The Identification of a Potential Solution to Improve the Construction Project Performance in the Chinese Construction Industry: by Analyzing Similar Construction Industries in Other Developing Countries

by

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ABSTRACT

The Chinese Construction Industry has grown to be one of the largest construction markets in the world within the last 10 years. The size of the Chinese Construction Industry is on par with many developed nations, despite it being a developing country. Despite its rapid growth, the productivity and profitability of the Chinese Construction Industry is low compared to similar sized construction industries (United States, United Kingdom, etc.). In addition to the low efficiency of the Chinese Construction Industry, there is minimal documentation available showing the performance of the Chinese Construction Industry (projects completed on time, on budget, and customer satisfaction ratings).

The purpose of this research is to investigate potential solutions that could address the poor efficiency and performance of the Chinese Construction Industry. This research is divided into three phases; first, a literature review to identify countries that have similar construction industries to the Chinese Construction Industry. The second phase is to compare the risks and identify solutions that are proposed to increase the performance of similar construction industries and the Chinese Construction Industry. The third phase is to create a survey from the literature-based information to validate the concepts with the Chinese Construction Industry professionals and stakeholders.

TABLE OF CONTENTS

Page

CHAPTER Page

LIST OF TABLES

Table Page

LIST OF FIGURES

Chapter 1

EXECUTIVE SUMMARY

Overview

The research performed has been documented in three papers that have been published in journals or will be submitted to journals in the future. The papers document the follows:

1. Identifying a Potential Solution to Improving the Performance of the Chinese Construction Industry
2. Comparing the Chinese Construction Industry with Other Developing Countries to Identify an Applicable Solution to Low Construction Performance
3. Using the Best Value Approach to Improve Construction Project Performance in the Chinese Construction Industry

These papers have been combined into one dissertation document to meet the formatting requirements of the University.

Research Summary

The Chinese Construction Industry (CCI) has grown to be one of the largest construction markets in the world within the last 10 years. The size of the CCI is on par with many developed nations, despite it being a developing country. Despite its rapid growth, the productivity and profitability of the CCI is low compared to similar sized

construction industries (U.S., U.K., etc.). In addition to the low efficiency of the CCI, there is minimal documentation available showing the performance of the CCI (projects completed on time, on budget, and customer satisfaction ratings).

The purpose of this research is to investigate potential solutions that could address the poor efficiency and performance of the CCI. This research is divided into three phases; first, a literature review to identify countries that have similar construction industries to the CCI. The second phase is to compare the risks and identify solutions that are proposed to increase the performance of similar construction industries and the CCI. The third phase is to create a survey from the literature-based information to validate the concepts with the CCI professionals and stakeholders.

Phase I focused on a literature research that searched for a solution to the CCI issues through the following methodology:

1. Identify construction industries of developing countries that are similar to the CCI.
2. Develop a methodology to identify the similar construction industries [Four characteristics will be used to do this: construction GDP, corruption index, construction GDP growth, and available documented information of the country's construction industry].

Phase II is to:

1. Identify the risks of the CCI and similar construction industries.
2. Identify what similar risks the CCI share with similar construction industries.
3. Identify potential solutions for the CCI by researching what construction industries that are similar and have the same issues as the CCI have done to solve their issues and risks.

Phase III will include:

1. Create a survey for CCI professionals to validate the proposed solutions.
2. Do analysis of the survey results to identify the validity of the proposed solutions.
3. Recommend future research.

In Phase I the author identified 10 developing countries in Asia. After looking at the four indicators of similarity it was found that Saudi Arabia and Vietnam were the most similar. Both countries share a similar construction GDP, corruption index, and construction GDP growth. At the same time, Saudi Arabia and Vietnam had enough documented information on their construction industries to verify similar risks and issues.

Phase II used literature research to identify risks and performance information of the two similar industries causing their inefficiency and performance issues. The result of the research and analysis was as follows:

1. 30 papers were found for the CCI and 72 risks were identified. These risks were prioritized by frequency of the risks in the 30 papers.
2. The major risks of the Kingdom of Saudi Arabia Construction Industry (KSACI) and the Vietnamese Construction Industry (VCI) were also identified through previous studies. Both countries risks were also prioritized by the frequency they appeared in multiple studies.
3. The KSACI, VCI, and CCI all had similar risks identified.
4. The majority of the top 15 risks of the KSACI and VCI were found to be similar to the top 15 risks of the CCI.
5. The CCI's top 10 risks were different than the KSACI and VCI. The CCI had five risks in their top 10 risks that the KSACI and VCI had experienced but were not in their top 10 risks. Of the different five risks, four were directly related to government involvement in China.

After identifying similar risks, the author investigated potential solutions proposed to mitigate these risks in the KSACI and the VCI. The only potential solution with documented performance information was the Best Value Approach (BVA). Five major studies were found that identified the feasibility of BVA in both the KSACI and the VCI.

Phase III was to create and use a survey to validate if the similarities in the risk and the potential solution could be utilized in the CCI. A survey was designed from Phase II results and sent to CCI stakeholders. The survey was designed in English based on previously published survey information then translated into Mandarin. The survey

included a test phase and a final phase. The test phase was designed to determine if the questions were understandable. Based on the feedback from the test survey, the author created a final survey and sent it to a wider pool of respondents. Survey responses were collected online.

In the test phase, 67 people responded. After receiving feedback, the author adjusted the survey and sent it to 140 professionals (137 responded). The survey results showed that the test and final surveys had similar results. It found that only 21% of respondents are satisfied with current CCI performance. Stakeholders with more than five years of experience were even more dissatisfied with the performance of the CCI. When estimating the average percent delayed and over-budget, the majority of respondents said 50% of projects are delayed and over 40% of projects are over-budget.

The author compared the risk impact responses from the test survey and the final survey. The results were validated using IBM SPSS Statistics v25. A risk factor analysis revealed that two variable components were related, the skill-related risks and the government involvement related risks. In comparing the ranked list of risks from the surveys to the list of risks from the literature research, it was found that the most widely agreed upon risks are ‘legal and contract issues’ and ‘relationships and Guanxi’. The other risks were validated as negatively impactful to performance, but the ranking of the impact is inconclusive.

Survey respondents were asked to describe the nature of government involvement, contracts, and Guanxi in the CCI. According to their responses, and additional research, government-owned contractors are more likely to win bids on larger projects in China. Furthermore, many contracts are awarded based on previous relationships and preference; this is referred to as Guanxi in China. This results in a unique system of contracting, funding, and supply chain management.

Survey respondents were asked whether BVA is a potential solution to performance issues in china despite the CCI's unique processes. In the final survey, over 50% of respondents believe that BVA concepts could improve performance in China, but 46% of respondents said they do not know if it is possible to use BVA in China. Combined with the strong government involvement in CCI, the author purposes providing more education to CCI stakeholders on the BVA and conducting more expert interviews. The additional information is required to understand supply chain processes in China and whether the BVA can be implemented and adequately address performance issues.

Chapter 2

INTRODUCTION

The Chinese Construction Industry

In the last 10 years the Chinese economy has been the fastest growing and one of the largest in the world. Recent statistics have shown China's gross domestic product (GDP) increased from $4.6 billion in 2008 to $12.2 billion in 2017, making China the second largest economy in the world (Liu et al., 2012; Trading Economics, 2017). Compared to developed countries, it has surpassed their growth by over four times in many cases. Table 1 shows the difference between China's GDP growth and the *developed* countries. China's GDP has grown 144% in the last 10 years. Compared to other developed countries, the GDP growth of China is three times that of South Korea and six times the U.S. Meanwhile, some developed countries' GDP decreased. For instance, the GDP of Japan and Canada respectively dropped 20.3% and 17% from 2007 to 2017, which were the highest decreases in GDP of developed countries. France's GDP also dropped 15.3% at the same time. As a developing country, Russia's GDP dropped 42% for last 10 years (Trading Economics, 2017), which suggests that China's economy is becoming stronger and contributing more to the international economic stage.

Table 1

GDP Growth Comparison of Developed Countries vs. China.

Country	**GDP growth in last 10 years (2007-2017)**
China	144%
South Korea	41%
U.S.	27%
Australia	23%
U.K.	-8.40%
France	-15.70%
Canada	-17%
Japan	-20.30%
Russia	-42%

When compared to *developing* countries, China still has the fastest growing GDP. Table 2 shows the comparison between China's GDP growth and other developing countries. The next fastest growing countries are Vietnam (GDP growth is 107%) and India (GDP growth is 91%) (Trading Economics, 2017).

Table 2

GDP Growth Comparison of Developing Countries and China.

Country	**GDP growth in last 10 years (2007-2017)**
China	144%
Vietnam	107%
Mongolia	99%
India	91%
Indonesia	83%
Saudi Arabia	76%
Philippines	75%
Thailand	74%
Oman	33%
Bahrain	24%
Turkey	15%

Along with this economic growth, the Chinese construction industry (CCI) has also grown to be one of the largest in the world (Cook, 2013). China has done this by spending the most amount on construction turnover compared to other developed and developing countries on average (ENR, 2005). The CCI's contribution to the overall GDP increased from 3.8% in 1978 to 6.87% in 2018, creating a total output of 23.51 billion Yuan, about $3.291 billion (USD) (CCIA, 2016). At the end of 2018, there were 995,400 registered firms employing 55.63 million people working in the construction industry (Liu et al. 2013, CCIA, 2016). The size of the CCI is on par with many developed nations, despite it being a developing country.

