

Article

Analysis of Key Failure Factors in Construction Partnering—A Case Study of Taiwan

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Abstract: Construction partnering is commonly touted as a win-win arrangement for project owners and contractors alike. The failure or success of construction partnering arrangements is contingent upon a multitude of influences, many of which can be controlled through careful planning and active project management. This study examines the key failure factors (KFFs) of construction partnering projects based on data collected from a survey of industry professionals in Taiwan. Methods: Factor analysis is performed using data gathered from a survey of industry practitioners operating in Taiwan to identify KFFs and better understand the level of significance of each factor. A total of 15 failure variables (FV) were included in the survey. This study applied Principle Components Analysis to classify groups of crucial FV relevant to construction partnering based on their relative perceived contribution to project failure. Study results confirm that there are four KFFs to partnering failure in construction projects; they are absence of agility, collaboration barriers, partnering barriers, and organizational management barriers. The biggest influencer on partnership failure in construction projects is the association between absence of agility and organizational management barriers, while the next most significant is the relationship between collaboration barriers and partnering barriers. Avoiding failure of construction partnering requires careful planning and management considerations of the four KFFs found.

Keywords: construction partnering; key failure factor; principle components analysis; project management; critical success factors

1. Introduction

Construction projects are inherently complex, and success requires multiple project stakeholders working together cooperatively for a unified objective. Common stakeholders involved in construction projects include project owners, designers, engineers of various disciplines, planners, contractors, materials suppliers, and so forth. As the scale and complexity of construction projects grow, so does the number of stakeholders and complexity of stakeholder relationships involved in partnerships. Successful outcomes from partnerships in construction projects are achieved through capitalizing on the skills, abilities, specialized knowledge, and experience of the various teams and organizations engaged in the project. However, there is insufficient understanding of the dimensions of partnership relationships [1]. This lack of understanding can result in stakeholders failing to work together cohesively in a partnership. To improve construction partnership outcomes, this study explores the systemic factors of the construction industry, which can contribute to the failure of partnerships to

deliver on the desired project outcomes. Our study focuses on the Taiwanese construction industry due to the importance of the construction industry to the domestic economy.

For Taiwan, the construction industry is considered a critical foundation of the domestic business environment. The annual value of the construction industry makes up around 4–6% of Taiwan's total GDP (gross domestic product). However, the industry is plagued by the failure to deliver value in construction projects due to cost wastage, schedule delays, and so forth [2]. The relationship between project owners and professionals in Taiwan's construction projects is at times antagonistic, which hinders project progress and efficiency. The problem in Taiwan's construction industry often stems from project owners engaging low cost contractors, and these contractors (professionals) in turn reacting to a perceived exploitation by the project owners, the result of which is that the contractor's loyalty can diminish to the point where they are perceived as untrustworthy. This can happen multiple times within a single project. Replacing contractors not only introduces new risks and complexity to the project, but consumes time and effort better spent on ensuring quality outcomes for the project.

The failure of different organizations in the construction industry to work cohesively in a partnership can result from an environment of suspicion and commercial competition [3]. In the construction industry, teams working in partnership often continue to represent their own respective organizations, each with their own specific economic objectives, culture, and management styles. In this arrangement, each organization involved in the project will tend to act independently while potentially holding adversarial attitudes. As a result, construction project partnerships frequently experience communication and co-operation problems that can seriously impact productivity and delivery of positive outcomes. As such, the issues frequently experienced in the construction industry, such as disappointing end results, excessive supervision, wasted time and money, and poor team morale, can cause cost overruns and project delays, in turn often resulting in conflicts and lawsuits [4,5]. Furthermore, mistrust is often generated by a failure of integrity and unworthy information between partners [6]. Conversely, with a culture of trust and acceptance amongst stakeholders, project partnering can yield benefits for those involved in the partnership process [7]. Therefore, stakeholders of any construction project need to consider the key factors that can have a negative impact on a construction project's success and implement targeted measures to build a positive partnership culture.

The construction industry has undergone significant change over the past decade. Companies are now more active in seeking to increase efficiency via better management to maintain commercial competitiveness [8]. The acceptance of partnerships between construction owners and contractors is gradually increasing. Nevertheless, a growing number of projects involving partnering in the Taiwanese construction industry are not delivering the desired outcomes. Therefore, truly successful examples of construction partnerships are limited, and as a result there is more potential to learn from the failure of project partnerships. The challenge is formal research on the causes of failure in partnering projects in Taiwan is scarce and so further research is therefore warranted. To fill the knowledge gap, this study intends to identify and explore common Key Failure Factors (KFFs) for construction partnering in Taiwan.

The underlying factors that result in the failure to fully achieve project objectives is a topic of interest in many industries. Within this area of research, the common theme is that there is a multitude of underlying systemic issues which must be addressed effectively to avoid failure. The focus is on being able to identify and verify the underlying sociotechnical constructs and factors which contribute to project success or failure. The investigation of success and failure factors has been applied to a diverse range of pursuits reliant on efficient sociotechnical structures, including the operation of remote teams [9], implementation of software-based enterprise resource planning (ERP) systems [10], developing new insurance and banking products [11], and information system projects [12]. While each of the studies investigates the mix of organizational factors, strategic planning elements, and technical challenges in delivering successful factors, the specific failure factors involved are unique depending on the industry and project objectives. The assessment of chosen factors are based on the opinions of specialists in the respective fields and explored through statistical analysis.

Seeking to identify the unique construction partnering KFFs and exploring their internal relationship is important for ensuring successful future outcomes for construction partnering projects. Building on the inherent characteristics of each KFF, the study also proposes leading indicators of potential project partnership failure. The use of leading factors is based on the premise that prior to the failure of a partnership there are often signs and signals indicating the impending failure. Often such signals or warning signs are only recognized in hindsight after the failure of the project to meet the desired performance outcomes.

Need for Further Research

Partnering can be considered present via a range of features, characteristics, and interaction behaviors, creating a shared culture. It's the shared culture which extends beyond organizational boundaries and creates a relationship under the umbrella of *partnering* [13]. Also, partnering can be considered an enacting strategy that can be applied to a range of contract models rather than being simply viewed as an alternative contract form. Construction partnering is common in contemporary industry practice for the completion of larger and more complex projects. Successful partnering requires due consideration of the interests of all involved parties at all levels, including management, owners, general contractors, subcontractors, and worksite employees [14,15]. The partnering process aims to formalize working arrangements between different parties via a mutually developed, formal strategy of commitment and communication focused on achieving "win-win" results for different partners [16]. According to Wilson et al. [17], partnering can achieve quick and efficient results together with reduced start-up costs. Advantages of partnering include risk sharing, cooperative problem solving, increasing competitive advantages, and opening new markets, as well as improved ability to deliver the project to the customers' requirements.

