

## **Closing the Housing Gap in the UK: A Preliminary Study of Using the Offsite Construction Approach on Brownfield Site.**

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### **Abstract**

The housing shortage in the UK has remained a prevalent and pressing issue, prompting a need for innovative and sustainable solutions. One contributing factor to this is limited availability of land, including brownfields sites. The offsite construction (OSC) approach has been recognized as a viable and eco-friendly solution to addressing the issue, yet its potential on brownfield site (BFS) remains largely unexplored. Prior research of literature suggested that integrating OSC on brownfield site has the capacity to support housing supply, while addressing some of the challenges of developing on BFS. A focus group discussion was conducted to establish industry opinion on the factors militating against the wide adoption of OSC approach on BFS for housing development despite the promises both concepts hold to support sustainable housing delivery. The study found that the UK government actively promotes BFS redevelopments and OSC approach to achieve sustainability goals, protect the greenbelt, and mitigate the housing crisis through policy and financial instruments. The study further grouped the findings of adopting OSC approach on BFS under process, human impact and sustainability. The result contributes to the literature by promoting the integration of OSC approach and BFS development and offer valuable insights for policymakers on the efficiency and effectiveness of government support instruments in relation to OSC and BFS for sustainable housing solutions.

### **Keywords**

Brownfield site regeneration, offsite construction approach, process, UK housing.

### **1. Introduction**

The existence of housing crisis in the UK has been alarming in government reports. Reporting figures continually shows annual undersupply against set targets, consequently resulting in years of accumulated housing deficit (Office of National Statistics, 2023; Wilson & Barton, 2023). Amongst the several factors fostering housing undersupply are land availability and method of construction (Broun, 2022; Daniel et al., 2023). To these, the UK government have sustainably addressed by encouraging residential construction on brownfield site (BFS) and promoting the adoption of modern method of construction (MMC) of which offsite construction (OSC) approach is a subset (Gov. UK-DLUHC, 2022; UK Gov-MHCLG, 2020). According to Okeyinka et al., (2023), brownfield sites are derelict or under-utilized portions of land previously developed which may or may not be contaminated from previous use. While offsite construction approach is defined as the construction process which involves the manufacture of building components in the factory (offsite), and subsequently assembled on site (Ofori-Kuragu et al., 2022).

Prior studies on BFS for housing provision have focused more on diverse constraints, opportunities, affordability and gentrification occurring in BFS developed host communities (Gibilaro & Mattarocci, 2023; Squires & Hutchison, 2021). Some of the challenges of developing BFS are laws and planning policies (Charlson, 2018; Leger et al., 2016), poor market conditions, cost of remediation, lack of data, and environmental regulatory issues (Charlson, 2021; Hutchison & Disberry, 2015), the presence of underground infrastructure such as gas or water pipes, site accessibility constraints, and disturbance of remediated soil from onsite construction activities (Glumac & Decoville, 2020; Nuthanapati et al., 2019). Although OSC approach has been proposed as a potential solution to address some of these challenges based on its benefits (Elnaas et al., 2014; Ofori-Kuragu & Hill, 2021), trends of studies on OSC approach have shown integration between OSC and other sustainability concepts such as lean

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construction, circular economy and waste management (Li et al., 2022; Liu et al., 2019) but no studies have investigated this gap of adopting OSC approach on BFS for housing development.

Therefore, the aim of this study is to conduct a preliminary investigation into the feasibility of delivering houses on BFS using the OSC approach. More specifically, this paper addresses two primary questions within the UK context which are: (1) what are the expected benefits and barriers militating against the adoption of OSC approach on BFS in the UK? (2) what is the UK government's position in promoting OSC and BFS development for housing supply? Adopting the qualitative research methodology, the result adds to the scarce literature on implementing OSC approach on BFS for housing delivery and provides valuable insight for policymakers, developers, and communities seeking sustainable housing solutions.

### **2.0 Overview of Offsite Construction Approach and Brownfield Sites for Housing Delivery**

The sustainability movement has led to extensive research and innovations in OSC and BFS (Kibert, 2016). Since the adoption of OSC on BFS are being considered for housing delivery, this section shall consider a synopsis of previous study on both subject area and the governments contribution.

#### **2.1 The adoption of offsite construction approach on brownfield sites for housing delivery**

Development of BFS for housing delivery presents both opportunities and challenges. An opportunity identified by Cianfarani et al., (2023) and Cizler, (2013) is the potential for BFS redevelopment to mitigate climate change activities as development on greenbelt is reduced and the compact development of urban centers is enhanced. BFS redevelopment tend to increase the market value of properties within its neighborhood and encourage gentrification which tend to boost economic activities (Gibilaro & Mattarocci, 2023; Nur et al., 2021). Derelict buildings which may be hideouts for criminal activities are exterminated (England, 2023).

