

Analyzing the Key Drivers of Contractors' Temporary Competitive Advantage in the Competition of International High-speed Rail Projects

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Abstract

After temporary competitive advantage (TCA) being proposed, this concept has received extensive attention from academia and industry. For international HSR contractors, how to form their TCA and win out over the competition for new projects is crucial, while only few studies focus on this issue. The aim of this research is to develop a TCA system that reflects the characteristics of high-speed rail (HSR) contractors from corporation and project dimension. At first, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were conducted to explore and examine the key drivers and their relationships with contractors' TCA. The results revealed that experience-mining advantage was the most important factor of the six common factors. Next, common factors were divided into three dimensions and discussed in depth, including resource-based TCA (i.e., technical resource and social image) which had the highest significance, followed by performance-based TCA (experience-mining advantage and risk-controlling

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17 performance), and action-based TCA (i.e., funding strategy and organizational management).
18 Finally, two case study projects were selected to investigate the competition situation between CRH
19 (China Railway High-speed) and Shinkansen (Japan) in the international HSR market. This study
20 not only provides suggestions for contractors to improve their TCA in international HSR projects,
21 but also contributes to the theoretical framework for TCA theory.

22 **Keywords:** *High-speed rail (HSR) project; international contractors; temporary competitive*
23 *advantage (TCA); factor analysis; case study*

24 **1. Introduction**

25 In recent years, high-speed rail (HSR) entered a vigorous period of development and many
26 countries have made HSR construction plans, including “High-Speed Railway Strategic Plan” made
27 by U.S. Department of Transportation, “2050” transportation strategy formulated by Europe, etc.,
28 showing that HSR is in high demand in many countries (Zhou et al., 2014). However, huge market
29 demand has also attracted many competitors, competition between several HSR systems grows
30 keener (Zhang et al., 2019). HSR is generally larger in scale, longer in the construction period, and
31 with more considerable regional differences, so bidders often work in a form of international
32 consortia or joint ventures (Hwang et al., 2018). Therefore, it is necessary for contractors to fully
33 extract the advantages accumulated by each member over the years, then integrate and maximize
34 the use of them according to the specific competition environment, thus forming their advantages at
35 a particular time, which is the process of forming HSR contractors’ temporary competitive
36 advantage (TCA).

37 TCA, considered as the ability of companies to surpass their competitors, gain market dominance

38 and high profitability levels when facing a particular competitive environment, so as to ensure that
39 they can gain superiority in the competition within a certain period of time (Mcgrath, 2013; Huang
40 et al., 2015). After O'Shannassy (2008) proposed that all competitive advantages are temporary in
41 the complex and ever-changing environment, TCA has been valued and discussed over the past
42 decade. For example, Lee et al. (2010) used the software industry as an example to analyze
43 super-competition, and proposed that managing dynamic capabilities is the key to update short-term
44 advantages. Leavy (2014) explored the necessity to study TCA from four different dimensions:
45 strategy, philosophy, organization, and leadership. Therefore, companies need to respond quickly to
46 environmental changes in every dimension. Unfortunately, most previous research on TCA has
47 focused on two aspects, industry and enterprise (Chan, 2004; Agnihotri and Rapp, 2011), while few
48 studies involved the contractors' TCA in the project competition.

49 As suggested by D'Aveni et al. (2010), the time has come when enterprises pursue TCA, which
50 will become the core issue in the field of strategic management. Due to the one-off nature of the
51 project, and the ultra-competitive environment of the HSR industry, HSR contractors should
52 improve their TCA by integrating resources, accumulating experience, and adjusting strategies etc.
53 Therefore, this study aims to identify the critical variables contributing to contractors' TCA in the
54 competition of international HSR projects and develop an integrated TCA system that reflects the
55 specialty of HSR contractors from corporation and project dimension.

56 The rest of this research is structured as follows: Section 2 reviews the related literature. A brief
57 introduction of the overall research framework and the results of factor analysis are presented in
58 sections 3 and 4, respectively. Section 5 discusses six components in depth. Section 6 selects several

59 HSR projects to prove the practice value of the factor system. Section 7 provides concluding
60 remarks and directions for future research. This paper helps contractors better understand the
61 advantages and disadvantages they have compared to other competitors, and provides a reference
62 for project clients to select the best contractor. Moreover, due to the unique nature of international
63 HSR projects, this paper also contributes to the theoretical framework for TCA.

64 **2. Literature Review**

65 **2.1 Temporary Competitive Advantage (TCA)**

66 The research on the competitive advantage dates back to the mid-1980s (Porter, 1985). Through
67 several decades of development, this theory has matured. However, many researchers have found
68 that the increasing market competition and the rapid shift in customer demand make it difficult for
69 companies to maintain sustainable competitive advantage (SCA) (Ram et al., 2014), especially for
70 fast-internationalizing technology-intensive companies. Therefore, SCA starts being questioned,
71 with some scholars proposing TCA (O'Shannassy, 2008). Thomas and D'Aveni (2009) found that
72 the temporary part of competitive advantage is rising compared to the long-term component of
73 competitive advantage. McGrath (2013) proposed six strategies to achieve TCA, including
74 removing industry restrictions, adopting new standards and supporting innovation activities,
75 focusing on customer experiences and solutions, etc.

76 Based on the review of related literature, the TCA theory can be divided into three major research
77 categories: action-based TCA, resource-based TCA and performance-based TCA. In terms of
78 action-based TCA, Lavie (2006) proposed that long-term success requires dynamic actions to create,
79 destroy, and recreate short-term advantages continually. Therefore, companies should not only hit

80 the TCA of their competitors but also actively update their own TCA (Chen et al., 2012). The
81 resource-based theory assumed that the competitive advantage of the enterprise comes from
82 valuable, scarce, non-imitation, irreplaceable resources (Lavie, 2006). However, in many high-tech
83 industries, the transfer and diffusion of technical resources is rapid, hence companies are looking
84 for new resources to replace the old ones, which can help them create TCA (Derfus et al., 2008). As
85 for performance-based TCA theory, Thomas and D'Aveni (2009) proposed that the volatility of
86 corporate performance increased over time, indicating that the short-term effects of competitive
87 advantage are becoming more apparent. Overall, the research of the three genres is mainly from the
88 perspective of the enterprise, including business operations (based on resources), processes (based
89 on actions) and results (based on performance). D'Aveni et al. (2010) believed that it is necessary to
90 combine these three genres to conduct more comprehensive and reasonable research. To conclude,
91 despite the theoretical basis of TCA that has been clarified in the previous study, there are few
92 studies on the application of TCA theory.