Profit growth/stability and marketing advantage are the two principle reasons for entering into partnerships [18]. Profit growth/stability can be achieved by improving property management and building on efficiencies, while marketing advantage can be realized by increasing product value or improving marketing approach. Successful project partnering is based on multiple management and organizational factors, and determining which factors have the greatest influence over project success or failure has attracted the attention of much research. Isolating which key success factor (KSF) has the greatest influence requires detailed analysis of multiple factors of varying influence from completed construction projects.

The success factors for projects has been the subject of several studies, which have investigated different aspects of critical success factors (CSFs) for projects using a wide range of methodologies. Dvir et al. [19] analyzed several construction projects to determine key project success factors. They applied multivariate methods to analyze a sample of construction projects and identify key factors for project success. Findings of the study indicate that there are a wide range of variables which influence project success, varying depending on the type of project being undertaken. Cooke-Davies [20] examined success factors for projects based on analysis of questionnaires returned by 70 multinational firms. The focus was on answering three key questions: "what factors lead to project management success", "what factors lead to a successful project", and "what factors lead to consistently successful projects." The study identified 12 factors which in one way or another are critical to successful project outcomes. Gudiene et al. [8] applied the Analytic Hierarchy Process (AHP) to identify and rank the relative importance of 10 CSFs from data collected from selected construction projects in Lithuania. In the findings, it was clear that having realistic project goals and project planning have the greatest influence over project success. Chan et al. [21] used multivariate regression analysis to assess the success factors of design and construction projects. As a result, each factor's relative contribution towards the success of a project was established.

Guided through the application of a meta-analytic approach, Sparkling et al. [22] explored research trends in architecture, engineering, and construction project partnering over the last three decades. The study found that success in partnered-projects was attributed to (1) establishing partnering

workshops, (2) mutual goals and objectives effectively communicated, and (3) team-building sessions. However, partnering factors related to organizational outcomes were found to be of less interest to researchers. Chan et al. [23] reviewed 29 construction partnering studies to identify the associated benefits from project partnerships. Key benefits from partnering include closer commercial relationships, better control of cost, time, and quality. Hosseini et al. [24] identified the discrepancies between theory and practice to clarify the confusion of partnering. The discrepancies were established from a detailed literature review and 39 interviews with respondents from 44 construction partnering projects. The study found that either practitioners misunderstood what partnering actually entails or the base requirements are exceedingly rigorous and do not reflect the actual purpose of the concept.

Construction partnering is frequently touted as a way to accomplish a mutually advantageous outcome for project owners and contractors, which have been investigated in previous studies [24–27]. However, there is limited understanding of the KFFs which play a role in unsuccessful construction partnering outcomes. Accounting for both the KSFs and the KFFs provides a more balanced and comprehensive understanding of the factors which influence partnership outcomes and provides knowledge required to develop strategies for project partnership success.

To provide novel insights and guidance regarding failure factors found in construction partnering in Taiwan, this study aims to examine in detail key factors for failure in construction partnering. The objective of this study is to (1) identify a list of common causative variables for failure of construction partnering; (2) examine the association of the variables; (3) aggregate these identified FVs into a smaller number of groups via PCA; and (4) present leading indicators to avoid common causes of failed construction partnering.

2. Materials and Methods

This study employed the following methodology for the review of failure factors. Firstly, metrics were developed for computing failure attributes among construction partnering variables. Then, metrics were developed for measuring construction partnering variables, and a questionnaire survey was carried out to measure the failure attributes of the Taiwanese construction industry using the judgment of industry professionals. The questionnaire responses were then analyzed using IBM's Statistical Package for Social Sciences (SPSS).

Questionnaire Development, Distribution and Analysis

The exiting literature on construction partnering provides many established partnering factors relating to unsuccessful project outcomes [25,28,29]. Based on a comprehensive review of the literature 15 FVs associated with project partnering failure were selected. These 15 FVs were selected as the basis for the industry questionnaire. The chosen FVs are as follows: Absence of genuine and open communication (FV₁), A win-win attitude is absent between partners (FV₂), Absence of a commitment to co-operation between partners (FV₃), Absence of a positive relationship in partnership (FV₄), Unresolved disagreements (FV₅), Not all partners willing to negotiate (FV₆), Authority from owner is not readily given (FV₇), Complex Organizational bureaucracy (FV₈), Limited professional knowledge of managers (FV₉), Partnership priorities surpassed by commercial performance pressure (FV₁₀), Absence of training/support during partner assignment (FV₁₁), Bidding approach restricts flexibility (FV₁₂), Blueprint and regulation problems (FV₁₃), Major contractors absent in partnering (FV₁₄), Partners not suitable for a given project (FV₁₅).

Using a Likert-type scale for the questions with responses ranging from 1 (strongly unimportant) to 5 (strongly important), the questionnaire included the 15 selected FVs in construction partnering and other targeted questions to capture information on the respondent's professional background and experience. To ensure the validity of the survey a test questionnaire was sent to selected construction professional to complete and provide feedback. After this the survey was sent out to construction industry professionals working in Taiwan. Targeted subjects were selected from four key groups, being government agency employees, project owners, designers and construction contractors.

Factor analysis (FA) approaches use a defined methodology to identify groups of related variables and thus is an ideal technique for creating a more easily understood framework [30]. In this study PCA is used method to generate unique linear combinations of factors which are derived from the initial FV of interest to explain as much of the variance in the collected data as possible. The final principle components are what will be interpreted into the final KFF.

3. Results

An initial test study was undertaken to examine measurement accuracy of the characteristics and variables and to ensure the information received was suitable for the intended analysis methods. For the initial study, 42 experienced construction professionals comprising 12 project owners, 10 design firm practitioners, 10 construction contractors, and 10 academics were invited to review the draft questionnaire and provide feedback and comments based on their professional opinion. Thirty-eight questionnaires were completed and returned and found to be valid. Analysis of the draft questions showed that a Cronbach's α of 0.92 was achieved, signifying good reliability of information in the draft questionnaire [31].

