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CHALLENGES OF EARLY ESTIMATION OF INFRASTRUCTURE PROJECTS WITHIN THE UK: AN INFORMATION PERSPECTIVE

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This research examines the challenges of early cost estimation of infrastructure projects within the UK with a focus on why cost overruns are such a persistent issue. The research was carried out by an investigation of existing literature surrounding early estimation in construction, characteristics of UK-based infrastructure projects and cost overruns within infrastructure projects. The data were collected through fourteen semi-structured interviews with estimating professionals who work predominantly on infrastructure projects across the UK. The key findings were that the early estimation process consists of an intricate system of hard and soft information exchange from the many involved parties due to the social and political nature of infrastructure projects; this provides many challenges for the estimator. This led to the idea that an estimate is actually a soft input itself and should not be taken as a hard numerical figure but something which requires human interpretation. Moreover, these challenges are heightened by the number of unknowns and uncertainties that are again part of the very nature of large scale infrastructure projects. This is difficult to address as it is the process of converting soft information into hard information and when soft information is hardened it will inevitably lose some of its information or context. Unfortunately, cost estimates have become to be accepted as hard information even when it is known to be soft information that requires interpretation and sense making.

Keywords: cost overruns, early estimation, infrastructure projects, soft information

INTRODUCTION

Siemiatycki (2015) suggests that infrastructure is the fundamental element for successfully accomplishing social equality, economic growth and environmental sustainability. It was estimated that construction work within the UK would rise in both 2017 and 2018, and would reach for the first-time levels equivalent to those before the UK's 2008 recession. This has been attributed to a recent increase in infrastructure projects across the UK; it has been forecasted that infrastructure will be the leading growth area for the UK's construction industry for the first time in five years with the work set to increase by 56.9% by 2019 (Plimmer, 2016). Literature highlights that infrastructure projects across the globe persistently experience cost overruns and the UK is no exception to this. The infrastructure cost review (HM Treasury, 2010a) highlights that the average outturns for the UK's infrastructure projects are much higher than their European counterparts and argues that these greater costs were generally experienced

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early on in projects before construction had commenced. Several researchers point out that those who carry out construction cost estimations are dependent upon either their previous experience or a variety of cost information. This research attempts to explore and present the challenges of early cost estimation of infrastructure projects from an information perspective.

LITERATURE REVIEW

Infrastructure Projects

Frischmann (2012) believes infrastructure is imperative for both social and economic development but cautions that infrastructure assets are no short-term commitment and can come with profound consequences for the public. He further asserts that infrastructure assets fundamentally mould intricate systems of social activity within society, including both economic and political systems. Additionally, governmental funding of infrastructure projects can have a variety of economic benefits as it helps to generate employment within the related industries and it can attract capital investment; hence, they are political.

Although infrastructure is set to increase social and economic development, it is not without its issues. Latham (1994) highlights that there is no such thing as a risk-free construction project and whilst we can manage, reduce, share, transfer, or take risks, it is imperative that we do not ignore it. However, Beckers and Stegemann (2013) contend that it is common for large infrastructure projects to experience poor risk management throughout their project lifecycle due to inadequate planning. This is also reflected in the infrastructure cost review by HM Treasury (2010a) as it described how contingency and risk budgets are often overlooked and as a result are given inadequate budgets. This inadequacy of contingency could be attributed to the fact that a considerable percentage of the risk exposure is affiliated with undefined uncertainties in the conceptual stage and these risks are undetermined at the time of carrying out the early estimates and may not be realised until detailed designs have been produced or even when construction has commenced (HM Treasury, 2015). In theory, the quantity of these undetermined uncertainties should reduce following the use of quantified risk assessments as the design and project maturity progresses but this does not necessarily help the early stage estimates.

Early Cost Advice

Cost advice is provided to the client throughout a project's life-cycle and is defined as a technical procedure that utilises the full extent of information and materials that are available to generate estimations and predictions of the total cost of completing work in a specific time (Kwakye, 1994). A number of academics such as Serpell (2004) and Trost and Oberlender (2003) agree that the most valuable cost advice for aiding the client in decision-making is provided in the initial project stages when levels of certainty are extremely low. Other academics (Akintoye and Fitzgerald, 2000; Love *et al.*, 2002; Oberlender and Trost, 2001) attribute this to early cost advice being considered the initial step in the practice of cost management; they claim that it provides a thorough insight into the information surrounding a project, highlights the consequences that design choices have on the project cost and determines the client's likely expenditure. The early cost estimation is required by several parties such as the client, contractor and designers; it serves several purposes including establishing the initial budget for the project, determining the practicability of the project and enabling alternative design options to be evaluated on a financial level (Sonmez, 2004).