93 **2.2 Contractors' Temporary Competitive Advantage (TCA)**

94 In the increasingly competitive international construction market, contractors must analyze their
95 competitiveness to determine their competitive advantage (Tan, 2011; Alzahrani and Emsley, 2013).
96 Understanding the sources and drivers of competitive advantage is essential for proposing
97 appropriate strategies. Many studies are exploring or examining the critical success factors (CSFs)
98 of contractors' competitiveness. For instance, Lu et al. (2008) identified 35 CSFs for the
99 competitiveness of contractors and classified them into eight categories by factor analysis, including
100 project management, organization structure, organization resources, competitive strategy,

101 relationship, bidding technique, marketing, and technology. In recent years, some scholars have
102 found more factors that affect competitive advantage, such as knowledge management, R&D
103 (research & developing) capability (Lin, 2003; Kanchanda and Ussahawanitchakit, 2011),
104 international human capital (Wright et al., 2016), home nations and global scope of enterprises
105 (Liang et al., 2012) , local partner (Wu et al., 2011), and knowledge transfer (Ajmal and Koskinen,
106 2010; Oddou et al., 2013) etc.

107 Moreover, considering the heterogeneity of international HSR projects, some research showed
108 how to improve HSR contractors' competitive advantage, e.g., Liu and Liao (2010) explored how
109 service quality, complaint handling, customer satisfaction affect customer loyalty in Taiwan
110 High-Speed Rail (THSR) Corporation. Sun et al., (2011) compared CRH with Shinkansen in terms
111 of operation management and organizational management and proposed that fare adjustment
112 mechanism and environment protection should be put at the critical position to gain its competitive
113 advantage. Zhang et al. (2019) explored the sources of contractors' competitive advantage on
114 international HSR construction projects and found that technical skills were the most component in
115 the factor system. In addition, HSR project cannot only provide profit to the contractor, but also
116 bring considerable financial revenue to the host country, which gives a higher request to the
117 contractor's sense of social responsibility and ability to deal with trust crisis (Utsunomiya and
118 Hodota, 2011; Zhou et al., 2014; Vickerman, 2018). Therefore, winning an HSR project does not
119 only cover technical and economic issues but is also affected by many other factors including but
120 not limited to marketing, social image, etc.

121 However, the existing literature is not comprehensive enough, and reasonable theory is not used

122 to guide the reality, which indicates that new guidelines for HSR contractors need to be explored.
 123 Based on the previous TCA research, this paper combined the three theoretical categories (e.g.
 124 resource-based, action-based and performance-based TCA) to explore the key factors affecting the
 125 HSR contractors' TCA. Table 1 shows 25 variables identified in literature and their sources.

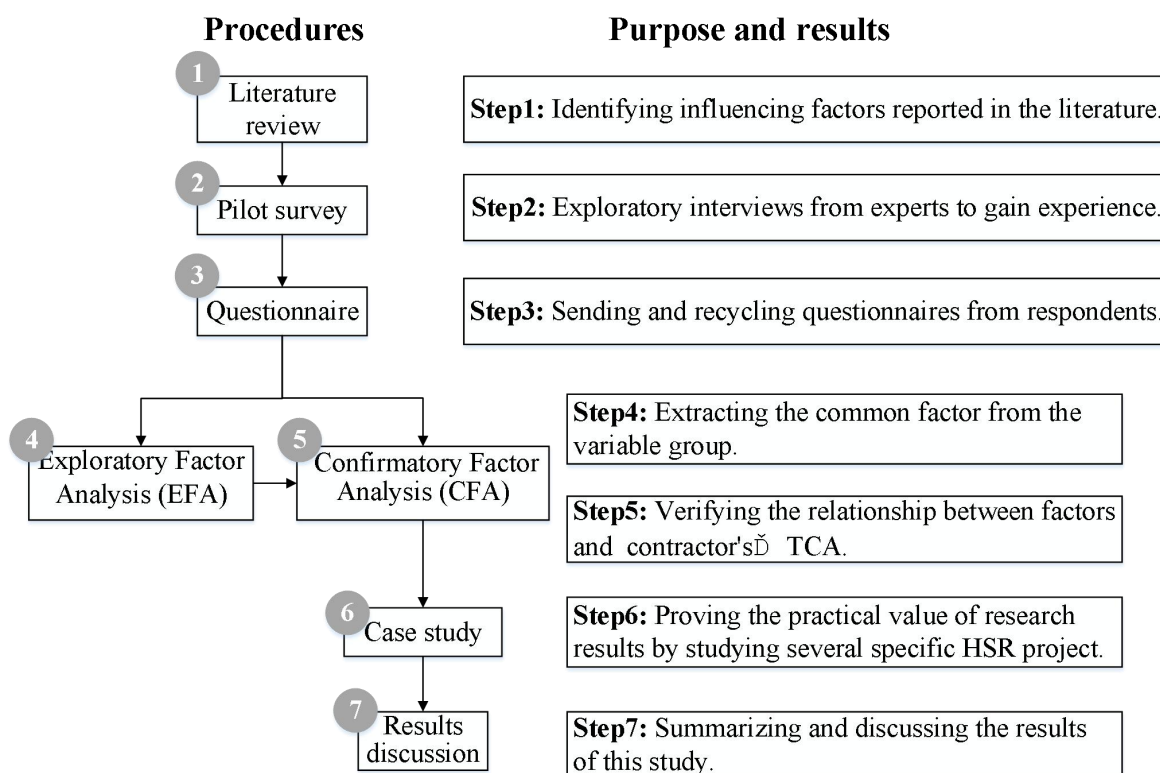
126 Table 1. Variables Identified in Literature

Variable code	Variables	Sources
V01	Tender price	Shen et al. (2006); Scheepbouwer et al. (2017)
V02	Financial performance	Green et al. (2008); Oyewobi et al. (2015)
V03	Financial capability	Lu et al. (2008); Huang et al. (2013)
V04	Historical contract non-performance	Obloj and Obloj (2006);
V05	Social responsibility	Du et al. (2010); Velásquez (2012)
V06	Cultural difference	Chan et al. (2004); Shenkar (2012)
V07	Productivity	Cottrell (2006); Helms (2013)
V08	Internationalization	Liang et al. (2012)
V09	Coordination ability	Wu et al. (2011)
V10	Human resources	Lu et al. (2008); Wright et al. (2016)
V11	Services	Tarawne (2014); Harrigan and Diguardo (2017)
V12	Past performance and experience	Shen et al. (2006); Rendon et al. (2015)
V13	Knowledge transfer	Ajmal and Koskinen (2010)
V14	Competitive Intelligence	Wright et al. (2009), Agnihotri and Rapp (2011)
V15	None accident history	San et al. (2010), San and Yoon (2013)
V16	Technology responsiveness	Kamruzzaman and HiroyukiTakeya (2008)
V17	Technology transfer	Glass and Saggi (2010)
V18	Patents & Innovation	Harrigan and Diguardo (2017)
V19	Eligibility & international criteria	Zhang (2012), Melykh and Melykh (2016)
V20	Resources integration	Engwall and Jerbrant (2003), Ghapanchi et al. (2014)
V21	Organizational flexibility	Kanchanda and Ussahawanitchakit (2011), Santos-Vijande et al. (2012)
V22	Project maturity	Ghapanchi et al. (2014)
V23	Marketing strategy	Chan et al. (2004), Tan et al. (2011)
V24	Risk management capability	Elahi (2013); Mu et al. (2014)
V25	Localization level	Brentani and Kleinschmidt (2015)

127 **3. Research Methodology**

128 **3.1 Overall Research Framework**

129 This study consisted of seven parts: literature review, pilot survey, questionnaire survey,
130 exploratory factor analysis (EFA), confirmatory factor analysis (CFA), case study and results
131 discussion as illustrated in Fig.1.