Despite the opportunities, developing brownfield site is a complex process, time consuming, expensive process and mostly requiring government intervention at various phases especially for remediation cost and land ownership issues (Green, 2018; Pizzol et al., 2016; Sun et al., 2022). Although, Rey et al., (2022) expressed a contrary opinion on cost with the claim that brownfield development is delayed by decontamination process less than it is on financial, Squires & Hutchison, (2021) and Glumac & Decoville, (2020), insists that cost is a major turnoff in brownfield development for housing delivery. Other challenges identified that mitigates against BFS development for housing are taxation, perception, disturbances to biodiversity, among more (Elnaas et al., 2014; Glumac & Decoville, 2020; Squires & Hutchison, 2021). However, for successful development of BFS, it is paramount to recognize the peculiarity of individual sites and handle related issues as such within the context of occurrence (Daniel et al., 2023), therefore, the need to explore industry opinion of the challenges of BFS development on the basis of related projects executed by selected professionals within the UK is a necessary success factor.

Addressing the challenges of developing BFS from literature, Glumac and Decoville, (2020), and Nuthanapati et al., (2019) suggested that methodological approaches be considered as measures. The methodological approach accentuated by Ofori-Kuragu & Hill, (2021) and Assaad et al., (2023) is the OSC approach, based on the capacity of OSC approach to overcome some challenges of BFS such as long project duration, disturbance to remediated site, and difficulty to access and navigate the site. The possibility of this measure is in the capacity of OSC approach to adapt to peculiar constraining site conditions, commence manufacturing of building components in the factory while site remediation is ongoing to save time, fewer workers on site and less onsite activities (Gao et al., 2020; Ofori-Kuragu & Hill, 2021).

Several studies have been conducted to harness the opportunities OSC approach offers by integrating OSC with various sustainability ideas. Liu et al., (2019) and Li et al., (2022) analyzed over 100 articles each on research trends to explore this ideology, while the former highlighted 50 concepts integration trends, the latter discovered 55 topic areas some of which are OSC and lean construction, circular economy, waste management amongst others, yet none of their studied trends considered any form of relationship in integrating OSC approach with BFS development. Thus, exposing the scarce information in research on OSC and BFS implementation despite the promises integrating both concepts holds in enhancing sustainability and housing delivery. Therefore, this study justifies the knowledge gap identified, and contributes to increasing knowledge on adopting OSC approach and BFS development for housing delivery.

#### **2.2 The Government's role in advancing offsite construction approach and brownfield site development**

Amongst the key schemes launched by the UK government to drive growth and development in the construction industry is the "Construction 2025" initiative (HM Government, 2013) and the "Construction Sector Deal" (HM Government, 2018). Each recognizes OSC approach as an innovation to enhance productivity, reduce waste and

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minimize environmental impact. Though some militating factors against these schemes have been exposed by Dziekonski et al., (2023), the government has not wavered in its support and commitment to OSC approach (Charlson, 2022), rather it has established a collaborative regional framework for knowledge exchange through the creation of offsite HUB in Scotland (Hairstans & Smith, 2018). Grants and loans are financial instruments initiated by the government to advance OSC approach in housing development (Broun, 2022). Reviewing the UK government's position through the lens of advanced OSC user countries such as Sweden, Japan, USA, Germany, Singapore, China and Canada, it is observed that the unified drivers for transformation from traditional construction to OSC are government coercive policies, regulations, and incentives (Oti-Sarpong et al., 2022). The justification for the proactiveness of these countries stems from the benefits derivable from OSC. Some of which are quicker construction, better quality, ability to incorporate sustainable features, the use of ecofriendly materials, reduction in waste, less disturbance to soil, overall reduction in building cost when economy of scale is achieved, and the ability to incorporate life cycle planning (Ofori-Kuragu and Hill, 2021; Assaad et al., 2023).

Similar strategies and initiatives have also developed over the years for brownfield regeneration. Year 2017, saw the establishment of the Brownfield Land Release Funds aimed to support the remediation and regeneration of brownfield lands owned by the local authorities to encourage accelerated housing development on brownfield sites (Wessendorff, 2017). Also, policies are in place to aid the development of houses on brownfield site (National Planning Policy Framework, 2023), though, emerging critic is the disharmony between policies across different local authorities and councils, consequently posing challenges in BFS development for housing delivery (Hutchison & Disberry, 2015; Leger et al., 2016). Considering the government's commitment to independently promote OSC approach and BFS for housing development, integrating both concepts holds the promise to support the governments sustainability goals through efficient housing supply and simultaneously addressing multiple policy objectives.