Love *et al.*, (2002) argue that an accurate and reliable cost estimate for a project in the early stages can lead to sound financial advice, which is a major factor which determines project success. But historically construction projects have experienced cost overruns at the feasibility stage (Betteridge, 1992). Additionally, Langmaid (2003) argues that in order to reduce the likelihood of inaccuracies occurring within early cost estimation, an in-depth understanding of the client's requirements is necessary from the very beginning of the project. However, Sonmez (2004) believes that since the level of design information available is minimal and the scope of the project is still unconfirmed, early cost estimates are anticipated to be inaccurate and lacking in precision. Aibinu and Pasco (2008) conducted a more recent study and found no improvements in the accuracy of early stage cost estimates from historical projects. Not surprisingly, many clients feel that the quality of the advice is inadequate (Ellis and Turner, 1986).

Information Requirements for Early Cost Advice

The information required at the conceptual stage is client led; an outline brief is required to identify the client's needs for the project and there should be a specification, design drawings and a list of abnormalities. Abdul-kadir and Price (1995) maintain that in actual fact the outline brief tends to contain a high level of the client's general requirements and much less of the specific exhaustive requirements. Eldin and Hikle (2003) summarise that the essential goal of the briefing stage is to develop a profound understanding of both the construction project and the client's prioritised requirements. They argue that this can potentially omit or ease design errors and thus the frequency of change orders once construction has commenced; in turn, this will reduce the likelihood of cost overruns.

Archetypally, cost advice is dependent on a variety of documentation produced by several different parties including: Design information, internal company data, historical data from sources such as the Building Cost Information Service (BCIS), manufacturer and supplier publications, trade magazines, and expert advice (O'Brien, 1994; Love *et al.*, 2002 and Arab, 2011). Traditionally, when offering cost advice, professionals strongly rely upon previous experiences and personal judgement (Akintoye and Fitzgerald, 2000). According to Lees and Fortune (1996), the issue with this practice is that cost consultants within construction inherently make misjudgements.

Challenges of Early Cost Estimation in Infrastructure Projects

In a study involving 245 large dams (total cost of USD 353 billion in 2010 prices) that were constructed between 1934 and 2007 across sixty-five different countries, Ansar *et al.*, (2014) found that 75% experienced a cost overrun with the average overrun at 90%, and there have not any improvement in budget accuracy over the seventy-three years that the data spanned. Siemiatycki (2015) claims that there is evidence indicating a positive correlation between project size and both cost and time overruns; infrastructure projects tend to be relatively large which could suggest why they make up a high proportion of the projects that do overrun. He identifies three core reasons for the occurrence of cost and time overruns: Optimism bias, technical obstacles, and tactical falsifications. Siemiatycki (2015) claims that when stakeholders speak about the causes for their project experiencing cost overruns, the technical obstacles tend to be at the forefront of discussion; this is to be expected as it reduces their level of accountability for the overrun. Most of the technical obstacles can be predicted and managed, especially with experienced professionals creating the budgets. Siemiatycki (2015) argues that if cost overruns were unpredictable then a normal distribution would be expected over a large sample. However, it has already been identified from aforementioned studies that the distribution is greatly skewed. In addition to this, large projects are usually delivered by

experienced professionals within the field so if the only causes were technical failures then it would be expected that the volume and magnitude of overruns would decline over time as the industry implements improvements to ensure more accurate forecasting and more efficient methods for project delivery; but this is not the case. However, due to the optimistic human nature, even with experience these professionals tend to underestimate both time and costs, meaning most megaprojects are destined to overrun. In addition to this, tactical falsifications can occur for promotional purposes in order to secure funding and approval for the project. However, some individuals such as Samset (2010) claim that early tactical underestimation rarely affects cost overruns as he argues that overruns are not relative to these early estimates that are used to seek initial approval but the final approved budget.

