building Research & Information*, 31(6), 455–463. <https://doi.org/10.1080/0961321031000108816>
- Blismas, N., & Wakefield, R. (2009). Drivers, constraints and the future of offsite manufacture in Australia. *Construction Innovation*, 9(1), 72–83. <https://doi.org/10.1108/14714170910931552>
- Bras, A., Ravijanya, C., de Sande, V. T., Riley, M., & Ralegaonkar, R. V. (2020). Sustainable and affordable pre-fab housing systems with minimal whole life energy use. *Energy and Buildings*, 220, 110030. <https://doi.org/10.1016/j.enbuild.2020.110030>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp0630a>
- Brown, T. (2024). Modern methods of construction in the housing industry. *House of Lord Library*. <https://lordslibrary.parliament.uk/modern-methods-of-construction-in-the-housing-industry/>
- Cai, J., Li, Z., Dou, Y., Li, T., & Yuan, M. (2023). Understanding adoption of high off-site construction level technologies in construction based on the TAM and TTF. *Engineering, Construction and Architectural Management*, 30(10), 4978–5006. <https://doi.org/10.1108/ECAM-05-2022-0439>
- Chen, K., & Lu, W. (2018). Design for manufacture and assembly oriented design approach to a curtain wall system: A case study of a Commercial Building in Wuhan, China. *Sustainability*, 10(7), 2211. <https://doi.org/10.3390/su10072211>
- Chen, Y., Okudan, G. E., & Riley, D. R. (2010). Sustainable performance criteria for construction method selection in concrete buildings. *Automation in*

- Construction*, 19(2), 235–244. <https://doi.org/10.1016/j.autcon.2009.10.004>
- CITB. (2019, May 3). *The impact of modern methods of construction on the skills requirements for housing—CITB* [Construction industry research reports]. Construction Industry Training Board. <https://www.citb.co.uk/about-citb/construction-industry-research-reports/search-our-construction-industry-research-reports/the-impact-of-modern-methods-of-construction-on-the-skills-requirements-for-housing/>
- CITB. (2024a, February 21). *Essential skills in construction*. <https://www.skillsbuilder.org/blog/essential-skills-in-construction>
- CITB. (2024b, May 15). *CSN Industry Outlook—2024-2028—CITB*. <https://www.citb.co.uk/about-citb/construction-industry-research-reports/construction-skills-network-csn/>
- CLC. (2020, December 8). *The construction playbook » construction leadership council*. <https://www.constructionleadershipcouncil.co.uk/news/constructionplaybook/>
- Clinton, C., & Chatrath, S. K. (2022). The value of consumer awareness and corporate social responsibility in marketing: An overview. In K. Ogunyemi & V. Bursal (Eds.), *Products for conscious consumers* (pp. 49–63). Emerald Publishing Limited. <https://doi.org/10.1108/978-1-80262-837-120221004>
- Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, 20(1), 37–46. <https://doi.org/10.1177/001316446002000104>
- Colapinto, C., Sartori, E., & Tolotti, M. (2014). Awareness, persuasion, and adoption: Enriching the Bass model. *Physica A: Statistical Mechanics and Its Applications*, 395, 1–10. <https://doi.org/10.1016/j.physa.2013.10.001>
- Creasey, T. (2020). *Applying the ADKAR model when change management is new* [Change management]. Research Institute. <https://www.prosci.com/blog/applying-the-adkar-model-when-change-management-is-new>
- Daget, Y. T., & Zhang, H. (2019). Decision-making model for the evaluation of industrialized housing systems in Ethiopia. *Engineering, Construction and Architectural Management*, 27(1), 296–320. <https://doi.org/10.1108/ECAM-05-2018-0212>
- Darlow, G., Rotimi, J. O. B., & Shahzad, W. M. (2022). Automation in New Zealand's offsite construction (OSC): A status update. *Built Environment Project and Asset Management*, 12(1), 38–52. <https://doi.org/10.1108/BEPAM-11-2020-0174>
- Dickinson, V. H., & Shaver, J. P. (1982). A test of consumer awareness for adults. *Journal of Consumer Affairs*, 16(2), 241–260. <https://doi.org/10.1111/j.1745-6606.1982.tb00174.x>
- Donaldson, T., & Preston, L. E. (1995). The stakeholder theory of the corporation: Concepts, evidence, and implications. *The Academy of Management Review*, 20(1), 65–91. <https://doi.org/10.2307/258887>
- Farmer, M. (2016). *The farmer review of the UK construction labour model – modernize or die, time to decide the industry's future*. https://learn.supplychainschool.co.uk/local/flactionplans/resource_intro.php?id=1648&modtype=url
- Feldmann, F. G., Birkel, H., & Hartmann, E. (2022). Exploring barriers towards modular construction – a developer perspective using fuzzy DEMATEL. *Journal of Cleaner Production*, 367, 133023. <https://doi.org/10.1016/j.jclepro.2022.133023>
- Flynn, D. (2023, March 1). *Why is the UK government backing MMC?*. KOPE. <https://www.kope.ai/blog/why-is-the-uk-government-backing-mmc>
- Franklin, M. (2021). *Agile change management: A practical framework for successful change planning and implementation*. Kogan Page Publishers.
