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Critical success factors of strategy-led planning of high-profile projects

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ABSTRACT
This study investigates the relationship between project strategies and project outcomes. Technical rationality theory is critical to this relationship; although it has been criticised in extant studies for its inability to define soft issues that associate with real-world scenarios. Strategy-led approach is an alternative to technical rationality. Normative studies have acknowledged the ability of strategy-led approach to project implementation as though it facilitates reflective interaction with problem-solving. This study targeted 154 organizations that won practice excellence awards of the New Zealand Institute of Building's (NZIOB) between 2001 and 2014. The awards are given to construction firms, adjudged through a rigorous competitive process as the most outstanding in the successful completion of high-profile projects in New Zealand. 40 valid responses from construction managers who completed projects that won NZIOB's practice excellence awards were analysed to evaluate the impact of strategies on project objectives. In addition, 35 critical success factors explored from literature were considered for statistical analysis. Findings from regression analyses show project strategies impacted 13 critical success factors that significantly shaped cost, time and quality outcomes of award winners' projects. Negative impact of critical success factors was reported also. The study concludes that construction managers rely on project strategies as projects became increasingly challenging; the systems approach developed from such success-driven practices will benefit both the research and practice communities as they seek ways to optimise project success.

KEYWORDS
Critical success factors; practice excellence awards; project planning strategies; project scheduling; project success; reflective practice

Introduction

Project planning is a challenging process; in particular, construction projects. This is because construction projects are known to be complex, dynamic, unique, risky and uncertain (Cho et al. 2009; Mahamid 2013; Issa et al. 2020). Because of these attributes, Ogunsemi and Jagboro (2006) argue, it is impossible to predict the outcomes of construction projects. In another argument by Flyvbjerg et al. (2018), an absolute success is often difficult to come by in construction projects. To understand why this is so, it is important to describe each attribute of construction projects as noted above. Complexity is the difficulty in decision-making due to multiple dependencies, including intangible considerations and the interconnectedness between internal and external events (Rees-Caldwell and Pinnington 2013). Dynamism refers to sudden or frequent changes to a project scope (Subramanyan et al. 2012). Uniqueness means novelty of projects and approaches to project implementation, whilst uncertainty means events that are neither predictable nor expected (Szczesny and König 2015). Thus, the essence of Flyvbjerg et al. (2018) argument is that it is impossible to achieve certainty in projects outcomes where these project attributes combine to typify uncertainty.

Traditional Planning Algorithms (TPAs) are widely used to plan construction projects. Examples of TPAs include Critical Path Method (CPM), Program Evaluation Review Technique (PERT) and Critical Project Chain Management (CCPM). Their limitations have been reported in relation to project characteristics (Hou et al. (2017). According to Phillips-Alonge (2019), project planners seldom plan adequately for conflicts and the trade-offs between contract relationships, co-production arrangements and the motivation of different stakeholders to facilitate project success. Whilst project plans can be linear, many elements of planning that drive project success are soft and complicated. These include relationships management: between project's multiple stakeholders, stakeholders' complex expectations, stakeholders' motivations and spontaneous demands of project success. According to Olaniran et al. (2017), success planning through these relationships requires more dimensions than simplistic linear modelling.

Construction managers often struggle with theory-to-implementation gap. This is because the relationship between success planning and implementation can be soft (Papke-Shields and Boyer-Wright 2017). As a result, according to Kuhn (2006), construction managers typically pay little attention to detailed planning during early stages of a project. This is further encouraged by client-related factors, such as ambiguity in client requirements, frequent variations to project scope and lack of robust work breakdown structures (WBSs) to accommodate client's frequent change orders. To these, Kumar (1989) recommends the utilization of early-stage strategies that are targeted at resolving internal and external issues within project environments. In the view of Clough et al. (2008), project strategies must be used to replace or implant CPM's tactical recommendations – this is because CPM is unable to fully explain some salient issues, including constructor's WBS, construction methodologies and activities' optimal start and finish times.

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Formulation, representation and assessment of alternative strategies are vital for project success. This is especially true for projects that are characterised by repetitive elements over multiple, discrete locations such as high-rise buildings, bridges and transmission lines (Russell et al. 2014). According to Abeysekera (2007), work rate, rhythm, slicing and packaging are the bases for strategy development, such that projects can be delivered on time if they are planned to allow for sufficient cost variations. This may be true in some projects. Nonetheless, in an analysis of high-profile projects in the United Kingdom, Rotimi and Ramanayaka (2015) found no such common basis for strategy planning in industry practice. Thus, novel theoretical or empirical claims on strategy planning need robust validations. Whilst normative literature explains the importance of strategies, a notable knowledge gap is in the lack of objective verification to support how strategy-led approach assists construction managers to achieve intended project outcomes. In addition, construction planning literature is deficient in distinguishing strategy-led project planning and implementation from TPA-driven contents. In particular, they do not explain the processes of defining soft issues, handling multiple problem entities and assisting practitioners to think or reflect in action.

For greater clarity, this current study defines strategy as the determined efforts of construction planners in making decisions to solve problems towards optimizing success realization regardless of project characteristics. The study investigates the relationship between project strategies and the realization of project outcomes, by exploring the empirical significance of critical success factors (CSFs) and the relationship between them in strategy-led approach for planning and implementing high-profile construction projects. The overarching significance of this is that success is a critical desire in project outcome; however, the road to success is often undefined and actions taken to achieve success can be difficult to transfer from one project to another. This study analyses the experiences of notable project actors who had been acknowledged as outstanding by their community of practice; in particular:

- actors who have been assessed consistently through objective instruments of success denominators,
- actors who have demonstrated strong motivation to succeed in their projects and have made themselves accessible to others for objective judgment,
- actors who have achieved success once or repeatedly with different clients, across different high-profile projects, over several years, and
- actors whose strategies have been reviewed critically by their fiercest peers.

Project characteristics and planning

According to Famá et al. (2015), project characteristics are a typical challenge of planning. Planners often struggle with how intangible attributes and the interconnectedness amongst planning entities induce complexity whilst developing work schedules. Such complex phenomena are onerous to resolve. Huizeng et al. (2012) have reported that rational paradigms often fail to resolve such complexities adequately. This is because rational methods are based on technical rationality (TR), an assumption that a complex matter should be sub-divided into smaller manageable parts such that each 'small part' is resolved separately in a reductionist manner (Checkland 1999). Through Heisenberg's uncertainty principle, chaos theory and soft-versus-hard systems paradox, planning theorists have explained how such small parts interconnect in a complex matter (Olatunji 2016; Bagarello et al. 2018; Casadio and Scardigli 2020; Diwekar et al. 2021). Since the whole is greater than the sum of its parts, interconnectedness cannot be neglected – thus the theory of holism (Arageorgis 2013; Jörgenfelt and Partington 2019). In construction, numerous project management objectives and constraints are the small parts. If treated separately, a deficient attention to critical activities, regardless of how small they are, can cause a project to fail (Famá et al. 2015). Secondly, TR relies only on systematic and scientific knowledge through which it encourages mathematical techniques to represent issues. Thus, problem-solving is independent of the decision-maker when formal rules are applied. However, real-world scenarios are characterized by soft issues such as social, cultural and behavioural dimensions, which TR cannot explain adequately – a phenomenon described by Rotimi and Ramanayaka (2015) as selective inattention.

Because of the limitations of technical reality, construction managers often resolve complex matters through reflective interaction. This could be by way of experimentation or by acting as problem agents. Schon (1992) describes this as an alternative paradigm, also known as Reflective Practice (RP) of 'thinking-in-action' or 'reflection-in-action' whilst in a deliberate state. RP decisions are heuristic in nature. They are not characterised by the precision in solutions driven by TR. However, they depend on the experimenter and the project context. Therefore, RP approaches must facilitate practitioners on effective learning that involves a continuous comparison of how their heuristic decisions work in the real-world. Such interactive learning does assist in generating more appropriate decisions in subsequent iterations than when they are absent.

