UNIVERSITY OF CAMBRIDGE

Transforming construction: impact case study

Benefits to industry: better understanding of risk perception of OSM; health and safety; improved safety performance

Safety performance implications of construction using offsite manufactured products: A study of risk perception and behaviour

Opportunity for innovation

The government's Infrastructure and Projects Authority's document *Transforming Infrastructure Performance*, published in December 2017, sets out changes to the way infrastructure is planned, procured and delivered to transform the productivity of the sector and benefit the wider economy. The drive towards modern methods of construction brings further focus to off-site manufacturing which was favoured in the Autumn Budget (2017) as an example of construction innovation. Digital technology and innovation will be the route to delivering and extracting maximum whole life value from infrastructure. The Industrial Strategy White Paper (2017) stated that five government departments have committed to adopt a presumption in favour of off-site construction by 2019 across suitable capital programmes.

In recent years there has been increased interest in off-site manufacturing (OSM) which, as well as offering innovation, is widely acknowledged to reduce on-site time for workers and the potential for site-based accidents and ill health.

Addressing risk

OSM construction removes a number of high frequency, low severity risks from the construction site, and replaces them with fewer, low frequency, but potentially high severity risks. Studies suggest that these risks should be easier to identify and control despite little evidence to the case; a lack of workplace studies linking construction risk perception and risk taking behaviour presents a better understanding of how individuals on site form their views on the risk faced, how they assess and identify the risk, and what assumptions they make before deciding how to act.

The approach

This research aims to investigate how risk perception of workers towards OSM affects safety performance. A qualitative research approach was applied to a cause-and-effect relationship (between perception of OSM risk and safety performance) causal case study using embedded units comprising two Laing O'Rourke concrete framed construction projects. Data collection involved twelve semi-

structured interviews with frontline workers on these two projects. Secondary data from observation and document reviews supported the interviews by way of triangulation. Content analysis was carried out using a constant comparative method. The secondary data collection included reviewing project documents relevant to the use of OSM, project safety records, and reflecting on project observations. This research explores the subject of risk perception within the construction environment with the intention of understanding its value in supporting improved safety performance.

The case study

The context for this study of risk perception and safety performance was provided by Laing O'Rourke, which specialises in an OSM approach to projects. The focus was on two embedded units. Project 1 was a shell and core structure delivered by a LOR subsidiary which delivered five connected 8-9 storey concrete frames within central London for a residential development. Project 2 was delivered wholly by LOR and comprised three towers of 23, 15 and 18 storeys respectively within a mixed development. Both projects had been operating for 12 months each and the study took place at the busiest parts of the programme.

Participants were site workers who predominately worked installing OSM products from one of three stakeholder groups; operatives, supervisors and site engineers. This focused the study towards experienced workers, rather than those with little knowledge of OSM products. The population size was 50. Primary data was collected through in-depth interviews to understand motivations for behaviour. The data from the interviews were coded with open, axial, and selective/theoretical codes using an inductive approach.

Advantages of OSM

Safety benefits of OSM have been identified as lessening of work at height, a reduction in noise and work in confined spaces, a reduction in congested work and greater control of factory works. Health benefits identified include reduced exposure to wet products and less reliance on labour intensive work; robotic machinery able to replicate manual handling tasks within the factory. Previous research highlights that use of off site production (OSP) means 'off-task' activities are reduced and that within an OSM project accidents are more likely to occur 'on task'.

Concerns for use of OSM

While the advantages of using OSM are persuasive, there are accompanying challenges. Supervisors tolerating habitual departures from rules and poor supervision has been connected with many accidents. In a construction culture that prioritises production, the question must be asked whether the ability to install quicker through prefabrication distracts from safe behaviour rather than necessarily directly supporting it. Are the changes that OSM brings to the workforce recognised and is training and capabilities appropriate for managing this risk?

Perceived risk and adjusted behaviour

Findings demonstrate that working with OSM products is seen as both undemanding physically and mentally. In the eyes of the worker, it's safer than in-situ construction. Although OSM construction demands strict process adherence to maintain safety, it is suggested that this need is incompatible with project constraints. Workers will act unsafely because the system allows it; limited training in technical risks, inconsistently applied controls, and repetition of errors in supply mean that workers feel flexibility is crucial to meet demanding schedules. Workers adjust their behaviour to balance out these constraints because the perceived risk is simply not big enough for them to think twice, and because they perceive the risk they are taking is both normal and acceptable.

This shows that the change to OSP greatly reduces site housekeeping hazards, and therefore off-task risks, but conversely increases the risk of tasks at hand, most of which have significant consequences due to the size of the components being moved. The relationship of the supervisor to the operative or the manager to the supervisor is critical for decision making on site.

Recommendations

As the research only focuses on a very specific case study, there may be concerns regarding the ability to generalise from the results. However, the study is not seeking to identify new theory, but to relate findings to existing theories enabling wider generalisation.

Construction using OSM is a positive step forward, bringing structured process to an industry which is historically inefficient. However, applying OSM to a construction site changes much more than the method of construction; it affects the responsibilities of individuals, it affects the types of risks which are prevalent, and it changes the workplace from one associated with minor injuries, to one with the potential for catastrophic disasters.

As the study can do little to challenge the increased pressure that workers feel OSM construction sometimes creates, recommendations are made to improve the accuracy of risk assessment, and to challenge risk acceptability by increasing consistency of delivery. Risk perception must be considered fundamental within safety planning. Through ignoring how risk is framed and communicated, and by inconsistently applying controls, serious accidents with OSM are not unlikely, but inevitable. This research provides knowledge regarding the safe use of OSM, and challenges the perspective that OSM is lower risk than traditional construction, instead taking the perspective that it is different risk and should be analysed as such.

Benefits

Through understanding what their employees think about risk, companies can understand how employees make decisions and target communications accordingly and more effectively.

The Laing O'Rourke Centre for Construction Engineering and Technology, in the University of Cambridge Department of Engineering, was launched in 2011 with industry partner Laing O'Rourke to fulfil a shared vision of transforming the construction industry through innovation, education and technology. The Construction Engineering Masters (CEM) degree programme is designed to shape the next generation of industry leaders and undertake innovative research projects that deliver value to industry.

Case study

This case study is based upon a Laing O'Rourke Centre for Construction Engineering and Technology Construction Engineering Masters dissertation titled: *Safety performance implications of construction using offsite manufactured products: A study of risk perception and behaviour* (2015). The research is by Martin Pike, currently Senior Construction Engineer at Mace.

Further details

For more details about this case study contact:
Centre Manager
Laing O'Rourke Centre for Construction Engineering Technology
Department of Engineering
University of Cambridge
Tel: +(44(0)1223 332812
Email: centre.manager@construction.cam.ac.uk
Website: www.construction.cam.ac.uk