The final survey population selected for the study focused on construction practitioners and professionals operating in Taiwan. The questionnaires were distributed through a variety of targeted methods and channels to maximize response rate and industry representation. A total of three hundred thirty-three questionnaires were disseminated with two hundred twenty-one valid questionnaires completed and returned, representing an overall response rate of 67%. As shown in Table 1, more than 20% of respondents were equipped with a minimum of 15 years' construction work experience. Furthermore, there is a relatively even distribution in the years of work experience in construction of respondents. Of the 221 respondents, the following categories of construction work experience <5 years, 5–10 years, 10–15 years, and >15 years, each accounted for approximately a quarter of all respondents. This diverse spread in the years of experience in construction industry across respondents ensures a good representation of opinions from a range experience levels.

Table 1. Summary information of survey respondents.

Item	Category	No.	Percentage (%)
Profession	Government agency employee	39	17.6
	Project owner	32	14.5
	Project design firm	63	28.5
	Project contractor	87	39.4
Work experience (yrs.) in construction	<5	52	23.5
	5–10	53	24.0
	10–15	68	30.8
	>15	48	21.7
	>20	19	8.6

3.1. Survey Analysis and Exploration of Top FVs

Table 2 lists the 15 FVs that have an overall mean equal to or greater than 3.60 (when rounded to two decimal places). Next, FVs were ranked based on overall means taken from all respondents, where two or more FVs shared the same overall mean, the FV with the lowest standard deviation was given the greater importance. The results show that the key groups of respondents appear to have slightly different perceptions concerning FV importance. Though the rankings differ for the respondent groups, the results appear to show comparable patterns in the ranking of the FVs. More than a half of 15 FVs had means greater than 3.95, and these eight FVs were selected for further investigation. A description of the characteristics of the eight key FVs is provided in the following sections.

Table 2. Ranking of Failure Variables (FVs) based on the survey results with rankings based on the different project participants surveyed.

Failure Variables (FV _n)	Participants									
	Overall		Government Agent Employee		Project Owners		Project Design Firms		Project Contractors	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
FV ₁	4.29	2	4.21	2	4.25	1	4.21	2	4.40	1
FV ₂	4.04	5	3.92		3.97		4.06	5	4.10	6
FV ₃	4.14	4	4.10	4	4.22	2	4.11	3	4.15	4
FV ₄	3.59	15	3.38		3.53		3.63		3.67	
FV ₅	4.30	1	4.38	1	4.09	4	4.29	1	4.36	2
FV ₆	4.00	7	3.97	6	4.00	6	4.05	6	3.98	
FV ₇	3.98	8	3.95		3.75		4.03		4.05	
FV ₈	3.79	12	3.56		3.59		3.81		3.95	
FV ₉	4.18	3	4.15	3	4.16	3	4.08	4	4.28	3
FV ₁₀	3.83	10	3.72		3.72		3.84		3.91	
FV ₁₁	3.87	9	3.95		3.66		3.84		3.93	
FV ₁₂	3.77	14	3.54		3.47		3.94		3.87	
FV ₁₃	4.03	6	4.03	5	4.03	5	3.87		4.15	4
FV ₁₄	3.78	13	3.77		3.81		3.71		3.82	
FV ₁₅	3.80	11	3.85		3.59		3.81		3.84	

Note: Bolded numbers indicate the rank differs amongst participants. The FVs are as follows: Absence of genuine and open communication (FV₁), A win-win attitude is absent between partners (FV₂), Absence of a commitment of co-operation between partners (FV₃), Absence of positive relationships in partnership (FV₄), Unresolved arguments (FV₅), Not all partners are willing to negotiate (FV₆), Authority from owner not readily given (FV₇), Complex organizational bureaucracy (FV₈), Limited professional knowledge of managers (FV₉), Partnership priorities surpassed by commercial performance pressure (FV₁₀), Absence of training/support during partner assignment (FV₁₁), Bidding approach restricts flexibility (FV₁₂), Blueprint and regulation problems (FV₁₃), Major contractors are absent in partnering (FV₁₄), Partners are not suitable for a specific project (FV₁₅).

3.1.1. Unresolved Disagreements (FV₅)

Unresolved arguments, if left unchecked, can negatively influence project operations and performance. The primary stakeholders in many construction partnerships are the owner and the construction contractor, and all stakeholder groups bring their own culture and relationships which require co-operation and collaboration to effectively co-ordinate their time, resources, and communications [32]. In this study, the term *conflict* is applied to *unsolved disagreements* between two or more project partners. Project partners are principally concerned with completing a successful project which delivers on agreed quality and specifications, as well as meeting specified budgetary and scheduling constraints. Successful project outcomes depend on, amongst other factors, how effectively partner organizations resolve conflicts and maintain robust professional working relationships.

Characterized by numerous complex operations which can change from day to day, construction projects typically feature challenging working conditions, a diverse workforce, and a high risk of occupation injury. With such diverse and dynamic working conditions, conflicts and arguments between construction partnering organizations are an inevitable event. As such, conflicts arise in all construction projects, and if they are not promptly addressed, even minor conflicts can escalate and negatively influence project outcomes, as a result of relationship breakdown between construction partners. As a method to readily resolve conflict as it arises, Manley et al. [33] proposed designing agreed conflict management procedures which requires partners to anticipate ways disputes are likely to occur in individual projects, and strategies for handling conflicts as they arise is developed.

Dispute resolution typically occurs using the methods of negotiation, mediation, arbitration, and litigation. Negotiations between partners involved in a dispute can be used as a forum to discuss and resolve issues resulting in conflict to the approval of both parties. If successful, no other parties are required to be involved and proceedings can be kept relatively informal. The next step in elevating conflict resolution is mediation. In mediation, partners experiencing conflict engage the services of

an independent and impartial person to assist in dispute resolution process. The final decision for any outcome is up to the partners involved in the conflict, as the mediator does not have authority to enforce the outcome. Arbitration in many aspects is comparable to mediation with the exception that the arbitrator carries the authority to deliver a decision that is final and cannot be appealed. The final and least desirable of all options is litigation. Litigation is an expensive and protracted process for all parties that involves the legal system. Well-developed and executed procedures for conflict management are required to avoid or resolve conflicts effectively and economically.