### 3. Research Methodology.

This study adopted the qualitative research methodology to seek industry position on the needed insights for this preliminary investigation. Qualitative research according to Hennink, Hutter and Bailey (2020), is an approach that allows examination of people's experience using a set of research methods such as interviews, case studies, focus group discussion among others. The interview and case studies are more demanding and cumbersome, compared to the focus group which offers the advantage of bringing experts together from similar industry and experience to discuss topics of unified interest (Omar, 2018). Though related studies on housing development on brownfields predominantly adopt review of government documents, reports and archival case studies as other qualitative data collection approaches, (Hutchison and Disberry, 2015; Leger, Balch and Essex, 2016b; Charlson, 2021), the focus group has the advantage of providing an avenue for participants to directly learn from counterparts during discussion while also networking (Doody, Slevin and Taggart, 2013).

#### 3.1 Data Collection

Adopting the Nyumba et al., (2018) and Omar, (2018) steps to focus group discussion technique, this research design commenced with the development of the list of questions to be discussed based on the research objectives. Invitations were sent to participatory company's representatives detailing the venue of the discussion for the meeting. All participants gave consents to participate in the focus group meeting and the aim of the session was explained to the participants in the invitation.

The purposive sampling method employed was based on selecting participants knowledgeable in the topic of discussion, participants expertise to match the objectives of the study, and the availability of the participants (Omar, 2018; Campbell et al., 2020). The participants are not a representative of the entire industry population rather, a sample focused on the topic of discussion, hence, a limitation to generalizing the results from this study. However, more diversity of participants expertise, will capture a broader range of experience and perspective, as such will further strengthen the findings from purposive sampling (Rabiee, 2004). The sample size was determined by the number of attendees, nonetheless, 25% above the required number of invitations were sent out to prevent issues around not meeting the required audience (Nyumba et al., 2018).

Information on the demography of respondents is detailed in table 1 below. The focus group meeting started with setting duration, familiarizing with the questions and appointment of a moderator from among the participants while the researcher acted as the assistant moderator. Appointing a moderator according to Nyumba et al., (2018) from amongst the participants help to build trust, to allow for genuine answer in course of discussion, while the researcher acting in the capacity of an assistant moderator observes non-verbal reaction and ensure all the questions were dully discussed. Knowing that this appointment could exposed the focus group discussion to bias of steering the discussion towards the moderator's interest area and the moderator giving preferential attention to certain participants, this bias

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was minimized with the development of interview questions to keep discussions within the study objective and prior meeting was held between the researcher and the moderator before commencement of the focus group discussion to ensure strict adherence to interview protocol. The researcher as the assistant moderator also asked follow-up questions, which helped to minimize every form of bias. The meeting lasted for a period of one hour. The participants were professionals within the built environment who have been involved in housing development through planning to completion stage. This means they are experienced with both policy documents, planning regulations and actual post contract construction process on site. The highest years of experience of the participant in the focus group is 47years. This means a wealth of experience through years of learning and re-learning of strategies in the built environment. The mix of participant's position is an advantage to this research as responses were given based on their areas of trade and department within the industry. Guided discussions continued until saturation point was reached and participants began to entertain unrelated discussions outside subject area, (Uquhart, 2013), hence an end to the focus group discussion.

Table 1: Respondents Demography

S/No	Position of participants within organization	Code	Years of industry experience (Range)
1	Business Development Managers in Construction	P01	15years
2	Business Development Managers in Construction	P02	2years
3	Business Development Managers in Construction	P03	1year
4	Business Owners in Construction	P04	4years
5	Business Owners in Construction	P05	10years
6	Associate Director Building	P06	25years
7	Planner	P07	10years
8	Researcher in Built Environment	P08	6years
9	Researcher in Built Environment (Geologist)	P09	20years
10	Researcher in Built Environment	P10	14 Years
11	Sales Manager in Modular/Passivhaus	P11	Above 7years
12	Consultant in Built Environment	P12	47years
13	Retrofit Officer	P13	8 years
14	Lecturer in Built Environment	P14	20years
Total Number		14	