Project implementation is also challenged by dynamism and uncertainty (Cho et al. 2009; Issa et al. 2020). The suitability of mathematical techniques to manage them in schedules has been debated variously – e.g. see Rotimi and Ramanayaka (2015). For example, reserve analysis recommends adding a percentage of an initial duration estimate to critical activities as buffers: Chen and Hall (2021), using Parkinson Law, argue that humans expand work to suit the allocated time by working slower; whilst Rand (2000) used Student Syndrome theory to argue that people leave much of their work towards the end. Thus, reserve analysis does not guarantee productivity; rather it has a reductionist focus on the time-entity of planning (Fallah et al. 2010). In addition, according to Lee et al. (2006), reserve analysis does not consider certain critical qualitative variables, such as nature of construction activity, workplace condition and delay of succeeding activities. Because of association of soft issues, Taroun (2014) finds construction managers often use heuristic methods to manage project dynamism and uncertainty in schedules. Such pragmatic approaches are underexplored by planning researchers (Tysiak 2011).

Project uniqueness also challenges TR approaches. The Project Management Institute (PMI) 2017) recommends RP approaches such as analogous estimates and expert judgments to manage planning for project uniqueness. Similarly, terminologies such as tacit knowledge, fuzzy-set based algorithms, unorthodox planning, strategy-led approach and living through a project in-advance have been used to acknowledge RP in construction (Wong and Ng 2010; Addis 2016). Nevertheless, a systematic approach has not been developed to practice RP in construction project planning and implementation.

Strategy planning for project success

PMI (2017) provides general guidelines on RPs for effective management of project cost, time and quality. However, such generic rules are insufficient to handle project uniqueness. Genetic and firefly algorithms are also considered as RP tools for schedule optimisation (Hou et al. 2017). Whilst some studies such as Kadri and Boctor (2018) switch initial deterministic schedules into fuzzy set-based schedules, others use nondeterministic methods (Faghihi et al. 2014). Nevertheless, metaheuristics provide optimal solutions only occasionally (Mejía et al. 2012). Artificial intelligence has been criticised also: according to Hassabis et al. (2017), human interaction with complex matters is more sophisticated than what machine learning is able to simulate currently. Technology assists; however, a strategy-led approach relies on experienced construction managers to interfere with project characteristics (Russell et al. 2014). An empirical study by Liu and Shen (2002) articulates the additionality of construction managers' experience to project performance and the causal relationships between their experiences and project outcomes.

A strategy-led approach is not to replace traditional planning algorithms (TPAs). Their complementary role can be clarified philosophically by using soft-versus-hard system methodologies. Soft systems methodology acknowledges real-world issues are messy. Hard systems methodology (HSM) relies on reductionism and mathematical techniques to model complexity. In the alternative, soft system methodology (SSM) uses graphical representation to define the interconnectedness of the hierarchical entities of a complex problem. When an issue is simplified through SSM, systematic knowledge (i.e. TR) is useful to find an appropriate solution. If a problem can be well-defined (i.e. not complex), HSM itself is adequate to provide a solution. Thus, HSM is a special case of the general SSM (Checkland 1999). Exploring this association in a strategy-led approach in construction project planning, Rotimi and Ramanayaka (2015) conclude RP can be a pre-condition to TR or TR can be within an RP context or RP can be a constraint for TR. However, their study does not explain the core concept of a system approach.

In a strategy-led approach, construction managers select a suitable strategy as the basis of planning at the early-stage of their involvement and this attempt seems deliberate. Suggestions from previous studies include work rate and rhythm, slicing and packaging (see Abeysekera 2007), linear scheduling and BIM for projects of repetitive natures (see Russell et al. 2014); and Sun Tzu's Art of War for quality management under extreme challenges (see Low et al. 2005). In the current study, early-stage strategy is deemed the 'main strategy'. Sub-strategies are developed to complement a main strategy. Similarly, emerging opportunities are developed to aid strategies in the implementation stage (Rotimi and Ramanayaka 2015).

Critical success factors in high profile projects

Success is the single most critical objective of a project. Scholarly discussions on project success are subjective, albeit robust. This is because success means different things to different people. Whilst project completion to budget, contract schedules and specified quality are popular denominators of project success in many studies, there are schools of thought who think project success is not complete without absolute safety, stakeholder satisfaction and neutral environmental impact, amongst others (Stone 2011; Gunduz and Yahya 2015; Pinto and Mantel 1990; Prabhakar 2008). Nonetheless, there are many studies where project success is not defined by any of these – cost, schedule, quality, safety or stakeholder satisfaction. Rather, success is achieved when practical completion is attained – regardless of predefined expectations. For example, Aibinu and Pasco (2008) found construction clients have considerable tolerance for variabilities of cost, schedule and quality. Olatunji (2018) concludes projects have more meanings to stakeholders than being simplistic on definitive variables; rather, because of project's strategic and subliminal values, stakeholders often consider actual deliverables as the true indication of success instead of pre-project speculations. Ahiaga-Dagbui et al. (2015) also conclude that extant studies that fixate excessively on definitive attibutes of project success are ineffective as they are stagnated by narrow bias. They recommend the way to go is for research efforts to go beyond superficial contributions to project performance studies, by considering success attributes beyond 'academic' (unrealistic) expectations – which the authors described as 'overeserached and stagnated', and adopt practices that extend beyond zero vision (also see Love and Smith 2016).

Success literature spans extended dimensions involving various elements to the realization of the objectives of project success. Whilst researchers have held nuanced views on what true success means in a project and whether absolute success is achievable (e.g. see Flyvbjerg et al. 2018), there is a wealth of knowledge in normative literature in which researchers have provided clear pathways to project stakeholders on how to achieve success with their project objectives. Twenty of such factors were provided by Zwikael and Globerson (2006), chief amongst which is project stategy. Other studies have reported a larger number of success descriptors than Zwikael and Globerson's twenty – e.g. Chua et al. (1999) reported sixty-six factors; however, Sanvido et al. (1992) have recommended a thematic categorization of success factors. Such themes are attributable to project objectives, work resources, organizational descriptors and events that are external to projects.

Critical success factors that are related to project objectives include setting-out project objectives of each stakeholder clearly, ensuring decisions are taken on time, and that clients are involved actively in the production processes underlying their projects such that they are able to monitor and provide objective feedback timely (Chua et al. 1999; Kometa et al. 1995). In addition, according to Penttilä (2006), projects are likely to succeed when stakeholders are able to handle the complexities underlying their project design and development processes, including coping with bifurcations, error management, meeting complex requirements of scheduling, contracts and technologies, as well as complex and unforeseen site conditions – also see Love and Smith (2016), Karami and Olatunji (2020) and Olaniran et al. (2017).

Factors relating to work resources include considerations that can help improve efficiencies of human, materials and plant resources, including minimising shortages and wastes, deploying appropriate technologies, and coping with variabilities, breakdowns and planned idle time (Chua et al. 1999; Karami and Olatunji 2020; Pinto and Mantel 1990). Similarly, issues relating to external factors that could shape project success include political, economic, social and environmental triggers. These have been well-articulated by Love et al. (2015), Love and Ahiaga-Dagbui (2018), Love and Smith (2016) and Olaniran et al. (2017). Factors relating to project attributes have also been well-reported also. Examples include the ability of contractors to understand the uniqueness of clients and their projects, as well as their ability to facilitate project finance and ensuring cashflow efficiencies (Aje et al. 2017). According to Issa et al. (2020), it is also critical for projects to have systems that minimises delay and errors in design and project development processes. Work supervision, organizational leadership, staff motivation and

Table 1. CSFs in construction project planning and implementation.