3.1.2. Absence of Genuine and Open Communication (FV₁)

The term open communication is used to describe an open exchange of resources such as ideas, skills, and technology via various effective approaches [34]. Continuous two-way communication enables the free flow of information, providing an avenue for information sharing of new processes and high-level information not typically available outside of construction partnering arrangements. Many studies on the topic of effective construction partnerships emphasize how effective communication in a partnership is considered crucial to successful construction partnering [35]. Conversely, ineffective communication will often result in the failure of a construction partnership. [36] considers communication to be the principle element of success, and as such the main factor for the prevention of construction partnership breakdown. Effective Partnering requires a continuous open and honest communication between all team members on a construction project.

Moore et al. [37] believe that partnerships used only to convey information between the head office and the site office will fail. Problems on site must be solved without delay, with outcomes communicated to all levels of the workforce hierarchy. If continuous open and honest communication are not embraced by project partners, they will lack the resilience to effectively manage problems as they arise. Moreover, project partners will struggle to effectively integrate their respective resources and achieve common goals from a project. Consequently, project partners are placed in a problematic position driven by inefficient project implementation, potential resulting in partnership failure and commercial uncertainty for each party.

Avoiding partnership failure necessitates continuous project information exchange between partners. Ideally the communication channels should reflect organizational structures and specify information that should flow through each channel both from the top down and bottom up. The frequency and timing of communication must allow decision makers to receive timely information, but not overload them with superfluous information. Furthermore, the flow of communications from management to rest of the organization must be well timed to ensure workers feel engaged and respected. To compliment well-structured formal communications, an open and positive working environment requires informal communication lines within the project team.

3.1.3. Manager(s) with Limited Professional Knowledge (FV₉)

The role of managers is to guide and lead organizations towards achieving their goals. Organizations principally exist to achieve certain purposes or goals, which are often motivated by commercial success. In this context managers are responsible for finding the most effective use organizational resources to achieve organizational goals. Managers lacking adequate professional knowledge related to construction have the potential to put partnership success at risk depending on their position within an organization. The success of a manager depends on performance rather than personality traits alone, and the capability of a manager to perform successfully depends on their managerial skills [38]. As a manager progresses, from lower-level management positions to upper-level management positions, technical skills become less essential and conceptual skills grow in importance. In general, for the construction industry personnel in supervisory or operational management positions require technical skills, middle managers need well developed interpersonal skills and high-level conceptual skills are a must for senior management. The typical practice in the construction industry is that as people advance further in management positions, they steadily become

less concerned with technical aspects of a project and more involved with strategic management and direction of the organization. Therefore, if managers were to work in supervisory or operations positions without the appropriate technical knowledge or skills can put a construction partnership at risk.

For a company to be viable, the workforce needs to be skilled enough to continually adapt to technical innovations within various engineering disciplines to remain competitive, especially when operating in advanced economies. It should be noted that when a mismatch exists between leader orientation and situation (for example that a manager lacks necessary technical knowledge or skills), the leader should provide targeted professional development and training to help them change the situation, thus improving leadership perceptions of situational control.

3.1.4. Absence of a Commitment to Co-operation Between Partners (FV₃)

Partnerships are founded on a commitment of partners to operate in co-operation rather than competition and conflict, eventually leading to a more amicable relationship. Without such a commitment from all partners, the partnership will indeed fail. Bennett and Jayes [39] identified that the continuity and establishment of long-term co-operation offers one way of achieving greater equality within a partnership. The nature of the construction is such that members of a partnership are used to operating in a highly adversarial cutthroat environment. Although numerous examples of trust and co-operation are being established well within partnerships, numerous situations also exist where the state of co-operation is either fragile or non-existent [40].

Avoiding the failure of a partnership requires members being dedicated to continuous co-operation. Bresnen and Marshal [41] have argued that co-operation cannot be “engineered” to fit a profile required by the partnership. The literature on implementing a successful partnership posits that it is a technical managerial problem that uses proven techniques to manage organizational behavior. For partners that lack the required level of co-operation and are unwilling to adopt an effective team culture initiative such as team building exercises and financial incentives can improve co-operation levels. To ensure partnership success over failure, there is need for a change of perception, from a perceived adversarial approach towards a culture of increased cooperation.

3.1.5. A Win-Win Attitude Is Absent between Partners (FV₂)

A win-win attitude is when all partners in the project are engaged in the success of the project for their own commercial success as well as the delivery of an outcome that meets the project owner’s expectation. Such an attitude is arguably the principle ingredient for success, as it requires equality within partnerships. Without this win-win attitude, relationships are destined to fail [42] The high prevalence of litigation in the construction industry is primarily the result of an absence of a win-win attitude between partners.

In this study the commitment to a win-win attitude is the fifth highest ranked key contributor to personnel perceptions of partnering success. Therefore, it can be held that if partners are not steadfast in having a win-win attitude, then the partnership is unlikely to fully realize success. For partnership success, Chen et al. [27] have subscribed to a win-win working environment as opposed to an environment that creates winners at the expense of losers. This is certainly the case for survival in a competitive industry such as the construction industry, with partners who are reluctant to move away from the traditional adversarial mentality. To remedy this mentality, partnerships must foster a win-win culture in place of the all too common win-lose mindset.

According to Bennett and Jayes [39], the equity created through a win-win attitude fosters a relationship with a balance of rewards and risk that is based on the efforts of each partner to achieve common goals. Creating an atmosphere that supports a win-win attitude is an important means of preventing partnership failure. A win-win attitude involves partners actively working together to for a common purpose, with each party agreeing to approach each situation in an anti-adversarial style.

3.1.6. Blueprint and Regulation Problems (FV₁₃)

Any construction company, be it traditional or partnership based, will face a risk of failure resulting from blueprint and regulation problems. To reduce project duration, it is common practice to begin the construction phase before completion of the design phase. During the construction phase, the building is constructed as per agreed plans, specifications, schedules, and budgetary constraints. Throughout the project, there is an underlying assumption that design plans and specifications are correct, as well as meet the requirements of the owner, as well as complying with all applicable codes and standards. While such assumptions may appear reasonable, the inherent nature of construction work is such that there are often unexpected changes and unforeseen challenges.

Furthermore, it is an unfortunate fact that even in the largest of projects, plans and specifications frequently contain errors. The process of design preparation involves teams of individuals performing a wide range of tasks such as design calculations, coordinating related tasks, and producing numerous technical drawings. Even with the best efforts of the design teams, it is very uncommon for a complete set of flawless plans and specifications to be developed the first time; rework is often required. There needs to be enough agility in the working arrangements to identify any potential problems with blueprints and regulations, then correct issues before undue delay or cost is occurred. Failing to capture such flaws in time can result in contractors unintentionally and without knowing violate code requirements. Violations of code regulations is a serious concern for any construction project potentially resulting in building inspectors to place stop orders on projects pending rectification.