- Galati, A., Moavero, P., & Crescimanno, M. (2019). Consumer awareness and acceptance of irradiated foods: The case of Italian consumers. *British Food Journal*, 121(6), 1398–1412. <https://doi.org/10.1108/BFJ-05-2018-0336>
- Gan, X., Chang, R., & Wen, T. (2018). Overcoming barriers to off-site construction through engaging stakeholders: A two-mode social network analysis. *Journal of Cleaner Production*, 201, 735–747. <https://doi.org/10.1016/j.jclepro.2018.07.299>
- Gan, X., Chang, R., Zuo, J., Wen, T., & Zillante, G. (2018). Barriers to the transition towards off-site construction in China: An interpretive structural modeling approach. *Journal of Cleaner Production*, 197, 8–18. <https://doi.org/10.1016/j.jclepro.2018.06.184>
- Garrett, H., Mackay, M., Nicol, S., Piddington, J., & Roys, M. (2021). *The cost of poor housing in England*. 16.
- Garrison, B. (2023, October 18). *Concerns-based adoption model (CBAM)* [Accelerating systematic change in STEM higher education]. Change Theories Collection. https://ascnhighered.org/ASCN/change_theories/collection/cbam.html
- Ginigaddara, B., Perera, S., Feng, Y., & Rahnamayiezekavat, P. (2022). An evaluation of offsite construction skill profiles. *Journal of Financial Management of Property and Construction*, 27(1), 16–28. <https://doi.org/10.1108/JFMPC-08-2020-0057>
- Goulding, J., Pour Rahimian, F., Arif, M., & Sharp, M. (2015). New offsite production and business models in construction: Priorities for the future research agenda. *Architectural Engineering and Design Management*, 11, 163–184. <https://doi.org/10.1080/17452007.2014.891501>
- Goulding, J., & Rahimian, F. (2019). Offsite manufacturing: Envisioning the future agenda. In J. S. Goulding, & F. P. Rahimian (Eds.), *Offsite production and manufacturing for innovative construction: People, process and technology* (pp. 1–22). Routledge.
- Gusmao Brissi, S., Debs, L., & Elwakil, E. (2021). A review on the factors affecting the use of offsite construction in multi-family housing in the United States. *Buildings*, 11(1), 5. <https://doi.org/10.3390/buildings11010005>
- Hamzeh, F., Abdul Ghani, O., Saleh Bacha, M. B., & Abbas, Y. (2017). Modular concrete construction: The differing perspectives of designers, manufacturers, and contractors in Lebanon. *Engineering, Construction and Architectural Management*, 24(6), 935–949. <https://doi.org/10.1108/ECAM-11-2014-0148>
- Harrison, J., Freeman, R., & Abreu, M. (2015). Stakeholder theory as an ethical approach to effective management: Applying the theory to multiple contexts. *Review of Business Management*, 17, 858–869. <https://doi.org/10.7819/rbgn.v17i55.2647>
- Heptonstall, I., & Jenkins, E. (2022, November 16). *Report to optimise social value in offsite construction*. Supply Chain

- Sustainability School. <https://www.supplychainschool.co.uk/offsite-social-value-report/>
- Hiatt, J. M. (2006). *ADKAR: A model for change in business, government and our community* (1st ed.). Prosci Research.