132 Fig. 1. Conceptual Model of the Study
133

134 **3.2 Data Collection**

135 Prior to comprehensive research, a pilot survey was carried out with ten experts who had more
136 than ten years of HSR project experience to determine whether the pre-defined 25 factors in Table 1
137 could affect contractors' TCA in the international HSR project. Details about ten respondents are
138 given in Appendix I. Through this process, V25 was removed because it was considered with a high
139 relevance with V06 and V07. By studying the comments and suggestions received from the experts,

140 the final list was formed, including 24 reasonable factors to ensure their comprehensiveness and
 141 appropriateness of them to represent the TCA of HSR contractors.

142 Following the pilot study, the questionnaire was designed with two parts. In the first part, the
 143 background information of survey participants was asked, such as work experience, and job
 144 category, etc. The other part included participants' attitudes towards the impact of 24 factors on the
 145 contractors' TCA. A five-point Likert-scale was used to measure their perception of the importance
 146 of each variable, ranging from the numerical score of 1 (not important) to 5 (extremely important).

147 The questionnaire survey was performed during November and December of 2017. A total of 554
 148 questionnaires were distributed through the field and web-based reviews to the professionals with
 149 rich experience and knowledge on this issue. 275 responses were returned, representing a response
 150 rate of 49.64%. After removing invalid questionnaires that were not answered completely, 256 final
 151 usable questionnaires remained, which were suitable and enough for later research. As shown in
 152 Table 2, around 81% of the respondents were project staff with experience in HSR industry, with the
 153 remaining being scholars who worked on research in HSR management. The data also indicates that
 154 the respondents have extensive knowledge and experience in the field, which strengthened the
 155 confidence of the data quality.

156 Table 2. Background Information of Respondents in the Survey

Years of Experiences		≤ 5	6-10	11-15	16-20	>20	Total	Percentage
Academia	Professor	0	0	2	3	3	8	3.13%
	Associate Professor	1	8	5	3	1	18	7.03%
	Assistant professor/lecturer	15	7	0	0	0	22	8.59%
Industry	Senior manager	12	5	8	6	8	39	15.23%
	Department manager	2	16	9	7	9	43	16.80%
	Project manager	5	13	18	6	5	47	18.36%
	Technical supervisor	6	4	5	3	2	20	7.81%

	Engineer	18	10	4	2	8	42	16.41%
	Others	8	3	1	3	2	17	6.64%
Total	256	67	66	52	33	38	256	100%
Percentage	100%	26.17%	25.78%	20.31%	12.89%	14.84%	-	-

157 **3.3 Factor Analysis**

158 In this paper, EFA is usually performed to reveal potential factor mechanism and to construct
159 theoretical system, especially to extract the common factor from the variable group as well as to
160 explain the complex interactions of different variables. But it has been criticized for its data-driven
161 and subjective nature. Therefore, to ensure the accuracy of the model, CFA is often performed to
162 test the hypothetical factor system. In this paper, EFA is used to analyze data from practitioners who
163 had more than five years of experience to explore the potential factor system, based on the
164 assumption that more experienced practitioners are more likely to provide more effective
165 information. Afterwards, CFA was performed to test the factor mechanism revealed by EFA. In this
166 way, EFA provides a theoretical basis for CFA, and CFA validates and corrects the results of EFA,
167 which helps to build an unbiased framework model (Chen et al., 2012).

168 **4. Empirical Results**

169 **4.1 Exploratory Factor Analysis (EFA)**

170 EFA was performed by SPSS23.0 using the questionnaire data from 189 respondents with over
171 five years of experience. According to Maccallum et al. (2001), when determining whether a data
172 set can be done with EFA, two main conditions must be met, namely the sample size and the degree
173 of correlation of the variables. Specifically, the sample size selected in EFA should be at least five
174 times the number of variables, to ensure the accuracy of the research (Floyd and Widaman, 1995).
175 This paper selected 196 samples and 24 variables, with a ratio of over 8:1 meeting the requirement.

176 Secondly, the results of the Kaiser-Meyer-Olkin (KMO) and Bartlett's test must ensure that the
177 initial variables are strongly correlated (Deng et al., 2014b). In this research, the
178 Kaiser-Meyer-Olkin index was 0.866 higher than the minimum value at 0.8, indicating that the
179 correlation between variables was satisfactory. The Bartlett's test ($\chi^2=2662.81$, $df=276$, sig. = 0.00)
180 suggested that the data were suitable for EFA. Besides, the communality values over 0.50, the
181 corrected item-total correlations higher than 0.30, and the Cronbach alpha values for the final six
182 factors over 0.70 indicated that each extracted element was internally consistent and reliable.

183 As revealed in Table 3, six factors could be extracted by merging variables with relatively higher
184 factor loads, which accounted for 71.53% (>60%) of the total variance. According to Joliffe and
185 Morgan (1992), a variable with a factor load below 0.45 should be considered as a weak index
186 element and should be removed from the whole indicator system. In this study, all the factor loads
187 ranged from 0.664 to 0.905, suggesting the reliability of all variables in this indicator system. Then,
188 six common factors were renamed according to their common characteristics of the variables with
189 relatively higher loads. They were experience-mining advantage (F1), funding strategy (F2),
190 organizational management (F3), technical resource(F4), risk-controlling performance(F5), and
191 social image (F6).

