ARTIFICIAL PROBLEMS WITH ARTIFICIAL SOLUTIONS? EXPLORING THE ROBUSTNESS OF USE CASES WITHIN AI-FOCUSED CONSTRUCTION MANAGEMENT RESEARCH

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Artificial Intelligence (AI) is a rapidly growing focus of construction management research. Various government strategies, research and innovation funders, and industry reports express the tremendous potential that AI is perceived to offer for this domain. While these perceptions may ultimately be proved correct, it is also likely that the current expectations for AI are based largely on technological optimism and deterministic trends that presume value prior to empirical validation. Therefore, this work analyses the body of AI research for construction management, using a purposive sample of the ARCOM abstracts database, with a focus on use case explication. Findings revealed only 56% of the sample papers contained any type of use case, the majority of which were superficial and drew on generalisations of efficiency and accuracy counterpointed with human subjectivity. Some use cases identified lacked contextual justification, which in the case of predictive AI for planning and scheduling diluted the use case arguments made therein. The lack of robust use cases within the body of research was concerning, thus suggestions are made for ways in which researchers can ensure their work is robust and valid rather than simply conforming to the dominant technocratic orthodoxy of our time.

Keywords: artificial intelligence; technology; use case; workers

CONTEXT

Artificial Intelligence (AI) has pushed itself to the forefront of the Industry 4.0 Revolution. With the ability to hold dominion over the nascent technological landscape, AI is able to bring together myriad different applications through the internet of things (IoT), perform human functions with far greater speed, accuracy and efficiency, and indeed take on tasks that humans could simply never achieve due to the sheer volume of data or the numbers of different factors or variables involved (i.e., Big Data). The pace and scope of such technological developments, described as 'exponential' by Brynjolfsson and McAfee (2014), shows few signs of slowing down.

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With the potential to influence (and, seemingly, always enhance) almost all aspects of human endeavour, it is therefore unsurprising that the construction sector, long criticised for poor performance, a lack of predictability and over-reliance on manual labour (Farmer 2016), has rushed towards technology, and AI, as the solution to all its ills (Sherratt *et al.,* 2020).

However, this sprint towards adoption, loudly cheered on by construction firms, governments, research funders (Green 2022) and, not coincidentally, the technology developers and providers themselves, is not without concern. Other factors are at play, not least the inevitable influence of Ellul's (1954) theory of Technique through which our expectations and understandings of what is acceptable and desirable about technologies are shaped. Through Technique, the rapid and unquestioned adoption of technology, in all forms, is positioned as the only appropriate direction for progress, the only logical step to take - if only because we can, with little to no consideration as to whether we should (Sherratt 2022a). Challenges against such technocratic determinism become moot as implementation is surely inevitable because without it, optimum efficiencies could not be achieved. Technology is often ascribed with a neutrality that it arguably does not deserve, and we should be far more wary of its power to influence and shape its own manifestations. How technology, through Ellul's theory of Technique, weaves its twin cloaks of technological optimism and determinism has previously been discussed in depth by Sherratt *et al. (*2020; 2022a; 2024) and so is not repeated here.

However, the consequences of Technique are arguably evident enough, and the body of research surrounding technology within construction management has seemingly become enthralled; technological optimism and determinism abound (Sherratt 2022a). Construction management researchers, like everyone else in the world, are not immune to Technique. For example, considerable hyperbole surrounds the use and benefits of wearable technologies for construction safety: 'It is time construction… strongly embraced these emerging trends in technological development to drastically enhance safety performance.' (Awolusi *et al.,* 2018:104). Yet following a granular analysis of the peer-reviewed body of work on the use of wearable technologies for safety management, the case for implementation, '…could generously be considered 'limited'…. [and is] nowhere near able to make claims of effectiveness in the field…' (Sherratt 2024). Thus, it is based on little to no empirical evidence that we are urged, as an industry to 'strongly embrace' technology to 'drastically enhance' safety on construction sites. This is Technique writ large.

