

Joint-contract function effects on BIM-enabled EPC project performance

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1 **Joint-contract function effects on BIM-enabled EPC project performance**

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16
17 **Abstract:** Engineering, procurement, and construction (EPC) contracting does not promote
18 collaboration and thus, may not be suitable for building information modeling (BIM) projects.
19 Joint-contract functions that combine contractual control, coordination, and contingency
20 adaptability may positively influence the performance of these BIM-enabled projects. This
21 study hypothesized that perceived fairness, calculative trust, relational trust, and positive
22 outcomes of distrust influence the relationship between joint contract functions and BIM-
23 enabled project performance. It collected 252 observations from industry practitioners in EPC
24 oil and gas projects and analyzed them using partial least squares structural equation modelling
25 (PLS-SEM). The results show no direct effect of joint-contract functions on BIM-enabled EPC

26 project performance but do show significant total and indirect relationship effects that are
27 influenced by perceived fairness and relational trust. The findings contribute to construction
28 contracting research by empirically showing how formal contracts focusing on joint-contract
29 functions can influence BIM-enabled EPC project performance. The current findings also shed
30 light on appropriate contract framing for BIM-enabled EPC project stakeholders, an area not
31 explored in the previous literature.

32 **Keywords:** Contract Functions, Control; Coordination; Contingency Adaptability; Trust;
33 Distrust; Building Information Modelling (BIM); Engineering, Procurement, and Construction
34 (EPC)

35

36 **Introduction**

37 The use of building information modeling (BIM) has become prevalent in various industries.
38 It is not only a digital representation used to plan, design, control, and maintain facilities, it
39 also affects the conventional ways that project participants define their roles and collaborate
40 (Liu et al. 2017). Several studies argue that conventional contracting—including the
41 engineering, procurement, and construction (EPC) approach—is not suitable for projects that
42 implement BIM (e.g., Lee et al. 2018). The goals of EPC-contracting parties can conflict in the
43 following sense. First, an owner aims to complete a project within a certain timeframe and
44 budget and according to desired specifications, whereas a contractor aims to make the highest
45 possible profit from the project (Berends 2007). The conflicting positions between the owner
46 and the EPC contractor can give rise to opportunism, in which both parties do anything to
47 realize higher gains, regardless of the expense to the other (Lu et al. 2016). In addition, the
48 nature of EPC projects, which typically involve high asset specificity and uncertainties, further
49 increases the possibility of opportunistic behaviors by the contracting parties (Lee et al. 2018).
50 As such, EPC contracts grounded in transaction law (Williston and Lewis 1920) and in a

51 transaction cost economics approach usually impose more thorough contractual obligations.
52 On the one hand, more thorough contracts enable parties to minimize uncertainty and thus
53 restrain potential opportunistic behaviors (Williamson 1985). On the other hand, the contracts
54 can have detrimental effects on cooperation in a BIM work environment (Goshal and Moran
55 1996; Wuyts and Geyskens 2005). The possibility of detrimental effects prompts the
56 overarching question of what complementary approaches can best facilitate BIM
57 implementation in EPC contracts.

58 Prior research has demonstrated that formal contracts can restrain relational norms and may
59 result in distrust between the parties (Malhotra and Murnighan 2002). However, formal
60 contracts also have the potential to facilitate the development of close, cooperative
61 relationships by better aligning the expectations of parties (Mayer 2007). Schepker et al. (2014)
62 provided some important insights, including the observation that firms should focus on the
63 functional approach in contracting to succeed in their transactions. There are three main
64 contract functions in an exchange: control, coordination, and contingency adaptability
65 (Eckhard and Mellewigt 2006). To protect the contracting parties, the control function defines
66 tolerable behaviors and applicable sanctions in BIM implementation (Benaroch et al. 2016). It
67 is also used to reduce transaction and administration costs (Teng et al. 2019). Contractual
68 coordination aligns the expectations of contracting parties by harmonizing the resources and
69 activities required for delivering BIM (Eckhard and Mellewigt 2006). In the context of this
70 study, contingency adaptability (or “adaptation”) refers to the provisions or guidelines for
71 handling unanticipated situations that arise from using BIM (Luo 2002). Formal contracts often
72 describe a mutually agreed tolerance zone for handling unexpected circumstances and conflicts
73 arising from using BIM. These can include solutions for delays that result from ineffective
74 collaboration among team members (Li et al. 2019), data error, or data loss. These solutions
75 and guidelines are included in engineering and construction contracts as independent terms

76 (e.g., procedures for handling delays due to BIM imperfections) or as clauses related to specific
77 areas (e.g., dispute resolutions, damages stemming from the use of BIM, etc.).

78 In this paper, it is argued that BIM in EPC projects can be implemented more effectively
79 through the lens of joint-contract functions. This approach enables firms to pay closer attention
80 to all three functions of formal contracts to improve exchange efficiency. In related previous
81 studies, Wang et al. (2017) investigated the impact of contractual control, coordination, and
82 adaptation on various aspects of relationships (such as prior interactions, standard levels of
83 cooperative behavior, and voluntary cooperative behaviors) and Quanji et al. (2016)
84 investigated the relationships between contractual control, coordination, adaptation, and
85 contractual partners' voluntary and obligatory cooperation. The two studies showed the
86 usefulness of joint-contract functions in investigating cooperative behaviors. These functions
87 can also improve project performance in BIM. As there is more potential for EPC contracting
88 parties to engage in opportunistic behaviors, joint-contract functions can play an important role
89 in effective governance for projects involving BIM. Contractual control reduces opportunistic
90 behaviors, and contractual coordination and contingency adaptability foster interorganizational
91 trust between owners and contractors, all of which enhance cooperative behaviors between
92 contracting parties and contribute to improved performance.

93 Combining the three main contract functions also helps mitigate adverse effects from the
94 individual contract functions, which also positively affects BIM-enabled project performance
95 (Lee et al. 2018). For example, high levels of control breed low levels of trust (Faulkner 2000),
96 whereas a contract environment that emphasizes coordination and contingency adaptability can
97 build and strengthen trust, thus leading to better BIM performance (Lee et al. 2018). The
98 authors of the current paper argue that interorganizational trust may influence the effect of
99 joint-contract functions on project performance. In a previous study on the effects of contracts
100 on trust, Jiang et al. (2016) showed that contracts influence relational trust positively, but they

101 did not explore how contracts influence relational trust and contribute to project success.
102 Moreover, distrust (which is often perceived in contractual contexts) can have a pernicious
103 effect on exchange performance but may have a positive impact on project performance (Lee
104 et al. 2018). Furthermore, a contractual relationship that favors fairness can reinforce trust, thus
105 leading to more effective collaboration (Benítez-Ávila et al. 2018). Perceived fairness is
106 another important variable that could mediate interorganizational trust and influence the
107 relationship between joint-contract functions and BIM-enabled project performance.