Table 3 shows the ratio of construction GDP over Annual GDP from different countries, including developed countries and developing countries. The average ratio of construction GDP among countries is 3.2%, which the U.S. construction industry's contribution to the GDP is 3.5% and Australia's is 2.1%. The only Asian country which has a construction industry that contributes to the GDP comparable to the CCI is Japan. However, as a developed country, Japan uses its construction industry as a control mechanism and support for its overall economy. When looking at Japan's overall GDP and its construction GDP, it can be observed that when the overall GDP went up, the construction GDP went down at the same time. The same is true for the opposite; when the overall GDP went down, the construction GDP would increase. Japan uses construction to boost their economy in times of economic decline.

Table 3

The Ratio of Construction GDP Over Annual GDP of Different Countries.

Country	Construction GDP / Annual GDP
China	6.87%
Canada	6.50%
Japan	5.20%
Vietnam	4.40%
U.S.	3.50%
Australia	2.10%
Russia	1.80%
SEA Average	1.70%
U.K.	1.40%
France	1.20%
India	1.20%
South Korea	1.20%
Average	3.20%

Comparing the CCI GDP's growth rate to the U.S., the U.S.'s construction GDP declined by 20% in last 12 years (Trading Economics, 2017). Other research identifies that China's construction industry spending growth rate is higher than the U.S., and Eurozone countries (Global Construction Outlook, 2013). For the international market participation, one research shows that China ranked No.3 within the construction global market in 2013 (Global Construction Outlook, 2013). It was the only developing country to compete with developed countries in the international construction marketplace.

Performance Issues of Chinese Construction

Despite the CCI's rapid growth and its importance to the country's economy, the productivity and profitability of the CCI is low compared to similar sized construction industries. The CCI faces many issues dealing with its performance. Publications show that overall productivity is low. Multiple case studies show the CCI is lower performing (Deng

et al. 2013; Liu et al. 2012; Liu and Deng 2009; Sha et al. 2008; Wang 2004; Wang et al. 2006; Shen et al. 2006; Wei and Lin 2004). However, there is minimal documented information regarding the performance of the CCI (time, cost, and customer satisfaction).

Low productivity

China's construction industry plays an increasingly important role in the world. But its performance is poor compared with that of its foreign counterparts, and other developed countries. Despite the significant development of the CCI, the low industry performance in various domains is frequently criticized by researchers (e.g., Deng et al. 2013; Liu et al. 2012; Liu and Deng 2009; Sha et al. 2008; Wang 2004; Wang et al. 2006; Shen et al. 2006; Wei and Lin 2004). One set of research findings stated that compared to the U.S. construction industry, the CCI employed 31 times more people and the average output per person is only 5% of U.S.'s workforce and 6% of output of the average Japanese workforce. Although the CCI spends more than the U.S., it delivers 23 times fewer construction projects/services than the U.S., which shows the major issue the CCI deals with regarding their low productivity and inefficiency (Zhang et al. 2008, Xu et al. 2005). Insufficient expenditure on machinery and equipment also affects the labor productivity negatively. In the year 2005, the equipment fee accounted for less than 7% of the total project fee in China, while it accounted for 20% in the U.S. The official statistics revealed that in 2006 the overall labor productivity in terms of value added was 25,741 Chinese Yuan per person. The information also shows the value of machines per laborer is 9,109 Chinese Yuan per

person, and the power of machines per laborer is 4.9 kW per person. All these figures are very low compared with western construction industries (Zhao et al. 2009).

CCI Deficient Performance

CCI organizations do not track or report information on construction performance. Failure of performance measurement in the construction industry has been criticized in literature, including a review by Yang et al. (2010). Another study also identified that there was minimal literature that simultaneously measures overall performance, efficiency and effectiveness (Hu et al. 2018). A preliminary literature research revealed that there is no documentation on the CCI's overall performance published. There were only two studies performed that found performance information on construction projects in China. One study researched stakeholder satisfaction; it found that out of 200 construction projects in China in 2005, 24.3% had violated related regulations and only 13% could be ranked as "good quality" (Zhang et al. 2008). Similarly, one study surveyed 139 construction firms in China and indicated that 'improving construction quality' as the most common competition method, indicating the significance of quality issues for Chinese firms (Wang et al. 2006). Another research found that in 2005, only 12.85% of 515 government projects in Shenzhen and Hong Kong completed within the scheduled completion date [of the projects delayed the average delay was 21.34% over the original schedule]. Also, in 2004, 73% of 30 government projects reported being 20.3% over the original budget (Zhang et al. 2008).

The CCI has the following characteristics:

1. CCI is a large component of the country's GDP. (Statistical analysis of construction industry development, 2017, 2018)
2. Productivity and Efficiency is poor. (Shen et al. 2011, Li 2003, Zhao et al. 2009)
3. Large international market share. (Cook, 2013, Akhter and Barcellos 2011, Zhao et al. 2009.)
4. Perceived performance issues, but little documentation of actual performance and quality.

Research Questions

The CCI is growing faster than any other construction industry in the world. Despite its rapid growth, performance is suffering (according to delays, costs overruns, and stakeholder satisfaction ratings).

The main research question (MRQ) is:

Is there a potential solution to address poor performance in the CCI?

To further address the main question, this study is divided into four research questions:

1. What is causing poor performance in the CCI?
2. What potential solutions could be considered?
3. Would CCI stakeholders agree with the potential solutions?
4. Is it possible to implement the potential solutions in the CCI?

Proposal

While the CCI is the largest among developing countries, there are many other construction industries that share similar characteristics and performance issues. By investigating construction industries of other similar developing countries, the author hopes to identify potential solutions to address lower performance in the CCI. Worldwide, there has been an effort to identify higher performing practices in risk management, project management, and procurement. There are many developing countries where the construction industry has seen rapid growth despite facing the similar issues as China. This research seeks to investigate potential solutions used by researchers from other developing countries and conduct a survey analysis to determine if the same solutions can address performance issues in the CCI.

Research Approach

This research uses a combined data collection method. Initial data collection will create a detailed literature review of potential solutions to address performance issues in other construction industries of developing countries. Second, using this initial information, the researcher will create a validation and investigation survey to CCI stakeholders. The methodology will proceed as follows:

1. Conduct a literature research to identify other developing countries that have similar construction industries compared to China. Comparison will be made based on the following: overall GDP, construction GDP, corruption index, and construction GDP Growth.

2. Identify the risks and performance of the CCI.
3. Identify major risks causing low performance in similar countries and compare risks between CCI and the similar countries.
4. Perform literature research on construction best practices and potential solutions identified by other researchers from similar construction industries to China.
5. Create a survey from the risk and performance information to validate the performance of the CCI.
6. Survey the CCI stakeholders to:
    a. Verify the performance level of the CCI from industry stakeholders.
    b. Validate the CCI risks found from the literature research.
    c. Confirm whether CCI stakeholders believe the potential performance solution(s) found in the literature research will work in China.

Thesis Outline

The research is divided into three phases. Phase 1 is a detailed literature review to find other construction industries in developing countries that are similar to the CCI. Phase II is to and potential solutions these similar countries identified in documented research. Phase 2 is a survey research to verify and validate from CCI industry stakeholders the CCI's current performance and risks and to confirm if the industry agrees with the feasibility of potential solutions.

Phase 1 is focused on a performing a literature research to identify construction industries that are similar to the CCI. Four criteria will be utilized. The criteria are construction GDP, corruption index, construction GDP growth, and available documented information of the country's construction industry.

Phase II is to identify risks and performance factors of the CCI and similar construction industries. Phase II will also include identifying proposals in the similar construction industries to identify if the proposals can be used in the CCI.

Phase III will include the creation and the utilization of the survey to identify if the stakeholders in the CCI will validate the performance and risk factors identified from literature search in Phase II. It will also include the proposed solutions from similar construction industries can increase the performance in the CCI and be implemented in the CCI.

Conclusions and Recommendations

At the conclusion of this research, the author summarizes the results and findings of both the literature and survey research. Using this information, the author provides recommendations for further research to improve the performance of the CCI.

Chapter 3

LITERATURE REVIEW

The following section summarizes Phase 1 and II of this research. In this section, the author details the literature review process and the corresponding findings. The findings detail information regarding the risks and issues the CCI and construction industries of similar developing countries face and potential solutions that research has identified could mitigate these issues.

Literature Review Research Methodology

The following methodology was followed to complete the literature research:

1. Identify other developing countries that have similar construction industries compared to China. Comparison will be made based on the following: overall GDP, construction GDP, corruption index, and construction GDP Growth.
2. Perform a literature research identifying all documented risks and issues of the CCI.
3. Analyze the CCI risks found and prioritize the risks by the frequency in which they were found in the literature research.
4. Repeat steps 2 and 3 for construction industries similar to the CCI.
5. Compare and analyze the CCI risks to the risks of similar construction industries.

6. Investigate potential solutions, that have been identified by other researchers, to address the same performance issues as the CCI in the similar construction industries.

Comparing Construction Industries

The analysis shown herein collected the following information on major developing countries in Asia:

1. Corruption index
2. Construction GDP
3. Construction GDP growth

The researchers identified two websites to research the construction GDP and corruption index of the major developing countries in Asia. The first website was the only source available that documented the desired information. The second source was used as a verification source. Two sources were used:

1. Trading Economics (2017)
2. Corruption Perceptions Index (Transparency International, 2017)

Table 4 shows the major developing countries and their information. The corruption index score varies from 9 to 89 with 179 countries involved. The corruption index score of the developing countries were looked at first. Any developing country within 5-10 points of China's score was considered. China's Score is 40 and the corruption index score goes from 46 to 33. The lower the corruption score, the more

corruption that the country experiences. Corruption score being defined as: Corruption Perceptions Index (CPI).

Table 4

Corruption Index of Developing Countries.