### 3.2 Data Analysis

The qualitative analytical technique suitable to analyze the focus group data according to Doody, Slevin and Taggart, (2013) are: comparison analysis, classical content analysis, keywords-in-context analysis and discourse analysis. While the comparison analysis compares information between two or more focus groups discussion, the classical content analysis looks out for similarities in information between two or more focus groups. The keyword-in-context contextualizes the use of words central to the development of themes and the analysis can be between groups, within groups of intra-member analysis. Keyword-in-context has the advantage of analyzing results for single focus group discussion and emerging themes are managed within the context of the research objective. Lastly, the discourse analysis tries to understand social interaction and cognition through a study of daily communication of participants. This study adopted the keyword-in-context data analysis based on the assumption that participants responses to questions are influenced by their peculiar project experience, organizational culture and structure, including visions, goals, aspirations, and positions occupied within the organization. In addition, only a single focus group discussion meeting was held. The limitation in analyzing and reporting focus group discussion through keyword-in-context is the loss and overlook of other salient non-verbal and contextual cues resulting from extreme emphasis on words and their usage by participants, and researchers own bias in interpreting the context and meaning of words (Doody, Slevin and Taggart, 2013; Onwuegbuzie et al., 2009; Krippendorff, 2019). Minimizing this limitation, the research questions for the focus group discussion employed the semi-structured format to allow broad discussion on area of concern, and in reporting the findings, direct quotation of some respondent's statement were included to authenticate the results of this study. Overall, the lack of clarity by most users in the method adopted for data analysis is often-highlighted a disadvantage with the focus group discussion, as a result, only a limited number of literatures are able to mention prior study using a comparable strategy (Wibeck & Naset, 2020).

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Typical example when contextualizing keywords during the analysis, of opinion on how government can better promote the adoption of OSC approach and BFS for housing development, *respondent P01 mentioned streamlining the permit application process to save time, respondent P05 mentioned employing more staff to speed up application approval process, while participant P13 mentioned the need to improve policy timeline guiding approval process.* The key words-in- context under these three responses is timely approval of permit documents from the relevant authorities.

**4. Discussion of Results**

This section discusses the results from the analysis of the focus group under the following context: the benefits and challenges of adopting OSC approach on BFS development for housing delivery, and the government’s role in promoting OSC approach and BFS for housing development.

**4.1 Benefits and challenges of adopting the implementation of OSC approach on BFS for housing delivery.**

Adopting OSC approach on BFS is a welcome innovation appreciated by participants, as they mentioned their prospects for this strategy to boost housing delivery. Nevertheless, there are challenges militating against the adoption. Figure 1 below outlines the responses in three themes: process, human impact and sustainability.

