SPOTLIGHT ON CONSTRUCTION COST OVERRUN RESEARCH: SUPERFICIAL, REPLICATIVE AND STAGNATED

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Construction projects routinely overrun their cost estimates. A plethora of studies have thus been dedicated to investigating the root causes, sizes, distribution and nature of overruns. The causes range from a poor understanding of the impact of systemicity and complexity projects, unrealistic cost targets and misguided trade-offs between project scope, time and cost to suspicions of foul play and even corruption. In spite of the vast attention dedicated to the problem of cost overrun, there has been limited evidence to support the claim that the size or occurrence of cost overruns is reducing in practice. A review of the literature reveals that it may not be an exaggeration to claim that the bulk of our current cost overrun research may be largely inadequate and deficient to deal with the complexity posed by construction projects. This paper provides a critique of current cost overrun research and suggests that the adoption of systems thinking is required to better understand the nature of cost overruns. We explore some of the embedded methodological weaknesses in the approaches adopted in a majority of cost overrun research, particularly the lack of systems thinking and demonstrable causality. We reach the following conclusion - cost overrun research has largely stagnated in the refinement and advancement of the knowledge area. It has largely been superficial and replicative. A significant paradigm and methodological shift may be required to address this perennial and complex problem faced in construction project delivery.

Keywords: causality, cost overrun, cost control, project performance, replication, research method, systems thinking.

INTRODUCTION

Cost estimates prepared in the early stages of a project allow a client to evaluate most economical tenders, secure funding or perform a cost-benefit analysis. These estimates also often become the basis for cost control during project delivery. Where the project is a commercial asset, the initial capital investment to deliver the project must be balanced with the cost of maintenance and operations over the life-time of the project to ensure it remains profitable and that planned returns on investment are achievable. Thus, decisions made during the formative stages of a project carry far-reaching economic consequences and can seal the financial fate of a project. Effective cost

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Ahiaga-Dagbui, D, Smith, S D, Love, P E D and Ackermann, F (2015) Spotlight on construction cost overrun research: Superficial, replicative and stagnated *In:* Raidén, A B and Aboagye-Nimo, E (Eds) *Procs 31st Annual ARCOM Conference*, 7-9 September 2015, Lincoln, UK, Association of Researchers in Construction Management, 863-872.

planning, therefore, relates design of buildings to their cost, so that while taking full account of quality, risks, likely scope changes, utility and appearance, the cost of a project is planned to be within the economic limit of expenditure.

Unfortunately, construction projects regularly still make the news headlines, not for being remarkable engineering accomplishments that will support and stimulate economic growth and social integration of communities, but rather for being poorly managed and often over budget. A significant number of construction projects routinely overrun their cost estimates. According to the works of Flyvbjerg *et al.* (2002), infrastructure projects are reported to have an 86% probability of outrunning their set cost targets. The average size of these overruns can be as high as 45% for rail projects, 34% for bridges and 20% for road projects. Love *et al* (2012) and Odeck (2004) on the other hand found that overruns could be as high as 70% and 183% more than the initial estimate respectively. The global audit and professional services firm, Ernst and Young, reviewed the performance of 365 infrastructure projects delivered in the oil and gas industry and found that at least 64% of the projects were faced cost overruns to varying degrees. The projects recorded an average cost overrun of 59%, representing an incremental cost of US$500 billion in real terms (Ernst and Young 2014). Merror (2012) also found that up to 78% of oil and gas projects face significant cost overruns at an average of 33%.

Cost overrun has been attributed to several sources including scope creep and rework (Love *et al.* 2005), unrealistic cost targets and misguided trade-offs between project scope, time and cost (Ahiaga-Dagbui and Smith 2014b), a poor understanding of the systemic and dynamic nature of projects (Eden *et al.* 2005), unidentified or improperly managed risk and uncertainty (Okmen and Öztas 2010) to suspicions of foul-play and corruption (Wachs 1990).