3.1.7. Not All Partners Are Willing to Negotiate (FV₆)

Throughout the course of any large construction project, disputes will arise between project partners regardless of how well planned and administered. Disputes can vary greatly in nature from small disagreements which can be easily resolved to large complex disputes resulting in litigation. How well the partners involved in the project negotiate and resolve conflict and disputes will significantly impact on the overall success of the project. Inefficient resolution of disputes that arise between project partners often results in delays to the project while a resolution is found. Moreover, if project partners are not willing to negotiate the ability to respond promptly to emerging issues is greatly limited. Such situations limit the ability of the partners in being agile in ensuring the best overall outcome for the project. In worst case scenarios where negotiation fails to solve problems resolution through formal processes may be required. Resolution of disputes through officially binding processes such as formal arbitration is lengthy and involves substantial costs [43]. In a project partnership where all partners are willing to negotiate to overcome disagreements and progress the project in the most appropriate way. To be willing to negotiate partners must communicate openly and accept compromise for the good of the project deliverables.

This has seen the rise in alternative dispute resolution methods to avoid the lengthy and resource expenditure of formal litigation. Having an incentive for cooperative partnering is the first step in creating a project environment which avoids the need for escalating dispute resolution methods [44]. To achieve cooperative partnering each of the project partners need to be willing to negotiate with each other. Through a willingness to negotiate actively by all parties as required, resolutions to issues can be resolved quickly and the project can continue to progress.

3.1.8. Authority from Owner Is Not Readily Given (FV₇)

For partners to execute their role in the project to full effect and in a timely manner each partner requires certain authorities from the project owner. Without the authority forthcoming the partners are delayed in executing their respective roles which can result in overall delays to the project competition. These delays present potential barriers to partners becoming involved as delays can result in resources being tied up on projects which in turn can potentially affect commercial returns. Therefore, ensuring partnership and overall project success, authority from owners needs to be given readily to the require

project partners. The authority required will vary depending on the role in the project. In an industry survey of perceived causes of construction project delays in Jordon et al. [45], delays in construction projects could be the result from a number of contracting factors including project owners not allowing consultants the full authority to complete their work in the most expedient manner.

Given the relatively high ranking of this FV the issue of authority from the owner not being readily given is likely a pervasive issue for most if not all partners involved in construction projects. For authority to be given freely there needs to be an established relationship of trust that each partner will use the authority to act in the best interest of the owner and the overall project objectives. Establishing such trust founded upon building a working relationship which includes characteristics such as open communication and a commitment to cooperation.

3.2. Principle Components Analysis

The first step of PCA involves the determination of the strength of associations amongst the 15 identified FVs. This relationship is measured using Pearson's correlation coefficients for pairs of FVs. Pearson's correlation coefficient (r) is a measure of the strength of the association between the two variables where r values can range from -1.00 to +1.00. The nearer the result is to an absolute value of 1.00, the stronger the relationship between the pair of FVs. A correlation value of 0 indicates no linear correlation between selected variables of interest [45].

The correlation coefficients matrix for the 15 FVs is given in Table 3. The correlation coefficients validate that there are a numerous association amongst the FVs. To ensure the data was suitable for further analysis the validity of the matrix was testes. The Bartlett test of sphericity was 1205.675, with a significance value of $p = 0.000$, which excludes the population correlation matrix as an identity matrix. Furthermore, the value of the Kaiser-Meyer-Olkin (KMO) measure of sampling accuracy is 0.910, which surpasses the critical value of 0.5 required to deem the responses suitable for further analysis [46] Therefore, the data was considered suitable for further analysis.

Associations with correlation coefficients (r) greater than 0.5 were categorized as having a high correlation. The variables with a high correlation coefficient are as follows: FV₇ with FV₁₀, FV₁₁ and FV₁₂, respectively; FV₁₀ with FV₈, FV₁₁, FV₁₂, and FV₁₄; FV₁₄ with FV₁₅, respectively. Relationships with coefficients between 0.45 and 0.5 were considered to have a medium to high correlation. FVs with a medium to high correlation are as follows: FV₂ with FV₃ and FV₁₀; FV₇ with FV₅, FV₆, and FV₈, respectively; FV₁₀ with FV₂ and FV₆; FV₁₃ with FV₉ and FV₁₀; FV₁₄ with FV₈ and FV₁₁. Certain inferences can be obtained from the correlation coefficients. For example, the higher occurrence of "Major contractors not involved in partnering" implies a higher occurrence of "Partners unsuitable with specific project". The stronger correlations between FVs demonstrates that associations between FVs a worthy of further examination. The initial relationships are of limited material benefit to users as the correlation coefficient specifies a basic relationship between two variables. As a result, this information provides only a limited insight of influential variables in project partnering. Therefore, a detailed understanding of the associations between FVs of construction partnering cannot be achieved from correlation coefficients alone and require further analysis using PCA.

Table 3. Construction partnering failure variable (FV) correlation matrix.

	FV ₁	FV ₂	FV ₃	FV ₄	FV ₅	FV ₆	FV ₇	FV ₈	FV ₉	FV ₁₀	FV ₁₁	FV ₁₂	FV ₁₃	FV ₁₄	FV ₁₅
FV ₁	1.000														
FV ₂	0.419	1.000													
FV ₃	0.427	0.499	1.000												
FV ₄	0.291	0.315	0.246	1.000											
FV ₅	0.340	0.425	0.371	0.231	1.000										
FV ₆	0.259	0.376	0.411	0.223	0.425	1.000									
FV ₇	0.299	0.423	0.325	0.315	0.478	0.478	1.000								
FV ₈	0.200	0.413	0.301	0.253	0.271	0.389	0.452	1.000							

Table 3. Cont.