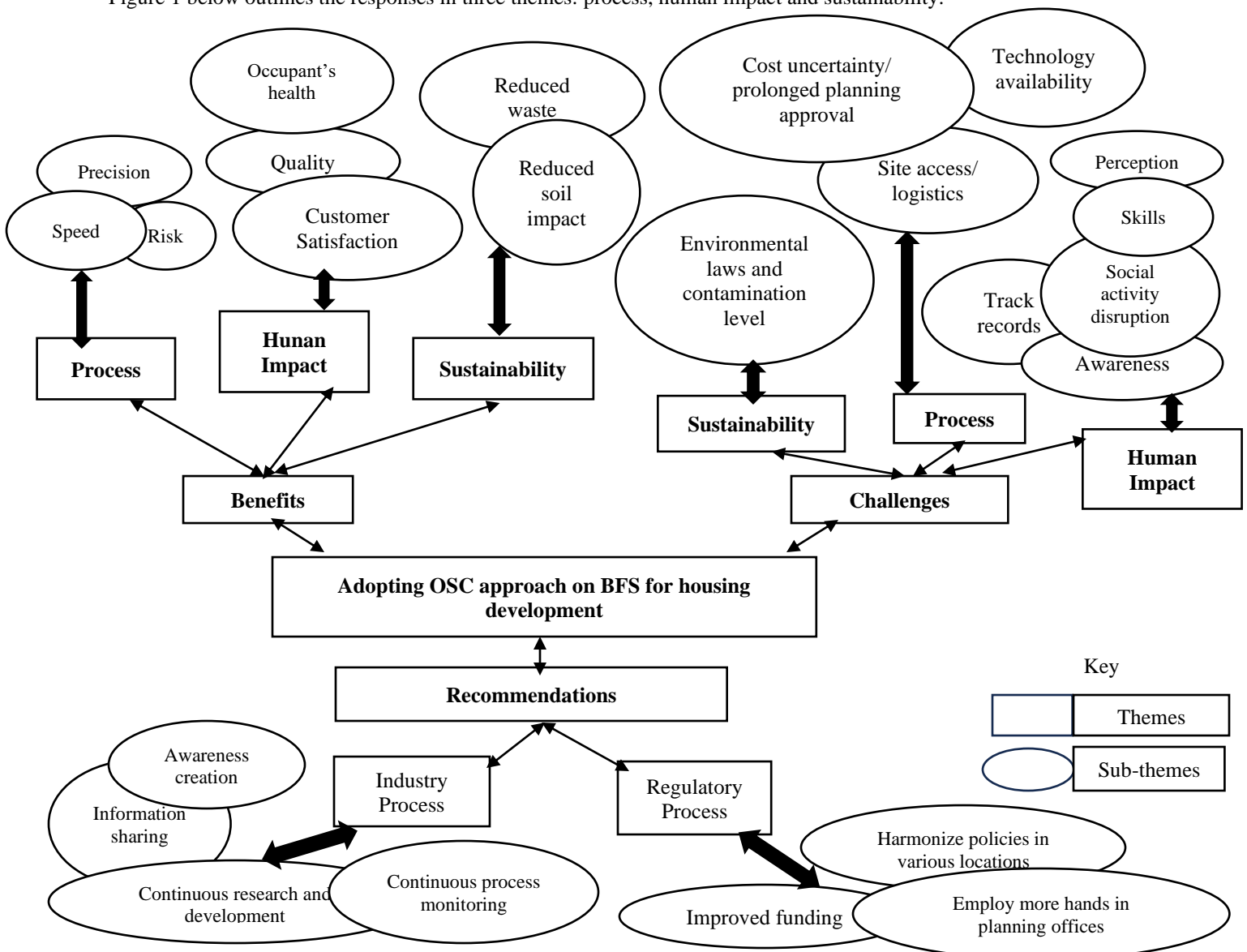


Figure 1: Benefits, challenges, and recommendations in adopting OSC approach on BFS for housing development.

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### 4.1.1 Benefits and challenges during the PROCESS of adopting the implementation of OSC approach on BFS

Certain benefits are achieved during the offsite construction process, these benefits are outlined in the subtheme as: precision in dimension of building components, speed of construction, and reduced exposure of workers to risky task and elements. The challenges identified under the process are cost uncertainty, difficulty in logistics during transportation of building components, difficulty in site accessibility, inadequate technology, and prolonged bureaucratic planning approval process. Some respondent's statements on these benefits are:

Respondent P11 on benefits, ... *"most of our customers are satisfied with the speed of construction using our offsite method .... machines do most of the cuttings as such measurements are always accurate, so we don't have a lot of waste from offcut "....*

Respondent P05 on challenges, " *...in schedule, you must allow extra time for permit approval... the number of workers in the planning offices are not enough to get the permit out timely..."*.

The speed of construction using OSC approach can offset the prolonged time spent in decontamination of BFS, and obtaining all necessary development approval permits, hence, supporting quicker housing delivery amongst other benefits (Assaad et al., 2023; Glumac & Decoville, 2020).

### 4.1.2 Benefits and challenges of HUMAN IMPACT on adopting the implementation of OSC approach on BFS

The benefits with direct human impact are, better quality houses with energy efficiency, better occupant's health resulting from better living environment with good air quality, and customer satisfaction. While the direct challenges impacting human are, know-how in terms of skills, social activity disruption during construction activities, perception around buildings not bearing required cultural looks, no proven successful track records of similar innovation, and lack of awareness about this approach. Some of the statements from respondents are:

Respondent P11 mentioned as quoted on benefits, "*...our clients identified their satisfaction in the temperature of the rooms, and insignificant heat escape is experienced, the conditioned temperature remains for a long time...."*

Respondent P09 mentioned as quoted on challenges, "*...this OSC is still new to construction, a lot of clients are not aware of it, .... neither do we have a lot of people who are skilled in the implementation of OSC on BFS"*.

These direct human impact benefits according to Ofori-Kuragu, Osei-Kyei and Wanigarathna, (2022), can be achieved based on the strategic OSC approach adopted. This is so because OSC approach is flexible and can be adjusted to address various site conditions and meet varying client's needs, subsequently resulting in overall client satisfaction, while at the same time, addressing some BFS development challenges.

### 4.1.3 Benefits and challenges of SUSTAINABILITY in adopting the implementation of OSC approach on BFS

OSC approach and BFS were both classed as forms of sustainability practices in housing provision by the respondents. The expected sustainability related benefits achievable from integrating both concepts are waste reduction, and minimal impact on soil. Since most activities are carried out in factories, fewer activities are witnessed onsite with less disturbance to the decontaminated BFS.

On challenges, inadequate information of contamination type and level, and varying environmental laws in various locations and local councils are identified as long-term concerns. The implication of the challenge of different regulations, laws and policies at various local councils as identified by Charlson, (2018), Leger, Balch and Essex, (2016), and respondents, are likely to affect standardization of implementation schemes and processes expected to guide OSC approach on BFS for housing delivery.

## 4.2 The UK government's role on promoting OSC approach and BFS development for housing delivery

Participants were asked to outline how the government policies and incentives encourage OSC approach and development of housing on BFS.