CSFs	Project-related factors	CSFs	Resource-related factors
1	Setting clear objectives	13	Minimising material shortages
2	Coping with variations	14	Coping with material changes
3	Improving communication	15	Deciding on off-site prefabrication
4	Speeding up decision making	16	Handling labour shortages
5	Handling unforeseen ground conditions	17	Coping with low skill levels
6	Improving project schedules/plans	18	Handling plant shortages
7	Coping with legal/ statutory requirements	19	Coping with low efficiency of plants
8	Ensuring monitoring and feedback	20	Coping with plant breakdowns
9	Better Handling design complexities	21	Avoiding wrong selections of plants
10	Coping with estimation errors	22	Reducing waiting time for test samples
11	Coping with site conditions		
12	Effective use of technology		
	Organization-related factors		External-related factors
23	Dealing with client's characteristics	32	Minimising political issues
24	Improving project financing from client	33	Minimising economic issues
25	Ensuring contractors cash flow	34	Minimising social issues
26	Minimising delays & errors in design documents	35	Minimising weather uncertainties
27	Improving site management and supervision		
28	Getting top management support		
29	Developing project organizational structure		
30	Getting lower cadres' support		
31	Smoothly work with sub-contractors		

smooth relationship with subcontractors and the entire supply chain structure are also critical (Liu and Shen 2002; Tabassi et al. 2012; Wu et al. 2016; Dallasega et al. 2018; Ju 2020; Yang et al. 2020).

These critical success factors are well-reported. However, it is important to validate them with high-profile projects – for example, whether such factors are valued importantly by expert reviewers for the purpose of significant professional recognition, or whether they play any valuable role in the success experiences of construction managers who had been adjudged as outstanding in their notable project achievements, or whether valuable insights could be built around them towards triggering new frontiers of knowledge management in building the culture of project success in specialised projects. For the purpose of evidential testing, the critical success factors identified in this review are summarised in Table 1, to be executed through the methodology described below.

Research methodology

For clarity, this study adopts the meaning of 'critical' as consideration that are vitally important to a named stakeholder regarding their expectations for project success, and 'success' as a stakeholder's own understanding of project success, including but not limited to practical completion. As the study aims to investigate critical success factors in the relationship between project strategies and project outcomes, construction managers are the custodians of the information and knowledge required for the research (Kumar 1989; Abeysekera 2007; Russell et al. 2014). Industry recognition was used as the yardstick to determine the inclusion and the exclusion criteria of the study. Respondents were selected on the bases of their completion of relevant construction projects and the recognition given to their accomplishments by a national professional institution, the New Zealand Institute of Building (NZIOB). The scope of the study was limited to recipients of NZIOB's annual practice excellence awards, awarded to building firms that completed high-profile projects within 18 months to the boundary years of 2001 and 2014. Such awardees have had their projects nominated, and have gone through a rigorous assessment process, and have emerged winners after being so adjudged by a team of industry experts. The nomination and assessment processes are well-reported on the website of the NZIOB via www. nzbuildingindustryawards.org.nz.

There are 11 categories in the awards. Six are related to project cost – that is, projects under NZ$5m, $5 m–$10m, $10 m–$20m, $20 m–$35m, $35 m–$100m, and projects over $100 m. Five categories of the awards are not based on cost; rather, they are targeted at recognising innovation, safety performance, consultants' practice excellence, interdisciplinary collaboration and young achievers (students' award). Recipients of these awards have been targeted because they have experienced project success in a practical form. In addition, they have performed key roles in their successful projects. They have worked on high-projects (that is, projects that drew more attention than others around them), and have had their successes recognised by a reputable community of practice. This target explains the uniqueness of this study: the study draws insights from respondents' experiences of success from notable projects, where recognition has been based on objective judgment. Other studies that may not have targeted these criteria may have only obtained data from mere perceptions of random people, where standardization of project success could have been non-existent.

The centrality of the researchers' expectation regarding data quality is that respondents are able to provide near absolute information from their personal experiences, reflecting on the outcomes of their own overarching decisions in influencing project success, not from mere perceptions as bystanders, third party reports, remote stakeholder or a party with very limited or no influence on projects' actual success. Recipients of the NZIOB practice excellence awards were the study population. The years between 2001 and 2014 had 14 award events, covering projects that were completed between November 2000 and May 2014. 154 is the maximum number of awards possible; assuming there were no joint winners, and that all awards were issued every year and that no single recipient got multiple awards in a single year. However, the ideal situation is that these assumptions are not absolute. It is not impossible for a single firm to win multiple awards across different categories. Joint winners are possible also. In addition, a primary goal of industry recognitions includes career advancement, and this can trigger job mobility. Thus, some employees (construction managers) may have moved

Table 2. Operational definitions of project characteristics.

Characteristics	Definition	Example
Complexity	Degree of difficulty in decision making due to multiple dependents, including intangibles and interconnectedness	Complex design, technology used, procurement methods, client requirements
Dynamism	Extent of sudden and frequent changes to a project scope	Change in scope, internal and external influences on project performance
Uncertainty	Amount of unpredictable or unexpected project events	Unforeseen performance requirements (ground condition, resource supply)
Uniqueness	Degree of novelty of approaches to project implementation	Novelty in the use of construction methods, type of project, procurement type or stakeholders

Participants were requested to rate these characteristics in terms of their overall influence towards the selected projects using a modified 0–100 scale with '0–20' being 'very low' and '80–100' being 'very high'. Their perceptions were used to test the following hypotheses.

across multiple award-winning organisations over the years captured for analysis. In essence, the research did not find a conclusive evidence to support the fact that the absolute population of the research data exceeded 154 in gross, and a nett that could be significantly less than 154. 154 companies named in NZIOB's repository were contacted; however, only 40 valid responses were received. For the reasons given above, the research is cautious in considering this as representing 26% of the population – although this is neither statistically insignificant nor logically inadequate to elicit useful outcomes. Amongst other reasons, some of the organizations may not have responded to the survey because they are out of business, or because they have changed their business orientation or business location, or because they do not want to disclose the secret of their success considerations, or because the contact person did not play a role in the projects that won specific awards.

The judges represented the industry thoroughly. To win an award, a mandatory criterion was to be involved in projects that experienced extreme challenges beyond typical issues. A self-administered postal questionnaire survey was used to collect the data that address the research questions. In particular, the critical success factors adopted for the research are well-reported in literature – see summary in Table 1. They have been tested many times by previous authors to be valid as hard variables, and as such, they fit for quantitative exploration – see Nicholls (2009). The additionality of this current study is to explore evidence around the hard variables (CSFs) from participants who have experienced project success themselves. Participants were requested to respond to the survey with reference to the projects for which they won awards, through a set of questions that were arranged in a certain order. However, an open-ended question, on the details of main, sub- and implementation strategies, was set as entry to the questionnaire. The questions were developed based on the conceptual model and hypotheses described below.

Conceptual model

Dependent variable: project success

Project success was the dependent variable and perceived from contractor's perspectives during the construction stage. Although cost, time, quality and client satisfactions were the priorities of construction managers' strategies in literature, the latter was eliminated from field investigation. This was because quantifying actual client satisfactions from construction managers' opinions would lead to unacceptable measurement errors (Malhotra et al. 2002). Equations (1) and (2) were used to calculate cost and timely achievements. Participants provided the planned value, actual value and out-of-scope variations in dollars and years respectively. Since quality was based on abstract measures (Equation (3)), a modified Likert scale was used, with '0–20' being 'very-poor' at one end and '80–100' being 'very-good' at the other end. Since the larger data range compared with the conventional 1–5 Likert scale, best-fit (regression) lines were considered as an accurate approach to the analysis.

$$C = \frac{PC + SVc}{AC} \tag{1}$$

$$T = \frac{PT + SVt}{AT} \tag{2}$$

$$Q = \frac{AQa}{AQi} \tag{3}$$

where C is Cost achievement, PC is Planned Cost, SVc is Scope Variation in terms of cost and AC is Actual Cost; T is Time achievement, PT is Planned time and SVt is Scope Variation in terms of duration and AT is Actual Time; Q is Quality achievement, AQa is Actual Quality achieved and AQi is Actual Quality intended.

Independent variables: project characteristics

Literature suggests a strategy-led approach can cope with project characteristics. However, project outcomes are often impacted by transition gaps between project strategy and implementation. Thus, four hypotheses ($H_{1–4}$) were set around project characteristics. The study assumes project characteristics are not mutually exclusive. For example, project uniqueness is known to create intricate layers to complexity (see Pauget and Wald 2013). However, the need to distinguish them is considered crucial when exploring the dimensions to strategy planning. Some aspects of project characteristics are pre-identifiable to a certain degree (for example: complexity) and hence construction managers may use deliberate strategies to cope with them. Spontaneous strategies may be more applicable for uncertainties. Therefore, four operational definitions were provided to the participants with examples to differentiate them as much as possible (see Table 2).