108 Against this background, this study aims to determine the direct effect of joint-contract
109 functions on BIM-enabled EPC project performance, and it also explores the mediating effects
110 of perceived fairness, interorganizational trust, and distrust. To test the research hypotheses,
111 the study employs partial least squares structural equation modeling (PLS-SEM) based on 252
112 questionnaire answers from industry practitioners involved in EPC oil and gas projects, and it
113 quantifies the direct effect of joint-contract functions on BIM-enabled project performance as
114 a complementary approach to EPC contracts. To the authors' knowledge, this is the first
115 attempt to empirically investigate the effects of formal contracts on BIM-enabled project
116 performance through the lens of joint-contract functions. Another area that has not been
117 examined by previous studies is the potential mediating effects of calculative trust and distrust,
118 relational trust, and perceived fairness between the contracting parties. By illuminating the
119 effects of joint-contract functions on EPC BIM-enabled project performance (and by
120 incorporating the mediating variables discussed above), this study provides more realistic
121 guidelines for the construction of EPC contracts based on joint-contract functions, which
122 promote effective collaboration in a BIM working environment.

123 The remainder of the paper is structured as follows. The second section discusses the
124 theoretical background and presents hypotheses that describe the relationships between joint-
125 contract functions, perceived fairness, interorganizational trust, and project performance. The

126 third section clarifies the research design, including the sampling, data collection procedures,
127 data analysis methods, and the applied measures. The fourth section presents the analysis of
128 the hypothesized model. The fifth section discusses the contributions and limitations of the
129 approach, as well as possible directions for future research. The last section concludes the
130 paper.

131

132 **Theoretical background and hypotheses development**

133 *Joint-contract functions and EPC BIM-enabled project performance*

134 As previously discussed, in the EPC approach, which emphasizes contracts and transaction
135 law, formal contracts are wielded as instruments of control (Williston and Lewis 1920; Dyer
136 1997). Furthermore, formal contracts that overly focus on control mechanisms can inhibit
137 relationship development, thereby preventing the benefits of BIM from being fully realized
138 (Huber et al. 2013). However, some degree of contractual control is necessary when using BIM
139 to mitigate the risk of exploitation (Das and Teng 1996). Contractual control not only allows
140 for behavioral control, such as through stipulating damages arising from breaching terms of
141 BIM use, but it can also take the form of input and output controls through terms that stipulate
142 BIM deliverables. Despite some of the detrimental effects of contractual control, Lumineau
143 and Hendersen (2012) show that contractual coordination can actually strengthen the
144 cooperative interaction between the contracting parties. Contingency adaptability provisions
145 can hinder strategic flexibility (Malhotra and Lumineau 2011), but they can also enable the
146 contracting parties to share knowledge while managing the changes associated with BIM
147 (Reuer and Devarakonda 2016).

148 There are numerous criteria for measuring successful project performance (Mir and
149 Pinnington 2014). The most common include the satisfaction of team members, value added to
150 the organization, the timeliness of projects, adherence to budgets and to the desired quality of

151 work, and effectiveness of interactions between team members (Thompson et al. 2007).
152 Contractual coordination and contingency adaptability reinforce collaboration among team
153 members in a BIM work environment by facilitating the intensive sharing of knowledge and
154 information (Zheng et al. 2017). As such, it is hypothesized that coordination and adaptability
155 directly influence the effectiveness of the interactions between team members, thus increasing
156 their work satisfaction. The harmonization between contractual control, coordination, and
157 contingency adaptability may also enhance the quality of BIM deliverables and ensure optimal
158 project performance. Parties that acknowledge the advantages of using functional contracting
159 can more easily achieve better outcomes compared with those that focus less on functional
160 contracting (Mellewigt et al. 2007). Hence, the following is hypothesized:

161 **H1:** Joint-contract functions positively and directly relate to project performance.

162

163 *Mediation effect of interorganizational trust*

164 Trust is “a psychological state which comprises the intention to accept vulnerability based
165 upon positive expectations of the intentions or behavior of another” (Rousseau et al. 1998, p.
166 395). Specifically, interorganizational trust is a firm’s expectation that another firm will not
167 behave opportunistically (Bradach and Eccles 1989). Interorganizational trust thus allows two
168 firms to exchange information and share responsibilities for decision-making (Zaheer et al.
169 1998). Interorganizational trust includes calculative, relational, and institution-based trust
170 (Rousseau et al. 1998). The aim of the current study is to determine how contract provisions
171 represented by joint-contract functions impact the trust between firms. Thus, the study
172 considers calculative and relational trust. Institutional trust, on the other hand, is affected by
173 institutional practices and exchange routines and is not part of the current analysis (Zaheer et
174 al. 1998).

175 Calculative trust arises from the positive and negative consequences that are predicted by
176 parties who are participating in a collaboration (Williamson 1993), and joint-contract functions
177 can influence the calculative judgement of parties in their evaluation of risks and potential
178 payoffs. For BIM, contract control may stipulate the damages to be paid, for example, in the
179 event of copyright infringements claimed by a third party. Contractual coordination allocates
180 the responsibilities of the parties in sharing, maintaining, and using the model, and it enables
181 parties to assess the magnitude and quality of efforts they must make in these processes. On
182 the other hand, contingency adaptability allows parties to make rational judgements about the
183 risks they bear in case of technical errors during BIM development. These functions support
184 calculative trust by allowing parties to consider the legal and economic consequences of
185 breaching contracts (Lumineau 2017).