Rank	Country	Score	Construction GDP ($)	Construction GDP (%)	Construction GDP Increase (2010 – 2017)
62	Saudi Arabia	46	$8.64B	4.8%	38%
64	Oman	45	$5.94B	8.9%	74%
70	Bahrain	43	$0.59B	1.8%	34%
75	Turkey	41	$8.08B	0.9%	75%
79	China	40	$844B	6.8%	172%
79	India	40	$35.7B	8.0%	14%
87	Mongolia	38	$0.22B	2.1%	80%
90	Indonesia	37	$19.21B	2.1%	86%
101	Philippines	35	$4.3B	6.2%	150%
101	Thailand	35	$2.27B	2.5%	36%
113	Vietnam	33	$1.29B	4.4%	40%

The construction GDP of the considered countries was then looked at. Construction GDP is defined as the amount charged by construction companies to customers for the value of work (produced during the reporting period) excluding VAT and payments to sub-contractors (Office for National Statistics, 2016). China's construction GDP is $844B—significantly higher than any other country. The country with the next highest construction GDP is India at $36B. The researcher noted that the magnitude of China's construction GDP makes the country unique from other developing countries. However, to identify countries similar to China, the percent the construction GDP contributed to the overall GDP was considered. China's construction GDP

contributes 6.8% to the overall GDP. Any developing Asian country that their construction GDP contributes more than 4% to the overall GDP was considered.

This narrowed the countries similar to China to only five countries (Saudi Arabia, Oman, Philippines, India, and Vietnam). Third, the next factor that was looked at was the construction GDP increase over the last 7 years. One issue China faces is that although their construction industry is one of the largest in the world, it is relatively young (Zhang et al., 2008). Many issues arise when an industry grows too quickly. Looking at the growth of the CCI over the last 7 years, it has increased by 172%. The only country that had a comparable growth was the Philippines that increased its construction GDP by 150%. India shows the lowest GDP growth with only a 14% increase. Given this, India stands out as an outlier among the five comparable countries, it was removed from the shortlist.

After this analysis, the four countries remained as similar to China and the CCI (see Table 5). The fourth and last step was to perform a literature search on these countries to identify which countries had enough documented information on their construction industry to be able to compare and provide potential solutions to the CCI. The search included 4 major research databases (ASCE Library, Science Direct, Taylor and Francis Online, Emerald Insights), and more than 3200 articles were reviewed to identify any information on the construction industries in any of the five countries listed in Table 5. Table 5 shows the result of the literature research.

Table 5

Analysis to Identify Previous Work of Construction Industry in Developing Countries.

Country	Reference of Construction Industry
Saudi Arabia	45
Oman	1
China	46
Philippines	0
Vietnam	50

The only two countries from Table 5 that had information published and research performed on their construction industries from the list of developing countries was Saudi Arabia and Vietnam. Even though the other two countries (Oman and Philippines) characteristics were more similar to China's, they were not developed enough to be able to perform research on their construction industry.

Comparing Construction Risks

In this section, the author analyzes risks associated with poor construction performance in developing countries. First, a literature research of risks in the CCI is summarized. Second, risks in the Vietnamese and Kingdom of Saudi Arabia construction industries (VCI and KSACI respectively) are summarized and compared to the CCI.

Risks in the CCI

To identify the major risks in the CCI, a literature search was performed through five databases with more than 6891 journals. The five databases included:

1. Emerald Journals
2. ABI/Inform
3. Google Scholar
4. ASCE Library
5. EI Compendix

These databases combined had the following characteristics:

1. Updated weekly with articles from 55 different countries (EI Compendex).
2. Has over 10 million papers and more than 650,000 are added annually (EI Compendex).
3. Maintains a database of articles from multiple construction related areas (Emerald Journals).
4. Publications from the entire world on topics that include facility management, engineering, construction, and project management (ABI/Inform).
5. Contains all articles and papers that can be found on the internet (Scholar Google).

Six search terms were used to look for articles in each database. These terms were derived from looking at other research efforts that performed literature research on construction risks and the terms that they used. For each search term for each database the following information was tracked:

1. The number of articles that the search term brought up
2. The number of articles that were relevant to the research topic
3. The year the article was published

The researchers read each abstract from articles published since 2003. Each abstract that was relevant to the research, the full paper was downloaded and read for information regarding risks in the CCI. Table 6 identifies the number of relevant papers that were identified from each database.

Table 6

The Number of Identified Relevant Papers from Each Database

Search Term	EI Compendix	Hits	Year touched	Emerald Journals	Hits	Year touched	ABI/Inform	Hits	Year touched	Google Scholar	Hits	Year touched	ASCE Library	Hits	Year touched
CCI	3356	3	2003	12412	4	2001	34000	1	2003	41400		2003	4911		2004
CCI Risks	5000	4	2003	9440		2001	11000	1	2003	347000	2	2003	4635	1	2004
CCI Issues	11897	2	2003	14706	2	2001	19455	1	2003	179	1	2003	6625		2004
CCI Performance	2199	4	2003	14366	1	2001	16522	1	2003	1740000	3	2003	10197	7	2004
CCI Risk Management	3855	1	2003	8707	2	2001	13135	1	2003	72300	2	2003	4274	2	2004
CCI Inefficiency	805	0	2003	2042		2001	845	0	2003	34900		2003	622		2004
Total Hits->	27112	14		61673	9		94957	5		2235779	8		31264	10	

The literature search identified 30 studies on construction risks in the CCI. Those 30 studies found 72 risks. Each risk was prioritized based upon the frequency in which they appeared in the studies. Appendix A identifies the risks that appeared most frequently in the studies and gives an example of how documentation was kept on each risk appearing in the different studies. Many of the studies identified unique risks that

didn’t appear in other studies as 47% of 72 risks only appeared in one study and 15% of risks only appeared in two studies.

Table 7 shows the top 15 risks that appeared the most in the literature search. The highest ranked risk was *Legal and Contract Issues*, it appeared in 12 studies (40%). The other top risks included: Relationships and Guanxi, Outdated Technology, Lack of expertise in construction services and Management Skills.

Table 7

Top 15 risks of China Construction Industry

Risk	Hits	Risk Category
Legal and Contract Issues	12	MDC
Relationships and Guanxi	11	Non-Transparency
Outdated Technology	9	Material and Technology
Lack of expertise in construction services	8	Vendor Capability
Management Skills	8	Vendor Capability
Project Financing	8	Finance
Skill level of labor	8	Vendor Capability
Government Control	7	MDC
Bureaucracy in organizations	6	MDC
Government Instability and Politics	6	MDC
Owner control and decision making	6	MDC
Quality and Buildability of Design Drawings	6	Vendor Capability
Corruption	5	Non-Transparency
Infrastructure support	5	Vendor Capability
Lack of Government Regulation and Standards	5	MDC

In analyzing the 72 CCI risks, the researcher first tried to group the risks into different categories to identify any additional patterns. The researcher identified seven main categories that encompassed all the risks. Table 8 identifies the seven main categories, the definition of each category and the percent of risks that were associated with that category.

Table 8

Risks Categories and Definition

Management, Direction, and Control (MDC)	Risks involving the buyer or government managing, directing or controlling the contractor in any way. This includes: Legal and contract issues, change of scope due to a stakeholder of a project, decision making of the buyer, requirements and approvals, and government regulations.	23.70%
Non-Transparency	Risks being caused due to issues in communication, misunderstandings, complexity, relationships, lack of accountability or support from management. This includes: Guanxi, organizational bureaucracy, government politics, corruption, and risk sharing.	16.60%
Vendor Capability	Risks being caused due to the contractor/vendor not being capable of delivering high performing projects. This includes: Lack of expertise and management skills, Inability to create quality design drawings, inability to manage labor supply, high worker turnover rate, no insurance, insufficient safety measures, and a lack of understanding of lean and efficiency principles.	10.40%
Material and Technology	Risks caused due to not having access or a knowledge of the latest technology and materials. This includes: outdated technology, outdated construction methods, materials required to be replaced during construction, and unknown capability of materials.	10.40%
Finance	Risks caused due to financial aspects of a project or financial conditions of the country. This includes: market and currency instability, delay in payment to the contractor, contractor mismanagement of project funds, rapid growth of skilled labor cost and contractor lending issues.	11.40%
Procurement	Risks caused due to how buyers select the contractor. This includes: type of procurement model, buyer low bidding projects, not hiring the right contractor, and the administration of procuring a construction service.	5.20%
Lack of information	Risks caused due to a lack of information of both the buyer and contractor. This includes: Unforeseen risks and inadequate site information.	1.90%

It was found that the first two categories (MDC and Non-transparency) included more than 40% of all the risks. Identifying that some of the biggest issues causing non-performance in the CCI does not deal with the Chinese contractors' ability to deliver high quality construction. It deals more with the interaction between the buyer and the contractor. This would also match up with the analysis on the individual risks, as *Legal and Contract Issues* and *Relationships and Guanxi* were the two most frequently occurring risks in the 19 studies that were performed.

It was also identified that although vendor capability only included 10.4% of all the risks, however, 3 out of 10 of the topmost frequent risks involved the vendor's lack of capability. For the categories of *Financing and Materials and Technology*, it was also found that each one of these had one risk in the top ten most frequent risks.

Risks in VCI and KSACI

In the last five years, two research studies at Arizona State University were performed by PhD students from the Kingdom of Saudi Arabia (KSA) and Vietnam on the major risks that KSA and Vietnam have documented and are currently facing. Both of these research efforts performed in-depth literature research compiling all information on previous studies performed identifying and prioritizing construction risk and issues. These research efforts also surveyed construction professionals in their countries to validate previous research and identify any risks the industries are currently facing.