192

193 Table 3. Factor Load Matrix after Rotation and the Extracted Common Factors

Variables	Mean Value	Rank	Communalities	Item-Total Correlation	Factor load matrix *					
					1	2	3	4	5	6
Coordination ability	3.58	14	0.700	0.564	0.888					
Past performance and experience	3.59	13	0.794	0.655	0.840					
Knowledge transfer	3.56	17	0.725	0.558	0.830					
Human resources	3.60	12	0.840	0.636	0.813					
Services	3.80	4	0.631	0.448	0.777					
Competitive Intelligence	3.63	11	0.638	0.583	0.723					
Internationalization	3.36	24	0.515	0.481	0.664					
Tender price	3.81	3	0.796	0.530		0.861				
Financial capability	3.69	7	0.734	0.481		0.821				
Productivity	3.64	10	0.708	0.530		0.787				
Financial performance	3.88	1	0.721	0.563		0.782				
Resources integration	3.55	19	0.722	0.477			0.813			
Organizational flexibility	3.47	20	0.717	0.521			0.754			
Marketing strategy	3.57	16	0.577	0.396			0.732			
Project maturity	3.58	14	0.575	0.390			0.730			
Eligibility & international criteria	3.65	9	0.516	0.332			0.669			
Patents & Innovation	3.74	6	0.878	0.483				0.905		
Technical responsiveness	3.75	5	0.852	0.490				0.875		
Technology transfer	3.84	2	0.838	0.537				0.846		
Risk management capability	3.46	21	0.625	0.329					0.773	
Historical contract non-performance	3.56	17	0.674	0.410					0.771	
None accident history	3.67	8	0.670	0.450					0.754	
Social responsibility	3.44	22	0.863	0.411						0.888
Cultural difference	3.41	23	0.861	0.414						0.882
Cronbach alpha					0.916	0.876	0.825	0.916	0.734	0.849
Eigenvalues					7.288	2.954	2.401	1.704	1.503	1.318
Variance (%)					19.636	12.740	12.563	10.749	8.548	7.297
Cumulative variance (%)					19.636	32.376	44.939	55.688	64.237	71.533
Kaiser-Meyer-Olkin measure of sampling adequacy					0.866					
Bartlett's test of sphericity		Approximate χ^2			2662.81					
		<i>df</i>			276					
		Significant			0.000					

195 4.2 Confirmatory Factor Analysis (CFA)

196 This research initially established an indicator system that affects contractors' TCA in
197 international HSR projects, including 6 grade I indexes and 24 grade II indexes. Since the grade I
198 index is a general indicator and cannot be measured directly, it is called a latent variable. Grade II
199 index can be measured directly and is named the observable variable.

200 Above all, the first-order CFA was performed adopting Amos 23.0. The results show that a load
201 of each factor exceeds the critical value of 0.5 and is significant at the 5 % level, indicating that the
202 model has good convergent validity. Then a second-order CFA model was built and estimated
203 parameters by maximum likelihood (ML). The ML method was used because it provided an
204 unbiased, effective, and consistent estimate when the sample size is large. Thompson et al. (2000)
205 proposed that the minimum sample size should be ten times the number of the observed variables,
206 while Tabachnick and Fidell (2001) believed that the sample size should be empirically analyzed in
207 the range of 200-400. In this research, 256 questionnaires were used to examine 24 variables (Table
208 4), meaning that the sample size met the requirements.

209 Following the collected data, six common factors were linked to contractors' TCA in HSR
210 projects. Fig. 2 demonstrates the second-order CFA model integrating the measurement model and
211 the structural model. Also, to evaluate the fitness of the overall model, all parameters in the
212 proposed model must be successfully estimated. Alzahrani and Emsley (2013) suggested that the
213 integrated model could be evaluated by a series of statistical fitness indices. Specifically, the model
214 should meet the standards for absolute fit, incremental fit, and parsimonious fit. After validation, the
215 goodness of fit of the initial model is shown in Table 4. All indices complied with the recommended
216 standards, indicating that the second-order CFA model can be deemed suitable.

