RESEARCH SUMMARY

Drivers, barriers and enablers: construction sector views on vertical extensions

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Buildings and construction are responsible for around 38% of global greenhouse gas (GHG) emissions, making decarbonisation of the construction sector essential in combatting climate change. Limiting resource consumption and waste generation by transitioning to a circular economy (CE) is key to reducing emissions.

The adaptive reuse of existing buildings, such as through their vertical extension, is one of the most effective ways this can be done.

Introduction

The paper summarized here investigates construction sector professionals' current awareness, uptake and experience of vertical extensions, as well as the key drivers, barriers and enablers affecting implementation. It does so via a survey and follow-up interviews.

Economic factors are revealed to be the primary driver for extension projects, though case-by-case variability results in commercial risk in some instances. Other barriers include difficulty appraising existing structures, resistance within the construction sector and unfavourable tax regimes.

Mandatory whole-life carbon assessments and adjustment of tax regimes are recommended to increase uptake of vertical extensions, as well as enhanced education of engineers and greater consideration of CE amongst stakeholders.

Cover image shows the timber vertical extension at the Old Gramophone Works, London
Image courtesy of Studio RHE/Wood Wards

Rooftop extension at the Arding & Hobbs building, London Image courtesy of Stiff + Trevllion/ Wood Awards

Embodied carbon currently makes up 18% of the whole life emissions of buildings in the UK, with this expected to grow to 38% by 2030. Despite this, embodied carbon remains unregulated in the UK. Embodied carbon can be reduced by transition to a circular economy (CE), which minimizes the linear flow of materials by retaining them at their highest level of usefulness, for as long as possible.

Adapting and reusing buildings – rather than demolishing and replacing them – is one of the most effective CE strategies. Vertical extension refers to the adaptation of an existing building through the addition of new storeys, realizing the embodied carbon savings of building reuse whilst also gener-ating new useable floorspace.

In England, there is a streamlined permitted development (PD) planning route for certain extension types. Despite this, and notwithstanding the numerous cases seen in the UK to date, uptake remains limited.

Aims and scope of the paper

The primary aim of the study summarized here is thus to identify the key drivers, barriers and enablers of vertical extension, and how these compare with those of other sustainable construction practices.

This paper yields new insights on drivers, barriers and enablers of vertical extension. The conducted survey and interviews also, for the first time, assess stakeholders' awareness,

Vertical extension at the Technique Building, London. Image courtesy of Heyne Tillett Steel/ Wood Awards

uptake and experiences of this construction technique.

Overview of extant research and literature

The main drivers of vertical extension identified in the literature that this report examined are environmental and economic, including carbon and CE benefits, and the ability to maximize refurbishment potential and thus asset value.

Potential for reduced project costs and programme are also noted,as well as the relaxation of planning requirements for some extension types.

Applying life cycle profit and carbon analyses to six case studies in Sweden, Sundling et al. (*A development process for extending buildings vertically – based on a case study of four extended buildings, Construction Innovation, 19*, 2019) showed vertical extensions to have the lowest environmental impact and highest return on investment.

The Swedish authors also highlighted the ability of vertical extensions to finance environmental retrofit and increase the density of urban areas without enlarging their footprint.

In terms of barriers, work by J. Pattison (*Vertical extensions: technical challenges and carbon impact, The Structural Engineer, 99*, 2021) considers technical challenges of vertical extensions using first-hand experience and hypothetical case studies.

The barriers identified are solely from a structural engineering perspective and include issues associated with increases in design loads; the reuse of foundations; structural appraisals; intrusive investigations; and structural robustness and fire.

Through consideration of real-world case studies, Sundling et al. identify a limited number of non-structural yet-still-technical barriers to vertical extension.

These include site constraints (e.g. working at height and disruption to surrounding buildings) and the installation of building services. This work also outlines the need for further researchon the barriers and enablers of vertical extensions and acknowledges the ine￿cacy of case studies in identifying non-technical factors.

Conclusion and recommendations

The ability of vertical extension to increase the value of buildings is revealed to be its primary driver at present.

The interviewees revealed that the primary drivers of vertical extensions are economic. This is generally rooted in a desire to increase asset value and the potential to do so at a reduced cost. Possible savings are identified in the avoidance of land costs, a typically reduced material requirement and potential for a reduced programme in comparison with demolition and new build projects.

Although the majority of survey respondents believed that material costs will be lower for vertical extension schemes, there was disagreement regarding the influence of total project costs, with some believing this to be an enabler and barrier respectively. Despite being recognized by the majority of interviewees, embodied carbon savings were consistently viewed as a secondary benefit.

Despite this, high case-by-case variability and deficiencies in the costing of uncertainties result in an uncertain and unfavourable business case in some instances. This can create a barrier in the form of commercial risk, which is worsened by current tax regimes and conservativity of the construction sector. Although widely acknowledged, environmental benefits are viewed as a secondary benefit of vertical extension at present.

Technical considerations such as the justification of reserve capacity, working within spatial constraints and unavailability of design information are identified amongst the most inhibitive barriers to vertical extensions.

This is not perceived to be an indication of technical infeasibility, however, with these barriers suggested to result from the inexperience of engineers, clients' unwillingness to compromise and limited consideration of future reuse in new build design.

In addition to the above suggestions for potential future

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research, four overarching recommendations are made based upon the findings of this study:

1. The content of undergraduate civil and structural engineering courses should be reviewed to ensure the appraisal of existing structures is adequately addressed. This would serve to combat the neglect of this reported by interviewees and thus the resultant disparity in engineers' ability to design for reuse. Such a review of course content is consistent with the Joint Board of Moderators' recognition of the need to increase focus on the climate crisis in civil and structural engineering degrees (Joint Board of Moderators, 2021).

2. VAT rates for refurbishments should be aligned with those for new build projects across all use types. This would provide a financial incentive for vertical extensions, countering the effects of project uncertainty. Improving the business case in this way would serve to allay concerns regarding commercial risk and mitigate the economic barrier this represents.

As well as vertical extensions, realignment of VAT rates would serve to enhance the uptake of adaptive building reuse more generally.

3. Whole-life carbon assessments should be made mandatory for all construction projects. This would serve to more clearly articulate the embodied carbon savings associated with building reuse and elevate this from a secondary benefit to a primary driver of vertical extension. Building upon this with sequential benchmark targets and regulatory limits would further promote vertical extension, forcing clients to consider building reuse and encouraging associated design compromise.

4. Encouraging greater consideration of CE by all stakeholders is suggested as a final means of enhancing the uptake of vertical extension.

This would counter the presently limited consideration of future reuse in the design and construction of new buildings, as well as the resultant barriers of poor availability of original design data and reduced technical feasibility.

In addition to encouraging key CE strategies such as design for adaptability and longevity, and the proficient storage, management and transfer of design data, this would serve to promote the benefits of CE more widely.

This may also enhance clients' willingness to compromise on perceived design requirements and provide consultants, architects, engineers and contractors with greater grounds on which to challenge their brief. More widespread integration of CE considerations in local authority planning requirements is suggested as one way in which this enhanced engagement may be achieved.

*The entire paper may be read in full **here***