H_1: complexity has negative impact on time, cost and quality achievements.

H_2: dynamism has negative impact on time, cost and quality achievements.

H_3: uncertainty has negative impact on time, cost and quality achievements.

H_4: uniqueness has negative impact on time, cost and quality achievements.

Independent variables: CSFs in project planning and implementation

To be suitable, a strategy-led planning approach must influence most CSFs positively, contributing to desired project outcomes.

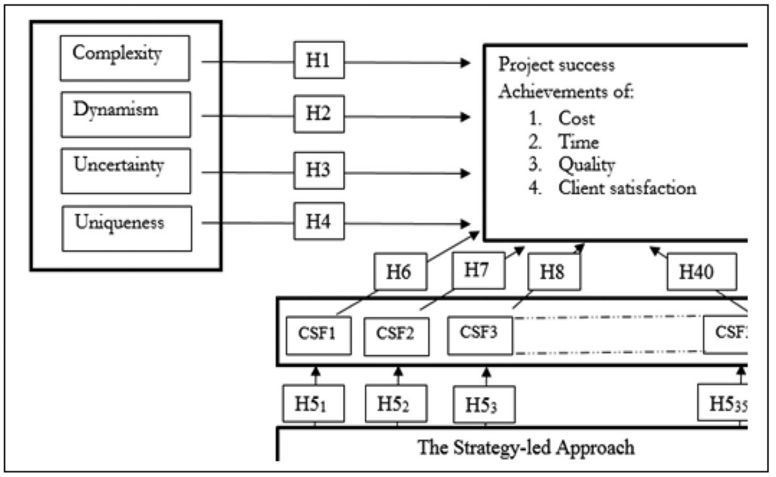

Figure 1. Conceptual model typifying relationships between critical success factors.

Thirty-five CSFs in construction project planning and implementation were selected from literature – presented Table 1. H_5 was set to test how much influence project strategies had on them. To manage the questionnaire, they were sorted under four categories: project-related (n = 12), organisational-related (n = 9), resource-related (n = 10) and external-related (n = 4). An extended 0–10 Likert scale was used to measure strategies' influence towards CSFs. The scale was limited to ten points because of the large number of variables. An overarching assumption for this part of the study is that strategies towards achieving CSFs influence selected success measures positively. Thus, $H_{6–40}$ were set:

H_5: a strategy-led approach has a positive influence on CSFs.

$H_{6–40}$: influence of strategies towards CSF1/CSF2/…/CSF35 has a positive impact on time, cost and quality achievements.

The model

Based on the 40 variables in $H_{1–40}$, Figure 1 illustrates the conceptual model where the variables are shown as interconnected independent and dependent variables. An integrated regression model was developed to finalize the model. Thus, an Equation was set as follows:

$$\text{Success}_{\text{cost/time/quality}} = f\,(\text{strategies' influence towards CSFs, projects characteristics}) \quad (4)$$

Data analysis

Open-ended questions were analysed using content analysis. In addition, reliability was checked prior to inferential statistics of quantitative data. Internal consistency of the abstract variables was recognized if Cronbach's Alpha exceeded 0.7. Missing data were tested using Little's Missing Completely at Random (MCAR), whilst randomly missing data were excluded list-wise from multiple regression. Independent variables were checked for multicollinearity and, normality was checked for data distributions. Considering the actual responses received (n = 40), Shapiro-Wilk test was considered as the most comprehensive normality test. For collinearity statistics, tolerance and variance inflation factor (VIF) were considered when higher than 0.1 and less than 10 respectively. In addition, some non-normal distributions were transformed using mathematical techniques. When this was not possible, the transformation was done using a process that used a factor analysis to form initial component factors. As explained later, these initial factors were accepted or rejected using substantial arguments and internal consistency check through Cronbach's alpha. Varimax rotation was used in the factor analysis to identify component factors. Kaiser-Meyer-Olkin values were considered when greater than 0.5. The Null Hypothesis – H_0: *variables were uncorrelated in the population* – was tested at $\alpha = 0.05$, using the Bartlett's test of sphericity. The items of a factor solution were significant only if the Eigenvalues were greater than 0.5.

Table 3. Demographic of the respondents.

Description	Number	Percentage
Education		
Post-graduate	5	12.5
Degree or equivalent	21	52.5
Diploma/certificate	12	30.0
On-the-job training	2	5.0
Industry experience		
11–15	7	17.5
16–20	13	32.5
>20	20	50.0
Construction Management experience		
0–5	2	5.0
6–10	12	30.0
11–15	12	30.0
16–20	10	25.0
>20	4	10.0

Findings and discussion

Construction managers from 154 organizations who had won NZIOB's Practice Excellence awards between 2001 and 2014 were requested to participate in the survey. 40 responses were returned after three reminders over 6 weeks. Some of the respondents may have worked for different award-winning organisations and some may have won multiple awards within the period covered in the analysis. These have not been considered in the analysis. Table 3 illustrates the demographics of participants. They were from diverse educational backgrounds and were well-experienced in the industry.

Table 4. Use of TPAs and project strategies.

Use of TPAs			Use of strategies						
				Main		Implementation		Sub	
TPA	No.	%	Themes	No.	%	No.	%	No.	%
CPM + PERT	15	39	Visualization	3	8	1	5	0	0
CPM + EVM	7	18	Design-related	4	11	1	5	1	5
CPM	6	16	Effective use of technology	3	8	5	25	5	23
CCPM	5	13	Planning-related	18	48	5	25	6	27
CPM + CCPM	4	11	Stakeholder management	8	22	5	25	10	45
PERT + CCPM	2	5	External-related	2	6	0	0	2	9
CPM + PERT + CCPM	1	3	Others	0	0	3	15	0	0
Other	1	3							
Total	38	100		38	100	20	100	24	100

Use of TPA and project strategies

Table 4 shows the use of strategies and TPAs in high-profile projects that won major awards. 38 participants answered this part of the questionnaire comprehensively. Analysis shows at least one TPAs was used in 97% of the cases. Although advancements of TPAs such as constraint-driven CPM and fuzzy set-based algorithms have rewards, they were not used by the participants. TPAs were used more as combinations, perhaps because instant properties of scheduling matters often decide their appropriateness. All participants developed a main strategy; however, sub- and implementation strategies were mentioned only in 24 (64%) and 20 (53%) cases respectively. This is not to say some projects were delivered without them; rather, some participants may believe in the main strategy as the most important and skipped the others. Among the seven themes identified, 'planning-related' was predominant across board. 'Stakeholder management' was the second most frequent. Next, there was 'effective use of technology' – a CSF to which TPAs or their advancements are inattentive. Four main strategies were 'design-related', indicating that early-stage integration of construction managers was critical. Visualization was mentioned as the main strategy in three cases. Under planning-related theme, five participants mentioned a concise construction work-breakdown structure as their main strategy. Six participants used resource-driven scheduling as the main strategy. Two participants prioritized the finest of the limited resources to critical activities. At least one participant amended the designs or construction methods to avoid or minimize problematic resources. One participant mentioned detailed and clear plans as their main strategy. Analysis shows an 'activity' was too large to be the planning block in extremes. Consequently, finer planning was required. Three participants relied upon segmental planning. To minimize interruptions and enhance knowledge integration, two participants were in favour of 'collaborative planning' between subcontractors and suppliers. 'Planning-related' sub-strategies focused mainly on parallel activities of scheduling: financial planning, resource balancing and risk management. Monitoring, detail planning and collaborative planning were also mentioned. Majority (80%) of 'planning-related' implementation strategies focused on monitoring and adjustments. One participant revised the initial schedule after realizing a potential for a large lead-time between the start of the roof construction and the finish of the building frame.