A review of the construction management literature, however, reveals that a plethora of studies have been dedicated to understanding the problem of cost overruns (Morris 1990, Flyvbjerg *et al.* 2004, Odeck 2004, Ahiaga-Dagbui and Smith 2013, 2014a, Love *et al.* 2015). Most of these studies usually identify several purported causes of overruns and often make recommendations for mitigating and containing the phenomenon. However, there seems to be no evidence of alleviating the problem or improving the reliability of cost estimates for construction projects. The industry may have earned itself the unenviable repute of delivering projects late and over budget, again and again, leaving clients dissatisfied and the tax-payer often out of pocket.

So, why are cost overruns so prevalent in the construction industry irrespective of the attention it gets both in academia and practices? Why has there not been much improvement in the *reliability* of initial cost estimates over the years? Surely the industry has become a lot better at managing projects. Procurement systems have greatly evolved from traditional adversarial design-bid-build to different forms of collaborative and relationship contracts. There are more measures now for accountability and cost control for project procurement. Information technology for construction has also improved significantly with the advent of Computer Aided Designs (CAD) and Building Information Modelling (BIM). There are now online collaborative platforms for effective communication, design, visualisation, simulation, control and coordination of the entire construction process. There appears to be growing take-up of digital 3D design and even 4D models that integrate the spatial and temporal aspects of a project to understand, predict, evaluate and manage even the most complex projects. Most of these IT systems support project cost estimation as

well as allow for the use of estimation software and advanced costing methods like feature-based estimation, genetic algorithms or fuzzy logic.

It is against this backdrop, this paper provides a critique of current cost overrun research and a nudge towards adoption of systems thinking in dealing with construction cost overruns. The paper will explore some of the embedded methodological weaknesses in the approaches adopted in a majority of cost overrun research, particularly the lack of systems thinking and demonstrable causality as well as the over-simplification of the cost overrun problem and replication. The paper concludes with some recommendations regarding the future direction of cost overrun research and mitigation.

COST OVERRUN RESEARCH: SIMPLISTIC, SUPERFICIAL AND REPLICATIVE

As already alluded to, there is no shortage of research dedicated to understanding the problem of cost overruns or making recommendations on how to alleviate this perennial problem in the construction industry. On the whole, this is commendable and should be further encouraged. However, there seems to be no evidence of real improvements in the reliability of initial cost estimates or the predictability of final cost, even with the use of new technologies available to construction experts. A critical review of the literature however quickly reveals that it may not be an exaggeration to claim that the bulk of our current research may be largely inadequate and deficient to deal with the complexity of construction cost overruns. Worryingly, it would seem that most studies are rather simplistic and superficial, replicative and not been cumulative enough to be effective in addressing the problem. On close scrutiny also, there would seem to be stagnation in the rigour and thoroughness of cost overrun research.

Memon *et al* (2012) undertook an investigation into the 'causes' of cost overrun in large construction projects in Malaysia. Using the extant literature, they first identified 35 different factors that could lead to cost overrun and then required of *clients, consultants and contractors* to rank these factors on a five-point Likert scale from 'not significant' to 'extremely significant'. These factors include 'poor project management', 'lack of coordination between parties', 'mistakes during construction' and 'slow information flow between parties'. A relative importance index, defined in equation 1, was then used to weight these factors. The strength of correlation between the various factors was also measured using the Spearman's rank correlation, ρ, to add some statistical rigour to the study.

$$Relative\ Importance\ Index = \frac{\sum_1^5 w.x}{A\ .N} \qquad \text{------- Equation 1}$$

Where

w = weighting given to each factor by respondents

x = frequency of response given for each cause

A = highest weight (i.e. 5 in this case)

N = total number of participants

Out of the 150 questionnaires distributed, 103 were returned with 97 valid. Fluctuation in prices of materials, contractor cashflow problems and client payment delay were

the top three 'causes' of overrun. Respondents were also required to recall the approximate extent of cost overrun (cost beyond contract sum) for the projects they were involved with within the past ten years. A majority (61%) of the respondents reported a range of 5% to 10% of contract sum. About 20% recalled overruns beyond 20% of contract sum.

