CRITICAL SUCCESS FACTORS: THE DEVELOPMENT OF A CONCEPTUAL FRAMEWORK FOR DEMOLITION PROJECTS

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Critical success factors (CSFs) are an established tool to distil key issues. While extensive research has been undertaken to develop CSFs for construction projects, no known CSFs study has been undertaken specifically for demolition projects. While some studies have looked at identifying CSFs for diverting end-of-life waste from landfill, their attention has been limited to the design phase and its impact on the performance of the demolition contractor. This study focused on the engagement and delivery process of demolition. 30 academic papers relating to the end-of-life phase of buildings were carefully studied to extract potential CSFs for demolition projects. As a result, 49 factors were identified and categorised under 5 main categories: Project procurement; project stakeholders, project management actions, project related factors; and external factors. The identified factors were ranked based on their number of mentions in literature, of which the following were highlighted as most important: 1) Effective communication among project stakeholders; 2) Client to give sufficient time for demolition contractor to deconstruct rather than demolish; 3) Designers to consider the end-of-life in their designs; 4) Clean on-site separation of materials; 5) Government to provide financial incentives for demolition contractors for adopting less wasteful demolition methods; 6) Government incentives through standards to create a market for reused/recycled materials. From the CSFs study, a conceptual framework is presented which helps to clarify the complex nature of demolition projects and pinpoints the factors that affect the success of demolition projects.

Keywords: CSF, demolition, stakeholder management, end-of-life

INTRODUCTION

Critical Success Factors (CSFs) are an established tool to distil key issues and are considered to be one of the essential ways to understand the core challenges to a particular industry at a particular time (Bullen and Rockart, 1981). Many attempts by researchers have been made to identify CSFs for construction projects (Chan *et al*., 2004; Liu *et al*., 2012; Yong and Mustaffa, 2013; Alias *et al*., 2014) to reduce waste, improve efficiency, develop new strategies and processes, manage stakeholders, and to promote frameworks and guidelines for project success. In contrast, very few studies have been conducted for demolition projects and the end-of-life phase except for those which focused on minimising waste through design driven CSFs (Akinade el al., 2016). The demolition industry has been noted in many studies as lagging behind

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in terms of research compared to the construction industry (Quarmby *et al*., 2011; Thomsen *et al*., 2011). The study of project success and critical success factors for buildings end-of-life is therefore timely for many reasons. Firstly, the demolition contractor is required to take a lot of managerial decisions during the delivery process of projects (Diven and Shaurette, 2010), and to date, there is no evidence that a study has explored the CSFs at projects end-of-life (Akinade *et al*., 2016). Additionally, one of the major drawbacks in the current demolition industry is the lack of consideration in terms of the relationship between demolition contractors and other construction stakeholders (Kunieda, 2016). Also, Takim *et al*., (2004) noted that one of the hindrances of successfully managing a construction project is failure to determine relevant CSFs across project phases. Omran *et al*., (2012) added that improving the effectiveness of projects and achieving project objectives starts by determining the success factors, and at present, CSFs for demolition phase has not been fully explored. Thus, this study seeks to fill this gap.

LITERATURE REVIEW

When an old building reaches its end of life and no longer is able to serve its purpose, the building is taken down to make way for new buildings. The process of taking down buildings and dealing with the end-of-life phase is what is known as demolition (WRAP, 2009). Demolition is complex. Experts in the field require an understanding of waste management, recycling of materials, reclamation, hazardous materials, implosion, landfilling, project management, general contracting as well as knowledge in personnel, equipment, the nature of structures and architectural design and many other aspects to optimise the demolition process (Diven and Shaurette, 2010). Due to its complexity, demolition is considered to be the most dangerous business in construction, as many uncertainties are involved from one project to another, and lack of knowledge regarding areas like hazardous materials or the nature of the structure dealt with could lead to serious incidents (Hare, 2016). An example of this is the collapse of Didcot power plant in Oxfordshire where one person died and 3 others went missing in 2016.