	FV ₁	FV ₂	FV ₃	FV ₄	FV ₅	FV ₆	FV ₇	FV ₈	FV ₉	FV ₁₀	FV ₁₁	FV ₁₂	FV ₁₃	FV ₁₄	FV ₁₅
FV ₉	0.222	0.388	0.316	0.230	0.256	0.372	0.353	0.371	1.000						
FV ₁₀	0.203	0.455	0.401	0.243	0.384	0.498	0.536	0.576	0.435	1.000					
FV ₁₁	0.255	0.423	0.367	0.254	0.332	0.439	0.528	0.434	0.394	0.529	1.000				
FV ₁₂	0.195	0.365	0.194	0.245	0.324	0.360	0.529	0.380	0.272	0.508	0.400	1.000			
FV ₁₃	0.119	0.340	0.224	0.171	0.275	0.330	0.426	0.388	0.406	0.458	0.425	0.397	1.000		
FV ₁₄	0.191	0.326	0.341	0.256	0.325	0.357	0.396	0.467	0.279	0.560	0.462	0.391	0.404	1.000	
FV ₁₅	0.147	0.381	0.348	0.249	0.192	0.399	0.326	0.284	0.407	0.437	0.417	0.417	0.305	0.530	1.000

Note: KMO measure of sampling adequacy = 0.910; Bartlett test of sphericity = 1205.675; Degrees of freedom = 105; Significance $p = 0.000$.

3.2.1. Establishing Failure Factors with PCA

The scree plot generated as part of the PCA process is shown in Figure 1. The scree plot shows there is a distinct inflection point in the slope at the fourth component which gradually trails off for the remaining components. This indicates that a significant proportion of the variance is explained in the first four factors which all have eigenvalues above one. Given the results a four-factor model based on the Kaiser Rule of selecting all factors with an eigenvalue greater than one [47] were deemed the most suitable for further analysis. To improve the interpretability of the PCA results Varimax rotation was used to simplify the initial PCA results. The rotation process simplifies components by maximizing the variance of the loadings within components. As a result, this increases the loadings which are high post extraction, and lowers the loadings which are low post extraction [47].

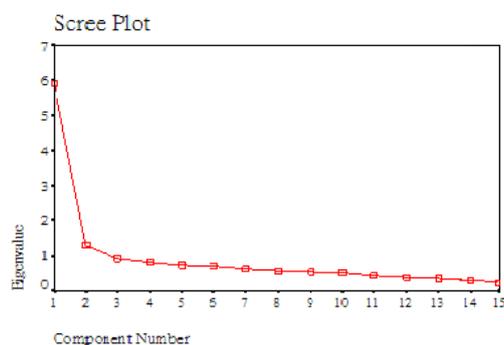


Figure 1. The eigenvalues for the 15 failure variables (FV) for construction partnering.

An FV loading greater than 0.5 (when rounded to 1 decimal place) for a KFF was deemed acceptable and was retained. In the PCA results, each of the individual FVs belongs to only one of the KFFs. The final PCA results in Table 4 show that six FVs were associated with KFF1, three on KFF2, three on KFF3, and three on KFF4. The four extracted KFFs were described as absence of agility, collaboration barriers, collaboration barriers, and organizational management barriers, respectively. These four KFFs in combination explains 63.61% of the overall variance, and all Cronbach's α values were greater than 0.65, signifying a satisfactory level of reliability.

Table 4. Key failure factors (KFF) with associated factors loading and variance post varimax rotation.

Key Failure Factors & Associated Failure Variables	Factor Loading	Variance Percentage	Cumulative Variance Percentage	Cronbach's α
KFF1: Absence of agility		42.230	42.230	0.8306
Authority from owner is not readily given	0.650			
Bidding approach restricts flexibility	0.611			
Unresolved arguments	0.589			
Partnership priorities admitted by commercial performance pressure	0.531			
Absence of training/support during partner assignment	0.523			
Not all partners are willing to negotiate	0.469			

Table 4. Cont.

Key Failure Factors & Associated Failure Variables	Factor Loading	Variance Percentage	Cumulative Variance Percentage	Cronbach's α
KFF2: Collaboration barriers		9.147	51.377	0.7093
Absence of genuine and open communication	0.820			
Absence of a commitment to co-operation between partners	0.718			
A win-win attitude is absent between partners	0.556			
KFF3: Partnering barriers		6.571	59.948	0.7122
Partners are not suitable for a given project	0.893			
Major contractors are absent in partnering	0.770			
Absence of a positive relationships in partnership	0.474			
KFF4: Organizational management barriers		5.660	63.609	0.6595
Limited professional knowledge of managers	0.886			
Blueprint and regulation problems	0.713			
Complex organizational bureaucracy	0.473			

KFF1: Absence of agility

The absence of agility group (KFF1) encompasses six FVs related to how the organizations in the partnership approach foundations of the relationship and build a capacity to be flexible and agile in establishing the axioms of the working partnership. Project partnering can promote organizational flexibility in the partnering organizations [48]. However, an absence of agility is a real concern for partnerships as agility and flexibility is essential in being able to respond and adapt to change and uncertainty in a highly competitive business environment. Project stakeholders tend to view flexibility differently, and stakeholders with incentives linked to the achievement of clearly defined project outcomes support flexibility. Moreover, while owners support flexibility, for managers and contractors, flexibility is less positively received as it often necessitates increased resource outlay to support adoption.

In this context agility refers to the capacity of partners to respond to change and be flexible in how the project and the partnership are structured to achieve the best possible outcome. Without the ability to be agile and respond to challenges effectively, the full benefits of the partnering arrangement may not be realized. Broadly agility requires cohesion amongst partners and having the capacity and empowerment to make decisions which ensure positive outcomes for a construction project.

The results show that an absence of agility can result from the underlying lack of cohesion in the relationship between partners which can be driven by unresolved conflicts (FV₅), and a lack of effective negotiation amongst partners (FV₆). Avoiding partnership failure, requires effective dispute resolution and a willingness to constructively negotiate. In a high involvement type relationship like that of construction partners, there is an expectation to have some level of tension due to the need to come to an agreement on joint matters which have conflicting issues [13]. The presence of unresolved conflicts and an unwillingness to negotiate can influence further decisions as partners may not readily make the required decisions or take required actions to support the progress of a project. The lack of agility is further influenced by the way in which the bidding process is structured (FV₁₂), as a fundamental driver for the overall project structure, the partnership members need to be able to be flexible in adapting to the bidding process. While partner companies need to be able to adapt to varying bidding processes, project clients need to consider how the bidding process will affect the ability of contracting companies to be agile in avoiding situations which negatively impact partnering relationships.