- Hines, P., Francis, M., & Found, P. (2006). Towards lean product lifecycle management: A framework for new product development. *Journal of Manufacturing Technology Management*, 17(7), 866–887. <https://doi.org/10.1108/17410380610688214>
- Hosseini, M. R., Martek, I., Zavadskas, E. K., Aibinu, A. A., Arashpour, M., & Chileshe, N. (2018). Critical evaluation of off-site construction research: A scientometric analysis. *Automation in Construction*, 87, 235–247. <https://doi.org/10.1016/j.autcon.2017.12.002>
- House of Lords. (2022). Meeting housing demand. *HL Paper* 132, 110.
- Hoyer, W., Chandy, R., Dorotic, M., Krafft, M., & Singh, S. (2010). Consumer cocreation in new product development. *Journal of Service Research*, 13(3), 283–296. <https://doi.org/10.1177/1094670510375604>
- Hussain, M., Khokhar, M., & Asad, A. (2014). Green awareness effects on consumers' purchasing decision: A case of Pakistan.
- Jaillon, L., & Poon, C. (2010). Design issues of using prefabrication in Hong Kong building construction. *Construction Management and Economics*, 28(10), 1025–1042. <https://doi.org/10.1080/01446193.2010.498481>
- Jiang, W., Huang, Z., Peng, Y., Fang, Y., & Cao, Y. (2020). Factors affecting prefabricated construction promotion in China: A structural equation modeling approach. *PLoS ONE*, 15(1), e0227787. <https://doi.org/10.1371/journal.pone.0227787>
- Jin, L., & Slowik, P. (2017, March 17). Literature review of electric vehicle consumer awareness and outreach activities. *Atlas EV Hub*. <https://www.atlasevhub.com/resource/literature-review-of-electric-vehicle-consumer-awareness-and-outreach-activities/>
- Jin, X., Ekanayake, E. M. A. C., & Shen, G. Q. P. (2022). Critical policy drivers for modular integrated construction projects in Hong Kong. *Building Research & Information*, 50(4), 467–484. <https://doi.org/10.1080/09613218.2021.2010030>
- Kale, S., & Arditi, D. (2010). Innovation diffusion modeling in the construction industry. *Journal of Construction Engineering and Management*, 136(3), 329–340. [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0000134](https://doi.org/10.1061/(ASCE)CO.1943-7862.0000134)
- Kelley, K. M., & Sánchez, E. S. (2005). Accessing and understanding consumer awareness of and potential demand for edamame. *HortScience*, 40(5), 1347–1353. <https://doi.org/10.21273/HORTSCI.40.5.1347>
- Larney, M., & van Aardt, A. M. (2010). Case study: Apparel industry waste management: A focus on recycling in South Africa. *Waste Management & Research*, 28(1), 36–43. <https://doi.org/10.1177/0734242X09338729>
- Lee, Y., Kozar, K., & Larsen, K. (2003). The technology acceptance model: Past, present, and future. *Communications of the Association for Information Systems*, 12, 752–780. <https://doi.org/10.17705/1CAIS.01250>
- Liu, Q., Ma, Y., Chen, L., Pedrycz, W., Skibniewski, M. J., & Chen, Z.-S. (2024). Artificial intelligence for production, operations and logistics management in modular construction industry: A systematic literature review. *Information Fusion*, 109, 102423. <https://doi.org/10.1016/j.inffus.2024.102423>
- London, K., & Pablo, Z. (2017). An actor–network theory approach to developing an expanded conceptualization of collaboration in industrialized building housing construction. *Construction Management and Economics*, 35(8–9), 553–577. <https://doi.org/10.1080/01446193.2017.1339361>