Apart from its risky nature, demolition is also considered to be a wasteful process (Chen and Lu, 2017). This is primarily because the construction and demolition industry predominantly follow a linear economy model; where building materials at their end-of-life are not used for the same purpose they were originally created for (Cheshire, 2016). Such materials are being ‘down cycled’ into lower grade products and used for different purposes outside of the construction industry (Magdani, 2014). For example, solid timber is chipped or burnt, structural concrete becomes non-structural aggregate, and modular units, such as bricks are crushed rather than reclaimed (Cheshire, 2016). Given that the construction industry demands approximately 40- 50% of the world’s extracted natural materials (Hradil, 2014), and demolition waste is considered to be the largest and most significant waste stream in many countries (Chen and Lu, 2017), the linear approach is deemed to be a highly wasteful approach (Cheshire, 2016). The demolition industry is also faced by many challenges that prevent its development:

- Clients impose a lot of pressure on demolition contractors to speed up the process; thus, restricting the demolition contractor in preparing for the demolition process (Clarke, 2009).
- There is a lack of incentive to retrieve materials from demolition projects because raw materials within the sector exist in large quantities and are relatively cheap

(Palmer, 2017), and therefore, demands for second hand materials are considerably low (Rios *et al*., 2015). This is one reason why designers generally do not priorities designing for deconstruction, as no market exist for second hand materials.

Compared to design and construction phases, demolition lags behind in terms of research (Thomsen *et al*., 2011), particularly in the areas of information management and communication; this justifies why the use of machinery in demolition has become very advanced, but not in terms of technology and development; for instance, there is little engagement with Building Information Modelling (BIM) as a useful new process and technology for projects at end-of-life (Akinade *et al*., 2016).

RESEARCH METHODOLOGY

Critical Success Factors (CSFs) are an essential management tools to help businesses implement their strategies and projects successfully (Addy *et al*., 2017). Rockart (1979) defined CSFs as "areas of activity that should receive constant and careful attention from management". The concept of CSFs has been applied extensively in various industries such as construction, information technology, medicine and production (Yong and Mustaffa, 2013). It proved to be one of the essential ways to understand the core challenges to a particular industry (Rockart and Bullen, 1981). The identification of CSFs for an industry helps to break down the complex nature of the industry into few discrete factors that require most attention (Lu *et al*., 2008); leading to improving the effectiveness of project delivery. If those factors are satisfactory, it will guarantee a successful delivery of the project (Lu *et al*., 2008).

The methodology of CSFs, however, has been critiqued by some. Fleisher and Bensoussan (2007) considered CSFs to be too obvious that it would not provide any advantage, or they will be so elusive that they will defy any decision making or action. Additionally, Waugh (2017) noted that if wrong CSFs were identified for a specific industry, it would lead to an opposing result and prove detrimental to the work. However, the methodology of CSFs suits this research because the process of demolition is complex by its nature; the demolition contractor is required to make a lot of managerial decisions during projects which include: Conducting pre-demolition survey, demolition method, separation of materials, disposal of those materials, management of stakeholders, and many others management related decisions (Diven and Shaurette, 2010; Oyedele *et al*., 2014; NFDE, 2016). Chini and Bruening (2003) mentioned that their decisions are primarily based on past experience; because often when demolition contractors arrive on site, there is significant uncertainty regarding the availability of information provided by the client (Clarke, 2009). Therefore, a CSFs methodology is suitable for demolition to break down its complex nature and pinpoint those activities that require more attention than others.

A methodology that is exploratory in nature is deemed essential for this study as no framework of CSFs exist for demolition projects. Reviews of literature showed that CSFs for demolition projects are scattered in various studies; thus, an extensive literature review was carried out to gather those scattered CSFs for demolition projects into one study. The CSFs approach employed in this study is a popular technique in construction research. Studies have identified five main steps for identifying CSFs: (1) to select a full set of possible success factors; (2) to survey the importance of each selected success factor for a given goal; (3) to calculate the importance index of each factor based on the survey data; (4) to extract CSFs from the selected success factors

according to the important indices; and (5) to interpret and analyse the extracted CSFs (Liu *et al*., 2012). Therefore, the procedure for identifying the CSFs for a specific industry often begins by conducting an extensive literature review and gathering those scattered factors in one group. This study sought to fulfil specifically the first of the five identified steps. The downside issues for a literature review approach includes lack of practitioners input, and the concern that the data may be out of date as most of the publications are numbers of years old. The literature studies were chosen based on three criteria:

Papers related to demolition projects: CSFs were extracted from those papers based on the researcher judgement.

Critical Success Factors studies on design and construction phases. Papers which covered the whole building life cycle and indirectly included issues of demolition.

Keywords of the papers, these are: Demolition, end-of-life, circular economy, critical success factors, deconstruction, and design for deconstruction.

Subsequently, the study sought to prioritise the identified list of CSFs based on the number of mentions in the literature. After prioritising the factors, the criteria for considering the CSFs in the framework were chosen based on two factors:

1. Factors which were mentioned in four or more studies;
2. Factors which complements the factors chosen in point 1 (only chosen from External Factors category). This will be further explained in the Discussion.