186 Jiang et al. (2016) demonstrated that, compared to calculative trust, relational trust has a
187 more significant effect on project performance. Relational trust is developed through
188 reciprocity and social-emotional exchange, which require a higher level of confidence in the
189 partner (Rousseau et al. 1998). Appropriate contractual control and contingency adaptability
190 give parties more confidence when sharing information within a BIM working environment,
191 since mutual interests are protected and uncertainties are reduced. Through promoting
192 information sharing and collective decision-making in a BIM environment, coordination and
193 contingency adaptability provisions foster relationships between parties. Several studies reveal
194 that trust is closely connected to project performance. For instance, interorganizational trust
195 has positive effects on cost performance improvement (Li et al. 2018). Furthermore, trust
196 moderates the relationship between manager relational exchanges and project performance
197 (Chen and Lin 2018). Trust also affects communication and, therefore, influences project
198 performance (Cheung et al. 2013). Hence, the following are hypothesized:

199 **H2:** Calculative trust has a positive influence on the relationship between joint-contract
200 functions and project performance.

201 **H3:** Relational trust has a positive influence on the relationship between joint-contract
202 functions and project performance.

203

204 *Mediating effect of interorganizational distrust*

205 Trust and distrust should be investigated separately since they are two distinct constructs
206 (Dimoka 2010). In this study, distrust refers to the state of being influenced by calculative
207 judgement. Contractual control allows for the easier identification of instances in which one or
208 the other party deviates from the contract terms. Thus, it supports the enforcement of
209 contractual terms (Lumineau 2017) and makes contracts more proficient in terms of the logical
210 judgements that motivate assumptions about the other party. Contractual controls also promote
211 calculative distrust. For example, calculative distrust can be associated with the following
212 scenarios: the protection of the intellectual property rights of BIM model contributors, auditing
213 a model to ensure the conformance of project deliverables, and stipulating damages arising
214 from the third party copyright infringement, among others. The contractual controls promote
215 calculative distrust—in other words, constructive skepticism and vigilance—safeguarding the
216 interests of both parties involved in the contractual relationship (Lumineau 2017). The
217 informed awareness that emerges from calculative distrust prompts the contracting parties to
218 take appropriate measures to mitigate risks (Smyth et al. 2010). In other words, trust and
219 distrust are simultaneously managed in this kind of antagonistic environment, in which parties
220 are as likely to distrust as they are to trust one another (Lewicki et al. 1998). This implies that
221 distrust may correlated with project performance, particularly if the parties experience
222 increased trust after a successful collaboration and transaction. Trust can positively affect a

223 transaction when fear and skepticism are minimized through appropriate distrust-related
224 contract provisions (Lee et al. 2018). Hence, the following is hypothesized:

225 **H4:** Calculative distrust has a positive influence on the relationship between joint-contract
226 functions and project performance.

227

228 *Multiple mediating effects of perceived fairness and interorganizational trust*

229 When the fairness principle is applied to construction projects, both parties in a contract
230 should hold equal positions for gaining economic advantage. When parties perceive there is
231 fairness in the transaction, they will exhibit positive behaviors that can improve project
232 performance, such as resolving problems collaboratively, working harmoniously, and engaging
233 in mutual support, all of which are essential for success in BIM-enabled projects (Lim and
234 Loosemore 2017). Perceived fairness can reduce the potential for dissatisfaction and conflicts
235 and bolster the legitimacy of organizational procedures. In construction research, perceived
236 fairness has been shown to affect claims and disputes (Spittler and Jentzen 1992). In these
237 ways, perceived fairness affects the cooperative behaviors of employees and the operational
238 efficiency of firms (Greenberg 1989).

239 There are two types of perceived fairness that influence decision-making: distributional and
240 procedural fairness. To achieve distributional fairness, the material outcomes of a cooperative
241 effort must be compatible with the perceived outcomes (Adams 1965). Procedural fairness not
242 only pertains to material outcomes but also to the process used to reach those outcomes
243 (Leventhal 1980). Contract functions can affect both types of fairness. Contractual coordination
244 and contingency adaptability affects procedural fairness by specifying the ways in which
245 parties involved in BIM collaborate, such as in the strategic coordination of BIM development
246 in stages through mutual discussions and procedures to prevent conflicts from arising.
247 Procedural fairness can induce a broad range of emotions in employees, including the feeling

248 of being respected, feeling loyalty to and recognized by a company, feelings of trust, and work
249 commitment (Collet 2008). Contractual control, which stipulates damages from a breach of
250 terms in BIM delivery, affects distributional fairness, which in turn influences efficiency and
251 productivity (Suliman 2007). It may be difficult, however, to realize absolute fairness (Lau and
252 Rawlinson 2009). In light of the above discussion, the following are hypothesized:

253 **H5:** Perceived fairness and calculative trust jointly and positively influence the relationship
254 between joint-contract functions and project performance.

255 **H6:** Perceived fairness and relational trust jointly and positively influence the relationship
256 between joint-contract functions and project performance.

257

258 *Multiple mediating effects of perceived fairness and interorganizational distrust*

259 Perceived fairness also impacts the positive outcomes of calculative distrust through joint
260 contract provisions. For example, control provisions may include requirements for compliance
261 audits and for the payment of damages for copyright infringement. These provisions invoke
262 the distributional and procedural judgements of parties and motivate the careful monitoring of
263 activities during BIM use (Provan and Skinner 1989), and the scrutinizing of actions that
264 diverge from agreed-upon terms (Klein and Murphy 1988). Fairness plays an important role in
265 mediating joint-contract functions, thus encouraging the positive outcomes of distrust.
266 Specifically, fairness has to do with the way individuals are treated and the sense of justice that
267 comes from the sharing of rewards (Lau and Rawlinson 2009). When perceived fairness
268 influences distrust provisions, it may impact project performance. Therefore, the following is
269 hypothesized:

270 **H7:** Perceived fairness and calculative distrust jointly and positively influence the
271 relationship between joint-contract functions and project performance.

272

273 **Research methodology**

274 *Data collection*

275 To collect relevant data, the researchers approached approximately 1,200 construction-
276 related practitioners worldwide via LinkedIn, most of them from oil and gas conferences and
277 workshops. It took two years to collect the contact details of all the practitioners who were
278 involved in planning, construction, engineering, contract, and information management of EPC
279 oil and gas projects. This kind of project was selected for two reasons. First, oil and gas projects
280 have exploited BIM for over 20 years. Second, the maturity of the BIM used in oil and gas
281 projects made it easier to conduct an investigation to identify the impact of contract functions
282 on BIM-enabled project performance, and EPC is one of the most popular project delivery
283 methods used in oil and gas projects.