Respondent P03 mentioned as quoted, '*our company is aided by the UK government to provide financial support to people who wish to develop on brownfield site. The government will bear a certain percentage of the decontamination cost to lessen the burden on the developer'*.

Although this information came in new and handy to some of the participants in the focus group, it reinforces the advantage, that participants tend to benefit from information shared during focus group discussion (Doody et al., 2013; Omar, 2018). Other responses are:

Respondent P07 stated that, '*The government has halted housing development on greenfield, I hope this will reserve our green land for the future generation as the UK hasn't got enough forest left and the biodiversity needs preserved"*.

Respondent P12 also added that "*the net zero drive by the government is helping the overall planning systems and more investment in OSC will help in achieving this, but regulations need to be amended to allow stronger drive for sustainability'*.

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The major tools used by the UK government to encourage development of housing on BFS, and overall adoption of OSC approach as a modern method of construction are policies and finance in form of incentives, which are similar tools employed by other advanced OSC user countries (Oti-Sarpong et al., 2022). However, the lagging factor is the level of coerciveness adopted by the UK government.

A summary of recommendations by the participants outlined are, the need for government to relax and harmonize planning regulations, the government should be the highest promoter of OSC approach by ensuring that all public sector projects procurement on BFS adopts OSC approach. Furthermore, policies should be improved to support developers and manufacturers of OSC components used on BFS for housing delivery, and tax relief be granted to developers and manufacturers adopting OSC approach. Finally, the process of obtaining planning permits should be streamlined to reduce time spent in obtaining approval, and BFS host communities should get better benefits from corporate social responsibility to promote support for the concepts.

## 5. Conclusions

This study sorts a preliminary insight into the viability of implementing OSC on BFS development for housing delivery by investigating the benefits and challenges in adopting OSC on BFS, together with an exposition of the UK government position in promoting OSC and BFS for housing delivery. It found some benefits and challenges which were classified into three themes namely, process, human impact and sustainability. Recommendations for mitigating some of the challenges were further grouped into two themes which are industry process and regulatory process.

On government position, this study found that the UK government is stern on promoting housing development on BFS to protect the greenbelt. To this end, policies and incentives are the government's instrument used. Creating awareness of the availability of financial aid is required to enable stakeholder's benefit.

This paper contributes to the body of literature by recognizing the impediments and benefits in integrating OSC and BFS development for housing. Both BFS and OSC approach exist as separate bodies of knowledge and this study has integrated and contextualized both concepts within the UK setting. The findings from this study could inform policy by highlighting the need for better accessibility and awareness of financial instruments available for stakeholder's benefits, and the need for a more effective evidence-based policy to further promote sustainable housing delivery on BFS, while enhancing the adoption of OSC approach within the construction industry.

The data used in this study emanated from focus group discussions; additional variables to enhance the implementation of OSC on BFS for housing delivery might be found through interviews and case studies. Despite being specific to the UK, countries with interest could adopt this study as a basis for preliminary information towards successful BFS regeneration for housing delivery.

## References

- Assaad, R., El-adaway, I. H., Hastak, M., & LaScola Needy, K. (2023). Opportunities and Challenges of Offsite Construction. *Lecture Notes in Civil Engineering*, 251, 555–568. [https://doi.org/10.1007/978-981-19-1029-6\\_42](https://doi.org/10.1007/978-981-19-1029-6_42)
- Broun, J. (2022). *Greener, Better, Faster the UK Government's Modern Methods of Construction (MMC) Policies and Strategies*.
- Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D., & Walker, K. (2020). Purposive sampling: complex or simple? Research case examples. *Journal of Research in Nursing*, 25(8), 652–661. <https://doi.org/10.1177/1744987120927206>
- Charlson, J. (2018). Regeneration of brownfield land: the environmental law challenges. *Journal of Property, Planning and Environmental Law*, 10(3), 202–218. <https://doi.org/10.1108/JPEL-12-2017-0038>
- Charlson, J. (2021). The Introduction of Brownfield Land Registers in England. *Planning Practice and Research*, 36(2), 216–229. <https://doi.org/10.1080/02697459.2020.1859213>
- Charlson, J. (2022). Briefing: UK public sector infrastructure and construction strategy, policies and vision. *Proceedings of Institution of Civil Engineers: Management, Procurement and Law*, 176(1), 3–5. <https://doi.org/10.1680/jmapl.22.00040>
- Cianfarani, F., Abdelkarim, M., Richards, D., & Kedarisetty, R. K. (2023). Assessing the Urban Vacant Land Potential for Infill Housing: A Case Study in Oklahoma City, USA. *Urban Science*, 7(4). <https://doi.org/10.3390/urbansci7040101>
- Cizler, J. (2013). Brownfield redevelopment as a measure for climate changes mitigation. *Journal of the Geographical Institute Jovan Cvijic, SASA*, 63(4), 57–73. <https://doi.org/10.2298/ijgi1304057c>

