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Adoption of unconventional approaches in construction: The case of cross-laminated timber

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HIGHLIGHTS

- Presents a case study exploring the adoption of novel construction materials.
- Applies a behavioural model to assess barriers to adoption.
- Locked-in actors lack the commercial opportunity to adopt new techniques.
- Lock-in limits the opportunity for those motivated to specify.
- Specific project contexts can align participants' interests allowing specification.

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ABSTRACT

Achieving sustainable development requires the decoupling of economic growth from the use of non-renewable resources. This depends on industry adopting unconventional approaches to production. This research explores the root causes of barriers to the adoption of such approaches in the construction industry, and applies a behavioural model to assess whether companies are hindered by capability, opportunity or motivation.

The long history of lowest-cost tendering in construction has led to a path-dependent lock-in to conventional market-driven objectives of cost and risk reduction; it is suggested that locked-in companies lack the commercial opportunity and hence motivation, rather than the capability, to adopt approaches perceived to increase cost or risk. Such companies will therefore tend to resist unconventional approaches, restricting the physical opportunity for other project participants. This theory is explored in a case study of first adoptions of cross-laminated timber (CLT) in UK projects, using a survey and series of semi-structured interviews.

The case study found that project contexts created market niches. This provided designers, who were motivated to use CLT, the opportunity to promote its use in the project. CLT was seen as key to successful resolution of project constraints, thereby providing motivation to other project participants to adopt the material.

1. Introduction

The global population is projected to grow to around 9.6 billion people by 2050, from approximately 7.2 billion today [1]. With this increase in population, and with each person having a legitimate aspiration for a comfortable lifestyle, the demand for homes, goods, energy and food is expected to increase. Unless economic growth can be decoupled from the use of non-renewable resources, this will, in turn, lead to increasing risks to the future supply of non-renewable resources [2,3].

The construction industry is the most resource intensive industry sector in the global economy. It is therefore exposed to the risks posed by resource scarcity, as well as changes in the availability and prices of globally traded commodities. Reducing the intensity of resource use in construction is, therefore, important for increasing industrial and economic resilience [4].

A shift to more resource efficient construction will require the adoption of novel techniques and behaviours by a traditionally conservative industry. Prior work by other researchers shows that

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attempts to introduce such approaches are often met with resistance (e.g. [5–12]). In particular, Giesekam et al. [13] undertook a meta-study of 1154 academic publications exploring barriers to the adoption of novel technologies. They analysed reported barriers under four headings – knowledge & perception; technical and performance related; economic; and institutional and habitual. Each of these types of barrier points to areas of focus and solutions that might help to reduce barriers to adoption. There is little corresponding recent work exploring the conditions under which such barriers are overcome.

However, prior work in the field of evidence-based practice has shown that interventions to change actor behaviour are more likely to be effective if they target causal determinants of behaviour [14] rather than such manifestations. Accordingly, this research aims to: increase the understanding of the systemic causes of the reported barriers in the construction industry; analyse how these systemic causes influence the adoption of unconventional approaches to construction; explore the contexts under which unconventional materials have been adopted as construction solutions; and propose further areas for study through which these barriers might be overcome.

This research project adopts a critical realist epistemology. Critical realism accepts the realist position that there is an underlying truth that can be described, but holds that attempts to describe that reality are fallible [64]. Critical realist methodologies assume that individuals display bias in responses, and triangulation of responses is encouraged.

The context dependent nature of construction projects means that quantitative approaches alone might be inadequate to identify and reflect the nuances of decision-making around materials. Accordingly, a mixed method approach was adopted to help build a deeper understanding of the problem context. Data was gathered in three phases: a literature review preceded an industry survey into cross-laminated timber (CLT) use. This was followed by a series of in-depth semi-structured interviews, which were analysed using thematic analysis.

As this work is explorative, more positivist, experimental approaches were considered inappropriate. The opportunity for more detailed case study of adoption was limited by the limited time available for the research.

The following section explores the commercial causal determinants of barriers to adoption of unconventional approaches, before Section 3 introduces a model for behaviour change, which provides a framework to analyse these causes. Sections 4–6 describe a case study of material adoption in the construction industry, which explores behavioural aspects of successful adoptions of CLT.

2. Commercial factors as the source of barriers to adoption of unconventional approaches in construction

2.1. Building purpose and value drivers

Buildings are developed for a purpose: to satisfy a need or to move towards some objective. Improvements in pursuit of these objectives add value to the client and are termed value drivers. This value may be financial, but need not necessarily be directly so [15]. For example, a new building may be procured to improve an organization's productivity. One way to achieve this increase in productivity is by improving the working environment [16]. As this increase in productivity is considered important to the client, more emphasis might then be placed on how design and construction decisions positively affect the working environment. This objective may well come into conflict with others, such as that of developing a building with low construction or operating costs.

The delivery of a construction project involves many actors, each with their own notions as to what drives value. When attempting to encourage construction project participants to approach the project differently, it is important to understand what their organizational value drivers are, and how they arose, as this can affect decision-making. The next section explores the conventional objectives of contracting businesses in the construction industry.

2.2. Avoidance of risk to commercial outcomes

The efficiency of the UK stock market means that listed companies that underperform compared to market expectations are at risk of their shares being sold [17,18]. This can lead to a fall in share prices, which, in turn, can make raising finance more difficult and increases the risk of takeover of those companies [19]. Conversely, exceeding market expectations leads to a raised share price, reduced risk of takeover and easier access to finance.

Market expectations of performance are described by a rate of return (profitability) on an asset, such as shares. This expectation is set by the trade-off between risk and return for a given asset, described by the Capital Asset Pricing Model (CAPM) [20]. Broadly, the higher the risk inherent in a share, the higher the required or expected returns. The CAPM model, despite some limitations, is widely used in the finance industry because of its simplicity, and is taught in introductory texts on investment appraisal [21].

For a given asset base, there are, therefore, two broad ways of improving market perception of a company and hence to increase share prices: to deliver lower than expected risk, or higher than expected returns. Historically, in the absence of concerns over resource depletion or global warming, delivering improvements in these areas were the primary conventional objectives of companies listed on the stock exchange. This has important implications for company processes and policies:

- profits need to be maintained (or grown) to fund a constant (or increasing) dividend per share [22];
- certainty of outcome is valued in the delivery of those dividends; and
- risk exposure should be reduced where possible for a given return.

Further, input prices – wages, materials, rents – are likely to be rising through inflation. Therefore, the maintenance of constant or increasing profits requires that either income increases at a rate higher than the rate of increase in costs, or that costs fall for a given level of income.

However, the standard approach to letting out construction contracts, lowest cost tendering, limits the opportunities for companies to increase income for a given contract. This lowest tender approach encourages a reliance on the adoption of enhancements to existing, tested products and processes (incremental improvements) over unconventional approaches to reduce costs or risk. Incremental improvements are preferred as they are based on a technology that is better understood and carries a more certain cost and risk profile [23]. As Mahapatra & Gustavsson explain, 'most market actors prefer to further develop or use existing technology' [9]. Through the need to match the bids of listed companies, unlisted contractors are then indirectly exposed to the same cost pressures.

2.3. Path-dependency and lock-in

Organizations develop know-how when working with construction materials. This confers market advantages by reducing future costs and uncertainty. Companies are, therefore, likely to