There are however remedies to this situation, and ways to seek to counter the influence of Technique within research of technology. In this paper, we specifically focus on AI and the research of its applications to construction management, because of its pervasive nature. To justify such research (and we use the term 'research' deliberately here to indicate an appropriate testing/validatory step taken prior to implementation) a clear rationale should be provided as to the benefits it is expected to bring. Research usually must justify itself in this way, to not only secure funding but also quite rightly to meet the requirements of ethical approval processes intended to avoid spurious research or wasted time and resources. With regards to AI, such justification can be most readily made through a 'use case'; a description of sequences of events that lead to a system doing something useful (Bittner and Spence 2003). We consider a 'good' use case to not only include consideration of the specific context in which the application of AI is explicitly situated, and thus the reasons and rationale for such application, but to also make clear evaluations of any human involvement, such as whether the AI is able to perform a task better (defined and explicitly stated whether better is faster, more accurate, or less wasteful, etc.) than a human, or is it something humans do not like to do (e.g., tedious repetitive functions). Any technology will not exist in isolation, they support processes and people, and thus a lack of consideration of human involvement would be incomplete.

Therefore, the aim of this study was to explore the rigor and robustness of use cases within the body of research focused on AI for construction management. We wanted to not only examine the influence of Technique on such research, but more explicitly unpack the rigor of the rationale that lies beneath, in the form of distinct use cases. We ask whether researchers are applying artificial solutions to artificial problems, or whether the body of work is taking a rational and well-justified research approach towards activities and process that are knowingly problematic, and in which AI could potentially have a role to play.

METHOD

The data for this study was drawn from the ARCOM Abstracts Database, which contains abstracts from leading journals in construction management, ARCOM conference proceedings, and PhD dissertations. A combined search on both terms [Artificial Intelligence] AND [Management] undertaken in February 2025 resulted in n=121 outputs. An initial review removed unpublished PhD theses and outputs that did not relate specifically to construction management as out of scope. For example, papers relating to design, facilities management and disaster recovery were not considered. A final screening eliminated one further paper that could not be accessed, resulting in a total of n=59 outputs for detailed analysis. By using the ARCOM database for our search, we were able to limit the sample to a manageable size, as well as draw on a database with specific relevance for this conference. A basic analysis of each paper was undertaken to determine the focus of the AI application and extract the details of any use cases therein. Additionally, a critical discourse analysis (Fairclough and Wodak 1997) was carried out to further unpack any presented use cases, to illuminate the dominant discourses that are shaping the justification and validation of AI within the field of construction management. Due to constraints of space, only the most prominent findings are shared below.

FINDINGS AND DISCUSSION

Research of the application of AI to construction management problems began in the 1980s (Hua 2008) with the creation of Expert Systems in which computers performed decision making using rule-based systems on a par with humans. AI has since developed through machine learning, to generative AI and large language models. Accordingly, the first pass of the sample data revealed papers published between 1985 and 2024. Earlier papers naturally focused more on AI embodiment through Expert Systems and remained tentative in discussing and considering the applications of AI for construction management. Later work is notably more detailed with regards to application to practice and has more recently begun to include evaluations and analysis of the contemporary use of AI by the industry itself. This suggests that academia is now perhaps lagging industry and is certainly behind the innovators of such technologies for commercial use.

Four different types of paper could be categorised within the data: n=5 opinion surveys, n=7 discussion papers, n=14 systematic or state-of-the-art review papers and n=33 technical papers that detailed the development/application of a specific AI for construction management. Technical papers are those that include details of the development of the AI technology, including explication of its architecture, any networks and models, and thus should also include a use case for the specific application as developed. Among the technical papers, the most prominent uses of AI were for prediction (n=19) including scheduling, planning and resourcing; enhanced decision making (n=8) in a variety of project management applications; and monitoring (n=5) of both the jobsite in terms of progress and productivity and the workers, ostensibly for their own safety.

Making the Argument for AI: Unpacking the Use Cases

33 of the 59 papers were identified through the analysis to contain something that could be deemed a use case. However, these 33 papers did not directly correspond to those identified as technical papers. In fact, n=7 technical papers did not make a use case at all, whilst use cases were identifiable in some of the non-technical papers. These use cases themselves ranged from detailed and focused arguments for the use of AI within that specific context, as found in n=6 papers, to weaker and more superficial evaluations extending to only one or two lines, as found in n=21 papers. Interestingly, several papers made their use case from the point of view of the technology itself (n=6). A total of n=26 papers did not make any type of use case at all. Overall, a use case of any type could only be identified in 56% of the papers of all types. This finding is itself concerning and suggests a field researching AI applications for construction management because it can, not necessarily because it should.

What does a 'Good' Use Case Look Like?