- Looby, K. H., Smith, S. T., & Shahrestani, M. (2022). Attitudes towards offsite prefabrication: A fuzzy approach to examining uncertainty within U.K. Industry perception. *Intelligent Buildings International*, 14(6), 738–752. <https://doi.org/10.1080/17508975.2021.2004385>
- Luo, L., Jin, X., Shen, G. Q., Wang, Y., Liang, X., Li, X., & Li, C. Z. (2020). Supply chain management for prefabricated building projects in Hong Kong. *Journal of Management in Engineering*, 36(2), 05020001. [https://doi.org/10.1061/\(ASCE\)ME.1943-5479.0000739](https://doi.org/10.1061/(ASCE)ME.1943-5479.0000739)
- Manager, T. D. P., & Lockhart, L. (2023, January 13). *Complete guide to Kanban Project Management: What to know*. The Digital Project Manager. <https://thedigitalprojectmanager.com/projects/pm-methodology/kanban-project-management/>
- Milbank Architects. (2022, June 19). *RIBA plan of work stages 2022*. <https://milbankarchitects.co.uk/riba-plan-of-work-stages-2022/>
- Miles, D. (2021). *Constraints to offsite construction in the UK*. <https://www.atamate.com/atamate-blog/constraints-to-offsite-construction-in-britain>
- Momani, A., Jamous, M., & Hilles, S. M. (2017). Technology acceptance theories: Review and classification. *International Journal of Cyber Behavior, Psychology and Learning*, 7(2), 1–14. <https://doi.org/10.4018/IJCBPL.2017040101>
- Moradibistouni, M., Vale, B., & Isaacs, N. (2019). Investigating the level of sustainability in off-site construction. In P. Ball, L. Huaccho Huatucó, R. Howlett, & R. Setchi (Eds.), *Sustainable design and manufacturing 2019* (pp. 101–110). Springer. https://doi.org/10.1007/978-981-13-9271-9_10
- Mujuka, E., Mburu, J., Ogutu, A., Ambuko, J., & Magambo, G. (2021). Consumer awareness and willingness to pay for naturally preserved solar-dried mangoes: Evidence from Nairobi, Kenya. *Journal of Agriculture and Food Research*, 5, 100188. <https://doi.org/10.1016/j.jafr.2021.100188>
- Munir, K. A. (2003). Competitive dynamics in face of technological discontinuity: A framework for action. *The Journal of High Technology Management Research*, 14(1), 93–109. [https://doi.org/10.1016/S1047-8310\(03\)00006-3](https://doi.org/10.1016/S1047-8310(03)00006-3)
- Nadim, W., & Goulding, J. (2009). Offsite production in the UK: The construction industry and academia. *Architectural Engineering and Design Management*, 5(3), 136–152. <https://doi.org/10.3763/aedm.2008.0094>
- Nadim, W., & Goulding, J. S. (2010). Offsite production in the UK: The way forward? A UK construction industry perspective. *Construction Innovation*, 10(2), 181–202. <https://doi.org/10.1108/14714171011037183>
- Ngoc Nguyen, B., London, K. A., & Zhang, P. (2020). Analysis and visualisation of stakeholder relationship in offsite construction: Social Network Analysis approach. *IOP Conference Series: Materials Science and Engineering*, 869(6), 062029. <https://doi.org/10.1088/1757-899X/869/6/062029>

- NHBC. (2016, June 1). *Modern methods of construction: Views from the industry*. NHBC. <https://www.nhbc.co.uk/foundation/modern-methods-of-construction-views-from-the-industry>
- Nyemba, W. R., Muzoroza, R. K., Chikuku, T., & Mbohwa, C. (2017, December 10–13). *Unlocking the economic value and potential of design for manufacture and assembly in a developing country for sustainability*. 2017 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), Singapore (pp. 1817–1821). IEEE. <https://doi.org/10.1109/IEEM.2017.8290205>.
- Oakley, M. (2018). *The value of off-site construction (2018 update)*. WPI Economics. oakl.