This approach to cost overrun research is not untypical at all- Kaming *et al* (1997), Ameh *et al.* (2010), Mansfield *et al.* (1994), Jackson (2002), Enshassi *et al.* (2010), Durdyev *et al.* (2012), Rosenfeld (2014) and many others have all conducted almost identical studies. A careful scrutiny of most of the studies aforementioned, reveal some common pathologies in much of cost overrun research:

1-Lack of systems thinking

This is perhaps the most common shortcoming in the methodological approach adopted in cost overrun research. Most studies identify single points in a causal chain where an intervention may have reasonably been implemented to change performance and prevent an undesirable outcome. This includes past research by some of the authors of this current paper (AandB) as well as studies by Odeck (2004), Durdyev *et al* (2012), Flyvbjerg *et al* (2004) and Mansfield *et al.* (1994). The identification of singular causes, which in most cases only describe the proximal causes, is counterproductive, as overrun causation can only be understood by looking at the whole project system in which it occurs and how variables dynamically interact with one another. Problems very seldom occur as stand-alone issues. Even though they may superficially appear to be different, sources of poor performance on construction projects are very much interrelated, sometimes in rather complex ways. The crucial skill in understanding cost overrun is not the ability to list or rank factors but the capacity to see connections and the dynamics between the various sources. Hamilton (1997) outlines two important properties of systems thinking that would be useful in cost overrun research - every part of a system has properties that it loses when separated from the system and every system has some essential properties that none of its parts do. Thus, when a system is taken apart, it loses its essential properties (Von Bertalanffy 1956).

Singular cause identification approach is perhaps based on a faulty understanding of the nature of construction projects in general. As suggested by Rodrigues and Bowers (1996), traditional approaches to investigating project management related problems usually assume that if each element of the project can be understood, then the whole project may be controlled and delivered effectively. Of course, this approach has yet to help project managers deliver their projects on budget and agreed timescales. It is important to therefore to adopt a systemic, or causal loop approaches when investigating complex problems like cost overruns particularly in large public projects. Boateng *et al* (2013) and Ackermann *et al* (2007) have both applied this systemic approach for identification and modelling risk in project delivery.

2-Illusion of causality - correlation does not mean causality

A significant number of cost overrun research set out to identify the so-called 'root causes' of the problem but invariably only end up scratching the surface of this complicated problem. Finding strong correlations between factors does not mean the factors are *causes* of the phenomenon under study. For example, the fact that high 'graffiti' (Skogan 1990) and 'broken window' neighbourhoods (Wilson and Kellig

1982) correlate rather strongly with high crime levels does not mean that graffiti or broken windows *cause* the crimes. The next example borders on the absurd, but aptly sustains the argument being developed. Since 1883, eight Pontiffs have died, five in Grand Slam years of the Six Nations rugby tournament. This led to the conclusion that *"every time Wales win the rugby grand slam, a Pope dies, except for 1978 when Wales were really good, and two Popes died"* (Payn*e et al.* 2008). [Note: the authors of the Pope study did not intend the findings to be taken seriously, but it supports point nonetheless. There was no Papal death the last time Wales won in 2008 anyway].