For the creation of the framework, this paper followed Chan *et al*., (2004) model which grouped the identified CSFs for construction projects under 5 main categories: Project procurement, project stakeholders, project management actions, project-related factors, and external factors. This model was also utilised in various studies including Mustaffa and Yong (2013) and Alias *et al*., (2014).

RESULTS

30 studies related to end-of-life phase were carefully studied to extract potential CSFs for demolition projects. These include journal papers, articles, government reports, and industrial reports. Then, the identified CSFs were put in spreadsheets, which facilitated the process of organising, analysing and finding insights in the data. Putting all data in one place also facilitated the process of generating the success factors from the conducted literature review and aided in merging similar CSFs together to form one success factor. As a result, 49 potential CSFs were identified and are shown in table 1. The factors are listed and ordered based on their number of mentions under the following categories: Project procurement, project stakeholders, project management actions, project-related factors, and external factors.

DISCUSSION

Procurement and Project-Related Factors

Very little information was found regarding demolition project procurement in the literature. However, one CSF that was mentioned in several studies was the importance of comparing different demolition methods prior to selecting the optimal option. This would therefore link to the project-related factors identified in this study such as: 1) Complexity of the project, 2) Duration given by client, 3) Building type, 4) Building age, 5) Building location, and 6) Building size.

Project Management Actions

Many CSFs were identified in the project management actions category for demolition contractors. The highest-ranking CSFs in this category cover the issues of: 1) Effective communication; 2) Clean separation on-site; 3) Running pre-demolition audits assessment to check the suitability of elements in an existing building or structure; and 4) Clearly defined goals and objectives. This category mainly represents the role of the demolition contractor/project manager during the delivery process of the project. Factors like effective communication and clearly defined goals align with previous studies of CSFs on the role of the contractor during construction projects (Chan *et al*., 2004; Yong and Mustaffa, 2013; Addy *et al*., 2017).

Table 1: List of Critical Success Factors developed from the literature

Description of critical success factor	Relevant Literature
Project Procurement	
1. Compare alternative demolition methods prior selecting the optimal one.	Arham (2003); Clarke (2009); Chen and Lu (2017).
2. Involve the structural engineer at the planning stage	Clarke (2009)
3. Consult waste recycling company to discuss how the waste will be managed and taken out of site	Instant Waste Management (2017)
Project Stakeholder	
1. Client to give sufficient time for demolition contractor to create an incentive to deconstruct rather than demolish.	Chini and Bruening (2003); Chan et al. (2004); Endicott et al. (2005); ICE (2008); Clarke (2009); Rios et al. (2015).
2. Designers to consider the end-of-life in their designs	Chini and Bruening (2003); Endicott et al. (2005); BAM (2014); Adams (2015); Rios et al. (2015); Akinade et al., (2016).
3. Government to provide financial incentives for demolition contractors for adopting less wasteful demolition methods	Chini and Bruening (2003); Endicott et al. (2005); Oyedele et al. (2014); Akinade et al. (2016); Chen and Lu (2017).
4. Government incentives through standards to create a market for reused/recycled materials	Chini and Bruening (2003); Endicott et al. (2005); Tingley and Davison (2011); Oyedele et al. (2014); Rios et al. (2015)
5. Government legislations requiring consideration of design for deconstruction to facilitate future deconstruction	Thomsen et al. (2011); Tingley and Davison (2011); Rios et al. (2015); Akinade et al. (2016)
6. Client to provide an integrated set of as built drawings or any relevant information regarding the project	Chini and Bruening (2003); Clarke (2009); Diven and Shaurette, (2010); Tingley and Davison (2011)
7. Stringent legislation from government on the use of recycled materials in new construction projects	Jeffery (2011); Oyedele et al. (2014); Akinade et al. (2016).
8. Engaging demolition contractor at the design stage at early stages of the project.	Rios et al. (2015); Ulyatt (2015) Akinade et al. (2016).
9. Top management support to project team	Chan et al. (2004); Addy et al. (2017)
10. Designers to increase their preference for recycled products in their specifications.	Oyedele et al. (2014); Adams et al. (2017).
11. Engage the structural engineer at the planning stage	Clarke (2009)
12. Project team leaders commitment to meet cost, time, and quality.	Chan et al. (2004)
13. Motivating skills of the project team managers.	Chan et al. (2004)
Project Management Actions	
1. Effective communication among project stakeholders	Chan et al. (2004); Clarke (2009); Tingley and Davison (2011); Liu et al., (2012); Yong and Mustaffa (2013); Amade et al. (2015); Addy et al. (2017).
2. Clean on-site separation of materials	Chini and Bruening (2003); Clarke, (2009); Tingley and Davison (2011); Jeffery 2011); Chen and Lu (2017).