284 The survey, which consisted of four sections, was distributed to respondents, who answered
285 questions based on their most recent projects. Section A of the survey inquired about the project
286 and personal details. To help respondents understand and respond to the survey, BIM was
287 referred to as three-dimensional (3D); four-dimensional (4D, Construction Sequencing); five-
288 dimensional (5D, Cost Estimation); and six-dimensional (6D, Asset Lifecycle Management)
289 modeling and its associated technologies; and/or digital data involved in the design, production,
290 and maintenance process. Oil and gas projects were referred to as projects related to building
291 facilities for oil, gas, and their derivatives (e.g., methanol, fertilizers). This included drilling
292 and production platforms; floating production storage and offloading systems (FPSO); floating
293 liquefied natural gas (FLNG); onshore oil and gas plants; and other related infrastructure (e.g.,
294 pipeline, jetty, and ship loading facilities). Sections B, C, and D comprised questions on the
295 measurement items for the contract functions related to BIM, interorganizational trust and
296 distrust, and project performance, respectively. Each variable consisted of four measurement
297 items except for project performance, which consisted of seven measurement items. A two-

298 round pilot survey was conducted to validate and revise the draft questionnaire as required
299 (Jiang et al. 2016). In the first round, the questionnaire was distributed to three experts in oil
300 and gas contracts and engineering and project management, respectively. After revising the
301 questionnaire, it was sent to nine oil and gas project practitioners for further comments. The
302 questionnaire was then revised until it was suitable for online distribution, which took place
303 from May to July of 2018. The time frame given for responding to the survey was two weeks.
304 A follow-up reminder was sent five days before the response expiry date. In total, 276
305 responses were collected, with 2.6% of surveys having some missing values. Following the
306 assertion by Schafer (1999) that a missing rate of 5% or less is inconsequential, the
307 observations with missing data were removed from the dataset. After elimination, the sample
308 comprised 252 responses. Although the PLS-SEM algorithm has a bootstrapping feature to
309 deal with skewed data, Hair et al. (2014) suggested that the skewness and kurtosis of the data
310 should be + or -1. The data used for analysis in PLS-SEM that had a skewness exceeding 1
311 were transformed to ensure they fell within the limits of +1 or -1.

312

313 *Data analysis method*

314 PLS-SEM was used to determine the influence of joint-contract functions on project
315 performance and gauge any mediating effects on the relationship. This method was selected
316 for its precision in prediction-oriented analysis compared with covariance-based SEM (CB-
317 SEM) as well as for its ability to deal with complex models (Rigdon et al. 2017). Moreover,
318 the bootstrapping feature available in the PLS-SEM algorithm allowed for a more robust study
319 of skewed data and formative measures, as it transformed the data under the central limit
320 theorem (Ringle et al. 2009).

321

322 *Sample data*

323 Referring to Appendix 1, the respondents who worked with project owners represented 44%
324 of the sample and the EPC contractors, 56%. Most of the involved firms have operated for over
325 50 years, and their projects were mostly onshore plants and other associated facilities and in
326 Asia, North America, and Oceania. The contract values for most projects were above USD 500
327 million with durations of 2–5 years. Additionally, most respondents had more than 20 years of
328 working experience in the construction industry, as project managers (37%), contract managers
329 (13%), engineering managers (13%), construction managers (12%), information managers
330 (7%), project control managers (6%), and in other related roles (13%). Oil and gas projects
331 were found to fall significantly under the three-dimensional shared information model (40%),
332 with 32% of respondents stating that the shared information model used in the projects included
333 digital fabrication. Although 46% of respondents stated that the projects did not include other
334 BIM uses, 30%, 16%, and 8% of respondents mentioned the projects applied a four-
335 dimensional model for construction sequencing, a five-dimensional model for cost estimation,
336 and a six-dimensional model for asset lifecycle management, respectively.

337 To assess sampling error, the potential non-response bias was evaluated. Lindner et al.
338 (2001) suggested investigating this type of bias through an independent t-test to compare the
339 significant differences between early and late responses. As there is no consistent definition for
340 “late respondents,” they were stipulated as those who answered the survey after receiving the
341 reminder email. The outcomes indicated no non-response bias, since the difference between
342 early and late responses was not significant. After cleaning the data, the authors examined
343 missing values using Little’s missing completely at random test. The outcomes of the test
344 showed that the Chi-square was 48.405 with $DF = 40$ and $Sig. = 0.170$, which was not
345 significant. This suggested that missing values were random. The number of missing values
346 was 2.6%, where a 5% or lower missing rate was considered insignificant (Schafer 1999).
347 Hence, the observations with missing data were removed from the dataset.

348

349 *Measures*

350 The measurement items for contract functions were obtained from prior studies and BIM
351 contract protocols. The respondents were given an opportunity to clarify any doubts before
352 responding to the questions. Some items for contract functions may have looked similar but
353 had different meanings. For instance, contractual control was measured by the specified
354 contract terms that defined a right to audit for conformance in delivering BIM (*CON_1*) and
355 stipulated damages against the party that failed to comply with the terms related to BIM
356 deliverables (*CON_2*). Contractual control was also measured by general controlling and
357 monitoring of BIM deliverables terms (*CON_3*), such as the requirements of contracting parties
358 to deliver BIM as specified in the contracts, and the terms that specified solutions for non-
359 conformance of BIM deliverables (*CON_4*). For *COR_4*, contractual coordination provided
360 dispute resolution provisions for parties to achieve collective action to deal with the conflicts
361 arising from delivering BIM, which is different from contractual control.

362 The measurement scales for project performance, perceived fairness, calculative trust, and
363 relational trust in Table 1 draw from measurement scales validated in prior studies. Calculative
364 distrust was measured following the literature (Lumineau 2017). All construct indicators were
365 measured using 5-point Likert scales, ranging from strongly disagree to strongly agree or from
366 extremely low to extremely high. Reflective constructs formed the indicators. All constructs
367 were reflective, except for the joint-contract function, which was formative. Thus, the three
368 contract functions—contractual control, coordination, and contingency adaptability—
369 influenced the joint-contract functions. Although joint-contract functions were interpreted as
370 formative constructs, they repeated the indicators in the three contract functions. Since joint-
371 contract functions had a reflective measurement model, as in Figure 1, all relevant reliability
372 and validity tests had to be cleared when measuring the reflective model, with the exception of

373 the discriminant validity between the three distinct and joint-contract functions (Hair et al.
374 2014).

375

376 **Results and data analysis**

377 SmartPLS 3.0 was used to analyze the measurement models and the structural model. The
378 assessment followed Hair et al. (2014).