Muchenagumbo (2015) advises that infrastructure projects are often unique, once in a lifetime projects. As a result, initial estimates may be produced for each project at different stages within the project's life-cycle and projects that are at the same stage within the cycle can have extreme variance in terms of their uncertainties affecting the project costs (HM Treasury, 2015). However, history highlights that similar types of projects tend to face the same categories of uncertainty; this suggests that the use of appropriate historical data will enable the desired understanding of the cost implications for the project, even within early stage estimating. Unfortunately, this does not completely solve the issue as risk and uncertainties may be inadequately represented because of early cost estimates being susceptible to powerful stakeholder's desires and demands (HM Treasury, 2015). Furthermore, Williams (2009) identifies that infrastructure projects are susceptible to "scope creep", where the project, client and even specification and design requirements change during the process of delivery. Accurate estimating becomes even more of a challenge due to this characteristic where the scope is often indeterminate and susceptible to change for a considerable proportion of the project lifecycle. In order to consider this within the cost estimate a contingency is required to facilitate the instigation of such changes (HM Treasury, 2015).

Another challenge that can affect a cost estimate is that many public infrastructure projects are susceptible to optimism bias. Lovallo and Khaneman (2003) suggest that most individuals are greatly optimistic the majority of the time. They further suggest that cognitive research has determined a variety of reasons for this such as an inclination for people to exaggerate their own talents and their degree of control over a situation. People will happily accept recognition for positive results and will even de-emphasise the contribution of luck and chance in achieving the result; whilst attributing any negative occurrences to external factors such as bad weather. Organisations can often intensify these tendencies of over optimism; since there is often strong internal competition employees are encouraged to accentuate the auspicious factors of any proposals they make to improve the chances of their proposal being selected. These early proposals often act as anchors and lay the foundations for any future financial or technical estimates that are produced, meaning the estimates will be plagued with this over-optimism. Some organisations even praise optimistic estimates whilst pessimistic ones are regarded as negativity; this can hinder an organisation's capacity for critical thinking. In combination, the natural human tendency of optimism along with implicit organisational intimidation for positive outcomes results in a persistent underestimation of costs.

There are many stakeholders within infrastructure projects who will benefit either in terms of status or financially, from the successful delivery of a distinctive public works project; yet these individuals will experience no direct repercussions or accountability if overruns occur. Flyvbjerg *et al.*, (2002) reject technical reasons as a cause for cost

overruns technical faults can be accounted for in appropriate contingency budgets as it is possible to adequately predict the risk based on historical projects and data. But they view tactical falsification and over-optimism as the key facets in causing cost overruns. They classify two causes of cost overruns as “fools” or “liars”. The “fools” are those that are over optimistic and may overlook the significance of certain risks and uncertainties and the “liars” are the selfish individuals fuelled by greed, seeking to deceive the public to get a project started for their own gain. Their evidence suggested that cost estimates used for project approval decisions are greatly and strategically deceptive and tactically falsified. However, these findings have been questioned by Love and Ahiaga-Dagbui (2018).

RESEARCH METHOD

The goal of the research is to understand what is happening within infrastructure costing at the early stages and to determine what is unique within the infrastructure to be causing the high volume of cost overruns compared with other types of construction. Due to the social and political nature of infrastructure projects within the UK upon which the study is based, the reality of what goes on is intersubjective. Therefore this study adopted an interview method in order to investigate this issue. The data were collected through fourteen semi-structured interviews with estimating professionals who work predominantly on infrastructure projects across the UK. Professionals with more than fifteen years of cost management experience within UK-based infrastructure projects were selected for this purpose. These interviewees had a total of 265 years of experience in estimating within infrastructure projects. Interview method allowed the collection of in-depth experiences of early estimation and its challenges from the selected professionals. Interview with each professional took approximately 40-50 minutes. Within semi structured interviews open-ended questions were also employed to get a wider view of the situation. Interview questions were focused on finding out current industry practices and views on factors affecting estimation and methods used, cost overruns, project scope, information requirements, representation of risk, uncertainties and apportionment of contingencies, optimism-bias and strategic falsification. The collected data were transcribed and coded to establish emerging themes. An information perspective is taken to analyse data emerging from various themes. A rich picture (See Figure 1) was then used to capture these themes and explore the relationship between participants and emerging themes and create new ideas.

Analysis and Findings

A variety of factors that can affect estimation were put forward by interviewees. Interviewee 1 named ground conditions as the most important factor for affecting estimates. Contrarily, interviewee 3 believed that ground conditions are only of concern to engineers. However, there was a common consensus across the interviewees that there is a need for thorough site investigation and ground surveys to be carried out prior to early estimates to reduce uncertainties. Interviewee 11 identified that lack of information is a big issue and it can affect the accuracy of estimates, whilst interviewee 7 feels that the stakeholders need to take a more realistic view of what an estimate actually is. Some of the less senior interviewees from the contractors’ side emphasized that even though they know there are a variety of factors that can influence their estimate, they would not seek to allow for these within their estimates unless they were specified in the client’s brief or design drawings. Interviewee 5 justified this for legal reasons by saying, “in lots of infrastructure projects designers take the lead. From an estimating point of view, you rarely step away from design because if you do, you are embodying yourself in the design

and you have to be very, very careful [as] if it's a failure then all of a sudden you're liable".