- Ofori-Kuragu, J. K., & Osei-Kyei, R. (2021). Mainstreaming pre-manufactured offsite processes in construction - are we nearly there? *Construction Innovation*, 21(4), 743–760. <https://doi.org/10.1108/CI-06-2020-0092>
- Ofori-Kuragu, J. K., Osei-Kyei, R., & Wanigarathna, N. (2022). Offsite construction methods – what we learned from the UK Housing Sector. *Infrastructures*, 7(12), 164. <https://doi.org/10.3390/infrastructures7120164>
- Osmani, M., & O'Reilly, A. (2009). Feasibility of zero carbon homes in England by 2016: A house builder's perspective. *Building and Environment*, 44(9), 1917–1924. <https://doi.org/10.1016/j.buildenv.2009.01.005>
- Pan, W., Gibb, A. G. F., & Dainty, A. R. J. (2007). Perspectives of UK housebuilders on the use of offsite modern methods of construction. *Construction Management and Economics*, 25(2), 183–194. <https://doi.org/10.1080/01446190600827058>
- Pan, W., & Sidwell, R. (2011). Demystifying the cost barriers to offsite construction in the UK. *Construction Management and Economics*, 29(11), 1081–1099. <https://doi.org/10.1080/01446193.2011.637938>
- Patton, M. Q. (2002). *Qualitative research & evaluation methods*. SAGE.
- Prosci, I. (2020). *The global leader in change management solutions*. Prosci. <https://www.prosci.com>
- Queirós, A., Almeida, F., & Faria, D. (2017). Strengths and limitations of qualitative and quantitative research methods. *European Journal of Education Studies*, 3, 369–387. <https://doi.org/10.5281/zenodo.887089>
- Ragozzino, R. (2006). Firm valuation effects of high-tech M&A: A comparison of new ventures and established firms. *The Journal of High Technology Management Research*, 17(1), 85–96. <https://doi.org/10.1016/j.hitech.2006.05.006>
- Rahimian, F. P., Goulding, J., Akintoye, A., & Kolo, S. (2017). Review of motivations, success factors, and barriers to the adoption of offsite manufacturing in Nigeria. *Procedia Engineering*, 196, 512–519. <https://doi.org/10.1016/j.proeng.2017.07.232>
- Rajanayagam, H., Poologanathan, K., Gatheeshgar, P., Varelis, G. E., Sherlock, P., Nagaratnam, B., & Hackney, P. (2021). A-State-Of-The-Art review on modular building connections. *Structures*, 34, 1903–1922. <https://doi.org/10.1016/j.istruc.2021.08.114>
- Raynor, de B. (2021, April 21). *Construction industry in the UK- Statistics & facts*. Statista. <https://www.statista.com/topics/3797/construction-industry-in-the-uk/>
- Razkenari, M., Fenner, A., Shojaei, A., Hakim, H., & Kibert, C. (2020). Perceptions of offsite construction in the United States: An investigation of current practices. *Journal of Building Engineering*, 29, 101138. <https://doi.org/10.1016/j.jobe.2019.101138>
- Ridings, J. (2024, January 26). 'Throwing money' at MMC has not worked, Lords inquiry concludes. *Inside Housing*. <https://www.insidehousing.co.uk/news/simply-throwing-money-at-mmc-has-not-worked-lords-inquiry-concludes-84849>
- Robichaud, L. B., & Anantatmula, V. S. (2011). Greening project management practices for sustainable construction. *Journal of Management in Engineering*, 27(1), 48–57. [https://doi.org/10.1061/\(ASCE\)ME.1943-5479.0000030](https://doi.org/10.1061/(ASCE)ME.1943-5479.0000030)
- Saad, A. M., Dulaimi, M., Arogundade, S., Zulu, S. L., & Gorse, C. (2024). Modern methods of construction (MMC) and innovation negativism in the UK public sector. *Built Environment Project and Asset Management*, 14(2), 147–163. <https://doi.org/10.1108/bepam-06-2023-0108>
- Saunders, B., Kitzinger, J., & Kitzinger, C. (2015). Anonymising interview data: Challenges and compromise in practice. *Qualitative Research*, 15(5), 616–632. <https://doi.org/10.1177/1468794114550439>