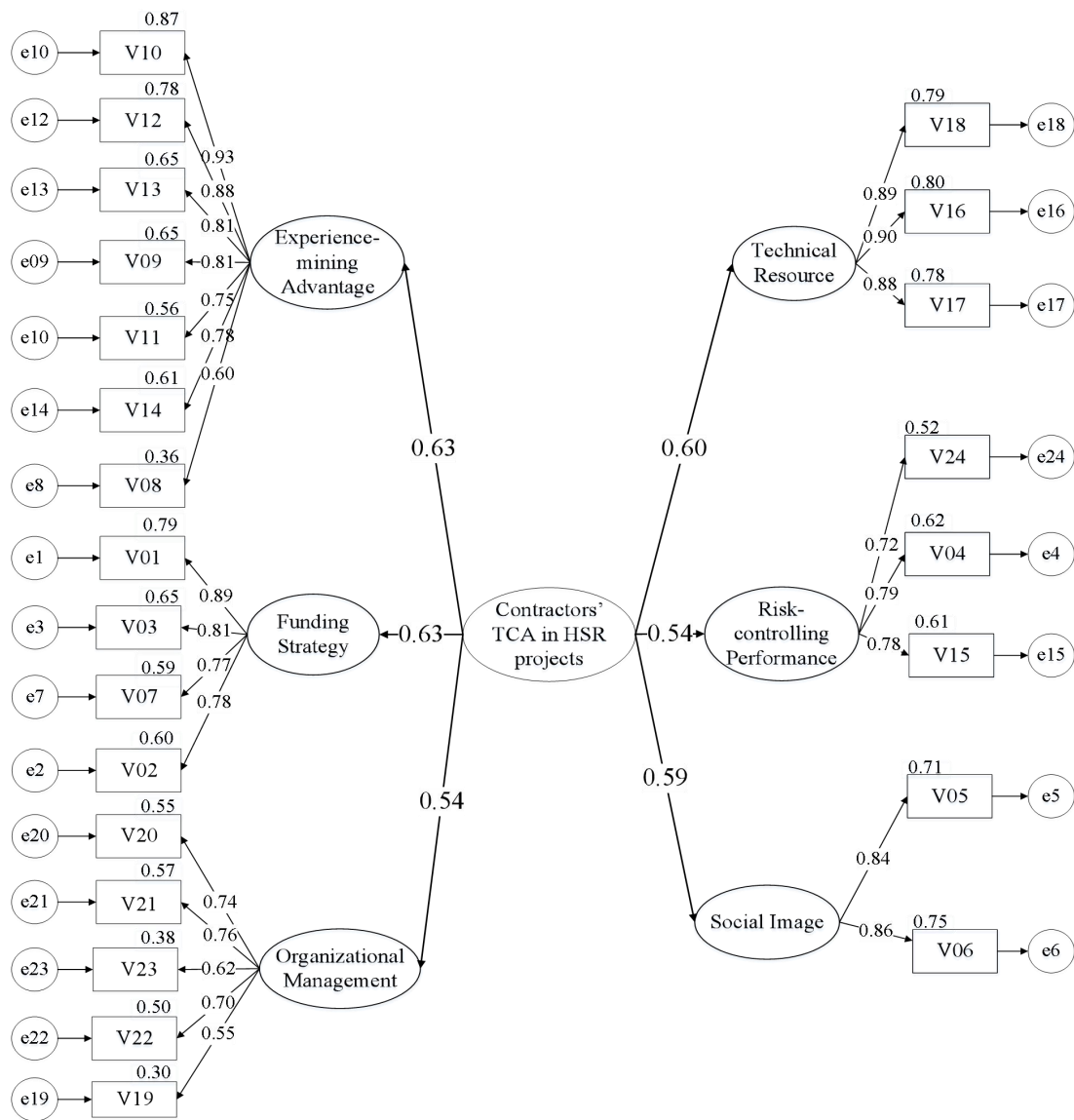


Fig. 2. Second-order CFA Model

217

218

219 The analysis of path coefficients estimates the effects of variables in a causal system based on a
 220 structural equation. In the current model, all latent variables were related to the TCA of contractors
 221 in HSR projects, but their path coefficients differed. Table 5 lists the path coefficients of the six
 222 latent variables in the optimized structural equation model in descending order. The final
 223 second-order CFA model revealed that three latent variables, i.e., experience-mining advantage,
 224 funding strategy, and technical resource had the highest weights, with relative importance at 18.18%,

225 17.90%, and 17.05%, respectively.

226 Table 4. The Goodness of Fit of the Second-order CFA Model

Type	Index	Fit standard of fitness	Value	Result
Absolute fit	χ^2 test	> 0.05, good fit	0.051	√
	CMIN/DF	< 2, good fit	1.152	√
	RMR	< 0.05, good fit	0.044	√
	RMSEA	< 0.08, not bad fit; <0.05, good fit	0.024	√
	GFI	> 0.90, good fit	0.918	√
Incremental fit	NFI	> 0.90, good fit	0.923	√
	RFI	> 0.90, good fit	0.914	√
	IFI	> 0.90, good fit	0.989	√
	TLI	> 0.90, good fit	0.988	√
	CFI	> 0.90, good fit	0.989	√
Parsimonious fit	PGFI	> 0.50, good fit	0.753	√
	PNFI	> 0.50, good fit	0.823	√
	PCFI	> 0.50, good fit	0.882	√

227 Table 5. Results of Direct Path Coefficient and Weights of Relative Importance

Relationship	Direct path coefficient	p-Value	Statistical results	Weights of relative importance (%)
F1: Experience-mining Advantage→TCA	0.636	<0.001	Accepted	18.18%
F2: Funding Strategy→TCA	0.631	<0.001	Accepted	17.90%
F4: Technical Resource→TCA	0.600	<0.001	Accepted	14.77%
F6: Social Image→TCA	0.590	<0.001	Accepted	17.05%
F5: Risk-controlling Performance→TCA	0.543	<0.001	Accepted	15.34%
F3: Organizational Management→TCA	0.521	<0.001	Accepted	16.76%

228 Note: When a result is statistically significant (p-value < 0.05), the model is well fitted, and the path coefficient have a reference
229 value.

230 5. Discussion

231 5.1 Six Components

232 5.1.1 Experience-mining Advantage

233 The first component is named as experience-mining advantage, which was the most significant
234 factor of contractors' TCA. Experience mining means that the company collects instances of past

235 experiences as well as useful knowledge from consortium members, and stores them in the
236 experience database for use, making themselves more competitive in the HSR market (Linden et al.,
237 2009; Shen et al., 2013). It was described by seven sub-criteria, among which the more important
238 factors included: coordination ability (weight of relative importance at 16.76%), past performance
239 and experience (15.86%), and knowledge transfer (14.57%). Since HSR project is a complex,
240 large-scale system involving many industries, contractors with rich experience would be more
241 likely to identify potential management or technical problems by experience mining, which would
242 become a significant advantage in the competition.

243 This component is often reflected in several levels: (1) coordination experience mining with
244 consortium members. The joint venture is usually initiated by the core enterprise, enhancing TCA
245 through resource sharing and risk sharing (Kamminga and Meer-Kooistra, 2007). When the
246 consortium establishes a specialized supply chain in cooperation, members can combine valuable
247 resource that difficult to imitate together to help the alliance deal with the uncertain environment
248 and reposition itself in the dynamic market (Wu et al. 2011); (2) the construction experience mining
249 of similar projects. Experienced contractors tend to have more experienced employees and relevant
250 experts who will help enhance organizational management capabilities and ensure adequate and
251 sustainable cash flow (Shen et al., 2006). The contractors can also learn from failure so that this
252 doesn't happen again, thus helping to achieve success later (Doloi et al., 2011); (3) integration
253 experience mining of various resources. As the market shifts faster and the product life cycle
254 becomes shorter, how can the bidders use external resources to coordinate the members to achieve a
255 common goal has become the key (Lu et al. 2008). In short, the experience-mining advantage is a

256 comprehensive evaluation of the contractor's ability to utilize past project experience, including
257 previous operating conditions and coordination capabilities, which can be directly used to measure
258 the subsistence and development of contractors.

259 **5.1.2 Funding Strategy**

260 Funding strategy showed a path coefficient of 0.631, with a proportion of 17.90%. The three most
261 significant factors included tender price (27.38%), financial capability (24.92%), and financial
262 performance (24.00%). Funding strategy refers to the most proper project quotation and financing
263 means adopted by the contractor for opening up market, based on the accurate calculation of costs
264 and full estimation of competitors' quotation strategies (Shen et al., 2006; Huang et al., 2013). The
265 tender price provided by the contractors is an important source of TCA, which mainly comes from
266 two aspects, cost leadership and reasonable/reasonable pricing. The contractor's TCA can be
267 established to obtain greater benefits at the same cost or to obtain the same benefits at a lower cost.
268 Besides, compared to usual international projects, the proportion of financing in HSR is much
269 higher because of greater capital investment, longer investment recovery cycle, and more significant
270 scale economies effect (Utsunomiya and Hodota, 2011). Therefore, clients are more inclined to
271 choose the contractor with stronger financing capability. For example, Thailand's "Rice for HSR"
272 program with China demonstrated the diversity and flexibility of financing methods in HSR
273 projects. Financial performance is also one of the important indicators for evaluating bidders, which
274 indirectly reflects its project management capability to ensure the economic sustainability of the
275 project during its construction.