Just because two things strongly correlate does not necessarily mean that one *causes* the other. This would seem readily obvious, but can be easily overlooked. A correlation provides circumstantial evidence implying a causal link, but the weight of the evidence depends greatly on the particular circumstances involved. Ubani *et al* (2013) set out to investigate factors that cause cost and schedule overruns in Nigeria. They developed a questionnaire based on *"110 hypothetical cost overrun"* factors identified from the literature. The returned questionnaires from respondents were then analysed by measuring relative importance and correlation coefficients. They found that material related issues, including price fluctuation and shortages were the main causes of overrun. They rejected the hypothesis that contractual relationships, labour and design had any significant influence on cost overrun. They then recommended that clients, contractors and consultants *"should pay more attention to both material and external factors for there to be effective and efficient delivery on construction projects at the right time and cost."* It is readily obvious the lack of demonstration of causation between the factors identified or the superficially of their approach and recommendation. The reader is invited to take a closer look at the formulation of the following studies to see if *causation* has been sufficiently demonstrated to warrant their paper titles: *"Significant factors causing cost overruns in telecommunication projects in Nigeria"* (Ameh *et al.* 2010); *"Causes of construction cost and time overruns: The 2010 FIFA World Cup stadia in South Africa"*(Baloyi and Bekker 2011); *"What causes cost overrun in transport infrastructure projects?"* (Flyvbjerg *et al.* 2004) and *"Causes of delay and cost overruns in Nigerian construction projects"* (Mansfield *et al.* 1994).

3-Ambiguous and Superficial Factors

Poor project management, lack of coordination between parties, mistakes during construction and slow information flow between parties are some of the factors used in the survey by Memon *et al* (2012). Others like inadequate control procedures, slow decision making, waiting for information or poor documentation used in Frimpong *et al* (2003) are rather too ambiguous. They could be easily be misinterpreted by the respondents especially if they are all not thinking within the context of a particular project or situation. The reader is invited to pause for a moment here and think through the factors *"poor project management"* and *"poor documentation"*. It is very likely that several interpretations, scenarios or examples came to mind in that exercise. This may be a quick indication that such factors are rather too superficial and therefore must be broken down further if real sources of overrun are to be identified. Questionnaires may be a quick and easy way of sampling the views of respondents but can also be problematical if the researcher's definition of a factor does not correspond with the respondent's understanding.

Unless they were perhaps used in a structured case study, for example, it is argued that questionnaires alone may not be suitable for investigating complex and systemic problems like cost overrun on construction projects. Good project management or efficient document management will mean very different things to respondents. The factors are simply too high level to help in getting to the heart of the problem itself. Interviews allowing the surfacing of deep tacit knowledge and also enabling the capture of relationships can provide a much more comprehensive and effective representation of the situation.

4-Cross Perspective

To further complicate matters, respondents are often drawn from different professions in the industry. On first thought, this may seem a prudent approach as it helps to investigate the problem from different perspectives. However, both Durdyev *et al* (2012) and Memon *et al* (2012) for example, surveyed clients, consultants and contractors without controlling for the different perspectives of these professional. It might be agreeable that the perceived sources, sizes or nature of overruns will be significantly vary depending on whether the construction profession works for a client or the contracting firm, or whether they work in the public or private sector. It probably may be best to survey these groups separately than merge all their responses into one. This problem of context and cross-perspectives could at least be partially addressed by using structured case studies as all respondents would be reviewing the same project(s). The findings of this kind of study would usually be more revealing than a generic questionnaire without any context or background.

5-*Availability Heuristics*

Heuristics are mental shortcuts that help us make decisions and judgments quickly without investing a lot of time analysing information. One such heuristic is termed the *availability heuristic.* According to Gilovich *et al* (2002), availability heuristic is employed when someone estimates the frequency or probability of an event based on the *ease* with which instances or associations could be brought to mind. Even though heuristics can be extremely helpful, they can easily become a hindrance to deep and careful thinking. In their seminal work on heuristics, Tversky and Kahneman (1973) posit that availability can often be affected by various factors which are completely unrelated to the actual frequency or probability of the event under review- how busy the respondent is, their interest in the subject under study, level of experience, peculiarities of the most salient examples they can recall, their understanding of the questions in the survey or the time available to complete a questionnaire. Tversky and Kahneman (1973) thus warn that if availability is applied to the analysis of an event, these factors *"will affect the perceived frequency of the classes and the subjective probability of events. Consequently, the use of the availability leads to systematic biases".*