## 2.

- Daniel, E. I., Oshodi, O., Dabara, D., & Dimka, N. (2023). Towards closing the housing gap in the UK: exploration of the influencing factors and the way forward. *Construction Innovation*. <https://doi.org/10.1108/CI-06-2022-0148>
- Doody, O., Slevin, E., & Taggart, L. (2013). Focus group interview's part 3: Analysis. *British Journal of Nursing*, 22(5), 266–269. <https://doi.org/10.12968/bjon.2013.22.5.266>
- Dziekonski, K., Mascarenhas, F., Mahamadu, A. M., & Manu, P. (2023). Investigation into the key barriers to achieving UK “Construction 2025” Strategy targets. *Engineering Management in Production and Services*, 15(4), 116–127. <https://doi.org/10.2478/emj-2023-0032>
- Elnaas, H., Gidado, K., & Ashton, P. (2014). Factors and Drivers Effecting the Decision of Using Off-Site Manufacturing (OSM) Systems in House Building Industry. *Journal of Engineering, Project, and Production Management*, 4(1), 51–58. <https://doi.org/10.32738/JEPPM.201401.0006>
- England, H. (2023). *The Housing and Regeneration Agency Homes England-Measuring Social Value Paper 2: Brownfield Development Values*. [www.sqw.co.uk](http://www.sqw.co.uk)
- Gao, S., Jin, R., & Lu, W. (2020). Design for manufacture and assembly in construction: a review. *Building Research and Information*, 48(5), 538–550. <https://doi.org/10.1080/09613218.2019.1660608>
- Gibilaro, L., & Mattarocci, G. (2023). Financing Brownfield Redevelopment and Housing Market Dynamics: Evidence from Connecticut. *Buildings*, 13(11). <https://doi.org/10.3390/buildings13112791>
- Glumac, B., & Decoville, A. (2020). Brownfield Redevelopment Challenges: A Luxembourg Example. *Journal of Urban Planning and Development*, 146(2). [https://doi.org/10.1061/\(asce\)up.1943-5444.0000565](https://doi.org/10.1061/(asce)up.1943-5444.0000565)
- Gov. UK-DLUHC. (2022). Land Use Statistics: England 2022. *Department for Levelling up, Housing and Communities*.
- Green, T. L. (2018). Evaluating predictors for brownfield redevelopment. *Land Use Policy*, 73, 299–319. <https://doi.org/10.1016/j.landusepol.2018.01.008>
- Hairstans, R., & Smith, R. E. (2018). Offsite HUB (Scotland): establishing a collaborative regional framework for knowledge exchange in the UK. *Architectural Engineering and Design Management*, 14(1–2), 60–77. <https://doi.org/10.1080/17452007.2017.1314858>
- HM Government. (2013). *Construction 2025*.
- HM Government. (2018). *Industrial Strategy Construction Sector Deal*.
- Hutchison, N., & Disberry, A. (2015). Market forces or institutional factors: what hinders housing development on brownfield land? *Journal of European Real Estate Research*, 8(3), 285–304. <https://doi.org/10.1108/JERER-07-2015-0029>.
- Kibert, C.J., (2016). *Sustainable Construction: Green Building Design and Delivery*. 5<sup>th</sup> Ed. New Jersey, John Wiley & Sons Inc.
- Krippendorff, K., (2019). *Content Analysis: An Introduction to its Methodology*. 4<sup>th</sup> Ed. London, Sage Publications Inc.
- Leger, C., Balch, C., & Essex, S. (2016). Understanding the Planning Challenges of Brownfield Development in Coastal Urban Areas of England. *Planning Practice and Research*, 31(2), 119–131. <https://doi.org/10.1080/02697459.2016.1146428>
- Li, L., Luan, H., Yin, ; Xianfei, Asce, A. M., Dou, Y., Yuan, M., & Li, Z. (2022). *State-of-the-Art Review Understanding Sustainability in Off-Site Construction Management: State of the Art and Future Directions*. [https://doi.org/10.1061/\(ASCE\)CO.1943](https://doi.org/10.1061/(ASCE)CO.1943)
- Liu, G., Nzige, J. H., & Li, K. (2019). Trending topics and themes in offsite construction (OSC) research: The application of topic modelling. In *Construction Innovation* (Vol. 19, Issue 3, pp. 343–366). Emerald Group Holdings Ltd. <https://doi.org/10.1108/CI-03-2018-0013>
- National Planning Policy Framework*. (2023). [www.gov.uk/dluhc](http://www.gov.uk/dluhc)
- Nur, Z. Z., Nurul, H. A. M., & Nurul, L. I. (2021). *Brownfield Sites and Property Market Sensitivity* (Vol. 19).
- Nuthanapati, S., Adel, K., Al Awadhi, I., & Gas Processing, A. (2019). *SPE-197858-MS Civil Engineering Challenges in Brownfield Projects-A Case Study*.
- Nyumba, O. T., Wilson, K., Derrick, C. J., & Mukherjee, N. (2018). The use of focus group discussion methodology: Insights from two decades of application in conservation. *Methods in Ecology and Evolution*, 9(1), 20–32. <https://doi.org/10.1111/2041-210X.12860>
- Office of National Statistics. (2023). *House building data, UK financial year ending March 2022*.
- Ofori-Kuragu, J. K., & Hill, R. (2021). *An Exploration of the Potential for Using Modular Housing Solutions to Address the UK's Housing Shortage*. <https://www.researchgate.net/publication/358711883>



