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DESIGN AND BUILD – A DELAY REDUCTION METHOD FOR CONSTRUCTION PROJECTS

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The paper reports on a study of the impact of traditional and design & build delivery methods to ameliorate schedule delays in the South African construction projects. A case study approach of two similar projects was adopted for the study. Data was compiled from document analysis and semi-structured interviews. Selection of projects was purposive and convenience based. A comparative analysis of the two projects was performed on delays to inform on which delivery method ameliorated better the impact of schedule delays. Findings were that design and build marginally reduced the impact of consultant related delays. Little impact was however found for client, contractor and design change related delays. Most construction projects suffer delays, which inevitably increases the contract sums. Reducing the impact of delays is therefore critical. Choice of a delivery method offers an opportunity to reduce the delays and therefore it is valuable to understand which delivery method offered better results. Findings underscore the importance of seeking alternative methods to improve performance. The design and build method seemed to perform better than the traditional method on delay reduction. The implication is that although clients prefer "safe" methods, alternative delivery methods offered better results.

Keywords: Project delivery method, Traditional method, Impact of project of delays, Prevalence of project delays.

1 INTRODUCTION

The construction of large public and private sector water treatment facilities is largely implemented through a project delivery method named design-bid-build, otherwise known as the traditional method. Under this method, the management of the contracting parties and design of the facility is performed by engineering consultants or architects and the construction by a chosen contractor. However, these contractors are kept at a distance hampering synergy and innovation (Davis *et al.* 2008).

The traditional method of project delivery is still used as it is considered to obtain the lowest cost for the client and protect their interests with the expected guarantee of a sound engineering job (Love *et al.* 2014). Despite this the benefit to the client is lower than expected (Ng 2005) due to the consultants' lack of specialized skills and poor cooperation with contractors, ultimately leading to cost overruns caused largely by delays and rework. This has resulted in the decrease in

popularity of traditional fixed-price tendering through an engineering consultant (Oyegoke *et al.* 2009), due to competition from more modern and successful design & build delivery method.

According to Chan *et al.* (2011), the design & build project delivery method allows a selected engineering contractor complete control of the design and construction process. One entity is responsible for both the design and construction of the project, allowing the project owner to sign only one contract, thus maintaining a single point of responsibility. This allows the contractor to apply their expertise and determine practical constructability problems early on, usually only found at an advanced stage when rework is expensive. Design & build delivery methods harness the expertise and experience of the selected contractor which maximizes client value by reducing delays, fostering innovation and reducing the project schedule. As a result, literature by Konchar and Sanvido (1997), Hale *et al.* (2009) and Ibbs *et al.* (2003) all found that design and build methods are beginning to produce better results than traditional methods globally.

The success of this method in developed countries has led to extraordinary growth in its adoption. However, the adoption of the design & build method in South Africa was low according to Grobler and Pretorius (2002). Further research is required to determine, whether local role players have the ability implement design & build effectively and reap its benefits.

1.1 Pre-Tender Decisions

The owner of a construction project has several important decisions to make before being put out to tender. Three such decisions which need to be made as early on as possible in a project according to the Design Build Institution of America (2015) are the; project delivery method, procurement method and contract type. Proper consideration of each decision is required to match the project characteristics, as these are some of the most important factors contributing to project success (Kumaraswamy and Dissanayaka 2001). The project delivery method defines the roles and responsibilities of the parties involved and is one of the most important decisions the project owner must make. According to the Construction Management Association of America (2012) there are four types of project delivery methods namely; Design-bid-build or traditional methods, construction management at risk, design & build and Integrated project delivery method. Before a construction project can go out to tender the project owner must make the above-mentioned important decisions which has the potential to impact greatly on the project success. The project owner must carefully consider the characteristic of the construction project and choose the best suited project delivery, procurement and contracting method.

1.2 Project Delivery Methods

In South Africa, the dominant project delivery method used to implement construction projects is the traditional method followed by the design & build delivery method according to Grobler and Pretorius (2002). The traditional delivery method, also known as design-bid-build is still the most commonly used method to procure construction projects (Mahdi and Alreshaid 2005). Under this method, the project is typically split into separate sequential phases of design development, tender, contract award and construction phases. The fundamental principle of the traditional method is the signing of two or more contracts by the owner, one with the designer and another with the contractor (Davis *et al.* 2008). The contractor is responsible for building the project as designed and the designer is responsible for designing the project to the client's specifications and also runs the project as the project owners' representative (Mahdi and Alreshaid 2005). This is intended to ensure a quality project, which meets the client's needs and is used on most public works projects. The clearly defined roles and responsibilities make the

contractual arranges easy to manage, however these relationships have been shown to become adversarial when rework and change orders are required, leading to cost and time overrun.