Saudi Arabia

In 2017, Dr. Algahtany performed research identifying risks and issues construction organizations were facing in the Kingdom of Saudi Arabia (KSA). Dr. Algahtany performed both a literature research and conducted a survey questionnaire to collect the information. The literature research performed reviewed all previous research performed identifying major risks that had occurred on KSA construction projects from 1977 to the present. The research found 24 studies, with 18 of them being published in refereed journals. After analyzing these studies 32 risks were identified and prioritized by the frequency in which they occurred in the 24 studies.

Dr. Algahtany then surveyed construction organizations that were certified by the Ministry of Municipal and Rural Affairs a KSA government organization in charge of delivering all KSA government construction. The survey asked the construction organizations to evaluate each of the 35 risks (3 risks were added due to consultation with a KSA construction expert) on a 5-point scale for both severity and frequency. The risks were then prioritized using the Importance index which takes into account both the severity and the frequency rating (see Table 9).

Table 9

The Overall Importance of Risks in the Saudi Construction Industry

Risk Factor	FI	Rank	SI	Rank	II	Rank
1- Owner's related risks						
Delay in progress payments by owner	90.740	2	96.559	1	87.618	1
Owners' practice of assigning contracts to lowest bidder	91.111	1	86.956	3	79.227	2
Slow decision making by the owner	79.629	5	82.888	6	66.004	3
Change orders by owner during construction	81.481	3	79.354	18	64.659	4
Excessive bureaucracy in the owner's administration	81.481	3	79.318	19	64.629	5
Delay in approving shop drawings and sample materials	77.037	7	82.173	7	63.304	8
Owner's team lack of experience	77.037	7	79.775	15	61.456	10
Owner's poor coordination with the construction parties and government authorities	75.555	10	80	12	60.444	11
Changes in specifications during construction	71.851	16	80	12	57.481	14
Unrealistic contract duration	72.222	13	79.565	16	57.463	15
Interference by owner in the construction operations	75.849	9	73.333	30	55.622	18
Additional work due to changes in the scope of the project	71.111	18	76	27	54.044	21
Difficulties in obtaining work permits	69.629	22	76.179	25	53.043	24

Vietnam

In 2018, Dr. Nguyen Le, performed research investigating the Vietnam construction industry and the risks that were most impactful to their construction performance. As with Dr. Algahtany's KSA construction research, Dr. Le performed both a literature research and survey research of the construction professionals in Vietnam. The literature research looked for any studies performed within the last 15 years that identified non-performance causes in Vietnamese construction projects. Dr. Le reviewed more than 100 published papers and identified only 11 studies related to non-performance construction causes in Vietnam. These studies identified 23 risks that Vietnam currently

faces in their construction industry. These risks were prioritized based upon frequency (see Table 10).

Table 10

Top Risk in Vietnamese Construction Industry from Literature Research

No.	Top Risk in Vietnamese Construction Industry	Agreed Frequency
1	Poor design capacity and the frequent design changes	73%
2	Incompetent contractors	64%
3	Incompetence of project management	64%
4	Financial difficulties of owner	64%
5	Financial difficulties of contractor	55%
6	Poor site management and supervision	55%
7	Corruption	45%
8	Lack of experience in complex projects	36%
9	Slow payment of completed works	36%
10	Bureaucratic administrative system	36%
11	Lack of accurate historical information	27%
12	Interest and inflation rates	27%
13	Unpredictable government policies and priorities	27%
14	Incompetent subcontractors	27%
15	Slow site handover	27%

Using the research from Dr. Le and Dr. Algahtany, the authors created an adjusted list of top risks by combining the risks seen in Vietnam and KSA (see Table 11). A comparison shows that 80% of top risks of the Vietnamese construction industry (VCI) match the top risks of KSA construction industry (KSACI). Both studies by Dr. Le and Dr. Algahtany suggest that BVA is a potential solution to address risks in the VCA and KSACI.

Table 11

Combination of risks of KSACI and VCI

Combined Risk	KSACI	VCI
Approval delay by the client or government	Delay in approving major change by consultant Delay in approving shop drawings and sample materials Delay in performing inspection and testing by consultant	Slow site handover
Bureaucracy in organizations	Excessive bureaucracy in the owner's administration	Bureaucratic administrative system
Changes to the initial design	Design changes Changes in specification during construction	Poor design capacity and the frequent design changes
Communication between stakeholders	Owner's poor coordination with the construction parties and government authorities	
Corruption		Corruption
Delay in Payment	Delay in progress payments by owner	Slow payment of completed works
Government Instability and Politics		Unpredictable government policies and priorities
Inadequate Site Information		Lack of accurate historical information
Infrastructure support	External work due to public agencies (roads, utilities and public services)	
Instability of currency value		Interest and inflation rates
Lack of expertise in construction services	Consultant's lack of expertise Owner's team lack of expertise	Lack of experience in complex projects
Management Skills		Incompetence of project management Poor site management and supervision
Market Instability		Interest and inflation rates
Owner control and decision making	Slow decision making by the owner Change orders by owner during	

	construction Unrealistic contract duration	
Project Financing		Financial difficulties of owner Financial difficulties of contractor
Quality and Buildability of Design Drawings	Poor design capacity and the frequent design changes	
Skill level of labor		Incompetent contractors Incompetent subcontractors
Type of procurement model	Owner's practice of assigning contracts to lowest bidder	

Comparing Construction Risks of Developing Countries

According to the data found in literature search of CCI shown herein, all the risks in Table 12 are also risks in the CCI. On the other hand, each country has a different prioritization of each list of risks. Table 12 below shows a list of the top 10 risks in CCI. The table marks whether each of these top risks are also found on the combined list of risks of VCI and KSACI (Table 12). The data shows that only 5 of the top 10 risks in CCI are also top risks in KSACI and VCI. Of those 5 risks, 4 of them are government related issues (Legal and Contract Issues, Relationships and Guanxi, Government Control and Government Instability and Politics).

Table 12

Top CCI Risks Vs. VCI and KSACI

No.	Top 10 Risks in CCI	Top VCI and KSACI Risks
1.	Legal and Contract Issues	
2.	Relationships and Guanxi	
3.	Outdated Technology	
4.	Lack of expertise in construction services	x
5.	Management Skills	x
6.	Project Financing	x
7.	Skill level of labor	x
8.	Government Control	
9.	Bureaucracy in organizations	x
10.	Government Instability and Politics	

Investigating Potential Solutions

Almost 100 papers and publications were found on the Kingdom of Saudi Arabia and Vietnam construction industries (KSACI and VCI). These papers reviewed the issues, risks, and solutions that the countries have found to be able to improve their construction industries'. The literature research into these three construction industries found that all the countries also currently suffer from low-performing construction services and are seeking for ways to improve them. The literature did not identify many solutions that can help improve construction performance. However, there was one

potential solution identified called the Best Value Approach (BVA). BVA was identified by all three countries as a solution that could potentially work in improving construction efficiency and performance. The solution met all the requirements and constraints of the VCI and KSACI (Le, 2018).

The BVA was identified as the only solution that had documented performance information validating its ability to improve construction performance. It was found that KSACI had five Ph.D. candidates all performing research on the BVA (Alzara, 2016; Alofi, 2017; Alhammadi, 2017; Almutairi, 2017; Alghatani, 2018). In reviewing papers available on an online community called *Research Gate,* it was found that the BVA Saudi Arabian articles had more than 1852 reads, showing the interest in the KSACI community (Research Gate, 2018). Vietnam also had a Ph.D. candidate that is performing research on its implementation of the BVA (Le, 2018). All findings from the author was published on the same online community (ResearchGate) and has 4,124 reads. From the literature research it was identified that five major studies had been performed identifying the BVA to be the only model with the potential to help developing countries overcome their construction issues. These studies included the following:

1. CIB TG 61 Worldwide solutions to non-performance (Egbu et al., 2008; Rivera, 2017).
2. PBSRG Project Management Systems Comparison (Rivera, 2017; PBSRG, 2018).
3. Improving Infrastructure Projects in Sub-Saharan Africa (Monteng, 2016).

4. Saudi Arabian Classification System research (Alzara, 2016; Alofi, 2017; Alhammadi, 2017; Almutairi, 2017; Alghatani, 2018).
5. Risk Factors and Success Practices in Vietnam and other Developing Countries (Le, 2018).

CIB TG 61 Worldwide solutions to non-performance

A monumental research effort was performed in 2008 (Egbu et al., 2008), by Task Group (TG61) of the International Council for Building (CIB), which is now CIB Working Commission W117. The research effort investigated innovative construction techniques and systems that used performance metrics to increase quality and performance of services. The study involved 15 million articles and investigated 4,500 of them to ensure a complete search was made. The result of the effort identified that only 16 articles had documented that the method had increased performance and efficiency. It also discovered that there was only one method that had repeated testing to prove that the results could be replicated and that was the Best Value Approach (BVA) (at the time BVA was known as the Performance Information Procurement System (PIPS) / Performance Information Risk Management System (PIRMS)). The study found that 12 out of the 16 (75%) articles were written on the BVA.

Project Management Systems Comparison

In 2016, The Performance Based Studies Research Group (PBSRG), performed an analysis of all the major project management (PM) systems. This effort was headed by Dr. Alfredo Rivera who wanted to identify the highest performing project management method. This study performed a literature search on all the top PM systems, including: Lean, Six Sigma, Waterfall, Agile, etc. The effort involved a literature search of 10,503 articles, from which the researchers reviewed more than 800 of them. The results of the study found that although many of the PM models had numerous anecdotal testimonies that the model increased quality, decreased time, and decreased cost, there was minimal documented evidence showing that the models had impacted the performance of projects. The only PM model that had repeated testing and documented improvement of project performance was the Best Value Approach (BVA).