379

380 *Evaluation of measurement models*

381 The indicators in a reflective construct must be consistent with each other within the
382 construct. To measure internal consistency reliability, the suggested Cronbach's alpha's value
383 should range from 0.70 to 0.90 (DeVellis 2016) to demonstrate the intercorrelations of a set of
384 items. Table 2 shows that all Cronbach's alpha values are below 0.90, except for joint-contract
385 functions, which had a value of 0.927. However, it is less accurate to assess internal consistency
386 reliability using this measure, as it is responsive to the number of items measured on a scale
387 (Hair et al. 2014). Composite reliability (CR) is a more reliable internal consistency measure.
388 It considers the different outer loadings of indicators, measurement errors of the indicators, and
389 their variances. Table 1 shows that all constructs had CR values below the 0.95 threshold (Hair
390 et al. 2014). All outer loadings of indicators were above the 0.70 threshold, except for the
391 contractual control that stipulated damages against the party failing to deliver the digital model
392 and/or data, with the value of 0.609 in the joint-contract functions construct. This control was
393 removed from the model. The values of the outer loadings of contractual control defined the
394 right to audit for conformance in delivering the digital model and/or data in the joint-contract
395 functions construct; the distrust construct, in which one party was constructively skeptical
396 about the other party, enabled better work in the project; project performance constructs, which
397 indicated the outcome of the project, added value to the organization's operations; and the

398 project satisfying health and safety performance expectations were also below the threshold, at
399 0.672, 0.673, 0.686, and 0.649 respectively. Nevertheless, indicators with outer loading values
400 ranging from 0.40 to 0.70 should be removed if removal increases the value of CR or the
401 average variance extracted (AVE) (Hair et al. 2014). The deletion of these indicators reduced
402 the CR value; hence, they were retained in the model. Simultaneously, AVE was used to assess
403 the extent to which an indicator correlated positively with other indicators of the same construct
404 (Hair et al. 2014). The values of the AVEs of all constructs were above the 0.50 threshold,
405 demonstrating that the indicators in the constructs converged.

406 Discriminant validity is another important measure that analyzes the differences between
407 constructs. This measure shows a construct is distinguished from other constructs in a model
408 and captures a different phenomenon. In PLS-SEM, the heterotrait-monotrait ratio (HTMT) of
409 correlations is a new measure that assesses discriminant validity, as the Fornell–Larcker
410 criterion and cross-loadings do not detect discriminant validity reliably in some situations
411 (Henseler et al. 2015). Table 3 shows the HTMT value between contractual coordination and
412 contingency adaptability is 0.950. Henseler et al. (2015) suggested that indicators with low
413 correlations should be removed to reduce HTMT values. Hence, the lowest outer loading values
414 for contractual coordination (which delegates the roles of parties for delivering BIM and
415 provides dispute resolution provisions to deal with any conflicts) were removed (Table 2),
416 which reduced the HTMT value to 0.885.

417

418 *Common method variance*

419 The evaluation of common method variance is important since it influences the validity and
420 reliability of measurement models (Podsakoff et al. 2003). This type of systematic error occurs
421 when a single source of research design is used (Schaller et al. 2015). This study may be
422 affected by common method variance, as the data were collected through a single source, that

423 is, an online survey. Harman's (1976) single-factor test is a common method used to assess
424 variance. The result of the analysis showed a variance of 24.13%, meaning that it was unlikely
425 the common method variance affected the study outcomes (Podsakoff and Organ 1986). The
426 full collinearity test is a reliable method proposed by Kock (2015) to determine common
427 method variance in PLS-SEM research. The accepted criterion for variance inflation factor
428 (VIF) values is that it should not be above 3.3 when using the PLS-SEM algorithm (Kock
429 2015). The test in this study showed that all VIF values of the constructs were below 3.3,
430 indicating no common method variance.

431

432 ***Structural model evaluation***

433 To examine the structural model, Stone-Geisser's Q^2 value was calculated to evaluate the
434 predictive relevance of indicators. All constructs had positive Q^2 values (calculative trust =
435 0.081; calculative distrust = 0.041; relational trust = 0.137; perceived fairness = 0.055; joint-
436 contract functions = 0.569; and project performance = 0.11), indicating the predictive relevance
437 of the path model for the constructs. Next, the coefficient of determination (R^2 value) was used
438 to assess the predictive accuracy of the model. R^2 values range from zero to one. The higher
439 the R^2 value, the higher the predictive accuracy. In research related to predicting the drivers of
440 success, an R^2 value of 0.20 is considered high (Hair et al. 2014). In this study, project
441 performance had the highest R^2 value (0.233), followed by relational trust (0.225), calculative
442 trust (0.150), calculative distrust (0.098), and perceived fairness (0.092). In addition to the
443 evaluation of R^2 values, the effect size f^2 was used to evaluate the substantive impact of a
444 variable when removed from the model.

445 The small, medium, and large effect sizes were represented by the f^2 values of 0.02, 0.15,
446 and 0.35 respectively (Cohen 1988). Table 4 shows that all exogenous variables had at least
447 small effects on the endogenous variables, except for calculative distrust on project

448 performance and joint-contract functions on calculative trust and project performance, with f^2
449 values of 0.000, 0.010, and 0.009, respectively. Comparing the f^2 values of the variables shows
450 that relational trust and perceived fairness were the endogenous variables in the model.
451 Relational trust was affected by both perceived fairness (medium effect, $f^2=0.165$) and joint-
452 contract functions (small effect, $f^2=0.046$), whereas perceived fairness was solely affected by
453 joint-contract functions (small effect, $f^2=0.102$). Calculative trust was partially endogenous, as
454 it was affected by perceived fairness (small effect, $f^2=0.127$) but not joint-contract functions.