Strategies and CSFs

Table 5 shows the descriptive statistics of the impact of strategies towards CSFs. Although the mean values are shown, median and quartiles explained the sample data better because of the predominance (>80%) of non-normal distributions. The descriptive statistics were sorted from the largest to smallest by the 75th percentile first and then by the 50th and 25th percentiles. Nine CSFs were rated at 09/10 [project-related ($n = 6$), organisational-related ($n = 2$) and resource-related ($n = 1$)]. Amongst them, all except CSF2 had at least 75% of responses rated at 'very-high' (≥ 8). Then, CSF11 (project-related) and CSF32 (external-related) were rated at 8.5/10. There were 15 (43%) CSFs rated at 8/10, representing the organizational-related ($n = 7$), project-related ($n = 3$), resource-related ($n = 3$) and external-related ($n = 2$) factors. Thus, 75% of the CSFs were influenced very highly (≥ 8) by the strategies in the sample. The remaining 9 variables were rated at 'high' (6–8/10). Still, 7 of them had 25% data entities rated at 'very-high' whilst only 25% of the responses fell below 'high' (< 6). CSF19 (coping with low efficiency of plants) and CSF20 (coping with plant breakdown) were the least influenced, having only 50% of data in the 'high' region.

Due to the large number of variables, H_5 was tested using strategies' overall influence towards the 35 CSFs. Since the overall influence was normally distributed, T-test was performed. Considering a sample mean of 7.7, population mean was null hypothesized at $\mu_0 = 7.5$. The level of significance was above 0.05 ($p = 0.174$; $t = 1.386$; 39 degree-of-freedom (*df*)) and thus, μ_0 was accepted. Population mean of overall influence of strategies towards the CSFs was in the 'high' region. As a result, the study evaluated the contributions of CSFs towards the three success measures in relation to project characteristics.

Strategies and project success

Project characteristics and CSFs were consistent internally. Their Cronbach's Alphas were 0.861 and 0.937 respectively. Some CSFs had random missing data (Little's MCAR: Chi-square = 61.67; 59 *df*, $p = 0.381$). Normality was satisfied only by project characteristics. Since variations of cost, time and quality were assessed individually, factor analysis was inappropriate for their transformation. Similarly, a heuristic approach was followed because typical mathematical techniques such as logarithmic and square root are not suitable for normality analysis. Findings suggest a sinusoidal transformation supports normality. Yet sinusoid is an oscillatory, repetitive function; the original variables were linear. Thus, it was sceptical if the original variables were disturbed intolerably. However, Spearman correlation assured that the original and transformed variables were strongly correlated ($r_{time} = 0.989$; $r_{cost} = 0.985$; and $r_{quality} = 0.956$). Strong linear correlations occurred because the sample data belonged to a small region of the sinusoid (see Figure 2). Thus, in the regression, no extrapolation was done beyond this region.

Table 5. Descriptive statistics – strategy influence towards CSFs.

Rank	CSF	Descriptors	Mean	Median	Mode	25th	50th	75th
1	6	Improving project schedules/plans	8.5	9	9	8	9	10
2	9	Better Handling design complexities	8.7	9	9	8	9	10
3	1	Setting clear objectives	8.9	9	9	8	9	9.5
4	3	Improving communication	8.7	9	9	8	9	9
5	4	Speeding up decision making	8.7	9	9	8	9	9
6	23	Dealing with client's characteristics	8.4	9	8	8	9	9
7	27	Improving site management and supervision	8.5	9	9	8	9	9
8	13	Minimising material shortages	8.3	9	9	8	9	9
9	2	Coping with variations	8.2	9	9	7.5	9	9
10	11	Coping with site conditions	8.3	8.5	9	8	8.5	9
11	32	Minimising political issues	8.3	8.5	9	7	8.5	9
12	26	Minimising delays & errors in design documents	8.3	8	8	8	8	9
13	31	Smoothly work with sub-contractors	8.4	8	8	8	8	9
14	15	Deciding on off-site prefabrication	8.3	8	8	8	8	9
15	8	Ensuring monitoring and feedback	8.1	8	8	7	8	9
16	29	Developing project organizational structure	7.9	8	8	7	8	9
17	14	Coping with material changes	8.0	8	9	7	8	9
18	12	Effective use of technology	7.5	8	9	6	8	9
19	30	Getting lower cadres' support	7.5	8	9	6	8	9
20	33	Minimising economic issues	7.6	8	8	6	8	9
21	16	Handling labour shortages	7.8	8	8	7	8	9
22	5	Handling unforeseen ground conditions	7.6	8	7	7	8	8
23	25	Ensuring contractors cash flow	7.8	8	8	7	8	8
24	28	Getting top management support	7.4	8	8	7	8	8
25	34	Minimising social issues	7.7	8	8	7	8	8
26	24	Improving project financing from client	7.3	8	8	6	8	8
27	17	Coping with low skill levels	7.2	7.5	8	6	7.5	8
28	10	Coping with estimation errors	7.3	7	7	7	7	8
29	7	Coping with legal/ statutory requirements	7.3	7	7	6	7	8
30	22	Reducing waiting time for test samples	7.0	7	7	6	7	8
31	18	Handling plant shortages	7.0	7	7	6	7	8
32	21	Avoiding wrong selections of plants	6.9	7	7	6	7	8
33	35	Minimising weather uncertainties	7.2	7	7	6	7	8
34	19	Coping with low efficiency of plants	6.3	6	6	5.5	6	7
35	20	Coping with plant breakdowns	6.1	6	6	5	6	7

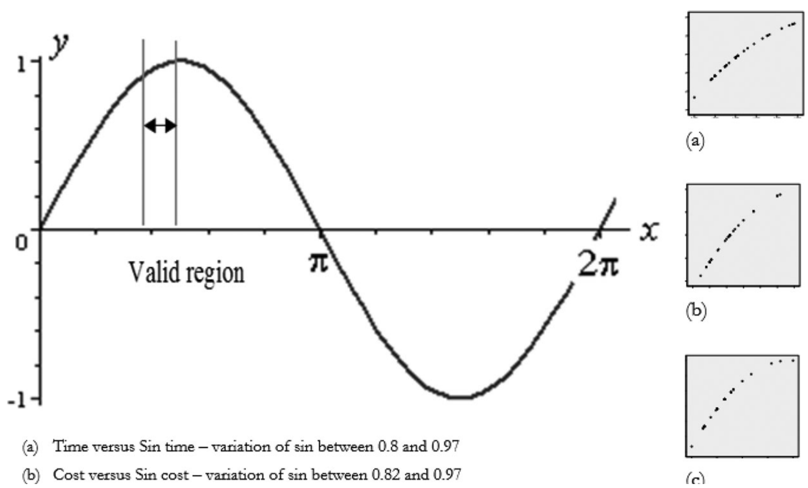

Figure 2. Original versus sinusoidal transformations.

No mathematical technique altered CSFs into normal distributions. Their transformation followed the process model shown in Figure 3. Dash-outlined boxes represent a process or a decision used to accept or reject a transformed solution. Factor analysis was the preliminary step; however, violation of normality could lead to misleading component factors (CFs). Thus, two additional steps were used for their acceptance: 1) substantial arguments based on literature and a preliminary study; and 2) CF's internal consistency through Cronbach's Alpha values. Due to sample inadequacy, the 35 CSFs were not considered together. The four categories (project-related, organization-related, material-related and external-related) were analysed separately first and the variables were interchanged later. Table 6 outlines only the accepted CFs and only 30 CSFs were transformed to acceptable solutions. The CF values were quantified by averaging the original variables. Amongst the remaining 5, CSF9, CSF35 and CSF19 were normal distributions, and were used in the regression in their original form. CSF31 and CSF20 were non-normal distributions, having been influenced by strategies at 8/10 and 6/10 respectively. Of the 'very-high' influence, only CSF31 was considered in the regression, notwithstanding its non-normality. Before the regression, multi-collinearity was checked between the 10 CFs, 4 CSFs (CSF 9, 19, 31 and 35) and project characteristics. Outcomes are reported in Tables 7 and 8.

