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Does Social Identity Theory Explain Why So Many Complex Rail Projects Have Cost and Time Overruns?

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Abstract

Social identity theory, uniquely applied here to the rail-industry, can be used to explain the relationship between, sector-designers on the one-hand, and main-contractors on the other-hand, and how such interactions affect project quality, and cost & time progressions; namely, this work finds that both groups have strong group entitativity, leading to behaviours that negatively impact the project, and contribute adversely to the measurable factors of success. These behaviours include a lack of trust between fellow-stakeholders, and a propensity to challenge others' capabilities and motivations. Senior level practitioners involved in complex rail projects across three different continents have been consulted within a structured, qualitative research approach towards a thematics' analysis, compliant with a classical Creswell methodology. Responses from participants indicate that projects that are successful have 'people-based' characteristics that overcome systemic difficulties, and are then able to counter any negative effects across disparate (professional) social identities. The work here finds that, in addition to trust, towards ensuring a successful rail-project, there is much need for what this research is defining as an overarching '*guiding mind*'.

Keywords: cost control, engineering management, projects, systems engineering, system integration, training and development, life cycle cost.

1 Introduction

Cost and time overruns for complex railway projects (CRPs) are often highlighted in the press and stories of seemingly huge gaps between budgets and actual cost grab headlines. The problem is international with the UK's Crossrail exceeding approximately £20 billion compared with the approved budget of £14.8 billion in 2010 [1]. The Indian government quarterly project statistics highlight rail projects as the project type with the highest overrun cost with rail project overspending at 54% compared with 3% for road projects [2]. It is estimated that cost overruns for active transportation projects in Australia during 2020 was $24bn and this could increase further [3]. The problem is not limited to any one region or country although recent research suggests it is more significant in English speaking countries [4].

1.1 Causes of Cost and Time Overruns

A wide range of causes have been identified often with a recognition that they are not singularly responsible for the associated cost and program overruns.

1. **Political interference** is often cited as a cause due to the opportunity that is taken by politicians to highlight failures of their competitors, and this cause can be exaggerated or distorted. Research has highlighted the impact of politicians taking actions to progress projects that should have had more scrutiny, further development or even where the project clearly did not have a good business case. Examples of governments spending money in marginal seats to influence elections has been identified with the political incentive to avoid fully revealing the costs whilst in government and trying to exploit any overspends when in opposition [5].
2. **The role of the client** is essential for the success of projects by providing clear direction, strategic leadership and working to resolve problems when they arise. The enquiry into the cost overruns on Inland Rail found that the ARTC board lacked both rail and major project delivery expertise [6]. An investigation into cost overruns in the UK [7] found that clients were often dependent upon consultants for support and lacked skilled expertise due to the difficulties of recruitment and the need to build a client team quickly.
3. CRPs are characterised by **complexity** and the requirement to engage with multiple stakeholders often with conflicting priorities and topics should be considered in addition to any technical or physical complexities.
4. The difficulties of achieving high quality engineering deliverables, estimates, risk registers and other outputs during **development** has been highlighted and identified as a cause of cost and program overruns [8]. This problem also leads to poor quality business cases that are approved without adequate information [9].
5. **Changes to scope** after budget approval has consistently been identified as a significant root cause of cost overruns [10]. This can obviously be caused by other factors already highlighted such as changes in direction by stakeholders, poor development, lack of understanding and changes in circumstances over the life of the project. Changes can be due to design errors or changes, and

these changes can result in rework or program delays [11]. Design changes can be initiated by the contractor, stakeholders or due to the natural evolution of the project as new information about ground conditions, interfaces or other circumstances evolve [12].

6. **Poor risk management** throughout the life of the project has been proposed as a significant contributor to cost overruns [13] this includes the methodology of risk management but also the whole approach to risk which has been found to include significant optimism bias [14].
7. Finally, the area that has been highlighted repeatedly is the **lack of capability within the supply chain** [11]. This can take many forms from a lack of project managers, designers and engineers to shortages of plant, materials and skilled labour to carry out the construction work.

Despite these causes, it is important to consider the context associated with cost overruns and the lack of standardised approaches to evaluating cost performance [15]. A lot of these overruns are against early budgeted estimates rather than contract awards or even the government funding authority. When this is considered the cost overruns are often much smaller with some researching estimating it at 23% and the cause was mainly due to scope changes [10].

1.2 Interaction Between Designers and Contractors

The interaction between designers and contractors is often discussed in terms of contractual relationships, management processes and the use of BIM and digital engineering however there is very little relevant research available explaining how the interaction may contribute to cost overruns. Many experienced senior industry insiders provide anecdotal evidence that the problems associated with this interface include misaligned objectives, lack of capability, lack of technical leadership, excessive complexity and inadequate processes to support the successful delivery of CRP's.