Design & build can be summarized as a delivery method where the responsibility of both construction and design falls under one entity. The owner of the project can then sign only contract, allowing all responsibility to be contained to single point (Mosey 1998). Under design & build, the complete design and construction is not always completed solely by the contracted entity, different forms exist, however in all cases the adversarial relationship experienced between design and construction teams found in traditional methods is mitigated. The design & build delivery method has numerous advantages largely as a result of the single point of responsibility. These advantages include: a shortened project duration (life Cycle), establishing more accurate cost, reducing cost, increasing innovation and reduced claims.

Table 1. Project delivery method schedule growth comparison.

		Schedule growth	
Author	**Project Type**	**Design & build (%)**	**Traditional (%)**
Shane *et al.* (2013)	Roads	23	20
Shrestha *et al.* (2012)	Highways	-4.2	4.8
Ibbs *et al.* (2003)	Buildings	4.1	6.5
Konchar and Sanvido (1997)	Industrial buildings	0	5
Hale *et al.* (2009)	Military facilities	11.4	13.8

The success of this method in developed countries as illustrated in Table 1 has led to extraordinary growth in its adoption. However, the adoption of the design & build method in South Africa is low according to Grobler and Pretorius (2002). Further research is required to determine whether local role players can implement design & build effectively and reap its benefits.

2 RESEARCH METHODOLOGY

The aim of this research was to determine how the project delivery method used on a construction project impacts on delays, thus allowing the researcher to determine whether the design and build project delivery method can reduce delays on construction projects when compared with the traditional method, as seen internationally.

This research made use of two similar case studies, which differed as far as possible by the project delivery method used only. The case study method was chosen for its ability to determine operational links over a period of time instead of simply frequencies of specific occurrences. It provides insights into organizations and gives an in-depth understanding of the issue being studied. Multiple sources of information were used for analysis, which included documentation and interviews. Documentation relating to delays was gathered for each case and entered into a case study database. The project contract managers of each case were interviewed in semi-structured manner, using a questionnaire as a guideline. Responses were transcribed and coded, allowing the generation of themes, which were compared with documentation allowing in depth analysis of each case. A comparison was then performed between cases and conclusions made from the findings presented.

2.1 Case Description

Case study 1 covered the capacity upgrade to a waste water treatment works which is managed by the government institution “ABC”. The institution required a 50ml/day conventional activated

sludge extension to the existing plant in the form of an additional module to treat the increasing load. The project was implemented using the traditional project delivery method resulting in the signing of five separate contracts between consultants and contractors. A competitive bidding process based on a supplied bill of quantities was used by the client. The selected contractor was awarded the contract at a cost of R118 million and expected duration of 110 weeks.

Case study 2 was performed on the capacity upgrade to waste water treatment works (WWTW), which is managed by the government institution "ABC". In 2014 the organization identified the need to upgrade the WWTW by 5ml/d within 2 years to cope with the expanding population of the area. However, due to space constraints on the plant, an upgrade using the treatment method in operation was not possible. A specialized solution was needed to fit the requirement. The researchers' organization was chosen as the only bidder able to meet the project requirements using their proprietary technology.

The design & build project delivery method was therefore used as the researchers organization held the technology rights. The researcher's organizations consultant was employed by the client in order to develop the tender specification. Once the contract was awarded, the consultant then returned under the employ of the researcher's organization, otherwise known as novation design & build. The researcher's organization was the sole supplier thus the price was negotiated to a guaranteed maximum price of R25 million with an expected completion time of 72 weeks.

3 ANALYSIS AND COMPARISON

Project documentation was gathered for each case and entered into a case study database. Interviews were then conducted and transcribed. The transcriptions were then coded using CAQDAS software and case specific themes developed. Analysis and comparison between cases was then possible using the gathered documentation, themes and literature.