276 **5.1.3 Technical Resource**

277 Technical resource also exerted an important influence on the contractors' TCA of international
278 HSR projects (17.05%), including technical responsiveness (33.71%), patents & innovation
279 (33.33%), and technology transfer (32.96%). Most HSR tender documents contain technical
280 response documents, with the degree of response and deviation descriptions for each engineering
281 component. Generally, the higher the technical responsiveness of a contractor would lead to a
282 greater chance of winning the project. Therefore, contractors should identify and understand the
283 customer's needs and develop a "personalized but cost-effective response plan". In addition, R&D
284 (i.e., research & development) innovation and technology transfer are also important drivers for
285 technical advantage. Innovation includes original innovation, integration innovation and
286 "re-innovation" after improvement, and the value of re-innovation is becoming increasingly
287 significant (Weerawardena and Mavondo, 2011). In brief, contractors should flexibly re-adjust
288 technology according to market variations, and create greater value for customers based on
289 maintaining the original technology leadership (Lin, 2003). Only in this way can contractors
290 convert their accumulated technique advantage into TCA, and further increase the chance of
291 winning the project.

292 **5.1.4 Social Image**

293 Social image was responsible for 16.76% of the total variances. It consists of the variables,
294 namely social responsibility (49.41%) and cultural difference (50.59%). Social image dynamically
295 shows the relationship between contractors and other stakeholders in the social environment with
296 different economic backgrounds and cultural traditions (Shen et al., 2006; Du et al., 2011). On the

297 one hand, if contractors have to maintain a positive social reputation to maintain their competitive
298 advantage in the HSR market (Du et al., 2010). On the other hand, the smaller cultural differences
299 between the country where the project is located and its host country, the more likely that the
300 contractor could win the project. For example, Spanish has brought the similar culture to Latin
301 America because of the long colonial history in the eighteenth century, so the Spanish National
302 Railways took an active part in the competition for HSR project in Brazil and Mexico. Hence, the
303 good social image that the contractors have accumulated and the similarity of the culture to the host
304 country will become their TCA.

305 **5.1.5 Risk-controlling Performance**

306 Risk-controlling performance accounted for 15.34% of the total weight, including historical
307 control non-performance (34.50%), none accident history (34.06%), and risk management
308 capability (31.44%). Risk-controlling performance refers to the contractor's capability to identify
309 unexpected events that may cause losses to the project and to select the most appropriate measures
310 to handle risky events (Mu et al., 2014). Firstly, the higher the completion of the previous project
311 contract by the joint venture members, the lower the breach rate, the easier it would be for the
312 contractor to win the project. As the process for a contractor to accumulate contract reputation is
313 long, the contractor must have the ability to minimize risk in the long run (Elahi, 2013). In addition,
314 many international HSR project clients have strict requirements on the safety performance of
315 bidders, so none accident history is another important factor that cannot be ignored (San and Yoon,
316 2013). For example, the bidding documents for the Brazilian HSR project indicated that HSR
317 operators who had experienced major casualties in the past five years were not allowed to

318 participate in the bidding, which made CRH and several European contractors who had major safety
319 accident unable to participate in the bid.

320 **5.1.6 Organizational Management**

321 Organizational management accounted for the smallest proportion of the whole variances
322 (14.77%). The three most significant factors are organization flexibility (22.62%), resources
323 integration (21.73%), project maturity (21.13%). In terms of HSR enterprise, effective
324 organizational management policies help them provide products and services that satisfy customers,
325 thereby gaining more value and winning sustainable competitive advantage in the market (Wen and
326 Qiang, 2016). Besides, since the HSR project is in an uncertain and dynamic competitive
327 surrounding context, flexible project organization can help them adapt to the environment quickly
328 and minimize the effect of external uncertainty to maintain the dynamic matching between the
329 organization and the environment (Vogel and Güttel, 2013). Temporary management advantage is
330 also reflected in the contractor's planning and implementation capabilities for project quality,
331 schedule, and cost objectives.

332 **5.2 In-depth Discussion of Components**

333 Primarily, the six components may be broadly sorted into two dimensions, as shown in Fig. 3.
334 TCA in the corporation dimension is developed from the perspective of construction enterprises,
335 which is heterogeneous and irreplaceable in different companies. To concluded, the formation of
336 TCA from the corporation dimension is mainly attributed to the technical resource (the operation
337 basis of enterprises), organizational management (the operation process of enterprises), and
338 experience-mining advantage (the operation performance of enterprises), which are accumulated

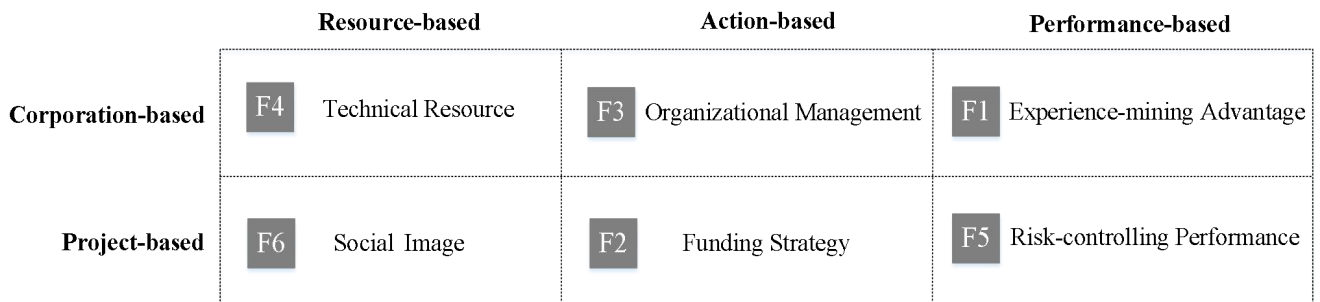
339 from corporate operations and project practices for decades. TCA in the project dimension is
340 determined by market behaviors taken by contractors according to different market structures and
341 environment in the particular project. To win the HSR project, contractors must utilize local
342 resources and adopt suitable competitive strategies, including their social image (the competition
343 basis of projects), funding strategy (the competition strategy of projects), and risk-controlling
344 performance (the operation performance of projects). Coincidentally, TCA in the corporation and
345 project dimensions both accounted for 50% of the overall factors as shown in Table 6. However,
346 scholars' research on competitive advantage often focused on only one aspect, with some
347 concentrating on the inherent advantages of enterprises (Melykh and Melykh, 2016), while others
348 are focusing on external markets (Liang, 2012). The two aspects are mutually reinforcing and
349 equally crucial for international HSR contractors.

350 These six components could be further divided into three categories, namely action-based TCA,
351 resource-based TCA, and performance-based TCA, as shown in Fig. 3. As displayed in Table 6,
352 resource-based TCA plays a slightly more significant role compared to another two categories,
353 which included technical resources from corporation and social image from project. Technical
354 strength is the core layer of the HSR industry, playing a decisive role in the competitive market.
355 However, technical resources are easily imitated or replaced because the diffusion of technique
356 throughout the whole HSR industry is very rapid (Lin, 2003). Therefore, if contractors want to
357 maintain a leading technical position, they must continue to carry out technological innovation
358 (Weerawardena and Mavondo, 2011). In terms of social image, another important part of the
359 contractor's resource advantage, it helps build a social network that exists outside the contractors

360 and is conducive to the acquisition of external resources. This social effect is more obvious in Asia,
 361 because partners in Asian countries tend to connect with each other through social and ethnic
 362 networks (Utsunomiya and Hodota, 2011).