The top ranked FV in KFF1 is FV₇ which relates to the owners not giving authority to the project partners. Provision of authority is crucial in allowing project partners to execute the required regular duties in the project. The effectiveness of shared authority relates to leadership in the partnering organizations. There must be a mutual understanding of the importance of shared authority on achieving positive outcomes [49]. A lack of authority reduces the ability of project partners to be agile in responding to challenges and issues that arise during the project. Partnerships can fail if partners are not given appropriate authority to contribute meaningfully to the partnership. Furthermore, partnership failure can result from possible conflicts between commercial interests and types of collaboration

in practice (partnering), as well as the intrinsic difficulties involved in any organizational culture change process (adversarial individualism) required to support effective collaborative approaches.

An absence of adequate support during the partnership (FV₁₁) limits the ability of partner organizations to identify signs of potential issues and effectively manage or negate the impacts on the overall partnership. Being agile requires the ability to readily identify potential issues, as well as being proactive in identifying solutions and taking action. Capacity building of partner organizations to be able to be agile and operate competitively in advanced economies requires a competent workforce with the skills to identify potential issues and to take appropriate action.

KFF2: Collaboration barriers

The collaboration barriers KFF is comprised of three FVs, Absence of genuine and open communication (FV₁), Absence of a commitment to co-operation between partners (FV₃), and When a win-win attitude are absent between partners (FV₂). In combination, the FV of KFF2 result in an absence of openness and trust between partners and create barriers to effective collaboration between partners. In a partnership with mutual trust, partners can constructively collaborate while free of barriers or concerns such as the hidden motives of other partners. Effective collaboration is fundamentally based on trust and without collaboration the full benefits of the partnership cannot be realized. With trust featuring as one of the most influential factors for partnering success, it is easy to understand why partnerships that lack trust are ineffective [16]. Trust based collaboration requires team building, open communication early in the project cycle [50]. Parties wanting to avoid partnership failure need to be able to trust, collaborate, rely on, and comprehend the decisions of other parties. When effective, no weak links will exist among team members [25].

The three FVs in this particular KFF all add up to collaboration barriers in a partnership. Open and honest communication with continuous information exchange in a partnership is a key requirement for successful collaboration in construction partnerships. An ongoing commitment to win-win outcomes was also found to be the other key contributor to the perception of partnership success. A win-win attitude inspires equity between the parties within the partnership.

KFF3: Partnering barriers

The partnering barrier KFF is comprised of the FVs partners not suitable for a given project (FV₁₅), major contractors are absent in partnering (FV₁₄), and absence of positive relationships in partnership (FV₄). Together these FVs present barriers to forming effective partnerships to meet the needs of the project as well as partnering organizations. Partnering barriers are created when the project partners fail to align to a common goal, resulting in a negative culture establishing in the partnership. A partnership operating where barriers exist results in an unhealthy organization [51]. Partnering barriers have a business cost which can be quantified in several ways, which result in reduced commercial success for the partnership. One way of eliminating barriers in a construction partnership is through actively fostering positive partnering culture.

In establishing an effective partnership, all partners need to be active in the partnership and be committed to positive relationships. Addressing these barriers to an effective partnership requires a co-operative environment with project owners and contracting organizations working together for the mutual goal of successful project outcomes. A cooperative environment provides an attractive incentive in comparison to the legal claims and litigation all too common in the construction industry where partnerships fail. The development of partnership spirit through developing positive relationships is critical to removing barriers to a successful construction venture. Organizational management teams must demonstrate fostering positive partnership spirit and work to ensure that this message infiltrates throughout the entire organization, while at the same time providing tangible evidence of action plans and policies that embody the partnering spirit. When performed correctly, partnering should provide a win-win construction project culture and environment.

KFF4: Organizational management barriers

The organizational management barrier KFF is comprised of attributes related to the structure and management of the partnering organizations in combination with the professional ability of the management team (FV₉ and FV₈), as well as the ability to manage blueprint and regulation FV₁₃. A typical construction project requires a multitude of skills, materials, and technologies that are usually delivered by several different parties. The complementary expertise of these various parties working in partnership can bolster the performance capability of a partnership given appropriate organizational management [2].

Project success or failure is greatly influenced by organizational management and the management team's ability to lead effectively, as well as manage complex blueprint and regulatory requirements. This raises the question of what constitutes effective management, and what skills managers must possess to ensure partnerships success. To this, there is some consensus that management is an art founded on the application, judgment, and common sense. Effective managers must possess proficiency in seven key business functions: planning, organizing, staffing, directing, motivating, leading, and controlling. Furthermore, effective managers need to have a sufficient level of proficiency in the technology used by the projects they manage to understand technical challenges faced in construction projects. Therefore, managers require familiarity and conceptual ability relating to the common tools and techniques used in technical disciplines such as construction engineering. Moreover, effective managers require certain soft skills to support the needs of their teams such as enthusiasm, stamina, and a desire for demanding work as teams need to be able to cope with frequent technical and political challenges.

Good organizational management structures require a capable management team with competency working in project partnerships. Katz [38] posited that an effective administration is highly associated with human skills, conceptual skills, and technical skills. Human skills are the interpersonal skills required to work well with others. Managers that show strong interpersonal skills are well attuned to the needs and motivators of the other project partners. To develop an overarching view of a project individuals are required to have strong conceptual skills. The required conceptual skills are characterized by the identification of various required functions and having a cognizance of how alterations in one function impact other functions. This skillset will enable managers to progress project outcomes and support the wellbeing of the parent organization. To be successful managers, they need to be provided with seniority commensurate to their responsibilities; however, managers frequently find their recognized authority incomplete. Thus, successful managers require a blend of technical, administrative, and interpersonal skills to achieve effective leadership. These skills provide the organizational ability to manage and respond to blueprint and regulatory problems quickly, and reduce the impact on project objectives.

3.2.2. Further KFF Analysis

For the four KFFs for construction partnering, one-way ANOVA testing was completed on the different participant's perceptions. For the ANOVA testing, a p-value of 0.05 or more indicates no significant associations between KFF. All the p-values from the ANOVA testing exceed 0.05 (Table 5). Therefore, this study concludes that no link of significance exists between the four KFFs. The resulting implication is that no significant differences are present between the perceptions of government employees, owners, design firms, and construction firms concerning the four KFFs of construction partnering. The correlation values among the four KFFs are shown in Table 6. Among the four KFFs, KFF1 (absence of agility) shows a high correlation between all three KFFs, most notably with KFF4 (organizational management party). Summarized explanations of the four extracted KFFs are provided below.

Table 5. ANOVA results for construction partnering based on participants' perceptions.