An example of a 'good' use case was identified in the work of Boussabaine (2001), as they sought to apply AI to construction project estimating as a predictive task. Within their use case, Boussabaine argued that AI can make better judgements than experts, is more accurate in application of such judgements, and that contemporary estimating practice was inconsistent due to '… the lack of a binding mechanism that relates the present case to past patterns.' (ibid 2001:105). However, Boussabaine also explicitly considered the human estimator within the process, drawing from the field of human psychology in comparison to the functionality of AI, noting that experts are better than AI at information selection, adding depth to the use case. Indeed, to the reader, this balanced use case suggests areas of human-technology 'co-working' may be necessary to optimise the use of AI for estimating. Interestingly, in this paper Boussabaine also calls for more research to demonstrate the 'benefits of such technology for construction management over traditional methods.' (ibid 2001). This is effectively a call for more evidence-based use cases, which we can only support, and the research is clearly framed as having the potential, as opposed to inevitability, for AI to '…be a valuable tool.' (ibid 2001:105).

A more recent paper also categorised as 'good' with regards to its use case consideration, was that of Cheng *et al. (*2019). They applied AI to construction planning and scheduling, again leveraging its predictive capabilities. Their use case was grounded in the argument that estimating is fundamentally challenging, due to the complex, uncertain and limited nature of relevant information, and thus humans draw on inevitably subjective experiences to supplement the process. This results in poor and inaccurate predictions. Cheng *et al.,* counter this subjectivity, and the limitations of human knowledge with those of AI, which can process greater volumes of data than humans. They use this situation to justify the need for their predictive model. Although they provide a caveat that their AI model is certainly not complete as further data is needed to train it for optimum performance, in practice the model's predicted project duration only differed by 4 days from the actual completion duration of their case study project. They too position AI as an assistant rather than replacement, noting that an enhanced version could offer '…a valuable tool for project managers, contractors, and clients for facilitating sober and informed decisions related to schedule management and planning.' (Cheng *et al.,* 2019:15).

However, such detailed use case considerations were rare within the data. More common was a generic use case of just one or two sentences. In the 19 papers mobilising AI for predictive purposes, as applied to the scheduling, planning and estimating of future projects, only four contained what was considered a 'good' use case. The others drew on broad arguments and presumptions for their justification, with the influence of Technique notable within the prose. For example, Zhu *et al. (*2021) state that 'Instead of depending on historical records and experts' experience, the scheduling process in time management can be automated by Big Data and AI.' This is undeniably a truth; the scheduling process certainly can be automated, but why this is a better option is less clear and was not well justified in any of the papers addressing this aspect of application.

In general, automation has historically reduced the need for workers and thus also wage bills (Sherratt *et al.,* 2020), so the ability to sack those pesky estimators demanding regular pay checks, sick and holiday pay, and reasonable hours, could certainly be considered a benefit for some. Instead, AI will happily work 24/7 for a one-off payment, or at least until software updates shift to a subscription-only based offering, when perhaps the human wages paid to estimators might start to look more attractive again. Most predictive AI use cases followed this argument; subjective human experiences and their pitiful collections of 'small data' (as opposed to Big Data collected by technology - both of which are inevitably 'historical' of course) summarily devalued and dismissed in the face of potential AI solutions. It seems the fact that we can now collect Big Data means we must, as more is always better, and it must be analysed, otherwise what are we collecting it for? Indeed, as volumes reach levels where decision making becomes impossible for human brains, AI can neatly offer the solution to a problem entirely of its own making. Yet that slightly insidious situation can be readily overlooked given the benefits of AI; in their use case supporting the development of construction labour productivity (CLP) models, Sarihi *et al. (*2023:423) go so far as to label human limitations in modelling such complexity as 'weakness'. However, everything has limitations, and to criticise human limitations whilst ignoring the limitations and weaknesses of AI in such applications is unbalanced at best, disingenuous at worst.

Diagnosing AI Myopia: Why Context Matters!

Indeed, one such limitation of AI emerges as Zhu *et al. (*2021) expand their use case by stating that 'With the applications of smart technologies, the whole process of project cost time management will be more accurate and efficient.' The twin objectives of accuracy and efficiency were often drawn on in the simpler use cases found within the data, the objective nature of AI eliminating the negative influences of subjective human experiences, bias and limited knowledge. Superficially this argument holds, as historically construction estimating is not known for its accuracy and predictability (Farmer 2016), but this is not necessarily the fault of those doing the estimating.