A survey of designers and contractors in 2000 [16] highlighted some potential issues such as process efficiency, misaligned financial incentives, quality, and level of design detail however this work did not explore the underlying reasons or provide any proposed solutions. There is a need to explore this topic further to confirm or reject these opinions and the research being carried out aims to fill this knowledge gap.

The designer/contractor relationship is complex and exists throughout the project life cycle. Some important characteristics are described below.

1) Evolving Relationship

The relationship between designers and contractors varies throughout the project lifecycle and the approach adopted can vary significantly depending upon procurement strategy, delivery model and other factors explored later. The evolving nature of the relationship is important to consider because it often changes the people involved from both the designers and contractors throughout the project life.

Early in the project life cycle it is unusual for there to be a significant contractor involvement, the designers normally lead the development of the concepts for a project focusing on project objectives, high level costs, deliverability and options. CRPs typically adopt a modern systems engineering approach using the 'V' cycle model derived from Systems Engineering Book of Knowledge [17]. As the project moves towards a funding decision it is common to have some contractor involvement to assist with estimating and to provide input from a constructability and program perspective however even at this stage there can be a reluctance to engage with contractors due to probity concerns. This stage can be problematic for both designers and contractors because the contractors can be reluctant to engage fully because it can exclude them from bidding on the main works. Designers typically lead the development activities working with the client-side team and this can result in a lack of effective challenge and involvement of contractors [10].

Following project funding there is typically a procurement process using the chosen procurement model involving the packaging of some or all of the project ready for market engagement. A variety of different contract models are available and at this point contractors often mobilise significant bidding teams and engage designers as part of preparing a response to the tender process. This is often where the key relationship between designers and contractors is established, and this is influenced by some of the themes discussed later. CRPs typically involve multiple contractors and designers working together. They initially prepare a tender submission and then work together to deliver the project.

The delivery phase when a project has started to carry out detailed design and site work can include many complex relationships with the client potentially providing a design capability either directly or through suppliers they directly employ. The team awarded the contract can be structured in many ways but typically has relationships aligned to the delivery model that has been adopted with the designer working as suppliers to the contractor(s) or through an alliancing arrangement.

The different models can be complex; however, they can significantly influence the relationship with the designers. During the mobilisation period the designers engineering deliverables are typically on the critical path of the integrated program and provide the early design and material procurement requirements. As the project progresses the designer's role reduces and may evolve to support construction and provide some assurance. Throughout the project the relationship between designers and contractors evolves and due to the nature of CRPs different parts of the project may be at different stages e.g. early work construction in advance of the commencement of some rail system design.

2) Formal Processes

Formal processes to describe the interaction between designers and contractors in CRPs are not normally introduced until the implementation phase of a project. These processes typically take the form of management plans with titles like engineering management, project management, BIM management, systems engineering, safety assurance, interface management, construction management etc. These documents aim to describe the processes that are necessary for designers and contractors to work together. Some of the activities that are described are listed below and the processes detail roles and responsibilities, decision making processes and describe how records should be kept.

1) Design reviews including the input from contractors to ensure that complex engineering deliverables are integrated between disciplines, safe, cost effective, maintainable, constructable and meets any other criteria established by the review process
2) Issuing of engineering deliverables from designers to contractors describing what, when and how information is exchanged ensuring that information is complete, usable and aligned with the project program
3) Requests for information, technical queries, field change requests and other similar contractor-initiated communications. These requests can lead to alterations or updates to already issued engineering deliverables
4) Project and contract management processes that includes revising and tracking progress against plans and deliverable trackers, commercial claims and progress.
5) Construction assurance processes where designers are involved in verification and validation activities to confirm that the contractor has built something that meets the requirements of the engineering deliverables issued by the designer.

These processes help to define the interactions between designers and contractors often building upon experience from previous similar work. Most CRPs have an integrated management system with a complex interaction between client systems, bespoke project systems and the systems from the individual companies. The level of integration between these systems varies significantly from fully integrated with all parties working in the same management system to a devolved system with only a few processes such as information sharing, correspondence and approvals using a common system.

3) Informal Interactions

The use of formal processes helps to define the varied and continuous interactions between designers and contractors for CRPs however they do not necessarily cover all interactions. CRPs have ongoing informal interactions that includes conversations and discussions at the personal level and at all levels of the organisations involved. CRPs can involve many different groups of people from different teams and locations within the same organisations as well from a wide variety of organisations. An example from a recent project in Western Australia had design teams from the same company working in offices spread across Australia and internationally, and other separate companies based internationally and only a handful of the design team were co-located with the construction team in Perth. Most interactions took place using electronic collaboration tools such as ‘Bluebeam’, ‘Aconex’, joint and individual company SharePoint systems and bespoke company tools. Microsoft ‘Teams’ became the normal format for meetings with people rarely meeting together during the design stages. Even during construction most of the design resource provided input remotely.