- Saunders, M., Lewis, P., & Thornhill, A. (2023). *Research methods for business students*. Pearson Education, Limited. <http://ebookcentral.proquest.com/lib/herts/detail.action?docID=7219451>
- Schoenborn, J. (2012). *A case study approach to identifying the constraints and barriers to design innovation for modular construction* [thesis]. Virginia Tech. <https://vtechworks.lib.vt.edu/handle/10919/32397>
- Shaikh, A. A., Alharthi, M. D., & Alamoudi, H. O. (2020). Examining key drivers of consumer experience with (non-financial) digital services – an exploratory study. *Journal of Retailing and Consumer Services*, 55, 102073. <https://doi.org/10.1016/j.jretconser.2020.102073>
- Shang, G., Jin, R., & Lu, W. (2020). Design for manufacture and assembly in construction: A review. *Building Research & Information*, 48(5), 538–550. <https://doi.org/10.1080/09613218.2019.1660608>
- Shang, G., Pheng, L., & Gina, O. (2021). Understanding the low adoption of prefabrication prefabricated volumetric construction (PPVC) among SMEs in Singapore: From a change management perspective. *International Journal of Building Pathology and Adaptation*, 39(5), 685–701. <https://doi.org/10.1108/IJBPA-08-2020-0070>
- Steinhardt, D., & Manley, K. (2016). Adoption of prefabricated housing – the role of country context. *Sustainable Cities and Society*, 22, 126–135. <https://doi.org/10.1016/j.scs.2016.02.008>
- Stephen, E. (2024, August 2). *How microsoft uses the ADKAR model to improve customer success*. Change Management. <https://www.prosci.com/blog/how-microsoft-uses-the-adkar-model-to-improve-customer-success>
- Sutrisna, M., Ramanayaka, C. D. D., & Goulding, J. S. (2018). Developing work breakdown structure matrix for managing offsite construction projects. *Architectural Engineering and Design Management*, 14(5), 381–397. <https://doi.org/10.1080/17452007.2018.1477728>
- Tavares, V., Gregory, J., Kirchain, R., & Freire, F. (2021). What is the potential for prefabricated buildings to decrease costs and contribute to meeting EU

- environmental targets? *Building and Environment*, 206, 108382. <https://doi.org/10.1016/j.buildenv.2021.108382>
- Taylor, M. D. (2010). A definition and valuation of the UK offsite construction sector. *Construction Management and Economics*, 28(8), 885–896. <https://doi.org/10.1080/01446193.2010.480976>
- Thomas, P. (2006). [Review of review of the prefabricated home, by C. Davies]. *AA Files*, 53, 85–87. <https://www.jstor.org/stable/29544826>
- UK Parliament. (2019). *Modern methods of construction inquiry – Committees – UK Parliament*. <https://committees.parliament.uk/work/1939/modern-methods-of-construction-inquiry/>
- UK Parliament. (2024, January 26). *MMC sector may continue to struggle without a fresh approach from the Government – Committees – UK Parliament* [Committees]. UK Parliament. <https://committees.parliament.uk/committee/518/built-environment-committee/news/199612/mmc-sector-may-continue-to-struggle-without-a-fresh-approach-from-the-government/>
- Williams, M. D., Rana, N. P., & Dwivedi, Y. K. (2015). The unified theory of acceptance and use of technology (UTAUT): A literature review. *Journal of Enterprise Information Management*, 28(3), 443–488. <https://doi.org/10.1108/JEIM-09-2014-0088>
- Williams, M., Rana, N., Dwivedi, Y., & Lal, B. (2011, June 9–11). *Is UTAUT really used or just cited for the sake of it? A systematic review of citations of UTAUT's originating article*. 19th European Conference on Information Systems, ECIS 2011, Helsinki, Finland. <https://aisel.aisnet.org/ecis2011/231>
- Wuni, I., & Shen, G. (2020). Critical success factors for management of the early stages of prefabricated prefinished volumetric construction project life cycle. *Engineering, Construction and Architectural Management*, 27(9), 2315–2333. <https://doi.org/10.1108/ECAM-10-2019-0534>