363 Table 6. Weight of Each Component in the TCA Theory

Contractors' TCA	Weight	Corporation dimension	Project dimension	Action-based TCA	Resource-based TCA	Performance-based TCA
F1: Experience-mining Advantage	0.1818	√				√
F2: Funding Strategy	0.1790		√	√		
F4: Technical Resource	0.1705	√			√	
F6: Social Image	0.1676		√		√	
F5: Risk-controlling Performance	0.1534		√			√
F3: Organizational Management	0.1477	√		√		
Total Weight	1.0000	0.5000	0.5000	0.3267	0.3381	0.3352



364
 365 Fig. 3. Two Classifications of Six Components

366 Performance-based TCA accounted for 33.52% of the whole factors, including
 367 experience-mining advantage and risk-controlling performance. Experience-mining advantage is
 368 based on the past performance of contractors, which contains coordination experience with
 369 consortium members, construction experience of similar projects, and integration experience using
 370 various resources. HSR project clients tend to choose experienced contractors who have better
 371 operational performance and the ability to work with consortium members. Also, clients are more
 372 inclined to choose bidders that can handle risks better than competitors, or that can enter the market
 373 with both high risks and high return while other rivals hesitate to enter.

374 The action-based dimension, which accounted for the smallest proportion of contractors' TCA
375 (weight: 32.67%), included organizational management and funding strategy. In hypercompetitive
376 dynamic HSR markets, contractors should maintain persistent information flow to predict rivals'
377 behavior, manage their organizations rationally, and adopt appropriate competitive strategies (Chan
378 et al., 2004). Organizational management refers to the actions for enterprises to integrate internal
379 and external resources to maximize the interests (Kanchanda and Ussahawanitchakit, 2011).
380 Nowadays, some excellent enterprises often cultivate their dynamic capabilities by innovating
381 organization forms and improving management functions to gain new competitive advantages.
382 Funding strategy is another important indicator for judging contractors' TCA in this dimension. If
383 HSR contractor can provide a lower offer according to the specific circumstance of the project, with
384 a lower interest rate and higher amount of loans without guarantees, they will be more likely to win
385 the bid. Conversely, if the competitor is unable to meet the financing requirements, it may not even
386 be eligible for competition.

387 **6. Case Study**

388 **6.1 Case Background**

389 In recent years, China High-speed Railway (CRH) , Canadian Bombardier (LRC), German
390 Siemens (ICE), and French Alstom (TGV) are the major four HSR systems in the global market,
391 which accounts for almost half of the total market share. Shinkansen (Japan) has a slightly lower
392 share than the four systems but in a very important position in the Asian HSR market. China and
393 Japan have become the main competitors in the Asian HSR market and had a fierce confrontation

394 on many typical international HSR projects (Utsunomiya and Hodota, 2011). Therefore, this study
395 uses competitions between CRH (China) and Shinkansen (Japan) in two HSR projects as examples.

396 In order to assess their TCA in the corporation dimension, each of the 15 variables was given a
397 detailed evaluation criterion. Then questionnaires related to variables were designed and distributed
398 to 10 respondents who had over 10 years of working experience in HSR companies, and relevant
399 details about ten respondents are given in Appendix I. Each variable was set on a scale of 1 to 5,
400 with 5 being the best TCA. For example, the variable “services” was defined as “the whole project
401 proposal, including design, manufacturing, construction, after-sale, and staff-training.” If the
402 contractor provides fairly good after-sales supporting services, the value of this variable maybe 5.
403 On the contrary, the variable may take the value 1.

404 Table 7 shows the factor scores of CRH and Shinkansen in the corporation dimension. From the
405 perspective of technical resources, CRH (4.565) takes the leading position compared with
406 Shinkansen (4.183). This is due to the core technologies of CRH such as engineering construction
407 and system joint debugging, as well as “introduction, absorption, then innovation” HSR strategy
408 taken by China. As for experience-mining advantage and organizational management, Shinkansen is
409 better than CRH, which is owing to its long operating history and rich experience. Overall,
410 Shinkansen (2.212) had a slightly higher score than CRH (2.132) in the corporation dimension.
411 Japan has the first HSR in the world, with traditional advantages in operating history, project
412 management, post-maintenance, and technology upgrading, which makes Shinkansen enjoy a high
413 reputation in the world.

414

415

Table 7. Factor Scores of CRH and Shinkansen in the Corporation Dimension

Contractors' TCA in the corporation dimension	CRH (China)	Shinkansen (Japan)	Weight
Technical Resource	4.565	4.183	0.1705
Organizational Management	4.112	4.376	0.1477
Experience-mining Advantage	4.107	4.688	0.1818
Total Score	2.132	2.212	-

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6.2 Data Analysis and Results

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In this part, two representative projects (e.g. Jakarta-Bandung high-speed railway in Malaysia and Mumbai-Ahmedabad high-speed railway in India) were selected to show the competitions between CRH (China) and Shinkansen (Japan). These two high-speed railways both had attracted international contractors to compete fiercely. However, the final winners of these two projects were different. Jakarta-Bandung high-speed railway has been contacted to Chinese contractors, while the Mumbai-Ahmedabad high-speed railway was contracted and constructed by Japanese contractors. Table 8 and Fig. 4 illustrates the factor scores of CRH and Shinkansen in the project dimension by different forms.

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Concerning Jakarta-Bandung high-speed railway, CRH is better than Shinkansen in two aspects: funding strategy and risk-controlling performance, but a litter lower in social image. After adding the total score of two dimensions together, CRH earns a score of 4.287, higher than Shinkansen's 4.116. And the success of CRH largely attributed to excellent funding strategy and risk management capability. China provided a loan condition that was more in line with Indonesia's national conditions without government funding and any guarantee from the government, which became their key success factor.