All forms of communications are used in these interactions, and the strength and success of these interactions are often dependent upon the following factors.

- Proximity
- Existing relationships
- Education
- Language
- Values
- Communications skills

1.3 Social Identity Theory

The topic of social identity in construction has only had limited research [18] but this has found that there are difficulties between different professional groups within construction organisations. Social identity theory explains behaviour between social groups [19] and has the following three stages.

- **Social categorization**: People categorize themselves and others into social groups based on external or internal criteria.
- **Social identification**: People identify with the social group they belong to.
- **Social comparison**: People compare their social group with other groups to enhance their self-esteem.

The first stage involves self-categorisation, and this uses criteria that are commonly accepted amongst the group such as education, career pathways etc [20]. The criteria can be physical characteristics, shared values, behaviours and can cover a wide range of attributes. The level of entitativity between groups can also vary with groups that have worked closely for long periods of time potentially having a high entitativity compared with groups that are separated by distance, language etc. Although the level of entitativity may vary based on social identity theory and specifically self-categorisation, designers and contractors can be categorised into social groups using the criteria shown in Table 1 below.

	Designers	**Contractors**
Education	Academic, degree qualification, possibly post graduate	Trade based qualifications, limited tertiary education
Social Economic background	White collar	Blue collar

Career Progression	Junior designer, senior, principal and then leadership roles that are either technical or managerial	Apprentice trade, competent at specific tasks, then in supervisory, management roles limited opportunity for technical specialism like to instead progress to more senior management roles
Skills	Based on an academic qualification providing a broad basis for competency. Company frameworks for competency based on discipline specific skills and seniority	Task based competencies e.g. plant operator, track layer. Management/leadership competencies part of progression within organization framework focusing on people, finance and organizational skills
Environment	Indoor, office/home based, computer based with digital tools, limited site exposure	Outside in all weathers, heavy physical work, wearing personal protective equipment, using plant and tools
Behavioural drivers	Legal, commercial concerns about consequences of any errors/failures to meet the client requirements or safety issues that could lead to litigation.	Safety concerns about own and others' welfare in the workplace, fear of consequences from delays to work or deviating from the designer requirements

Table 1: Comparison of Designer and Contractor Social Groups.

The categorisation in Table 1 is a simplification however it provides an illustration of some real and some perceived differences between designers and contractors. These differences can lead to social categorisation of designers and contractors as clearly defined separate and mutually exclusive groups of people. People within the industry identify with these groups and this is reinforced through processes and systems that defines the roles clearly and this encourages differentiation between designers and contractors.

The social comparison aspect of social identify theory is reinforced between designers and contractors by processes and systems and the contract mechanisms that are adopted and the challenges of building trust [21]. The contractors typically assign the work done by designers into different packages particularly during the early stages of the project lifecycle. There is very little research in this area, however the anecdotal evidence indicates that conflict between designers and contractors is often represented in terms of criticisms of the 'other' groups as not understanding the 'in group' requirements or lacking knowledge and capability.

The complexity associated with CRPs further enhances this differentiation and the packaging of work for either designers or contractors to deliver. Even within designer groups there are separate social categorisations between 'track engineers' and 'signal engineers'. Social identification and comparison may be reinforced through professional organisations such as the Institute of Railway Signalling Engineers or the Permanent Way Institute. It is also possible that the establishment of these groups could provide excellent opportunities to spread learning and expertise. They provide people with access to information, and they are not established exclusively for designers.

It is often hard to identify the single decision-making person within a particular engineering discipline and that is often seen when there are disputes between designers and contractors. This contrasts with the historic 'residential engineer' role that was common on projects and while it may appeal to be a nostalgic view of projects it could be considered as a method of improving project performance. Research in this area is very limited, out of date and only some of it applies to CRPs. The challenges of getting designers and contractors to work together could reflect differences in their shared values, norms, beliefs and goals. This research is looking to explore the idea that the designers have become more detached from the contractors' activities and the contractors similarly for design. The consequence of this is that people are more likely to identify with the group they belong to rather than accommodating the 'other' group.

2 Methods

A mixed methods approach has been adopted for this research with the first stage consisting of a comprehensive literature review which provided the key themes that form the basis for investigation in the second stage questionnaire. Questions were developed and piloted with a group of four participants to establish readability, relevance and clarity. The questions are grouped into the following themes and answered using a Likert scale with the opportunity to explain more in 'free text'.