- Wuni, I. Y. (2022). Mapping the barriers to circular economy adoption in the construction industry: A systematic review, Pareto analysis, and mitigation strategy map. *Building and Environment*, 223, 109453. <https://doi.org/10.1016/j.buildenv.2022.109453>
- Wuni, I. Y., & Shen, G. Q. (2020a). Barriers to the adoption of modular integrated construction: Systematic review and meta-analysis, integrated conceptual framework, and strategies. *Journal of Cleaner Production*, 249, 119347. <https://doi.org/10.1016/j.jclepro.2019.119347>
- Wuni, I. Y., & Shen, G. Q. (2020b). Critical success factors for modular integrated construction projects: A review. *Building Research & Information*, 48(7), 763–784. <https://doi.org/10.1080/09613218.2019.1669009>
- Wuni, I. Y., & Shen, G. Q. (2022). Towards a decision support for modular integrated construction: An integrative review of the primary decision-making actors. *International Journal of Construction Management*, 22(5), 929–948. <https://doi.org/10.1080/15623599.2019.1668633>
- Wuni, I. Y., Shen, G. Q., & Osei-Kyei, R. (2022). Quantitative evaluation and ranking of the critical success factors for modular integrated construction projects. *International Journal of Construction Management*, 22(11), 2108–2120. <https://doi.org/10.1080/15623599.2020.1766190>
- Wuni, I. Y., & Shen, G. Q. P. (2019). Holistic review and conceptual framework for the drivers of offsite construction: A total interpretive structural modelling approach. *Buildings*, 9(5), 117. <https://doi.org/10.3390/buildings9050117>
- Wusu, G. E., Alaka, H., Yusuf, W., Mporas, I., Toriola-Coker, L., & Oseghale, R. (2024). A machine learning approach for predicting critical factors determining adoption of offsite construction in Nigeria. *Smart and Sustainable Built Environment*, 13(6), 1408–1433. <https://doi.org/10.1108/SASBE-06-2022-0113>
- Yin, R. K. (2015). *Qualitative research from start to finish*. Guilford publications. https://books.google.com/books?hl=en&lr=&id=DvpPCgAAQBAJ&oi=fnd&pg=PP1&dq=info:oC0sroLkaMIJ:scholar.google.com&ots=HW6ioUhk-W&sig=0mlzl78YZmO5W8lGm_A95X7U1aw
- Young, B. E., Seidu, R. D., Thayaparan, M., & Appiah-Kubi, J. (2020, April 17). *Modular Construction Innovation in the UK: The case of residential buildings*. The 10th Annual Industrial Engineering and Operations Management (IEOM) Conference, Dubai. <http://ieomsociety.org/ieom2020/proceedings-full-papers/>
- Zhai, Y., Fu, Y., Xu, G., & Huang, G. (2019). Multi-period hedging and coordination in a prefabricated construction supply chain. *International Journal of Production Research*, 57(7), 1949–1971. <https://doi.org/10.1080/00207543.2018.1512765>
- Zhai, Y., Zhong, R. Y., & Huang, G. Q. (2018). Buffer space hedging and coordination in prefabricated construction supply chain management. *International Journal of Production Economics*, 200, 192–206. <https://doi.org/10.1016/j.ijpe.2018.03.014>
- Zhai, Y., Zhong, R. Y., Li, Z., & Huang, G. (2017). Production lead-time hedging and coordination in prefabricated construction supply chain management. *International Journal of Production Research*, 55(14), 3984–4002. <https://doi.org/10.1080/00207543.2016.1231432>
- Zhang, R., Zhou, S., Alexander, T., Khademasadi, S., & Whyte, J. (2019). Long-standing themes and new developments in offsite construction: The case of UK housing. *Proceedings of the Institution of Civil Engineers - Civil Engineering*, 172(6), 29–35. <https://doi.org/10.1680/jcien.19.00011>
- Zhou, J., Tam, V. W. Y., & Qin, Y. (2018). Gaps between awareness and activities on green construction in China: A perspective of on-site personnel. *Sustainability*, 10(7), 2266. <https://doi.org/10.3390/su10072266>