3. Run pre-demolition audits assessment to check the suitability of elements in an existing building or structure	Clarke (2009); Oyedele et al. (2014); NFDC (2016); Instant Waste Management (2017).
4. Clearly defined goals and objectives	Chan et al. (2004); Yong and Mustaffa (2013); Akinade et al. (2016); Addy et al. (2017).
5. Careful and safe storage for recovered materials	Clarke (2009); Tingley and Davison (2011); Akinade et al., (2016)
6. Continuous site management and supervision during demolition process.	Clarke (2009); Yong and Mustaffa (2013).
7. Project managements skills of demolition contractor	Amade et al. (2015); Addy et al. (2017).
8. Consult waste recycling company to discuss how the waste will be managed	Instant Waste Management (2017).
9. Involvement of different project stakeholders in the early planning of projects.	Yong and Mustaffa (2013).
10. Emphasis on high quality workmanship instead of low and quick demolition	Yong and Mustaffa (2013).
11. Use modern well-maintained demolition plant which use low fuel consumption	Clarke (2009).
12. Provide guarantees for reused materials	Tingley and Davison (2011).
Project related factors	
1. Complexity of the project	Chan et al. (2004); Yong and Mustaffa (2013)
2. Building Type	Chan et al. (2004); Chen and Lu (2017)
3. Project Size	Chan et al. (2004); Addy et al. (2017)
4. Duration given by client	Yong and Mustaffa (2013); Chen and Lu (2017)
5. Building Age	Chen and Lu (2017)
6. Building Location	Chen and Lu (2017)
External Factors	
1. Government/Industry programmes supporting deconstruction	Guy and Shell (2002); Chini and Bruening (2003); Rios et al. (2015); Akinade et al. (2016).
2. Provide training for demolition contractors and builders to deconstruct with minimal damage	Chini and Bruening (2003); Endicott et al. (2005); Tingley and Davison (2011); Rios et al. (2015).
3. Educate clients on the long-term benefits of deconstruction.	Tingley and Davison (2011); Rios et al. (2015); Akinade et al. (2016).
4. Use tracking technologies for each component at the construction stage (e.g. RFID) for future reference	Chini and Bruening (2003); Tingley and Davison (2011); BAM (2014).
5. Nature (weather conditions)	Yong and Mustaffa (2013); Amade et al. (2015); Chen and Lu (2017).
6. Educate the public on the benefits of using salvaged building components	Chini and Bruening (2003); Tingley and Davison (2011)
7. Award of more points for building deconstructability in sustainability appraisal	Oyedele et al. (2014); Akinade et al. (2016)
8. Educate clients on the importance of the preparation time prior demolition	Clarke (2009); Jeffery, (2011)
9. Increase the awareness of architects to the use of second hand materials	Guy and Shell (2002); Chini and Bruening (2003)
10. Available resources and advanced technologies of the firm	Chan et al. (2004); Addy et al. (2017)
11. Social Environment	Chan et al. (2004); Yong and Mustaffa (2013)
12. Economic Environment	Chan et al. (2004); Yong and Mustaffa (2013)
13. Professionals bodies to improve the awareness and benefits of recyclable materials and products among their members	Oyedele et al. (2014)
14. Waste management capabilities	Chen and Lu (2017)
15. Increased academic research in the field of demolition and end-of-life	Thomsen et al. (2011)

Stakeholders and External Factors

It was noticed that factors identified under project stakeholders are linked and substantially affected by external factors category, thus both categorise were merged together in the framework. For instance, for the client to give sufficient time for the demolition contractor to deconstruct rather than demolish, relies on educating clients on the importance of deconstruction. Similarly, once clients realise the long-term benefit of deconstruction and its positive impact on the environment, designers will subsequently begin to consider deconstruction in their designs because their customers

are interested. Therefore, the successful delivery of demolition projects starts at the early stages of designing and planning for the building; where clients and designers make their decisions.

The majority of clients however, consider traditional demolition to be the most cost-effective method to knock down a building and therefore the majority of clients are satisfied with the current situation (CEW, 2014). This explains why almost all existing buildings are not designed to be deconstructed (Akinade *et al*., 2016). This indicates that some clients might not be interested in taking on the burden of extra costs and may resist any changes. Therefore, many authors believe that the government has to provide financial incentives and set standards to encourage clients to use second hand materials and to consider design for deconstruction in their buildings (Chini and Bruening, 2003; Endicott *et al*., 2005; Tingley and Davison 2011; Oyedele *et al*., 2014; Rios *et al*., 2015). Providing government backed incentives for second hand materials and running programmes supporting deconstruction would increase the demand for second hand materials taken from demolition projects. This would result in encouraging demolition contractors to shift their preferred method to deconstruction to retrieve as many materials as possible with minimal damage hoping to make extra profit. This justifies why educating clients, the public, and architects on the importance of deconstruction is highlighted in this study as being important.