Without a carefully designed research and established context of projects being evaluated, results of the questionnaires, such as the ones conducted in (Ameh *et al.* 2010, Durdyev *et al.* 2012, Memon *et al.* 2012) become slightly problematic. It is no surprise that the same factors seem to come top of the list most of the time in these surveys - poor estimation, poor project management, inadequate risk management, unexpected ground conditions, scope changes or material price changes. These are the

usual suspects and they come to mind very readily for respondents. It will take more thoughtful research design, perhaps research conducted within the context of a particular project, to be able to partly circumvent these default responses that have yet to help mitigate or contain cost overrun in construction.

6-Replicative

Finally, replication, the performance of another study to statistically substantiate, or challenge, a hypothesis has significant value for research and therefore has been the cornerstone of scientific and social studies. It is based on a simple concept: *"trust, but verify"*. Where a replicative study results in different findings, it may indicate that the original hypotheses may have been incorrect or only partially correct, and that an alternative formulation may be able to reconcile apparent divergent results. Replication is therefore essential in helping to establish or disprove causal inferences, determination of generalisability of findings and even spur on new research. When carried out in a cumulative manner, it helps to build on previous studies and facilitates a better understanding of a phenomenon.

For cost overrun research, however, replication has largely been a case of reinventing the wheel - doing the same thing over and over. Edge (1995) aptly describes this sort of research as *"the mass production of a standard product"* lacking in *"intellectual expansion"* of the field. However, expansion in depth and detail of cost overrun research must take priority of mere quantity and bulk. Albeit with a slight variation in context, there has been little methodological advancement in the studies by Mansfield *et al.* (1994), Kaming *et al* (1997), Jackson (2002), Ameh *et al.* (2010), Enshassi *et al.* (2010), Memon *et al* (2012) and Durdyev *et al.* (2012). They mostly draw-up a tall list of supposed 'causes' of overruns in a questionnaire and require of respondents to rank them using their perceived frequency or importance. It comes at little surprise that Flyvbjerg *et al*. (2002) observed in their seminal studies that that the size of overruns have not reduced over the 70 years that they studied. They also concluded that *"no learning that would improve cost estimate accuracy seems to take place."* That may well be partly due to the stagnation in rigour and robustness of research dedicated to ameliorate the problem. In some ways, we might just be where we always were, and always will be if there are no significant paradigm and methodological shifts in cost overrun research.

CONCLUSIONS

We have explored some of the methodological deficiencies in the approaches adopted in a majority of cost overrun research. These include a poor understanding of systemicity and embeddedness of the sources of overruns, a lack of demonstrable causality and superficiality of the research design. We find that cost overrun research has largely stagnated in the refinement and advancement of the knowledge area - the bulk of it has largely been replicative. We would particularly like to highlight the lack of systems or holistic thinking in cost overrun studies, which invariably leads to the identification of single points in a causal loop of sources. We argue that this approach is a flawed simplification of the cost overrun problem and rather counterproductive. Overrun causation can only be understood by looking at the whole project system in which it occurs and how several variables dynamically interact with each other. It may be important to reiterate here that the crucial skill in understanding cost overrun is not

the ability to list or rank factors but the capacity to see connections and the dynamics between the various sources. It is suggested that significant paradigm and methodological shift may be required to properly understand the nature and sources of cost overruns. System dynamics or causal loop mapping, used in combination with structured-case studies, may be a better approach to investigating the cost overrun problem.

Finally, it may be worth mentioning that this paper was not meant as an attack on the works of respectable colleagues but an attempt to look intently at our collective efforts and map-out future directions for cost overrun research that effectively combines criticality and robustness. This is particularly important and timely especially against the backdrop of overwhelming evidence that cost overrun is as much a problem today as it has been decades ago. Besides, what is the benefit of doing the same thing over and over again if it is not yielding transformative results anyway?

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