1. Rail
2. Processes
3. Complexity
4. Contract Models
5. Design/Contractor Interface
6. Systems Engineering

7. BIM/Technology
8. Alignment
9. Social Identity

The participants have all held senior positions within client, contractor or designer organisations with many working in two or more areas. Approximately fifty people have been contacted, and nineteen responses have been received. The expectation is to achieve a sixty percent response rate and there will be follow up with interviews to explore the topics in more detail. Participants will remain anonymous and are from across the UK, Europe, Canada and Australia. The questionnaire and data gathering followed processes approved by the universities ethics team and data was collected using Microsoft 'Forms'. This enabled the data to be easily post processed and analysed.

3 Results

The results from the questionnaire provide strong evidence that there are issues in the relationship between designers and contractors. These are summarised in Table 2 below.

Statement	**Agree or Strongly Agree**	**Disagree or Strongly Disagree**
Designers have strong incentives to develop design solutions that consider total project cost	17%	
Designers are incentivised to produce unnecessary deliverables or more complex deliverables to increase income	52%	
Designers are incentivised to produce low risk deliverables to maximise profitability and/or avoid risk of claims	61%	
Contractors lack the necessary capabilities to use design deliverables without the support of designers	43%	
Designers are focused on producing deliverables for approval rather than for the construction of the project	74%	
Contractors know what to expect from the designer at all stages of the project		52%
Designers know what to expect from the contractor at all stages of the project		70%
Contractors are focused on building in a way that is lowest cost and quickest rather than compliant with the design deliverables	65%	
Levels of trust between designers and contractors is high		74%
Designers feel that contractors don't respect them	56%	
Contractors feel that designers don't respect them	52%	

Table 2: Responses Highlighting Designers/Contractor Relationship Concerns

Additionally, only 9% of people thought that designers had got better at producing fit for purpose designs in the last ten compared with 52% who thought they had got worse. A similar view of contractors was recorded when considering if they provided designers with the necessary information and support with only 22% saying it had improved in the last ten years and 48% stating it had got worse.

The issue of social identity was explored, and it was clear that the two groups had strong distinct identities as reflected in the responses below.

1. Designers have a strong sense of identity that is separate from the role of people who build things using tools and equipment - 91% agree or strongly agree
2. Contractors have a strong sense of identity that is separate from the role of people who design things using design tools and technology - 91% agree or strongly agree

It should be noted that 74% of people believed that categorising people into groups of designers and contractors or different engineering disciplines is an oversimplification of the group dynamics between people carrying out work on CRPs. This highlights the need for more research in this area and the need to understand the complexity of applying social identify theory for CRPs.

Solutions and characteristics of successful projects were also explored and people had strong views about the key things that influence the success of projects as shown in Table 3 below.

Statement	**Agree or Strongly Agree**	**Disagree or Strongly Disagree**
Digital Engineering has improved the interaction between designers and contractors	83%	
The introduction of systems engineering has reduced costs and risk	36%	
Project processes are well understood by all relevant stakeholders		75%
Contractors with in-house design capabilities are better at managing the commercial relationship designers	65%	
Having a clear guiding mind improves alignment between designers and contractors	95%	
Trust between designers and contractors is an important part of achieving a successful project	100%	

Table 3: Responses to Potential Solutions

The responses to these questions are probably not surprising although the lack of evidence that systems engineering has helped reduce cost and risk could be an interesting challenge to the common view that systems engineering is essential for complex projects to be successful. The low result could be explained by the response that 95% of people either agreed or strongly agreed with the statement that systems engineering varies widely between projects. The lack of consistency could be more of a concern than the application of systems engineering.

The free text responses provided some very useful information helping to explore some of the complexities associated with research in this field.

4 Conclusions and Contributions

The research can conclude that the relationship between designers and contractors is considered important for the success of projects based on the strong views of the people questioned. Currently the levels of trust are low, and the view of each other's performance is not positive with a view that this has deteriorated in the last ten years.

Social identity theory has not been used to explain the interface between designers and contractors previously so reaching conclusions based on the limited available information should be treated with caution. The level of entitativity between groups can vary with groups that have worked closely for long periods of time potentially having a high entitativity compared with groups that are separated by distance, language etc. The results showed high levels of entitativity based on self-categorisation and designers and contractors can be categorised into social groups. They exhibit some of the negative aspects identified by social identity theory such as distrust and negative views of the motivations of the 'other' group.

Some of the solutions such a digital engineering that have been applied extensively on projects are recognised for their value, however it appears little success has been achieved with the development of effective processes. The overwhelming support for the concept of a 'guiding mind' indicates that there is a strong view that a person or persons with clear decision-making authority, clarity of vision and the empowerment necessary to follow through on actions is critical for the success of complex projects.

In the next stage of the research more detailed interviews and investigations will be carried out and the trialling of the ISO 44001 collaboration process, adopting the concept of a guiding mind and exploring some of the other features identified as necessary for successful complex rail projects. It is possible that social identity theory could explain and help to solve the problems experienced on many complex rail projects.

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