Key Failure Factor (KFF)	Survey Participants	Sum of Squares	Degrees of Freedom	Mean Square	F-value	Significance
Absence of agility (KFF1)	Between factors	51.938	3	17.313	1.444	0.231
	Within factors	2600.867	217	11.986		
	Total	2652.805	220			
Collaboration barriers (KFF2)	Between factors	5.748	3	1.916	0.657	0.580
	Within factors	633.310	217	2.918		
	Total	639.0595	220			
Partnering barriers (KFF3)	Between factors	4.860	3	1.620	0.463	0.708
	Within factors	759.276	217	3.499		
	Total	764.136	220			
Organizational management barriers (KFF4)	Between factors	20.179	3	6.726	1.748	0.158
	Within factors	834.816	217	3.847		
	Total	854.995	220			

Table 6. Correlation values between the final four Key Failure Factors (KFFs).

KFF	Correlation Results	KFF1	KFF2	KFF3	KFF4
Absence of agility (KFF1)	Pearson correlation	1.000			
	Significance (two-tail)	0.000			
Collaboration barriers (KFF2)	Pearson correlation	0.577	1.000		
	Significance (two-tail)	0.000	0.000		
Partnering barriers (KFF3)	Pearson correlation	0.609	0.419	1.000	
	Significance (two-tail)	0.000	0.000	0.000	
Organizational management barriers (KFF4)	Pearson correlation	0.681	0.462	0.533	1.000
	Significance (two-tail)	0.000	0.000	0.000	0.000

3.2.3. Indicators of Potential Project Partnership Failure

Avoiding the failure of a project partnership requires being vigilant in identifying the characteristics and conditions that contribute to partnership failure. Leading indicators are a tool often used to identify antecedent conditions for an unwanted event which allows action to be taken before any significant loss is realized. In this case the leading indicator as a warning sign assumes that a condition or combination of combinations will provide a warning sign of potential failure.

Guided by the four KFFs identified using PCA, a series of leading indicators of potential partnership failure are proposed. The role of the leading indicators is to provide an indicator of potential antecedent conditions that could lead to future failure of a partnership. The use of indicators of business performance are growing in the construction industry; however, the main focus of these indicators has been focused more on business performance [52]. Through adding leading indicators of key business risk, construction partners can establish a more holistic view of their business risks.

The involvement and priorities of the project partners often change throughout the different stages of the project. Therefore, the different leading indicators for the KFFs change in relevance throughout the project timeline. Some of the indicators apply at the very inception of the project when the foundations of the partnership are being established, at the formation of the project partnership when the partnership is formally established and during the construction stage when on-the-ground works are in progress. The four KFFs and the related leading indicators are provided in Table 7.

Table 7. Key failure factors (KFFs) for partnership failure and suggested leading indicators of partnership failure.

KFF	Characteristics	Indicators of Partnership Failure	Key Partnership Stage(s)
Absence of agility	Partners are unwilling or lack the capability to respond agilely to issues as they arise	Partnering organizations do not have the capacity and support required to operate effectively in a partnership	Inception
		One or more partner is not supportive or is not committed to the purpose of the partnership	Inception
		All partners have authority commensurate to their role in the project	Inception Formation
		Bidding process are not suitable for the project type and project partners	Inception
		An absence of a conflict resolution process amongst project partners	Formation
		The conflict resolution process is not actively followed throughout the project to resolve arguments	Construction
Collaboration barriers	Barriers exist in communication and partnering approach which prevent cooperation and collaboration between project partners	Agreed communications are not established in the partnership	Formation
		A continuous commitment to cooperation between all partners is not made a core value of the partnership	Formation
		A win-win approach is missing from fundamental decisions made regarding the project partnering	Inception Formation Construction
Partnering Barriers	Barriers exist between partners due to ineffective engagement between partners or suitability for the project	Partners selected are not suitable for a given project	Inception
		Major contractors fail to be present and active during partnership	Construction
		Absence of positive relationships amongst partners	Construction
Organizational Management Barriers	Organizational management which lacks the requisite professional skill and organizational efficiency. Furthermore, there is difficulty in identifying and overcoming blueprint and regulation problems	Managers have limited experienced with working in partnerships	Formation construction
		Problems with blueprints or regulations are not identified and resolved effectively	Construction
		Excess organizational bureaucracy involved in the decision-making process	Construction

4. Conclusions

Through detailed analysis of survey results obtained from experienced Taiwanese construction professionals, the study was able to provide insight on what industry professionals were considered to be the key factors contributing to partnering failure. The questionnaire responses were used to group the 15 selected FVs into KFFs based on common factors using PCA. From the final four KFFs, the most significant KFF was absence of agility where an organization is not able to change direction and adapt to change in project partnering. The next groups ordered by significance are absence of collaboration where the partners are unwilling or unable to collaborate, partnering barriers resulting from partners not aligning to a common goal, and organizational management barriers which relate to how well organizational management can operate in partnership arrangements. Further analysis of the relationship between the KFFs shows that failure in construction partnering is influenced strongly by the interaction between absence of agility and organizational management barriers. Conversely, the relationship between collaboration barriers and partnering barriers is not as significant as expected. As the factors which prevent organizations being able to work effectively in a partnership would be expected to relate to both the partnering and collaboration barriers.

The findings of the study provide guidance for identifying signals indicating a potential failure and developing preventative strategies to ensure successful construction partnering. The study shows that the factors leading to the failure of construction partnerships is a complex mix of multiple factors and is significantly influenced by the mutual efforts of multiple stakeholders including owners, designers, contractors, and other important parties participating in the construction project either directly or indirectly. The study posits that failure in construction partnering can be avoided by implementing targeting strategies to overcome the four KFFs identified. Through considering both KFFs and success factors balanced strategies can be put in place when establishing partnerships to reduce the probability of failure and increase the chance of win-win outcome for all stakeholders involved in the project.

To support the practical implementation of measures to prevent potential partnership failures, leading indicators were presented to guide the identification of potential actions or conditions which have the possibility to lead to project failure. The leading indicator as a warning sign assumes that a condition or combination of combinations will provide a warning sign of potential failure. As the project progresses through the project cycle the potential causes of failure change. Therefore, the proposed leading indicators of partnership failure change and evolve through the project lifecycle.

The study presented is limited to the challenges experienced in construction partnering within Taiwan. Further study is required to investigate international experiences in project partnering, explicitly the factors which influence failure and success. Such investigation would help to better understand the intricacies of construction partnering outcomes in Taiwan and provide a comparison with international experience.

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