The Pre-tender decisions taken by the project owner are presented below and compared to findings in literature. It is clear that the decisions made by the project owner followed exactly that suggested by literature. Both cases made pre-tender decisions as suggested by literature and thus one can conclude that the environment was correct for both projects to succeed. Each case study's delays were then compared in order to determine the length and cause of delays, which were present for each case study. Delays affecting the project timeline were extensive in both case studies, however the causes under each case vary.

Table 2. Pre-Tender decision comparison.

	Case 1	**Literature**	**Case 2**	**Literature**
Project delivery method	Traditional	Traditional	Design & Build	Design & Build
Procurement method	Low Bid	Low Bid	Best Value	Best Value
Contract method	Fixed Price	Fixed Price	Guaranteed maximum price	Guaranteed maximum price

Table 3. Schedule growth comparison.

Case study	**Start date**	**Planned completion**	**Actual Completion**	**Overrun**	**Schedule growth**
Case 1	11/10/2012	16/11/2014	8/1/2016	625	81%
Case 2	2/5/2015	16/3/2016	incomplete	622 (at time of writing)	123%

Table 3 presents the schedule overrun experienced in each case study. Both case studies experienced schedule growth far in excess of that found in literature. In addition to the greater

schedule growth when compared to literature, design & build was also found to experience larger schedule growth than the traditional method. These discrepancies with literature were then analyzed further in conjunction with interview data in order to determine the cause. A detailed breakdown was then produced and illustrated in Table 4.

Table 4. Project delivery method impact on delays.

Delay type	Case 1 (Traditional)	Case 2 (Design & build)	Design & build delay impact
Civil	Significant	Mild	Reduction
Variation Orders	Significant	Mild	Reduction
Consultant	Mild	Negligible	Reduction
Design Changes	Mild/Negligible	Mild/Negligible	No effect
Contractor	Mild/significant	Mild/significant	No effect
Client	Mild	Significant	Large increase

Negligible <= 1 week Mild 0-3 Months Significant > 3 Months

Table 4 presents the impact of the project delivery method on delays. It is clear that design and build was able to reduce the effect of civil delays. This was in part due to the fact the contractor was able to choose their own trusted sub-contractor to perform the work. The civil sub-contractor was under the direct employ of the design & build contractor. This meant the design & build contractor was able to apply considerable pressure to speed up work and reduce potential delays due to design changes. The impact of variation orders was reduced from significant to mild. This was due to the ability of design & build to provide a more complete design up front, resulting in fewer changes during the project. In addition, the need for formal documentation and approvals was reduced because the design & build contractor was fully responsible for the design. Approvals for changes from an external consultant were not required allowing changes to be made without approval delays. The consultant delays were reduced from mild to negligible, largely due to the elimination of the need for official RFI's. The design process was more fluid under the design & build method as the consultant was in-house to the design & build contractor reducing the need for formal documentation and increasing cooperation.

No change in impact on design changes was found between case 1 and case 2. The impact on delays due to the contractor was also found to have no impact across delivery methods. However, it is possible this was due to the same contractor being used in both case studies. Perhaps the single most important finding is the increase in delays experienced due to client related factors. Under the traditional project delivery method, a consultant is present to act as the client agent and make decisions on their behalf and manage the construction process. Under the design & build delivery method the client has no agent to support them in decision making and management of the project. The design & build contractor now has the ability to make a large percentage of these decisions for the client, however, the client is still required to make some decisions. This places an extra burden on the client's resources to make these decisions and plan accordingly.

Furthermore, significant delays were experienced due to the inability of the client to complete work within their scope on time. The costliest decision by the client was to not award a variation to the design & build contractor. This decision, along with having work in the client's scope removed the single point of responsibility shown to be design & builds greatest advantage. The result of these decisions led to the projects most significant delays and ultimately caused the project to run vastly over schedule.

4 CONCLUSIONS

The aim of the research was to determine how the project delivery method effects the prevalence and impact of delays with goal of proving and reduction though the design & build method. The results of this research found that design and build was able to reduce the impact of delays related to: Civil, Variation Orders and Consultant.

However, while design and build was able to reduce the impact of delays in three areas, it also increased the impact of delays related to the project client. Importantly, this increase in impact of client related delays was so extensive that it negated the reduction in impact experienced in the three areas. As a result, design and build experienced 42% more schedule growth than its traditional counterpart. The design and build delivery method does not necessarily reduce delays on construction projects, however, the design and build project studied was not able to maintain the single point of responsibility required for successful implementation. Therefore, further research is suggested using a properly implemented design and build project.

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