455 The constructs' path coefficients were then analyzed. Bootstrapping was conducted for
456 5,000 iterations to identify the t -values, p -values, and confidence intervals of the paths
457 (Palanski et al. 2011). Table 5 shows that, although the direct effect between joint-contract
458 functions and project performance is 0.09 and the p -value is not significant, the joint-contract
459 functions had a significant total effect ($\beta = 0.227, p < 0.01$) and indirect effect ($\beta = 0.136, p <$
460 0.01) on project performance. Hence, **H1 is partially supported**. Table 4 also shows that there
461 was no significant effect of calculative trust on joint-contract functions and project
462 performance ($\beta = 0.230, p > 0.10$); therefore, **H2 is not supported**. In contrast to calculative
463 trust, relational trust was a significant mediator variable between joint-contract functions and
464 project performance ($\beta = 0.058, p < 0.01$), showing that **H3 is supported**. The results in Table
465 5 also show that calculative distrust insignificantly influenced the relationship between joint-
466 contract functions and project performance ($\beta = 0.001, p > 0.10$). Hence, **H4 is not supported**.
467 In terms of multiple mediation effects, **H5 is supported**. Perceived fairness and calculative
468 trust jointly influenced joint-contract functions and project performance ($\beta = 0.023, p < 0.10$).
469 **H6 is also supported**, since perceived fairness and relational trust jointly influenced joint-
470 contract functions and project performance ($\beta = 0.031, p < 0.05$). However, **H7 is not**
471 **supported**, as perceived fairness and calculative trust did not jointly mediate contract functions

472 and project performance ($\beta = 0.000, p > 0.10$). Figure 2 shows the final model for joint-contract
473 functions and project performance.

474

475 **Moderating effects analysis**

476 To determine whether the relationships in the structural model were influenced by different
477 project scopes and types, a moderating effects analysis was conducted with the finding that
478 relationships between constructs in the model were not influenced by scopes (e.g., FPSO,
479 FLNG, and other plants) and types of projects (locations, values, and durations) with the
480 exception of the paths in Table 6.

481 Table 6 and Figure 3 show that the positive relationship between joint-contract functions
482 and relational trust was stronger for projects located onshore but the relationship turns negative
483 for the projects located offshore. The relationship between joint-contract functions and
484 calculative distrust was positive for both low and high contract values. This relationship was
485 stronger for projects with higher value. Project duration moderated the relationship between
486 calculative distrust and project performance such that for shorter project durations, the effect
487 was negative, and for longer project durations, it was positive. By contrast, the relationship
488 between joint-contract functions and project performance was stronger for projects with a
489 longer duration but weaker when the project duration was shorter.

490

491 **Discussion and contributions**

492 *Joint-contract functions and the mediating effect of relational trust*

493 The results above provide new insights, including the observation that joint-contract
494 functions indirectly influence BIM-enabled EPC project performance through perceived
495 fairness and relational trust; this is despite the fact that the effects of joint-contract functions
496 on relational trust are not so pronounced in offshore projects. The results are different from

497 prior research in that formal contracts tend to restrain the establishment of relational norms
498 between contracting parties (Malhotra and Murnighan 2002). The outcomes of this study
499 explain how joint-contract functions can be used as a complementary approach to EPC BIM-
500 enabled projects, an area hitherto not empirically examined. The moderation analysis shows
501 that, when the EPC project duration is longer, the relationship between joint-contract functions
502 and a BIM-enabled project performance is stronger. These outcomes suggest that the
503 conventional approach of EPC contracts that focused on imposing contractual obligations to
504 safeguard transactions is no longer an effective governance method for long-term BIM-enabled
505 projects. In a BIM working environment, enhancing contractual coordination and contingency
506 adaptability, in addition to formal control, has implications on relational development and,
507 thereby, leads to EPC project success. These functions include providing operational
508 coordination for parties to discuss the necessary adjustments that need to be made to the BIM
509 model upon the completion of the model review, redefining the specific objectives of the BIM
510 model through mutual discussions upon the completion of the first-stage model development,
511 and achieving collective action for handling unforeseen circumstances that may involve BIM.
512 For EPC project success, construction contracting parties should view formal contracts as a
513 mechanism to achieve a shared purpose instead of a tool that solely protects their benefits and
514 interests. Focusing on contractual coordination in BIM model development and on contingency
515 adaptability for joint problem solving enables parties to implement BIM with dynamic
516 efficiency and embed relational elements into the BIM working environment.

517

518 *Perceived fairness as a cornerstone of joint-contract functions*

519 Although Lumineau (2017) proposed that excessive contract functions may have negative
520 effects on calculative and non-calculative trust, there is no study on how the extent of contract
521 functions influences trust. This study shows that perceived fairness influenced the degree of

522 calculative and relational trust and impacted EPC project performance positively and
523 significantly. This suggests that an adequate level of joint-contract functions could be
524 determined through the perceived fairness of both parties. This outcome broadens the views of
525 EPC practitioners and suggests looking beyond the traditional EPC contract setting. Contracts
526 that promote joint problem solving and fair risk allocation would clearly provide a team-
527 building platform and help cultivate rapport between contracting parties (Cheung et al. 2009).
528 Hence, EPC contracts should not be framed solely to benefit the client. Contracting parties
529 should consider the fairness of terms when devising BIM-related contract provisions to
530 maximize the potential for project success. For instance, EPC contractors should not be held
531 responsible for the failure to deliver BIM, which may be outside their control, and appropriate
532 time extensions should be granted so that contractors can rectify these errors or issues.

533

534 *Distrust does not necessarily negatively impact project performance*

535 This study also reveals a new perspective on distrust in terms of BIM-enabled EPC project
536 performance. It is commonly believed that formal contracts increase partner distrust and in
537 turn, induce non-cooperative behaviors (Wu et al. 2017). While joint-contract functions have a
538 significant effect on calculative distrust (which does not warrant its significant effect on EPC
539 project performance) the results demonstrate that they may not necessarily have negative
540 implications for EPC project performance. The relationship between joint-contract functions
541 and project performance is stronger when project duration is longer and contract value is
542 higher. This substantiates the fact that calculative distrust in EPC projects is necessary to
543 prevent knowledge leaks, support vigilance, and promote healthy suspicion and constructive
544 skepticism against the other party's opportunistic behaviors, all of which can boost confidence
545 and help both parties to perform better in BIM-enabled projects. Examples of functions that
546 can have these effects include defining the right to audit for conformance in delivering BIM,

547 controlling and monitoring BIM deliverables, and providing resolutions for non-compliance
548 with the terms and conditions of delivering BIM.