Improving Infrastructure Projects in Sub-Saharan Africa

In 2016, Dr. Emmanuel Moteng performed research through the SKEMA Business School in Lille, France, to identify if the BVA could improve project performance and efficiency in Sub-Saharan African countries, specifically the Democratic Republic of Congo (DRC). The DRC was currently engaged in an effort to create a hydro-electric dam in its country that would have the potential to create energy for almost all of Africa. The project had multiple issues that was causing delays and increased costs. The study analyzed the BVA to see if its approach could handle the causes of failure and constraint of the underdeveloped African countries.

Dr. Moteng through a literature research identified different factors of current project delivery systems and factors of the BVA. He then identified the constraints of the DRC and compared the current delivery methods to the BVA in which was more suited to the conditions of the DRC. The results are showed in Table 13. Dr. Moteng discovered that the current practices were failing because they required more management, communication, decision making, and owner expertise, which Sub-Saharan African countries do not have the capability of supplying.

Table 13

Link Between Research Questions, Propositions and Methods.

FACTORS	CCI CONDITIONS	DRC CONDITIONS	BEST VALUE APPROACH	CURRENT PRACTICES
Management	*Less Available*	*Less Available*	*Require Less*	*Require More*
Communications	*Less Available*	*Less Available*	*Require Less*	*Require More*
Decision Making	*Less Available*	*Less Available*	*Require Less*	*Require More*
Transparency	*Require More*	*Require More*	*Bring More*	*Bring Less*
Performance measurement	*Require More*	*Require More*	*Bring More*	*Bring Less*
Owner is the expert	*Less Available*	*Less Available*	*Require Less*	*Require More*
Alignment of resources	*Require More*	*Require More*	*Bring More*	*Bring Less*
No silos	*Require More*	*Require More*	*Bring More*	*Bring Less*

To identify how Dr. Moteng's research is related to the CCI, Table 6 was modified from Dr. Moteng's original version to include a column that identified the CCI conditions. The DRC and CCI conditions matched up perfectly, showing that the BVA could not only help the DRC but also the CCI.

Saudi Arabian Classification System Research

From 2016 to 2017, multiple Saudi researchers at Arizona State University performed their dissertation research efforts on identifying ways to improve the Kingdom of Saudi Arabia's construction industry (KSACI) and contractor classification system. Their studies showed that the KSACI had been delivering poor performing construction services for more than the last 10 years. The research also discovered that the current contractor classification system (CCS) also was not able to ensure that the government was receiving high performing construction services.

Dr. Saud Almutairi performed a literature searching 80 countries to identifying all the CCSs being used. Out of the 80 countries, he found that only 8 countries used a CCS. He also discovered that none of the CCSs had a way to continually track contractor performance over time. The only system that had showed a capability to regulate the performance of contractors over time was the BVA. From this research, the KSACI used the BVA principles to help reshape the Kingdom of Saudi Arabia's CCS.

Risk Factors and Success Practices in Vietnam

In 2018, Dr. Nguyen Le, performed research investigating the Vietnam construction industry (VCI) and the risks that were most impactful to their construction performance (Le, 2018). Le performed both a literature research and survey analysis of the construction professionals in Vietnam. In this industry survey, Le questioned Vietnamese construction professionals on their perspective of BVA potential

effectiveness in the VCI. Of the 140 respondents, 69.3% agreed that BVA principles would improve project performance (only 6.1% disagreed).

Investigating the Best Value Approach

The Best Value Approach is the only potential solution with performance information the authors found for Vietnam and Kingdom of Saudi Arabia. The major studies and references suggest these countries found to support this conclusion involved researching thousands of papers and analyzing delivery, project management, and contractor classification systems. The only method that both countries identified as a potential solution to their issues is the Best Value Approach (BVA).

The Best Value Approach (BVA) was derived from the industry structure model (IS) (see Figure 1). The IS model splits the industry up into two main quadrants:

1. The BVA quadrant that has high competition and performance; and
2. The Price Based quadrant that has low competition and performance.

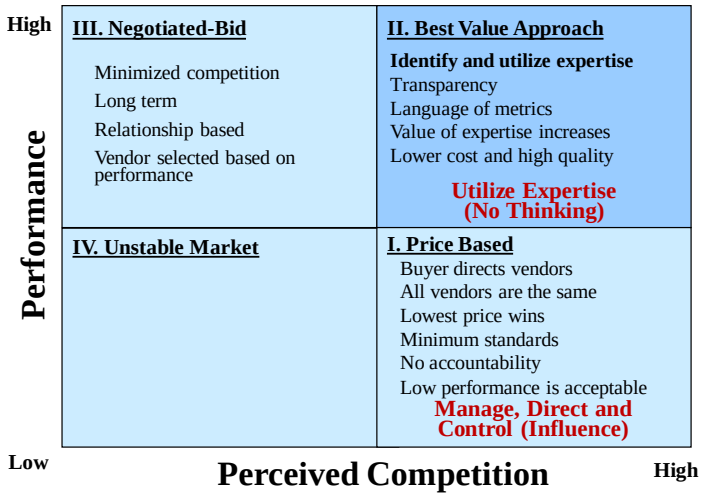

Figure 1: Industry Structure Model.

The model identifies that low performance is caused due to buyers trying to manage, direct, and control (MDC) vendors. The only way to move to the BVA quadrant is to utilize the expertise of the vendor, by moving the management and control of the project to the expert vendor.

The IS model identifies the following buyer traditional activities that are used to MDC vendors (Kashiwagi, 2018; PBSRG, 2018):

- Creating technical requirements and specifications.
- Partnering and developing relationships with vendors to enable the client to be involved with the management and development of the service.
- Using the contract as leverage over the vendor.
- Using a project manager to manage a vendor after they were awarded a contract.

- The IS model also identifies that the following activities will enable buyers to utilize the expertise of vendors:
- Minimize involvement in technical details of services.
- Move buyer activities to that of quality assurance (ensuring the vendor has created a plan and is measuring their performance through non-technical metrics) instead of quality control (ensuring the vendor is performing all their technical work correctly).
- Require vendors to tell the client what the technical specifications and requirements should be.
- Utilize internal buyer personnel to help and protect the vendor.

The BVA was developed to help buyers to understand and move to the BVA quadrant and perform the activities that enable them to utilize the expertise of vendors. The BVA splits a project up into three major phases (selection, clarification, and execution) (see Figure 2):

Selection Phase

All vendors compete based on their level of expertise instead of their technical scope of work. During this phase, the vendors are not given technical requirements or specifications, but a list of expectations and explanation of "what the client thinks they want". They are selected upon their past performance metrics, ability to identify risk, and

capability of their key personnel. The highest ranked vendor moves into the clarification phase.

Clarification Phase

This is the most important phase, as the vendor with the highest level of expertise is now required to create their scope of work and technical requirements which are required to:

- Explain how they will accomplish the work efficiently and with high customer satisfaction
- Identify their plan from beginning to end, all risks they do not control, all major milestones, how they will measure their performance, and justify their costs
- Respond to the client's concerns and feedback about the vendor's plan and the vendor must address those concerns in their plan

Regardless, if the concerns from the client are technical or non-technical, the vendor is required to resolve the concern using non-technical language. The contract is only signed when the client is comfortable with the vendor's plan, otherwise, the vendor will be eliminated from clarification and the next in line vendor will be notified for clarification.

Execution Phase

Upon signing the contract, the contractor can proceed to work according to their plan. Since the vendor was the entity that developed the plan and the metrics, it has now put them in full control of the project. Performance will be tracked and posted online for each contractor through Weekly Risk Reports (WRR) which the contractor will turn in on every Friday. If ever another stakeholder tries to control the expert, that is also reported on the WRR and the vendor identifies what the impact that control will have on the project's performance.

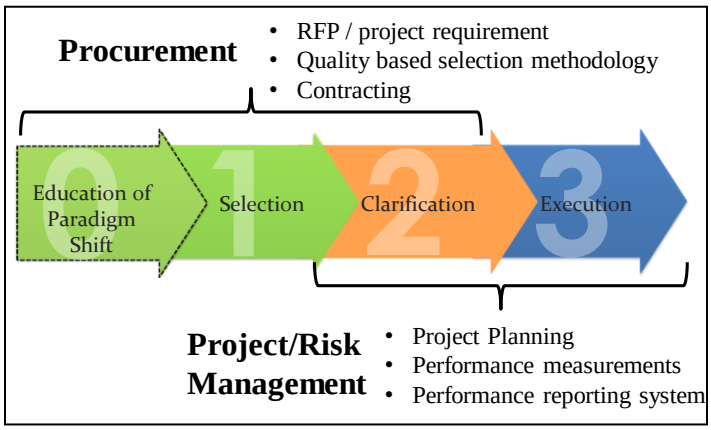

Figure 2: The Best Value Approach.

Many of these ideas are different from the traditional delivery models. However, BVA system has documented the following performance (Rivera, 2017; PBSRG.com, 2018):

- 2,000+ projects and services delivered (construction and non-construction).
- $6.6B of projects and services delivered with a 98% customer satisfaction and 9.0/10 client rating of process.
- Services delivered: construction, facility maintenance, IT, professional (design), redesign of systems and organizations and supply chain applications.
- $17.6M in research funding generated, due to the effectiveness of decreasing buyer cost of services on average by 31% (57% of the time, the highest performing expert was selected and was the lowest cost).
- Contractors/experts could offer the client/owner 38% more value and decreased client efforts by up to 79%.
- 90% of all project cost and schedule deviation is caused by the owner's non-expert stakeholders.
- Change order rates were reduced to as low as -0.6% (Rivera, 2017).
- CIB W117 has worked with over 123 unique clients (both government and private sector) and received 12 National/International Awards.
- 5 to 30 percent cost savings are achieved on the projects.
- The BVA is the most licensed technology to come out of Arizona State University licenses (61).