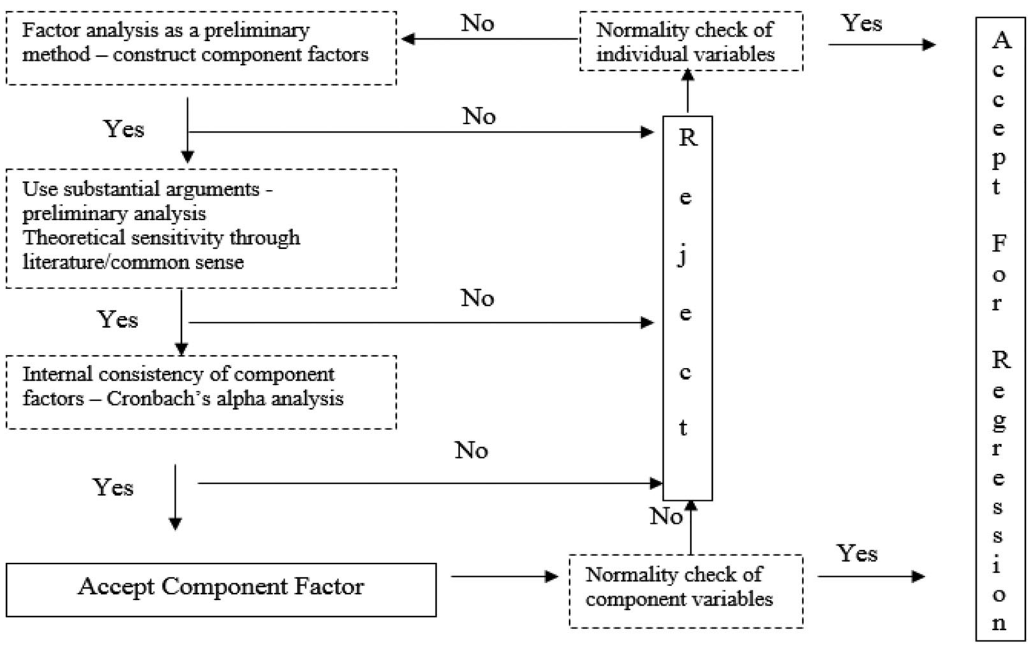

Figure 3. Process model for CSFs transformation.

Table 6. Accepted CF and their corresponding CSFs.

CF	CSFs belong to
CF1	CSF13; CSF14
CF2	CSF15; CSF16; CSF17; CSF18; CSF21
CF3	CSF28; CSF30; CSF29
CF4	CSF22; CSF27
CF5	CSF24; CSF23
CF6	CSF01; CSF04
CF7	CSF02; CSF06; CSF08; CSF12; CSF25
CF8	CSF11; CSF34
CF9	CSF32; CSF33
CF10	CSF03; CSF05; CSF07; CSF09; CSF10

Table 7. Collinearity statistics among contingency variables.

	Collinearity statistics	
Model	Tolerance	VIF
Dynamism	0.765	1.308
Uncertainty	0.809	1.236
Uniqueness	0.871	1.148

Dependent Variable: Complexity.

Regression models

First, data were checked for multi-collinearity by calculating the collinearity statistics tolerance and the variance inflation factor (VIF). Table 7 shows the tolerance values exceeded 0.1 in all the cases and VIF values were below 10. Accordingly, there were no multi-collinearity issues among the four variables around which the study hypotheses were built. This is because normality and multi-collinearity requirements were satisfied by the data.

Table 8 demonstrates the collinearity statistics of the 14 variables that are related to the influence of construction project strategies. 'Minimizing delays and errors in design documents' was used as the dependent variable and the remaining 13 items were set as independent variables. Outcome suggests the tolerance values all exceeded 0.1 and the VIF values were below 10. Accordingly, there was no multi-collinearity issue.

Following these, a step-wise regression was performed. To accept H_{1-4} and H_{6-40}, F-statistics should be less than $\alpha = 0.05$.

Table 8. Collinearity statistics of variables related to the influence of project strategies towards CSFs.

	Collinearity statistics	
Model	Tolerance	VIF
Smoothing work with sub-contractors	0.477	2.097
Minimizing weather uncertainties	0.556	1.798
Material shortage related	0.546	1.833
Coping with site conditions	0.285	3.506
Economy and political	0.256	3.902
Coping with complexities through integration	0.148	6.776
Dealing with client	0.298	3.355
Site supervision	0.318	3.142
Coping with low efficiencies of plants	0.213	4.677
Contractor's organization	0.360	2.776
Planning related development	0.352	2.839
Objectives and decisions	0.619	1.615
Labour and plant shortage related	0.403	2.483

Dependent Variable: Minimizing delays and errors in design documents.

Normal probability plots (P-P) were checked; normality assumption of the regression was satisfied if there was a straight line between (0,0) and (1,1). The assumption of constant variance was satisfied when there was no clear relationship between residual and predicted values of the Q-Q plots. At $\alpha = 0.05$, no project characteristics influenced success measures. Thus, H_{1-4} were rejected. Achievements of time, cost and quality were governed significantly by three CFs and CSF9 (see Table 9). CF7 influenced all success measures. Raw and standard equations were established for Sin_{cost}, Sin_{time} and $Sin_{quality}$ based on unstandardized (B) and standardized (β) coefficients respectively. CF7 and CSF9 determined 48% variance of Sin_{cost} ($R^2 = 0.48$; $p = 0.00 < \alpha = 0.05$). This is Equation 5, which was used to calculate cost achievements (inverse of Sin_{cost}). Figure 4 shows the variations of the dependent variable when: both independent variables vary similarly; and one variable changes, whilst the other variable is fixed at 5/10, the minimum of the valid region. Extrapolation is not valid for the sample data because valid data range for both independent variables was 5–10. Achievements of cost can be enhanced from 89% to 134% when strategies' influences towards CF7 and CSF9 increase from moderate (5/10) to

Table 9. Regression models.

Regression statistics			Raw and standard equations
Sin_{cost}			
R^2	0.480		Equation (5) (raw)
Significance of F change	0.000		$Sin_{cost} = 0.583 + 0.024CF7 + 0.015CSF9$
Independent variable	β	B	
Constant	0.583	–	Equation (6) (standardized)
CF7	0.024	0.524	$Sin_{cost} = 0.524CF7 + 0.357CSF9$
CSF9	0.015	0.357	Valid interpretation region: $5 < CF7, CSF9 > 10$
Sin_{time}			
R^2	0.373		Equation (7) (raw)
Significance of F change	0.000		$Sin_{time} = 0.662 + 0.016CF8 + 0.017CF7 - 0.008CF10$
Independent variable	β	B	
Constant	0.662	–	Equation (8) (standardized)
CF8	0.016	0.408	$Sin_{time} = 0.408CF8 + 0.417CF7 - 0.306CF10$
CF7	0.017	0.417	
CF10	−0.008	−0.306	Valid interpretation region: $5 < CF7, CF8, CF10 > 10$
$Sin_{quality}$			
R^2	0.208		
Significance of F change	0.003		Equation (9) (raw)
Independent variable	β	B	$Sin_{quality} = 0.640 + 0.027CF7$
Constant	0.640	–	
CF7	0.027	0.456	Valid interpretation region: $5 < CF7 > 10$

maximum (10/10). Furthermore, when the other variable is fixed at moderate influence, the maximum achievements by influencing CF7 and CSF9 were 112% and 102% respectively. CF7, CF8 and CF10 combine to determine 37.3% variance of Sin_{time} (see Equation (7)). More importantly, CF10 triggers consequences. However, 95% confidence interval of its B value was (0.04, −0.20). Thus, consequences are probable. Relationships amongst CF7, CF8, CF10 and the timely achievement were calculated. Since CF10 triggers consequences, optimum situation (126%) occurs when CF7 and CF8 are influenced by strategies to the maximum and CF10 is fixed at moderate influence. When the three factors are influenced to the maximum, timely achievement is lowered to 115%. The lowest significant influence (20.8%) was towards $Sin_{quality}$ and determined by CF7 alone. According to Equation (9), quality achievements compared to initial expectations could go up to 114% when strategies' influence is at the highest towards CF7.