All the interviewees agreed that stakeholders can affect estimates and proposed a variety of reasons for this. Interviewees 3, 5, 8 and 10 attribute it to stakeholder's change of mind or imposing conditions, whether it be public bodies or end user stakeholders. However, interviewee 7 did not put the entire onus on the client and attributed client led alterations to poor communication. Interviewee 11 even discussed how sometimes if an influential stakeholder has a figure in mind you may be encouraged to go with that figure, but it will not be an accurate estimate of the works. In addition to this, Interviewee 4 discussed other stakeholders who can have influence such as landowners, planning authorities, highways authorities and statutory bodies who can impose conditions and fees. Furthermore, interviewee 2 summarised this power related relationship saying, "you have less control in public sector schemes due to the high number of stakeholders involved, who want their input accepted".

Most interviewees agreed that they required some form of client led pre-tender information from the design team to start an estimation. This included: A brief, architectural drawings, structural drawings, civils drawings, engineer's calculations, material specification, location drawings for site access, schedule of works, input from highways, ground investigation details, special requirements, local regulations, site risks, planning permission details, land ownership information and the client's programme with an idea of the end date. Moreover, interviewee 7 stated that "you want as much as you can from the scheme in order to give an accurate price, the problem is you don't often get it". Interviewee 5 echoes this concern for adequate information not being there when it is needed. In addition to this, interviewees agreed that some sort of cost data and knowledge was required from a similar scheme, whether it be from previous experience, and historic data from pricing books or in-house data from their own company or other companies. Interviewee 7 identified that it can also be dependent on what type of contract terms are priced against. Most of the interviewees stated they have in-house records at their current companies with the exception of interviewee 11. Interviewees 4 and 8 believed their in-house information to be dependable as it is actual outturn costs. However, interviewees 1, 2 and 9 stated that they used estimated costs and believed it to be reputable if the final project cost came in within 5 - 10% of the estimated cost.

Whilst most of the interviewees maintained that the current methods for representing risk within the early estimates are inadequate, they feel there is no alternative. Interviewee 4 supported this stating, "...at a stage where you haven't got full design, I think a percentage on the estimated contract is the best you can do really". However, interviewees 1 and 9 both offer a potential improvement of risk representation by getting input from professionals who work specifically within each identified risk area.

Discussion: Hard and Soft Information

The rich picture in figure 1 presents findings from the data analysis and attempts to depict the information transfer of the early estimation process. Liberti and Petersen (2017) define hard information as quantitative information which can be conveyed easily in a detached manner and the data collection process has no effect on the informational content of the data. Meanwhile, Wiebe (2010) explains that soft information is subjective information that is based on feelings and perception. As can be seen from Figure 1, the estimating process for infrastructure projects is fundamentally built up of a number of hard and soft informational transactions.