549

550 *Effective collaboration among project participants without altering existing EPC contract*
551 *structure*

552 Finally, the mediation effects of interorganizational trust between joint-contract functions
553 and BIM-enabled EPC project performance demonstrate not only that owners and EPC
554 contractors should collaborate more intensively to build trust but also that other project
555 stakeholders with direct contractual relationships (such as specialist contractors and
556 subcontractors) should be involved directly in the collaboration process. For example, as per
557 Figure 4, the EPC project network is egocentric. Only the EPC main contractor plays a
558 prominent role in communicating between owners and other project participants. The owner
559 and other project participants are peripheral nodes in the project networks, and they depend on
560 the main contractor to deliver and receive information. This practice is fragmented, as each of
561 the project participants follows their own procedures (Fakhimi et al. 2017), and it increases
562 asymmetric information and opportunistic behaviors (You et al. 2018). In fact, all project
563 stakeholders are required to share and receive project information through a unified
564 information model. There is very little trust involved at the beginning of projects, but social
565 exchange relationships emerge as each party proves its trustworthiness. During the information
566 sharing process, as the parties engage more deeply in EPC projects (Shapiro 1987), relational
567 norms are established. As such, stakeholders in BIM contracts within EPC projects should
568 strive to harmonize relationships with other stakeholders in both their formal and informal
569 social networks. Ultimately, this will foster an effective and collaborative BIM work
570 environment.

571

572 *Limitations and future research directions*

573 The current study has certain limitations. The PLS-SEM method used here is exploratory
574 and different from CB-SEM. The CB-SEM approach uses strict measures of confirmatory
575 factor analysis to validate a developed theory, while this study uses PLS-SEM for exploration
576 and prediction. Additionally, the use of contract functions may be affected by the levels of BIM
577 use in a project. As such, the results of this study may be influenced by BIM use levels, since
578 BIM uses may vary by project.

579 There are several antecedents of joint-contract functions—such as BIM asset specificity,
580 behavioral uncertainty, and environmental uncertainty—which require attention, as the extent
581 of joint-contract functions that influence interorganizational trust may be affected by BIM
582 transaction attributes. Further, interorganizational trust predecessors, such as communication
583 and reciprocity, may strengthen the relationship between joint-contract functions and
584 interorganizational trust. If the influences of these predecessors are empirically proven, then
585 when devising BIM-related provisions, appropriate strategies should be considered to enhance
586 these factors to optimize the influence of joint-contract functions on BIM-enabled project
587 performance.

588 Since the model is an aggregate of three different contract functions (joint-contract
589 functions) in a BIM-enabled EPC project setting, the effect of the individual functions on EPC
590 project performance was not identified. For instance, the contract that specified the right to
591 audit for compliance while delivering BIM may impact perceived fairness (procedural fairness)
592 positively for one party but may induce distrust for the other party. How this contract function
593 translates into project performance is not clear. Future research on the model should investigate
594 the perspectives of both contracting parties and identify ways to achieve optimal trust between
595 parties during the development of BIM-related contracts. Additionally, industry norms and

596 standard contract provisions, which may have implications for the model beyond the scope of
597 this research, also require further investigation.

598 Although the study has successfully shown the mediating effects of interorganizational trust
599 and distrust in the relationship between joint-contract functions and BIM-enabled EPC project
600 performance, future studies should determine how contract functions influence trust among
601 project stakeholders through a comprehensive social network analysis. Through investigating
602 formal and informal collaborative relationships using social network analysis, researchers
603 could assess the dynamic evolution of interorganizational trust among project participants
604 during BIM-enabled project implementation (Lee et al. 2017).

605

606 **Conclusions**

607 This study has determined the direct and mediating effects of joint-contract functions and
608 BIM-enabled EPC project performance through PLS-SEM. The research outcomes have
609 demonstrated that relational trust has a positive influence on the relationship between joint-
610 contract functions and EPC project performance. It also showed that, while calculative trust
611 may not significantly mediate the relationship between joint-contract functions and EPC
612 project performance, its impacts are more pronounced in terms of perceived fairness. This
613 suggests that joint-contract functions may influence interorganizational trust for BIM-enabled
614 EPC project performance improvement when fairness is perceived. Moreover, the study
615 demonstrated that the calculative distrust influenced by the joint-contract functions may not
616 necessarily have negative implications for project performance. In other words, calculative
617 distrust arising from joint-contract functions may not be detrimental to EPC project
618 performance and is an important element in BIM-enabled projects. The examinations of the
619 effects of joint-contract functions on BIM-enabled EPC project performance and their
620 mediating effects have provided valuable insights for relevant industries, showing mainly that

621 BIM can be implemented effectively within a traditional EPC contract setting. The current
622 findings contribute to knowledge development of appropriate contract framing for BIM-
623 enabled EPC project stakeholders, an area not discovered in the previous literature. However,
624 for this complementary approach to be used effectively in EPC projects, certain changes should
625 be made to contracts to influence interorganizational trust, distrust, and perceived fairness
626 between owners and EPC contractors. This approach will maximize the potential for EPC
627 project success.

628

629 **Data Availability Statement**

630 All data generated or analyzed during the study are included in the submitted article and
631 supplemental data file.

632

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637

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Table 1. Measurement of key constructs

No.	Variables/ Code	Reflective Measurement Items	Modified from Referred Sources
1	Contractual Control (CON)		
	<i>CON_1</i>	The contract specified right to audit for compliance with the creating, using and maintaining BIM.	Lumineau and Henderson (2012)
	<i>CON_2</i>	The contract stipulated damages against the party which failed to conform to the obligations of creating, using and maintaining BIM.	Lumineau and Henderson (2012)
	<i>CON_3</i>	The contract provided provisions for controlling and monitoring BIM deliverables.	Lumineau and Henderson (2012)
	<i>CON_4</i>	The contract specified resolution for nonconformance to the terms and conditions of creating, using and maintaining BIM.	Lumineau and Henderson (2012)
2	Contractual Coordination (COR)		
	<i>COR_1</i>	The contract delegated duties to create, use and maintain BIM.	Lumineau and Henderson (2012)
	<i>COR_2</i>	The contract provided operational coordination for parties to discuss the necessary adjustments that need to make on BIM upon completion of the model review.	Lumineau and Henderson (2012)

- COR_3* The contract provided strategic coordination for Lumineau and parties to sharpen the second-stage specific Henderson (2012) objectives of BIM development through mutual consultations after completion of the first-stage BIM development.
- COR_4* The contract provided dispute resolution Lumineau and provisions to deal with the conflicts arising from Henderson (2012) developing, using and maintaining BIM.