- It is internationally recognized through repeated testing (Canada, Netherlands, Sweden, Norway, Finland, Botswana, Malaysia, Australia, Democratic Republic of Congo, France). Education efforts are in Poland, Saudi Arabia, India, Vietnam and China.
- Been audited four times: The State of Hawaii Audit [Kashiwagi et al. 2002; State of Hawaii Report 2002 (DISD)]; The Dutch Study on the Impact of PIPS (Duren & Doree, 2008); The Corps of Engineers (COE) PARC, 2008 (Kashiwagi, 2018); The Western States Contracting Alliance (WSCA) Agreement, 2011 (PBSRG, 2018).

Research on the BVA identifies that it is one of the only delivery methods that has repeated documentation showing that it can improve construction performance. It also is one of the only construction delivery methods developed in the last 20 years that has shown to improve construction performance in both developed and developing countries.

Applicability of the Best Value Approach with the Chinese Construction Industry

From the risk analysis of the different countries it was identified that the CCI has similar risks as the VCI and KSACI. Past research suggests that BVA effectively addresses issues created by the majority of these risks (Le et al., 2019, Algahtany 2018). However, the CCI has several top risks that are not present in the VCI or KSACI, such as:

1. Legal and Contract issues
2. Relationships and Guanxi
3. Outdated Technology
4. Government Control
5. Government Instability and Politics

From recent literature research on the BVA, it was identified that the BVA can resolve many legal and contract issues and relationship risks, however; it has only been able to do so with the strong support of the buyers and contractors (Kashiwagi, 2016). The authors were not able to find any research that showcases whether BVA is effective in mitigating risks dealing with Chinese government related issues. Specifically, Guanxi is unique to the Chinese culture. It is an ancient term used to describe close relationships, specifically, relationships used to promote business dealings (Cheng and Tang 2012). The authors could not find any data suggesting the BVA can address issues related to Guanxi

Discussion of Findings

The literature review show herein suggests that Vietnam and KSA have the most similar construction industry compare to China. All three countries are also experience performance issues in their construction industries.

Additional research was performed to identify the major risks the CCI is facing and compare them to the VCI and KSACI. The results of this research identified that the CCI is facing many of the same risks as the VCI and the KSACI, but the top 10 risks [prioritized by frequency in the publications of the CCI] in the CCI are different but similar to the other two countries. Of the five top risks unique to CCI, four are Chinese government related issues (Legal and Contract Issues, Relationships and Guanxi, Government Control and Government Instability and Politics). This could be due to a number of factors. One of the major factors could be due to the socialist government of China, in which, the government becomes both the buyer and the contractor in most construction projects (Zou et al. 2007; Zou 2007; Liu et al. 2013; Zhang et al. 2008; Xu et al. 2005).

In investigating potential solutions to address risks in Vietnam and KSA, the author only found one delivery method with documented performance information, the Best Value Approach (BVA). The BVA is the only method with documented performance information that has been investigated as a potential solution for construction performance issues in Vietnam and KSA. In researching the BVA, four major studies identifying the following:

1. BVA is the only construction method with repeated documentation showing high performing results.
2. BVA is the highest performing and most documented project management model.

3. BVA has the right factors enabling developing countries to implement the method.
4. BVA impacts every major step in project delivery (procurement, negotiation, contract creation, and project management).

The BVA has been implemented in 10 different countries and research has shown that it is able to deliver services for 30% cheaper and deliver almost 40% more value. Although the BVA seems to be a viable solution, further validation is needed to see if BVA is a potential solution for CCI.

Chapter 4

SURVEY AND RESEARCH VALIDATION

Through an extensive literature research, the author has investigated a potential solution to address performance issues in the CCI, the Best Value Approach (BVA). Previous research suggests that the BVA is a viable solution to address construction performance issues in other developing countries (Vietnam and KSA).

This section of the research seeks to validate results from the literature research and investigate the feasibility of the BVA in China.

Survey Methodology

To identify if the BVA could help the CCI improve the performance of construction projects the researcher followed the following method:

1. Design a survey for CCI stakeholders that measures the following:
    a. Current performance of projects in the CCI
    b. Satisfaction on the current delivery process
    c. Perception of the BVA and its ability to improve performance in the CCI
    d. Verification of top risks in the CCI
2. Validate survey questions and clarity among a test group. Issue the survey to larger population.
3. Analyze the survey results to identify the current performance and condition of the CCI.

4. Analyze the results to investigate whether stakeholders believe that the BVA is a viable solution for performance issues in the CCI.

The collected survey was quantitatively analyzed using IBM SPSS Statistics v25. The research team used the following techniques:

1. Cronbach's alpha coefficients to test internal consistency of the results,
2. Risk factor analysis to rank the risk factors in terms of degree of frequency, severity and importance
3. Spearman's rank-order correlation coefficient was then utilized to determine the degree of agreement of risk rankings between each responded group,
4. Factor analysis was used to derive interrelationships among the risk factors.

Survey Development and Overview

The first step in surveying the professionals in the CCI was developing the survey. This was a difficult process as most professionals in the CCI do not understand English well, and most of the research and explanations of the BVA is in English. Development of the survey went as follows:

1. Created a draft survey based on previously published survey information.
2. Translated the survey into Mandarin
3. Had two Chinese construction professors review and comment on the draft survey

4. Test Survey - Surveyed professionals from a Chinese construction group as a test survey to identify questions and issues with the survey and get feedback.
5. Full Survey - After adjusting the survey, send out final version of survey to Chinese construction professionals.

After going through this process, the survey was then modified, finalized, and sent out to multiple Chinese organizations located in the Fuzhou, Fuzhian province. The survey was sent over social media and direct contact. A link was provided for the professional to fill the survey out on the web.

The finalized survey included four major parts (see Appendix A):

1. Basic information – The surveyor would be asked personal information including name, company, number of years of professional experience.
2. Current satisfaction of CCI - Questions included: Current satisfaction with construction services, estimate percentage (%) of overall projects that are delayed, estimate average percentage delay for each project, estimate percentage (%) of overall projects that are over budget and estimate average percentage over budget for each project.

3. Risk impact – The top researched risks were provided in the survey and the professional was asked to identify how impacting each of the risks were to the performance of the CCI.
4. Best Value Approach – Questions were asked the professional to identify if they believed that different characteristics of the BVA could improve the performance of the CCI.

The questions used a five-point Likert scale of 1 to 5 to measure the respondents' evaluation of the CCI. The numerical values assigned for the Likert Scale are as follows: '5 = High Impact or Strongly Agree, 3=Don't know, 1 = Low Impact or Strongly Disagree'.

There are 204 construction professionals that participated in the survey. Of the respondents, 67 (33%) were from the test survey. The final survey was then sent out to 140 construction professionals, 137 of them fill out the survey, giving a response rate of 98%. Out of the 137 that filled out the final survey, 50% of them were vendors.

After the test survey and the final survey was administered, the researchers used the following techniques to analyze the survey data:

1. Cronbach's alpha coefficients to identify the difference in results from the test survey and the final survey
2. Mean score to identify the degree of impact each risk had or the degree to which the professional agreed or disagreed with a statement and
3. Factor analysis was used to derive interrelationships among the risk factors. These are described in the following sections.

Survey Results

The survey was administered to two groups, a test survey group and the final survey group. This section examines and compares the results of both survey groups.

Test Survey Results

The test survey was sent out by the principal of the College of Construction at the Fujian University of Technology. The principal sent the survey to multiple industry and academic groups to obtain an accurate assessment of the survey and potential results. Unfortunately, the test survey was unable to collect personal information on the professionals filling out the survey. However, the response rate of the survey was very high (89%) identifying that there were responses from project managers, engineers, and academics from the buyers' organizations.

The response to the test survey is shown in Table 14. From the 67 responses, 43% identified that they are not satisfied with the current CCI performance, 27% are undecided, and only 30% of respondents are satisfied with it.

Table 14

The Satisfaction of Test Survey

Satisfaction Rating	**Responses**	**Percentage**
Unsatisfied	29	43%
Neutral	18	27%
Satisfied	20	30%

The survey listed the Top 8 risks in the CCI. Respondents were asked to state whether or not they agreed that each item was a serious risk in the CCI (see Table 15). Responses were given on a 1-5 scale; the mean response score is shown in Table 4 as well. The risk that had the strongest agreement was project financing, which had a 70% agreement. This was interesting, because project financing was one of the top risks in the KSACI and VCI, however, current research did not identify it as one of the top 3 risks in the CCI. The second highest ranked risk was management skills which had a 60% of strongly agree. The third one was skill of labor which had a 48% of agreement. The risk with the least agreement was outdated technology which had a 30% agreement.

Table 15

Risk Measurement of Test Survey

RISK FACTORS	Mean	Survey Rank
Project Financing	4.090	1
Management Skills	3.776	2
Skill level of labor	3.388	3
Relationships and Guanxi	3.358	4
Legal and Contract Issues	3.284	5
Government Control	3.239	6
Lack of expertise in construction services	3.224	7
Outdated Technology	2.985	8

Respondents were asked if they believed the BVA concepts would improve the CCI. The researchers selected 5 key concepts shown in Table 5. Respondents replied on a 1-5 scale of agreement; Table 16 provides the mean score and the rank of most agreeable concept. More than 50% agreed that BVA would improve CCI performance. However, when asked if they believed the BVA would be accepted in the current CCI environment only 34% agreed. Although all the ideas and actions of the BVA are believed to be able to improve the CCI, the majority (65%) do not know or disagree that CCI could use BVA.