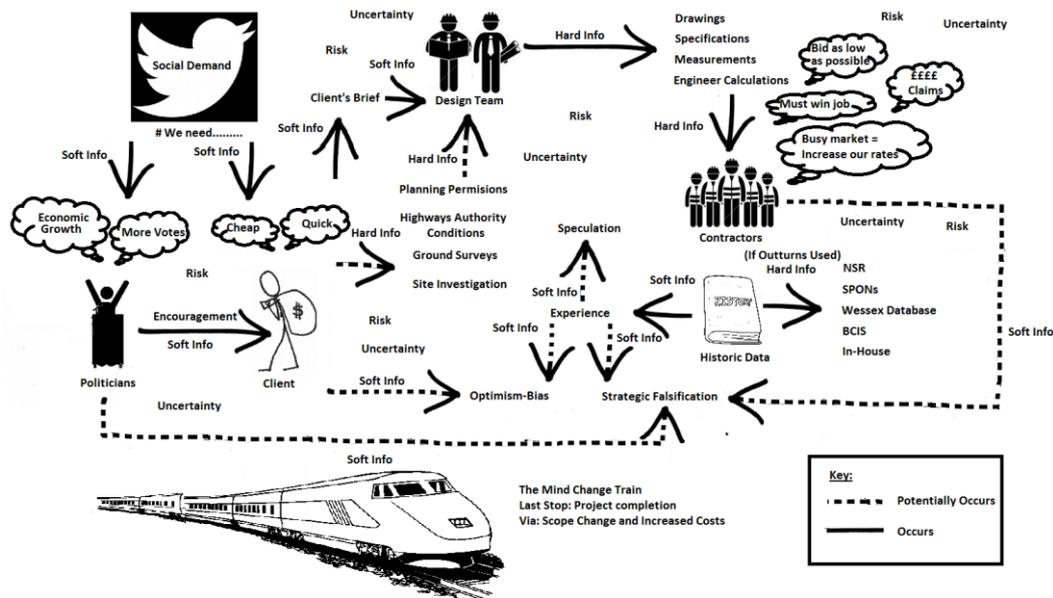


Figure 1: Informational Transfer in the Early Estimation Process

Furthermore, Bertomeu and Marinovic (2016) also determine that inaccuracies are more likely when soft and hard information are provided in unison; they argue that the combination of hard and soft information will make all information soft. Due to the nature of infrastructure projects being driven by social demand and biases in the political environment, there is a high volume of stakeholders involved; thus, subjective, soft informational inputs will be coming in from all directions. Therefore, an estimate will always be a soft information output. Moreover, Liberti and Peterson (2017) suggest that if some of the information input is qualitative it cannot all be represented by a single numerical figure; instead, an experienced individual needs to make a judgment call. This indicates that an estimate should not be taken as an absolute figure for project costs but as soft information which requires human interpretation.

An issue with an estimate being largely made up of soft information is that soft information is more susceptible to manipulation (Godbillon-Camus and Godlewski, 2005). This can stem from the stakeholders having different end goals; whilst the client wants to spend as little as possible, the contractor wants to make as much as possible, the politicians want popularity and for their desired scheme to go ahead and the engineers want to produce something practical and picturesque. Subsequently, this can often lead to a non-collaborative and disjointed information exchange process. Since the data can be easily manipulated strategic falsification and optimism-bias can creep in; the findings suggest that contractors seek to price a job as low as possible (while following the standard of estimation) and may misrepresent information. Additionally, clients can be too over-optimistic with timescale and costs and politicians often seem to ignore the risks and accentuate the positives of a scheme.

Additionally, uncertainties and unknowns plague the early stages of an infrastructure project (as depicted in Figure 1) and affect the estimation process. They too are based on soft information which also leaves them open to manipulation from stakeholders. However, the findings support that they can be reduced through appropriate research from clients such as ground surveys and site investigations. Nevertheless, these are not often carried out prior to estimation which could be due to reluctance on the client's part to spend money. Furthermore, the majority of the participants in the primary research felt that uncertainties and risks were not adequately represented within estimates. This is

difficult to address as it is the process of converting soft information into hard information and when soft information is hardened it will inevitably lose some of its information or context (Liberti and Peterson, 2017).

Thus, embedded within the very foundations of the estimating process for infrastructure projects is a fragmented, soft information exchange that is open to manipulation from many stakeholders involved. Hence infrastructure projects continually experience such a high volume of scope change throughout the project. Due to this very nature of the projects, soft data is a key element of the estimation process. However, budgets produced by estimates has become to be accepted as hard information even when it is known to be soft information that requires interpretation and sense making.

CONCLUSIONS

Cost overruns have become an accepted norm within the UK construction industry's infrastructure projects for a variety of reasons. Firstly, the early estimation process for infrastructure projects involves numerous data exchanges between various interested parties, which makes the whole process extremely intricate. Furthermore, due to the nature of infrastructure projects, there are a high number of interested parties within this intricate system of data exchange who can have an effect on the estimation process both explicitly or indirectly. This also means there is a high volume of soft information going into the estimation process which is susceptible to manipulation for personal gain. Hence, a cost estimate is essentially a soft informational output, thus it needs to be made sense of to provide meaning; therefore it should be considered as a way of providing advice to the client, not an absolute figure of anticipated project costs. Additionally, there will always be a high volume of uncertainties and unknowns on infrastructure projects and whilst appropriate research can reduce these, they will never be eradicated. These are both factors that you cannot get away from as they are inherent in the nature of the work. Therefore, even though cost overruns come with connotations of poor estimation as the literature review highlighted, it is not necessarily the case and estimators do not deserve to be stigmatised for it.

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