When considering the application of AI for planning and estimating, the internal tender evaluations that such estimates undergo before a formal bid is made to the client should be explicitly acknowledged. In this process, the schedule initially produced by the human estimator is reviewed by senior leadership, who often then adjust that estimate based on other factors, such as wider market evaluations, existing commitments and capacity, the potential profitability or prestige from the project, and ultimately, whether they actually want to win the work or not (Sherratt 2022b). In fact, it is highly unlikely that the schedule first produced by the estimator is identical to the schedule used to bid for and win the project and, therefore, what is retrospectively used to ascertain delay or cost overruns. Previous research identified other elements that can further influence project estimates, such as 'planning for claims' (Rooke *et al.,* 2004), and the 'planning fallacy' through which delusions (e.g., optimism bias) and deception (e.g., strategic misrepresentation) combine (Love *et al.,* 2022). And that is without noting that construction projects also endemically suffer from '…errors, scope changes, rework, price escalation, inflation, architecture of the project planning organisations, complexity and uncertainty, externalities…' (ibid 2022).

A robust case can therefore be made that we can never actually know whether human estimators are as bad as they seem in retrospect, because the 'tweaks' (e.g., best prices, tighter schedules) made to their outputs are undertaken in commercially sensitive spaces, well-hidden from view. Thus, to build an argument for AI based on a poor estimating track record as evidenced by subsequent project misalignment seems rather unfair. The industry's poor track record in prediction may have nothing to do with the estimators' experience, subjectivity, and reliance on historic data and everything to do with the CFO's annotations. It seems impossible, or at least unwise, for researchers to make blanket claims that this industry generates inaccurate estimates, and equally unwise to indicate that a more accurate number generated through AI will automatically be better. In addition, there is also the question of whether AI's outputs will suffer the same treatment before bids are placed. There is no reason to believe they would not also be tweaked and compressed, should a bid require it. Construction bids are not always aiming for accuracy, and thus, will AI actually be able to do a 'better' job in reality? Time will tell.

Technology is the Problem: It's also the Solution!

An unexpected finding from the analysis was that papers seeking to enhance existing technologies, including older 'versions' of AI, generally made more robust use cases than those seeking to initially apply technology to human processes. For example, Moselhi *et al. (*1991) sought to mobilise more sophisticated neural networks, to '…supplement or a complement…conventional expert systems.' Whilst Lu (2002:438) sought to specifically address merge event bias within PERT through the inclusion of near-critical paths within their model, to improve reliability.

However, the influences of Technique could be seen as proposed solutions to technological problems inevitably necessitated the application of yet more technology. No consideration of a human-centric alternative could be found within the data, even when current technological solutions had been identified as lacking. Although earlier researchers were more aware of the novel difficulties computing would likely introduce to construction management (Rowings 1991), the potential for a non-technical solution is now rendered moot through the influence of Technique.

For example, Fayek (2005) discussed the application of fuzzy logic to existing modelling as a solution to the problems and inaccuracies of existing predictive models. They note that such problems include: the inability to deal with numerous and simultaneous factors affecting productivity; the inability to allow the subjective evaluation of these factors; the reliance and need for significant-sized data sets for model development and testing; and inflexibility in adapting models to suit different project contexts and different factors. Interestingly, although humans can do many of these tasks - subjective evaluations, consideration of multiple factors at once, adaption of knowledge to different situations - co-working human/technology adaptions are simply not considered.

Indeed, AI seems to be growing ever more envious of what people can do. Son and Khoi (2024) look to metaheuristic algorithms (MA), which they say have '…superior performance, power, and shorter required computation times…' than other algorithms, to enhance time, cost, and quality optimisation. They state that 'MA frequently draws inspiration from real-world phenomena to develop better heuristic solutions to optimisation challenges.' (Son and Khoi 2024). Optimisation trade-offs are not purely numerical, hence the need for real-world phenomena input, yet such input was previously just called experience or expertise, readily found within humans. The presumption that AI can do this 'better' remains firmly entrenched, even though AI is now also having to 'experience' the real world (as humans long have) to be able to deliver the promises made on its behalf.

The most surprising paper found within the data was that of Hong *et al. (*2021) who also focused on predictive AI for construction scheduling and planning. Their focus however was not with how much better the AI is than humans in undertaking this process, but rather that humans are not helping AI due to their inconvenient, whimsical and, well, very human trait of labelling construction activities within construction schedules in ways they want to, rather than in ways AI wants them to. Hong *et al. (*2021) bemoan this thus: 'Activity names are devised to communicate between stakeholders, and therefore often are written using inconsistent terminologies across repetitive activities with omitted contextual information.' This, apparently, cannot stand! AI cannot learn from whimsical data, and we humans really should adapt to serve our new technological master. Activities should apparently not be named in ways easily understood by humans, including those doing said activities, because AI can't follow along. No matter that 'Blk4 RC slab L2 GL/1-3' makes perfect sense to the concrete gang pouring it, we should help AI out and use only standardised tasks and nomenclature so AI can process it. Whether the concrete gang can also then clearly understand it, given they must pour the right bit at the right time in real life, is apparently less important. This is perhaps an artificial problem. If robots were building our projects, then a common scheduling language would be appropriate, but they are not - yet. Instead, humans still build our buildings, and construction may remain a human endeavour for years to come. Thus, if AI wants to interpret schedule data, it should be able to adapt and learn from the humans who created the schedule, not the other way around.