Correlation between project characteristics and strategy use

Although not influenced towards success measures, the surveyed projects were challenged by project characteristics (Table 10). One sample t-test was used to calculate their population mean at $\alpha = 0.05$. The positive t-statistics implied that the population mean was greater than hypothesized values. Since all the population central tendencies were above 60 for project characteristics, the projects were challenged at 'high'.

After noticing that the impact towards success measures was insignificant, Pearson's correlations were checked between project characteristics and strategies' influence towards the CFs/CSFs that influenced at least one success measures (Table 11). As the highest correlations, complexity, dynamism, uncertainty and uniqueness explain 26%, 22%, 10% and 26% variances of the strategy influence towards CF7 respectively – these values are evident in their R^2 values from correlation analysis. CF8 had the least number of correlations. Complexity and uncertainty governed 15% and 24% of variances of the strategy influence towards CF8 respectively. Thus, the increasing project characteristics caused participants to rely more on project strategies to influence selected CFs/CSFs.

Discussion

The appropriateness of strategy-led approach

Considering the regression and correlation analyses, the conceptual model was modified as shown in Figure 5, which shows that a strategy-led approach is a suitable planning methodology for construction projects. Although, the findings did not contradict the conceptualized strategies in literature completely, however the claimed strategies require refinements or robust validation. It is not surprising that some strategies in planning literature, such as Sun Tzu's Art of War for quality management, were not used by the participants to manage the project characteristics because most academic suggestions on construction project planning and implementation remain unknown to the industry (Taroun 2014). Content analysis supported the study conducted by Rotimi and Ramanayaka (2015) on high-profile projects delivered in the United Kingdom that there were no universal bases for strategy as conceptualised by Abeysekera (2007). However, segmental planning mentioned in the field study showed similarity to Abeysekera's (2007) slicing and packaging as well as rate and rhythm. Finer planning – as the main strategy in some cases – agrees with Hegazy and Menesi (2010) that CPM's activity level is inadequate in some cases to develop realistic project schedules. In summary, using project strategies seemed context-dependent and hence, the strategy-led approach used by the awardees showed more similarity to what Kumar (1989) described as early-stage strategy development. One of the main purposes of RP is to support context-dependent decisions, such as the selection of a main strategy that is suitable for a construction project. However, a system approach that can assist RP is more sophisticated than the Kumar's (1989) recommendations on the strategy-led approach.

Regardless of the opinion in literature that a strategy-led approach could assist construction managers to influence the scope of construction project management in a holistic manner, including soft issues that are subjected to selective-inattention, no quantitative study supported this claim. This field study showed majority of the CSFs were influenced at 'very-high' by strategies that experienced construction managers used to overcome the project characteristics they faced in their projects (Table 5). Overall, project strategies could influence CSFs at upper fraction of 'high' region ($\mu_0 = 7.5$). Also, there was no

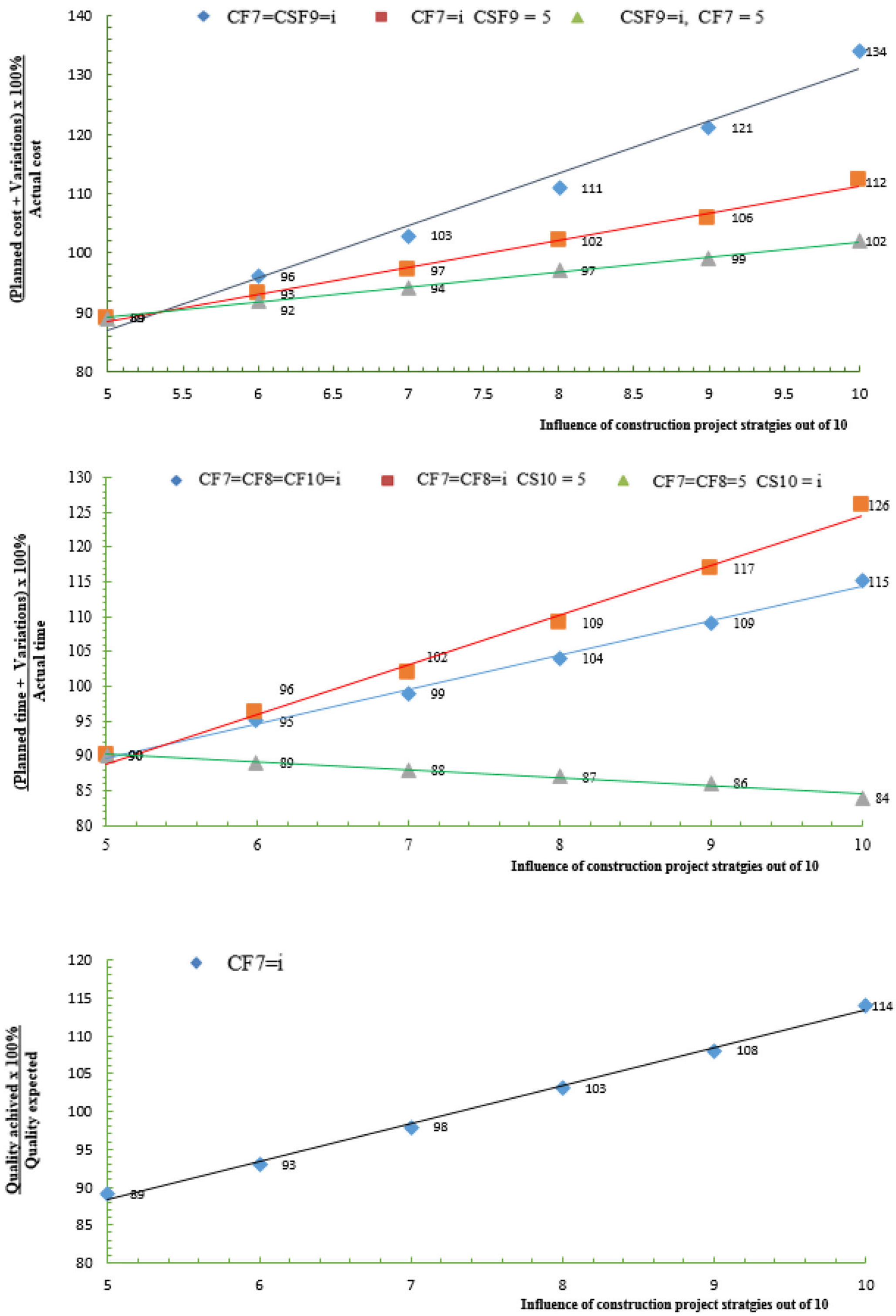

Figure 4. Strategy influence versus process success.

Table 10. Characteristics of selected projects.

Contingency	Sample mean	Hypothesized mean	t – value	Sig. level (2-tailed)
Complexity	79	75	2.380	0.022
Dynamism	73	65	3.929	0.000
Uncertainty	68	60	3.439	0.001
Uniqueness	77	70	3.390	0.002

Table 11. Correlations between project characteristics and influence of strategies towards CFs7, 8 &10 and CSF9.