Table 16

Professional Opinion of BVA System from Test Survey

	Test Survey		
BV Concept	**Strongly Agree**	**Don't know**	**Strongly Disagree**
If the contractor was required to document each stakeholder's performance, price and all risks cause the delay/over budget of the project, would CCI performance improve?	54%	25%	21%
Would a selection system that hires contractors based off of performance and price improve the performance of the CCI?	49%	24%	27%
If we hire an expert contractor by using the selection system mentioned above, making the expert contractor responsible for the planning, risk management, and project management of a project, will it improve performance of the project?	60%	31%	9%
Do you think if there is a selection system could make all of vendor's past performance transparent, that could eliminate "guanxi" in CCI environment?	51%	36%	13%
Do you think this system will be accepted by CCI environment?	34%	40%	25%

Final Survey Results

After the test survey was sent out, modifications were made to the survey and then it was sent out again to a multiple companies and organizations in China. The major modifications that were made to the survey were as follows:

1. Professional background information was requested from the respondents (i.e. name, years of experience, position, etc.)
2. Professionals were asked to estimate the performance of CCI projects (i.e. percent delayed and percent over budget)

3. Some questions were modified in the Chinese version to minimize confusion

The finalized survey was sent out over a period of six months. It was difficult to find Chinese organizations that were willing to participate in the survey. The researchers found 140 construction professionals willing to take the survey and 137 of them completed the survey. The response rate is 98%. The results of this survey were then analyzed in Tables 17–23. The demographics of the final survey is found in Table 17. For the second phase, 68 respondents worked for construction vendor side (50%), 18 for designers (13%), 15 for owners (including real state owner and government department, 11%) and 7 for project management which is consultants (5%). The participants held different level of positions, 51 of which were engineers (37%), 27 were project managers (20%), and 10 were designers (7%). 58% of respondents have more than 6 years of professional experience.

Table 17

Demographic Characteristics of Final Survey

Demographic Characteristics	Responses	%
Company		
Construction Vendor	68	50%
Design Institute	18	13%
Real Estate Owner	9	7%
Project Management	7	5%
Government Department	6	4%
University	4	3%
Inspector	2	1%
Total	114	
Industry Experience		
0-5 years	47	34%
6-10 years	50	36%
11-20 years	23	17%
Over 20 years	7	5%
Position		
Engineer	51	37%
Project Manager	27	20%
Designer	10	7%
Government Worker	5	4%
Cost Engineer	4	3%
Manager	3	2%
Professor	3	2%
Marketing	2	2%
Inspector	2	2%
Logistics	2	2%
BIM Technology	1	1%
Construction Vendor	1	1%
Safety Manager	1	1%
Structure Identification	1	1%

Project Performance

Tables 18 shows the results of the professionals' satisfaction of the CCI. Only 21% of all respondents are satisfied with the CCI. Respondents with more than five years of experience are less satisfied with performance.

Table 18

The Satisfaction with Current CCI Performance

Industry Experience	N	Unsatisfied	Neutral	Satisfied
Overall	137	42%	37%	21%
0-5 Years Exp.	47	34%	40%	26%
5+ Years Exp.	80	49%	33%	19%

In order to measure the perceived performance of the projects in the CCI, respondents were asked to estimate schedule delays and budget deviations (see Table 19). Respondents estimated what percentage of all CCI projects were delayed or over budget. Then they were asked to estimate the impact each factor. The majority of projects are delayed, while nearly 45% of projects are over-budget.

Table 19

Performance of CCI Projects

Survey Question	Mean	Median	Mode
How many projects are delayed?	57.7%	63%	80%
What is the average delay for each project?	34.2%	20%	20%
How many projects are over-budget?	44.9%	42.5%	50%
What is the average budget deviation for each project?	23.2%	20%	10%

Risk Analysis

The survey listed the top eight risks in the CCI (see Table 20). Respondents were asked to identify which factors they agreed or disagreed with (on a Likert scale; 1 is strongly disagree and 5 is strongly agree).

Table 20

Ranking of top CCI risk factors

Rank	Risk Factors	Mean
1	Project financing	3.810
2	Management skills	3.701
3	Legal and contract issues	3.474
4	Relationships and Guanxi	3.423
5	Skill level of labor	3.234
6	Government control	3.234
7	Lack of expertise in construction services	3.212
8	Outdated technology	2.934

The relationships between each risk factors were further investigated in order to identify the most significant ones. Factor analysis was used to first measure the multivariate interrelationships between and within the risk factors, and second, analyze the structure and correlations between the variables by defining a set of common underlying dimensions (also known as factors or components) (Hair, 1998). The Kaiser-Meyer Olkin (KMO) and Bartlett's Test of Sphericity were conducted to verify the legitimacy of factor analysis. In this study for the final survey, Bartlett's test approximate of Chi-square is 335.288 with 28 degrees of freedom, which is significant at the 0 level of significance, suggesting that the population correlation matrix is not an identity matrix. The KMO statistic of 0.793 is also greater than 0.5 which is satisfactory for the factor analysis.

The Principal Component method was utilized for factor extraction. The Oblimin rotations with Kaiser Normalization rotation method was selected for this analysis. Two (2) components were identified with Eigenvalues to be greater than 1 (shown in Table 21). These two components account for 57.04% of the variance in construction non-performance.

Table 21

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	3.469	43.367	43.367	3.469	43.367	43.367	3.147
2	1.094	13.672	57.039	1.094	13.672	57.039	2.365

Table 22 shows the two (2) component loadings extracted from the factor analysis and these exclude the factors with loading values of less than 0.5. The two components are labeled as follow:

- Component 1 – Project Experience and Technology Risks
- Component 2 – Government Involvement and Financing

Table 22

Factor Analysis Loading Results

Components	**Eigenvalue**	**Variance (%)**	**Risk Factors**	**Factor Loading**
1	3.469	43.367	Management Skills	0.911
			Lack of expertise in construction services	0.886
			Skill level of labor	0.736
			Outdated Technology	0.609
2	1.094	13.672	Government Control	0.899
			Relationships and Guanxi	0.713
			Project Financing	0.531

Component 1 – Project Experience and Technology Risks

All of the risks grouped in Component 1 relate to skill level or available technology. According to the factor loading analysis, this component has a more significant impact to overall perception of project risk (43.4% variance).

Component 2 – Government Involvement and Financing

The risks associated with Component 2 are government control, relationships and Guanxi, and project financing. Each of these risks has direct ties to government involvement or Chinese culture. The government uses a classification system that assigns contractors A to D certifications. All of the largest projects are assigned to A Contractors. While 56% of contractors are privately owned, only 0.12% of A Contractors are privately owned (NBSC, 2018, CCIA, 2016). The rest are owned by the government. This means that the largest projects (most expensive) are primarily dependent on government funding. Smaller contractors are can win bids for government projects by fostering "good relations" with government organizations (Guanxi). In China, both 'project financing' and 'relationships and guanxi' are directly linked to government involvement and financing.

Perceptions of the Best Value Approach

The final survey listed BVA concepts and ask respondents to state if they believe each factor could improve performance of the China Construction Industry (Table 23). Over 50% of respondents agreed with the first four factors. The final question of the survey asks whether or not CCI would be likely to implement these changes. Only 40% of respondents believe the CCI could implement BVA (46% don't know).

Table 23

Professional Opinion of BVA System from Final Survey

	Final Survey		
BV Concept	**Strongly Agree**	**Don't Know**	**Strongly Disagree**
If the contractor was required to document each stakeholder's performance, price and all risks cause the delay/over budget of the project, would CCI performance improve?	51%	34%	15%
Would a selection system that hires contractors based off of performance and price improve the performance of the CCI?	58%	31%	11%
If we hire an expert contractor by using the selection system mentioned above, making the expert contractor responsible for the planning, risk management, and project management of a project, will it improve performance of the project?	62%	25%	13%
Do you think if there is a selection system could make all of vendor's past performance transparent, that could eliminate "guanxi" in CCI environment?	50%	26%	24%
Do you think this system will be accepted by CCI environment?	40%	46%	14%

Comparing the Test Survey and Final Survey

To help support the validity of the final survey, it was compared to the test survey results to see if the opinions of the two populations showed any degree of disagreement and to measure statistical validity. After performing multiple tests, the overall statistics show that the test survey and the final survey results are statistically similar.

The Cronbach's Alpha Coefficients of the internal consistency reliability tests for risk factors' frequency and severity ratings of the survey results for the Test survey and the Final survey are 0.79 and 0.8 respectively. Litwin & Fink (1995) suggested that consistency is high when Cronbach's alpha is above 0.7. This confirmed that there is high internal consistency among the answers.

Both surveys show the majority of professionals are not satisfied with current Chinese Construction Industry (see Table 16 and Table 23). The final survey has more data for further significance.

Both surveys suggest that the greatest risk in the CCI is project financing. There were only two risks that scored differently between the two surveys: "legal and contract issues" and "skill level of labor". The final survey showed that "legal and contract issues" were more of an issue than "skill level of labor". Interestingly, in the final survey not

only did “legal and contract issues” score higher, but also the “relationships” and “Guanxi” also scored higher. This matches the interrelationship analysis performed on the risks identifying that those two risks are closely related.

Table 24

Comparison of Risk Factor between Test Survey Result and Final Survey Result

	Test Survey	**Final Survey**
Risk Factors	**Rank**	**Rank**
Project Financing	1	1
Management Skills	2	2
Skill level of labor	3	5
Relationships and Guanxi	4	4
Legal and Contract Issues	5	3
Government Control	6	6
Lack of expertise in construction services	7	7
Outdated Technology	8	8

The last section of the survey that was analyzed was the BVA concept section. The test survey and the final survey results for this section were similar. Analysis of the results showed that the ratings for each BVA concept were the same. The major difference that occurred in the evaluation of the BVA concepts were in the selecting a contractor based on performance and price and if the professional thought the BVA system would be accepted in the CCI environment. The test survey showed a lower ranking of these statements and the final survey showed a greater approval of these statements. This might be due to the different constituents that answered the questions.