- Ofori-Kuragu, J. K., Osei-Kyei, R., & Wanigarathna, N. (2022). Offsite Construction Methods—What We Learned from the UK Housing Sector. In *Infrastructures* (Vol. 7, Issue 12). MDPI. <https://doi.org/10.3390/infrastructures7120164>
- Okeyinka, O. M., Khan, R., Pathirage, C., Mahammedi, C. E. D., & West, A. (2023). A Critical Review of Developers' Decision Criteria for Brownfield Regeneration: Development of the BRIC Index. *Sustainability (Switzerland)*, *15*(9). <https://doi.org/10.3390/su15097105>
- Omar, D. (2018). Focus group discussion in built environment qualitative research practice. *IOP Conference Series: Earth and Environmental Science*, *117*(1). <https://doi.org/10.1088/1755-1315/117/1/012050>
- Onwuegbuzie, A. J., Dickinson, W. B., Leech, N. L., & Zoran, A. G. (2009). *A Qualitative Framework for Collecting and Analyzing Data in Focus Group Research*.
- Oti-Sarpong, K., Shojaei, R. S., Dakhli, Z., Burgess, G., & Zaki, M. (2022). How countries achieve greater use of offsite manufacturing to build new housing: Identifying typologies through institutional theory. *Sustainable Cities and Society*, *76*. <https://doi.org/10.1016/j.scs.2021.103403>
- Pizzol, L., Zabeo, A., Klusáček, P., Giubilato, E., Critto, A., Frantál, B., Martinát, S., Kunc, J., Osman, R., & Bartke, S. (2016). Timbre Brownfield Prioritization Tool to support effective brownfield regeneration. *Journal of Environmental Management*, *166*, 178–192. <https://doi.org/10.1016/j.jenvman.2015.09.030>
- Rabiee, F. (2004). Focus-group interview and data analysis. *Proceedings of the Nutrition Society*, *63*(4), 655–660. <https://doi.org/10.1079/pns2004399>
- Rey, E., Laprise, M., & Lufkin, S. (2022). Urban Brownfield Regeneration Projects: Complexities and Issues. In *Urban Book Series*. [https://doi.org/10.1007/978-3-030-82208-8\\_4](https://doi.org/10.1007/978-3-030-82208-8_4)
- Squires, G., & Hutchison, N. (2021). Barriers to affordable housing on brownfield sites. *Land Use Policy*, *102*. <https://doi.org/10.1016/j.landusepol.2020.105276>
- Sun, Y., Li, H., Lei, S., Semple, K. T., Coulon, F., Hu, Q., Gao, J., Guo, G., Gu, Q., & Jones, K. C. (2022). Redevelopment of urban brownfield sites in China: Motivation, history, policies and improved management. In *Eco-Environment and Health* (Vol. 1, Issue 2, pp. 63–72). Elsevier B.V. <https://doi.org/10.1016/j.eehl.2022.04.005>
- UK Gov-MHCLG. (2020). *MODERN METHODS OF CONSTRUCTION*.
- Urquhart, C., (2013). *Grounded Theory for Qualitative Research: A Practical Guide*. London. Sage Publications Ltd.
- Wessendorff, O. (2017). *Local Authority Land Release Fund*.
- Wibeck, V., & Neset, T. S. (2020). Focus groups and serious gaming in climate change communication research—A methodological review. In *Wiley Interdisciplinary Reviews: Climate Change* (Vol. 11, Issue 5). Wiley-Blackwell. <https://doi.org/10.1002/wcc.664>
- Wilson, W., & Barton, C. (2023). *Tackling the under-supply of housing in England*.