432

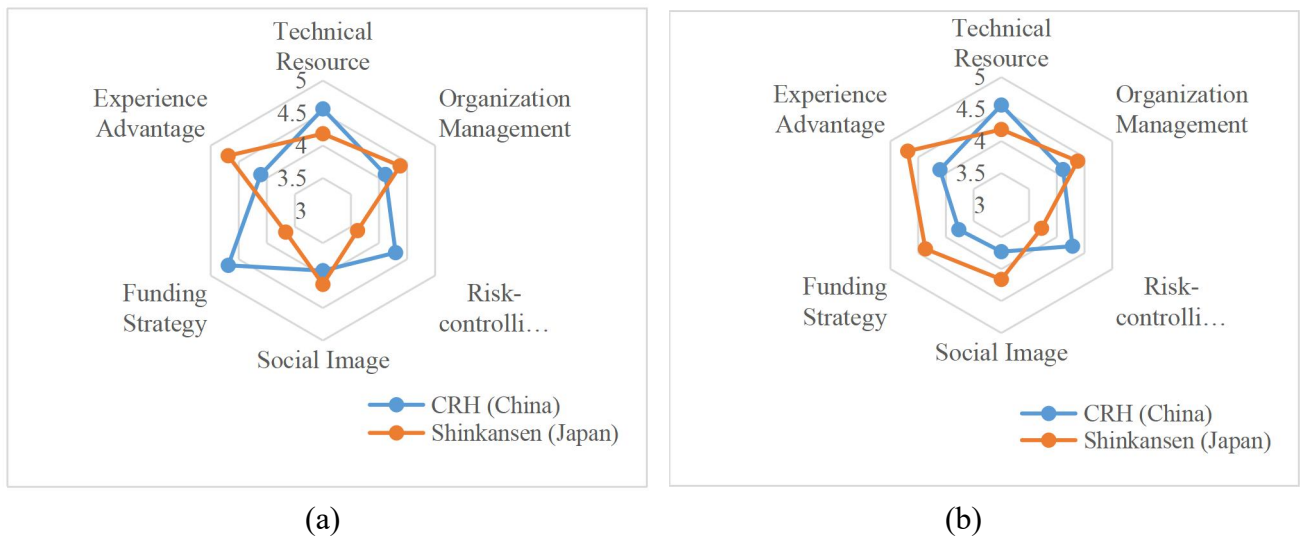
433

As for Mumbai-Ahmedabad high-speed railway, Shinkansen is better than CRH in funding strategy and social image, but slightly lower in risk-controlling performance. After summing up the

434 factor scores of two dimensions, 4.088 earned by CRH is lower than 4.263 from Shinkansen,
 435 suggesting the leading position of Shinkansen in the project. It is worth mentioning that Shinkansen
 436 had taken proper funding strategy in the competition, a total loan of approximately 190 billion yen
 437 was provided, the annual interest rate was reduced to 0.1% and the repayment period was extended
 438 to 50 years. Also, a good social image of Shinkansen in India had also helped them become the
 439 successful bidder.

440 Table 8. Factor Scores of CRH and Shinkansen in the Project Dimension

Contractors' TCA in the project dimension	Jakarta-Bandung high-speed railway (Malaysia)			Mumbai-Ahmedabad high-speed railway (India)		
	CRH (China)	Shinkansen (Japan)	Weight	CRH (China)	Shinkansen (Japan)	Weight
Funding Strategy	4.686	3.663	0.1790	3.767	4.369	0.1790
Social Image	3.925	4.136	0.1676	3.728	4.162	0.1676
Risk-controlling Performance	4.295	3.617	0.1534	4.284	3.725	0.1534
Total Score	2.155	1.904		1.956	2.051	



441
 442 (a) (b)
 443 Fig. 4. Factor Scores of CRH and Shinkansen: (a) Jakarta-Bandung high-speed railway, (b)
 444 Mumbai-Ahmedabad high-speed railway

445 7. Conclusions

446 TCA is being more and more emphasized by industry and academia, which promotes the

447 development and application of relevant theoretical research. Prior studies mainly focus on
448 industry-level and firm-level TCA, contractors' TCA in the project dimension has been overlooked.
449 If international HSR contractors want to stand out in a complex and ever-changing competitive
450 environment, it is not enough to maintain competitive advantage only through experience
451 accumulation and daily operation management. They should also adopt appropriate competition
452 strategies based on fully coordinating resources to form their TCA according to market conditions
453 in the host country and characteristics of other competitors. This paper created the final factors
454 framework by previous literature and pilot survey, and explained how factors affect contractors'
455 TCA in terms of resource, action, and performance, which contributes to the theoretical framework
456 for TCA theory.

457 In this study, a systematic integrated method was built by combining EFA and CFA to evaluate
458 contractors' TCA in the competition of international HSR projects. The results show that: (1) six
459 common factors identified by EFA are experience-mining advantage, funding strategy,
460 organizational management, technical resource, risk-controlling performance, and social image. (2)
461 experience-mining advantage outweighed funding strategy or technical resource as the most
462 important component according to CFA. Then six components were discussed in the perspectives of
463 corporation and project dimensions, action-based, resource-based, and performance-based
464 dimensions. The results revealed that resource-based TCA accounted for the largest proportion,
465 followed by performance-based TCA, and action-based TCA. Finally, the competitions between
466 CRH (China) and Shinkansen (Japan) in two international HSR projects were used as the examples
467 to verify the practicality of the study, which illustrated suitability of the evaluation system of

468 contractors' TCA for future application.

469 Despite the achievement of the objectives, there are still several limitations to this paper. Since
470 only a small number of experts and cases were utilized in the validation of the suggested model, it
471 may not be applied completely to actual decisions. The interrelationships between factors and their
472 influence mechanism on TCA are not analyzed in depth. Given this, further work will be conducted
473 to be more in-depth and practical on this issue. At first, the cause and effect relationships among the
474 underlying factors should be clarified in the future, which will be conducive for HSR contractors to
475 integrate optimal resources based on joint venture experience and take the most effective actions to
476 improve their TCA. Meanwhile, a more comprehensive approach should be developed to explore
477 the best cooperation mode of all members in the consortium, which will help contractors occupy a
478 rather favorable competitive position in the bidding. Another direction for future research is to
479 develop big data methods (e.g., web crawling and text mining) to help HSR contractors dynamically
480 assess their TCA and make real-time strategic decisions in the competition.

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484 assisted the research by completing the interviews or questionnaires about contractors' TCA in the
485 competition of international HSR projects.

486

487 **Appendix I. Features of ten respondents**

Respondents	Company type	Positions	Relevant work experience
Respondent #1	State railway administration	Section chief	21 years
Respondent #2	State railway administration	Section chief	18 years
Respondent #3	Train manufacturing company	Vice president	22 years
Respondent #4	Design and research institute	Deputy director	17 years
Respondent #5	Engineering consultancy services company	Senior engineer	15 years
Respondent #6	Management consulting company	Chartered financial analyst	12 years
Respondent #7	International project contracting company	Senior engineer	25 years
Respondent #8	General contractor	Project manager	15 years
Respondent #9	Civil construction contractor	Project manager	18 years
Respondent #10	HSR operator	Project coordinator	12 years

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