The test survey being more closely connected with the government and the final survey being less connected with the government.

Discussion of the Results

The survey results shown herein offer insights into in the performance of the CCI, risks that cause poor performance, and feasibility of apply BVA principles to address those risks. In analyzing the survey results and comparing the results to previous research, the authors have made observations unique to the CCI. These observations are discussed in greater detail in this section.

Validating Risks in the CCI

The risks identified in the literature research were listed in the survey and respondents were asked to rank their impact on overall performance in CCI. Table X below compares the ranking of risks between the final survey and the previous literature search. Observation suggests that most of the rankings are inconsistent with each other. The closest ranked risks (lowest average scores) are ‘legal and contract issues’ and ‘relationships and Guanxi’. These two factors are top risks according to both sources (the survey and the literature). No conclusions can be made regarding the importance or impact of the other risks without further validation and case study tests. As shown in Table 25, all risks show a mean score greater than 3 (other than ‘outdated technology’). This suggests that the suggests that, on average, survey respondents believe that each risk

does have some impact on CCI project performance. This validates the literature research in that each of the reported risks are somewhat impactful, but this research cannot quantify the scale of that impact ('outdated technology' is inconclusive).

Table 25

Comparing risk impact from survey responses to literature research

	Final Survey	Literature	Average
Risk Factors	**Rank**	**Rank**	**Avg.**
Project Financing	1	6	3.5
Management Skills	2	5	3.5
Legal and Contract Issues	3	1	2
Relationships and Guanxi	4	2	3
Skill level of labor	5	7	6
Government Control	6	8	7
Lack of expertise in construction services	7	4	5.5
Outdated Technology	8	3	5.5

Government Involvement in the CCI

As discussed in previous sections, 56% of all contactors are privately owned (NBSA, 2018). Because of the nature of the Chinese contractor classification system, only 0.12% of private contractors are selected to build the largest construction projects in China (CCIA, 2016). To make the situation worse, China's state-owned construction enterprises are large and inefficient, many have administrative processes and technology that are outdated and not competitive. Most of them have an equity debt ratio of 75%

(He, 2000). Small contractors win more government contracts when using relationships ("Guanxi").

One of the most important factors for contractors (private and public) to win bids is Guanxi. Guanxi is an ancient Chinese term that describes personal relationships. Today, Guanxi is used in business to form partnerships and select contractors. Research studies have shown that Guanxi is perceived from project stakeholders as the most important criterion determining the success rate of a project (Wang, X. and Huang, J., 2006).

In order to gain a better understanding of Guanxi in China, the authors included a question in the survey that asks, "What causes Ganxi?", or in other words, why Guanxi exists in China. Table 26 shows the response categories and the number of respondents for each category.

Table 26

The reasons for Guanxi in China

Responses Categories	Number of Respondents
Government involvement	21
Chinese Culture	12
Supervision/legal system	8
Bidding process	4
Subcontracting	6
Clients withholding information	4
Total	55

Since this question was a written response, answers varied between each respondent. Regardless, the results show that most of the respondents believe that Guanxi exists (or continues to exist) because of the government involvement in the CCI.

Of the 55 responses to this question, six described a subcontracting system unique to the CCI. The author created a model to illustrate one example of this system (see Figure 3).

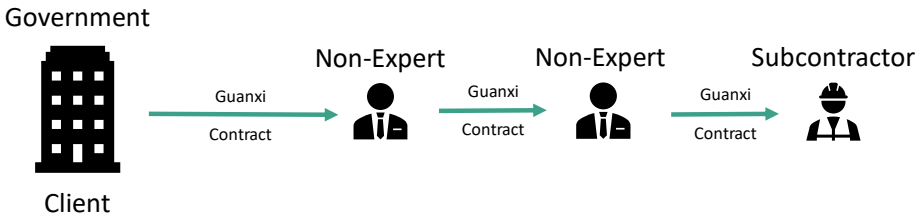

Figure 3: Guanxi and Subcontracting in the CCI

When the Chinese government bids for a project, they may award the project bid to a non-expert contractor based on a preexisting relationship (Guanxi). In some cases, the awarded contactor may not have the resources or expertise to complete the project. When awarded, the contractor may not receive any funding until the project is complete, so it is the contractor's responsibility to cover the cost of material and labor. When the contractor cannot cover upfront costs, they may hire another contractor (also based on a preexisting relationship). As was in the first case, this new contractor may not have the

abilities or funding to complete the job either. Thus, the second contractor will then hire another subcontractor to fund and complete the work.

When the work is completed, the client pays the first contractor who then pays the other subcontractors involved. The authors were unable to find evidence that suggests any other countries use this subcontracting system. This example of Guanxi may link several risks identified by the literature search (project financing, government control, relationships and guanxi, contract issues, and management skills).

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

Current data suggest that the Chinese construction industry (CCI) is suffering from low performance and efficiency. This research seeks to investigate potential solutions to address the poor performance in the CCI. To find viable solutions, the researcher conducted a detailed literature search of other developing countries, their construction industries, and potential solutions they documented that could improve the performance of their construction industries. This literature research suggests that Vietnam and the Kingdom of Saudi Arabia (KSA) have the most similar construction industries compared to China.

Both of these countries performed thorough research studies identifying all the solutions that could be used to improve their construction performance. Both Vietnam and the KSA found only one solution that had multiple test cases that had been documented and showed improve project performance after using it. The solution they found was the Best Value Approach (BVA).

The BVA was developed by Dr. Dean Kashiwagi at Arizona State University. The solution had been tested for more than 20 years and had performance results on more than 500 projects. The system has been audited 3 times by third parties to verify the

legitimacy of its performance documentation. The BVA was identified as a potential solution to improve the CCI performance.

To identify if the BVA solution that was proposed in both the Vietnam and the Kingdom of Saudi Arabia construction industries could also help the CCI, the author compared the risks of each of these countries. The risk analysis identified that the CCI shared most of the issues causing low performance in the other countries. However, the results showed that there were some issues dealing with project control and finances that were different in the CCI than in the other countries.

The author then surveyed CCI professionals to validate literature and identify if the CCI professionals believe that the concepts of the BVA could improve the performance of the CCI. Since most CCI professionals only speak Mandarin, and the original survey that was created was in English, two surveys were administered, the first being a test survey and the second being the final survey. Both surveys found the following:

1. Most CCI professionals are not satisfied with the current project delivery method.
2. The CCI is struggling to complete projects on-time and on-budget (with more than 50% of projects being delayed and 40% of projects being over-budget).

3. The top eight risks that the literature identified were verified as being issues by the CCI professionals. However, the impact and ranking of these risks is inconclusive.
4. The CCI professionals identified that they felt the BVA concepts would improve the performance of the CCI.
5. The CCI professionals felt that the BVA system probably would not be accepted in the CCI environment.

This research was able to verify the low performance of the CCI. It also was able to identify a potential solution (BVA) that the professionals in the CCI believe would improve the performance of the CCI. However, there are many professionals that doubt the BVA would be accepting in the CCI. Further research is needed

Research Questions Revisited

This section addresses the research questions posed in the introduction. The main research question is:

- Is there any potential solution to address poor performance in the CCI?

To further address the main question, this study is divided into four research questions:

1. What is causing poor performance in CCI?
2. What potential solutions could be considered?
3. Would CCI stakeholders agree with the potential solutions?
4. Is it possible to implement the potential solutions in CCI?

Main Research Question: Is there any potential solution to address poor performance in the CCI?

We identified the Best Value Approach (BVA) is the only potential solution with documented performance information identified by similar construction industries. However, it's inconclusive if CCI can implement the solution since its unique risks related to government involvement and the majority of CCI stakeholders do not know if BVA is feasible in the CCI.

What is causing poor performance in CCI?

According to the literature research, and validated by a group of 140 CCI professionals, the top risks in China are 'legal and contract issues' and 'relationships and Guanxi' (see Chapter 3). This research question is conclusive. Additional risks include:

- Project Financing
- Management Skills
- Skill level of labor

- Government Control
- Lack of expertise in construction services
- Outdated Technology

What potential solutions could be considered?

This research suggests that Vietnam and KSA have the most similar construction industries compared to the CCI. Other research studies show that the only potential solution with documented performance information applicable to Vietnam and KSA is the Best Value Approach (BVA) (see Chapter 2). This research question is conclusive.

Would CCI stakeholders agree with the potential solutions?

A survey of CCI stakeholders shows that over 50% of respondents believe that BVA concepts will improve construction performance in China (see Chapter 3). This research question is conclusive.

Is it possible to implement the potential solutions in CCI?

According to survey results from CCI stakeholders, only 40% believe that BVA could work in the CCI. The majority of respondents (46%) do not know if BVA is feasible in the CCI. This research question is inconclusive. Additional research is needed.

Recommendations

It is proposed that further research be performed testing the BVA in the CCI. The following would be suggested:

1. Provide more education and information to CCI participants on the BVA and conduct expert interviews.
2. Gather more information and case studies of how Guanxi operates and affects projects in the CCI.
3. Test the BVA on a pilot project in the CCI. Documenting the performance and the perceptions of all the CCI stakeholders.

The BVA shows great potential in being able to improve the performance of the CCI. However, since the CCI has some unique characteristics from other countries that the BVA approach has been identified as a solution by, implementation of the BVA should go slowly and more research and test should be performed to verify the BVA can be implemented and will improve the performance of the CCI.

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