CSF/CF	Complexity	Dynamism	Uncertainty	Uniqueness
CF07	0.510	0.470	0.328	0.518
CF08	0.382	–	0.486	–
CF10	0.442	0.428	0.547	0.402
CSF09	0.496	0.380	0.336	–

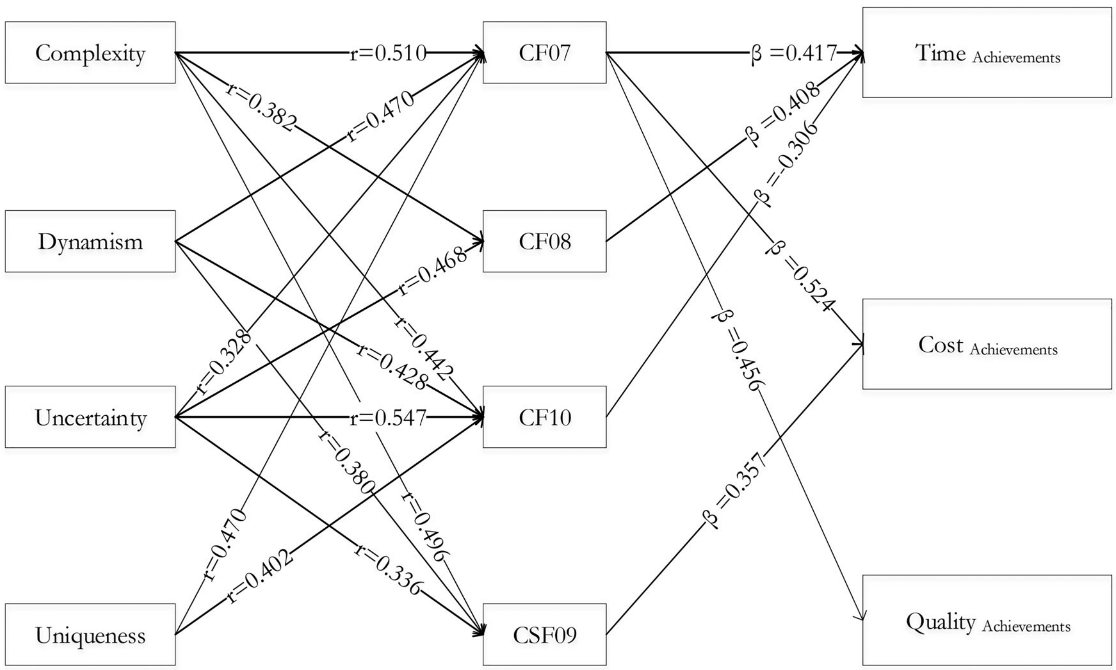

Figure 5. Final model - project characteristics, use of project strategies and CSFs/CFs.

clarification in literature on how this positive influence by project strategies towards CSFs would govern a particular project outcome eventually. Because of pragmatic issues, the current study could not consider all possible project outcomes. However, Figure 5 illustrates 13 CSFs significantly governed the variance of the achievements of cost (48%), time (37%) and quality (21%) in the projects surveyed: CSF02, CSF06, CSF08, CSF12 and CSF25 in CF07; CSF03, CSF05, CSF07, CSF09, CSF10 in CF10; CSF11 and CSF34 in CF08 and CSF09. The rest may have statistically significant correlations with success measure that the field study did not consider, such as meeting client's project aspirations, testing an innovation and minimising conflicts and legal claims.

CSFs of CF7 included: 1) improving project schedules/plans; 2) coping with variations; 3) effective use of technology; 4) ensuring contractor's cashflow; and 5) ensuring monitoring and feedback. They can be considered as the most important amongst the 35 CSFs because of the correlations their CF had with project characteristics and success measures. When the influence of strategies towards CF7 was moderate (5/10), achievements in terms of cost, time and quality were limited to 90% only. However, maximum influence by project strategies towards CF7 can boost these achievements by up to 134%, 105% and 114% respectively. Also, literature seems to pay more attention towards these CSFs whilst conceptualizing the suitability of a strategy-led approach. While Kumar (1989) and Russell et al. (2014) focus on the improvements that a strategy-led approach can potentially bring to schedules and plans, Abeysekera's (2007) conceptualization on rate and rhythm considers how a strategy-led approach can improve time schedules whilst also ensuring a smooth cash inflow even in a case of significant cost variations. In addition, many studies suggest selection of construction methodology is a strategic concern, yet strategy literature has no significant focus on a mechanism for ensuring feedback and monitoring. However, TPAs are criticized as insufficient to provide an information-rich progress monitoring model that can consider both quantitative and qualitative variables appropriately (Hegazy and Menesi 2010).

Whereas the strategy-to-implementation gap and strategy failures are well-documented and have led to cutting-edge research in other fields, this risk is rarely stated in construction. If mentioned, the discourse is limited to future study recommendations. The field study provided evidence to support that some strategic actions caused negative effects towards timely achievements. While a future investigation is required to answer why, it should be noted that these consequences were reported in high-profile projects that were delivered by well-experienced construction managers. It can be expected that the risk of strategy failure is much higher in a typical project. Nevertheless, future research will assist enhancing construction manager's awareness of the associated risk factors of the strategy process. Eventually, this knowledge will lead to a better strategy content. In addition, as the critical success factors and the theory of strategy planning are all well-established in global literature, the awareness raised through the findings of this study applies to the construction globally

Future study

Notwithstanding a long-held criticism on the inadequacies of TR to explain real-world scenarios, literature review on TPAs showed their advancements are not subjected to major paradigmatic shift. This deficit has been stressed for decades by construction management researchers (Dias and Blockley 1995; Clough et al. 2008; Taroun 2014). However, there is no systematic approach invented for construction managers to try heuristic procedures to cope with soft issues associated with construction projects. Also, an opinion in literature is that a strategy-led approach can support TR-RP co-existence. However, substantial evidence is required to validate this claim. Thus, the focus of a future study could be to develop a system approach from industry practice itself to support strategy development. Since the most unanswered questions of strategy process, content and context belong to the 'how' type, an exploratory study will be required first for theory development.

As articulated by Dias and Blockley (1995), there are two key concepts of a system approach that is suitable to cultivate RP. The first one is developed on emergentism, which believes that complex matters have emergent properties. This is because the hierarchically arranged parts of a problem are interconnected. Courtney (2004) explains emergentism using attention and cognitive control: the topography of human's prefrontal cortex has different areas for storing different types of information, however it is their neuroanatomical relationships that determine one's cognition, perception and behaviour. The question is how this kind of a system approach can be practiced in a strategy-led approach to construction projects. Because of selective inattention, quantification has limited ability to represent a complex matter and thus, experts rely on diagramming (i.e. a qualitative representation) to define interconnectedness of planned activities. Most construction planning algorithms that are claimed to be holistic (for example: constraint-driven scheduling and multi-criteria methods) are however reductionist and heavily rely on mathematical techniques to define the interconnectedness among the planning entities. Not surprisingly, evidence suggest that construction industry practice to complexity and uncertainty management is far different to academic suggestions (Kumar 1989; Taroun 2014; Rotimi and Ramanayaka 2015).

The second core concept of a system approach for RP is the process loop with interactions and feedback. Because real-world issues are often not well-defined, an experimenter is unable to provide precise solutions. Thus, the feedback loop facilitates continuous learning through an active participation in decision-making processes. TPAs acknowledge the necessity of monitoring and adjustments also. However, the next iterative estimate is based on a calibration against the world. This leads to strong mathematical approaches to adjustments and thus, Hegazy and Menesi (2010) stress that CPM does not facilitate an effective learning process. For example, if an activity implementation changes the parametric estimate (i.e. the unit rate of an activity progress in terms of time), the planner will use the revised rate for scheduling in the next project. Similarly, if at least one pessimistic, optimistic or most-likely durations are changed, three-point estimate will be altered for the next iteration. In both cases, no active learning happens because the decision-maker is not mindful of the variables that have caused a discrepancy in a past event and the probability of occurrence of such variables in a future event. However, RP encourages learning via a comparison with the world and professionals rely predominantly on graphical methods to reflect on the qualitative variables that caused any discrepancy between a decision and the outcomes. Thus, the future research of this study focuses on discovering the practical approaches that were used by the NZIOB awardees on the two core concepts of RP: emergentism and continuous learning.

Conclusion

Although project characteristics are unavoidable, an experienced construction manager can successfully cope with them and achieve intended project outcomes in terms of cost, time and quality by adopting a strategy-led approach to project delivery. Early-stage strategy development can enhance the appropriateness of initial schedules and plans. Nevertheless, construction managers should continue the formation and assessment of strategies during project implementation. Since they are heuristic in nature, strategy contents (for example: strategy-driven schedules) are not precise. Thus, an interactive mechanism should be developed to allow continuous empirical learning in a strategy-led approach. Further research can assist the industry to minimise the current strategy-to-implementation gap. Graphical representations that construction managers potentially use to model the project characteristics remain largely unknown. To develop a system approach for a strategy-led planning methodology, researchers will need to divert from the current TR paradigm, which largely relies on mathematical modelling of project characteristics, and explore RP techniques that experienced construction managers used to manage real-world scenarios.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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