Resistance is Futile: The Inevitability of AI

The influence of Technique in shaping the surrounding discourse was evident throughout the data, with the inevitability of AI particularly prominent. In some cases, this was explicitly acknowledged by the author(s) using precisely that word, for example: 'Big data application in the construction industry is inevitable in the current dispensation of the fourth industry' (Atuahene *et al.,* 2020:353). Apparently, there is no choice to be made. Some are even more vociferous in their arguments: ' [The] likelihood of success without betting on new technologies and labour skills boils down to zero' (Brandín and Abrishami 2021:365): AI is inevitable, and if you do not accept and adopt it, failure is also inevitable. That AI can influence academics to willingly make such threats on its behalf is quite impressive, if not also slightly terrifying.

Academics are also urged to focus on AI within their own research activities. More is needed: 'Despite the increased number of applications of fuzzy hybrid techniques in construction, research must expand to new areas in order to advance the practicality of these techniques and increase their widespread acceptance and use.' (Fayek 2020). Whether AI should be widely accepted and used when it has not yet been validated in practice seems to be placing the cart-before-horse somewhat, especially when viewed from an academic perspective. That eventual practicality is assumed is also a little worrisome. Indeed, uncritical presumptions that AI will improve things are arguably now firmly entrenched within much of the AI research discourse. As Goh *et al. (*2009) argue: 'In order to improve the quality of risk assessments in the construction industry, it is important to explore the use of artificial intelligence methods to ensure that the process is efficient and at the same time thorough'. Humans can of course be efficient and thorough, but AI is an inevitable improvement.

The inevitability of AI was perhaps best illustrated by Shang *et al. (*2023): 'There is an increasing need for AI to be adopted across industries as we weather the age of technological disruption.' Yet AI, and technological innovation is nothing like the weather. It is not inevitable and could be controlled. But as the theory of Technique dictates, the solution is to adopt more technology to deal with a disruptive situation entirely of our (its) own making.

CONCLUSIONS

In this paper we sought to explore the justifications used to research AI applications within construction management. To do so, we specifically analysed use cases within a purposive sample of research papers, drawn from the ARCOM abstracts database. Drawing on our previous research and experiences, we took an explicitly critical perspective, however our findings were still surprising. Just over half our sample made any kind of use case justification for the use of AI within their work. Only six of those achieved our 'good' evaluation, in which the activity, process and human engagement were all considered in the use case. Most of the remaining use cases were brief and tended to counter human subjectivity and other perceived weaknesses with the hard objectivity, efficiency and accuracy of AI. None of these papers discussed the human within the process explicitly, whether they enjoyed doing the tasks (as the lead author did for many years as a construction planner) or whether AI was taking on work that humans were not good at performing. In addition, there was a lack of wider contextualisation, which in the case of predictive AI for estimating and scheduling, is a considerable oversight that fundamentally undermines any use cases made on the grounds of poor human performance. That research is now reaching into spaces where the construction industry is chastised for not meeting the needs of AI was a startling finding, and one that makes us personally want to cling to the whimsey inherent in human ways of doing things.

The construction industry has plenty of problems that involve people, process and technology. Solutions to such problems are likely to be complex, yet our research found more than a few artificial problems in search of pre-determined artificial solutions mobilising AI. Ironically, despite all the complexity found in AI models, they are a simple solution in that they (at least in our data) often reduce the problem to only an issue of technology, ignoring both people and process issues that are also intertwined. Indeed, given wider societal and environmental concerns around AI, challenges to its ubiquitous use are sorely lacking amidst the influences of Technique. As are more fundamental challenges to the currently poor justifications and use cases used to underpin such research. We need to be more critical in what we're doing and clearer in how and why we're doing it, to avoid the hype and ensure construction management research of AI applications does not simply become an echo chamber of technocratic optimism and determinism. Use cases matter and should be the first thing looked for in any work advocating for AI application to any aspect of construction management. We all review such papers and can shape this field appropriately. We can and should do better.

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