A number of other points of interest can also be highlighted. Few studies emphasised the importance of engaging a new stakeholder at the early stages of planning and designing of a building (i.e. the demolition contractor) (Rios *et al*., 2015; Ulyatt, 2015; Akinade *et al*., 2016). Engaging the demolition contractor at the design stage would reflect positively on the end-of-life of the building, as the majority of the decisions will involve considering the end-of-life phase. Another fundamental factor which was found in one study is to increase academic research in the field of demolition and end-of-life (Thomsen *et al*., 2011). Without linking research and practice, the demolition industry is unlikely to move forward and develop.

The results of the CSFs exercise are brought together and illustrated as a conceptual framework in Figure (1).

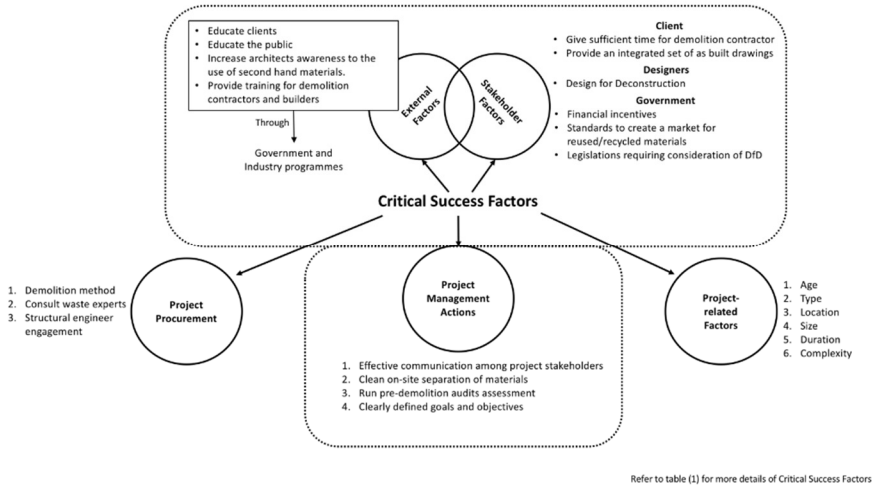

Figure 1: Conceptual Framework

This allows the interrelated logic of the various groups of CSFs to be clearly visualised. Project management actions represents the role of the demolition

contractor during demolition projects. Stakeholder factors represents the role of project stakeholders mainly from the beginning of life of the project. If those factors were considered, it will positively reflect on the performance of the demolition contractor, and therefore substantially increase the success rate of the project. For stakeholders to recognise the importance of considering the end-of-life of projects; relies heavily on External factors such as: Educating clients, architects, and the public on the importance of second hand materials. Thus, stakeholders and external factors categories were interlinked in the framework. Finally, project procurement and project-related factors were all considered in the framework due to their limited number.

CONCLUSION

A new conceptual framework for demolition projects was developed which contain five main categories: Project procurement, project stakeholders, project management actions, project-related factors, and external factors. This was achieved by following an exploratory research approach by reviewing 30 demolition-related studies. As a result, 49 factors were identified and prioritised based on their number of mentions, of which six main factors were highlighted due to their frequent appearance, these are: 1) Effective communication among project stakeholders; 2) Client to give sufficient time for demolition contractor to deconstruct rather than demolish; 3) Designers to consider the end-of-life in their designs; 4) Clean on-site separation of materials; 5) Government to provide financial incentives for demolition contractors for adopting less wasteful demolition methods; 6) Government incentives through standards to create a market for reused/recycled materials.

The framework will increase the awareness of the complex nature of demolition projects and assist demolition contractors to recognise those factors that are essential for project success. Also, the external factors found in this study can act as guidelines which points out the important areas that require attention for further development for the organisation and the industry as a whole. Furthermore, as demolition projects are filled with uncertainties, the critical success factors identified in this study can act as a roadmap for senior leadership and management to stay focused on the essential activities and not be diverted away from what is important. Finally, the presented framework opens opportunities for further research in the area of demolition and sustainability, and the opportunity to link academic research with industry professionals through refining and categorising those CSFs found in this study. This paper forms the first work package in a PhD project, where the second part will look to validate and refine the list of critical success factors found in this study with industry professionals.

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