3 Contingency Adaptability (COA)

- COA_1* The contract provided provisions that required Wang et al. (2017) revisions/updates of BIM in conjunction with the variations/changes to the works.
- COA_2* The contract provided principles or guidelines Wang et al. (2017) for handling unforeseen circumstances arising from developing, using and maintaining BIM.
- COA_3* The contract provided solutions for responding Wang et al. (2017) to various contingencies arising from developing, using and maintaining BIM.
- COA_4* The contract specified procedures for changes Quanji et al. (2016) made in BIM.

4 Calculative Trust (CAL)

- CAL_1* Considering risks and rewards, we believed the Poppo et al. (2016) other party would behave honestly in dealing with us.

CAL_2 Taking into account the high cost of misconduct, we believed the other party would behave trustworthily in performing the works. Poppo et al. (2016)

CAL_3 We believed the other party would act professionally and competently in performing the works. Poppo et al. (2016)

CAL_4 We expected the relationship with the other party would continue for a long time. Wu et al (2017)

5 Relational Trust (REL)

REL_1 Both of us were confident that our interests would be protected because we shared a common identity. Poppo et al (2016)

REL_2 We believed the other party would act effectively for us because we shared the same understanding of what matters. Poppo et al (2016)

REL_3 We believed the other party would be willing to share information with us given that both of us shared the common objectives. Poppo et al (2016)

REL_4 Both of us would be willing to look for a joint solution to a problem arising in the project because we shared the common objectives. Poppo et al (2016)

6 Calculative Distrust (DIS)

<i>DIS_1</i>	We believed monitoring of vulnerabilities (e.g. potential leakage of valuable knowledge) would safeguard our interest in the project.	Lumineau (2017)
<i>DIS_2</i>	We believed healthy suspicion of the other party would protect us against potential opportunism.	Lumineau (2017)
<i>DIS_3</i>	We supported vigilance against the other party.	Lumineau (2017)
<i>DIS_4</i>	We believed constructive scepticism of the other party enabled us to work more confidently in the project.	Lumineau (2017)

7 Perceived Fairness (PF)

<i>PF_1</i>	Our remuneration was commensurate with our ability, effort, input, and experience.	Lim and Loosemore (2017)
<i>PF_2</i>	We were provided with adequate resources to execute our work effectively.	Lim and Loosemore (2017)
<i>PF_3</i>	The risks that we were required to bear were equitable and commensurate with our capability to cope with them.	Lim and Loosemore (2017)
<i>PF_4</i>	We were paid equitably for the job that we completed.	Lim and Loosemore (2017)

8 Project Performance (PP)

<i>PP_1</i>	In general, the project team members were very satisfied with their work.	Thompson et al (2007)
<i>PP_2</i>		

	The project outcome added value to the business operations of our firm.	Thompson et al (2007)
<i>PP_3</i>	The rate of the project met the schedule as compared to other projects.	Thompson et al (2007)
<i>PP_4</i>	The rate of the project met the budget as compared to other projects.	Thompson et al (2007)
<i>PP_5</i>	The rate of the project met the quality of the produced work as compared to other projects.	Thompson et al (2007)
<i>PP_6</i>	The rate of the effectiveness of team members' interactions as compared to other projects.	Thompson et al (2007)
<i>PP_7</i>	The rate of the project met the health and safety expectations as compared to other projects.	Suprpto et al. (2016)

Table 2. Results summary of reflective measurement models

Variables	Indicators	Outer Loadings	Cronbach alpha	Composite Reliability (CR)	AVE
Contractual	<i>CON_1</i>	0.801	0.823	0.883	0.653
Control (<i>CON</i>)	<i>CON_3</i>	0.841			
	<i>CON_4</i>	0.842			
Contractual	<i>COR_2</i>	0.864	0.831	0.888	0.665
Coordination (<i>COR</i>)	<i>COR_3</i>	0.821			
Contingency	<i>COA_1</i>	0.818	0.857	0.903	0.699
Adaptability (<i>COA</i>)	<i>COA_2</i>	0.834			
	<i>COA_3</i>	0.840			
	<i>COA_4</i>	0.852			
Joint Contract Functions (<i>FUNC</i>)	<i>CON_1</i>	0.672	0.927	0.937	0.556
	<i>CON_3</i>	0.766			
	<i>CON_4</i>	0.770			
	<i>COR_2</i>	0.779			
	<i>COR_3</i>	0.763			
	<i>COA_1</i>	0.785			
	<i>COA_2</i>	0.768			
	<i>COA_3</i>	0.754			
	<i>COA_4</i>	0.793			
Calculative	<i>CAL_1</i>	0.767	0.777	0.857	0.601
Trust (<i>CAL</i>)	<i>CAL_2</i>	0.779			
	<i>CAL_3</i>	0.843			

	<i>CAL_4</i>	0.704			
Relational Trust	<i>REL_1</i>	0.798	0.811	0.876	0.639
(<i>REL</i>)	<i>REL_2</i>	0.858			
	<i>REL_3</i>	0.801			
	<i>REL_4</i>	0.736			
Calculative	<i>DIS_1</i>	0.793	0.745	0.824	0.540
Distrust (<i>DIS</i>)	<i>DIS_2</i>	0.751			
	<i>DIS_3</i>	0.718			
	<i>DIS_4</i>	0.673			
Perceived	<i>PF_1</i>	0.734	0.795	0.867	0.620
Fairness (<i>PF</i>)	<i>PF_2</i>	0.819			
	<i>PF_3</i>	0.776			
	<i>PF_4</i>	0.818			
Project	<i>PP_1</i>	0.729	0.840	0.879	0.509
Performance	<i>PP_2</i>	0.686			
(<i>PP</i>)	<i>PP_3</i>	0.725			
	<i>PP_4</i>	0.708			
	<i>PP_5</i>	0.758			
	<i>PP_6</i>	0.735			
	<i>PP_7</i>	0.649			

Table 3. Heterotrait-Monotrait Ratio (HTMT)

	<i>CAL</i>	<i>COA</i>	<i>CON</i>	<i>COR</i>	<i>DIS</i>	<i>PF</i>	<i>PP</i>	<i>REL</i>
<i>CAL</i>								
<i>COA</i>	0.255							
<i>CON</i>	0.144	0.838						
<i>COR</i>	0.255	0.950	0.847					
<i>DIS</i>	0.257	0.285	0.248	0.269				
<i>PF</i>	0.472	0.377	0.295	0.291	0.317			
<i>PP</i>	0.510	0.255	0.166	0.233	0.196	0.694		
<i>REL</i>	0.859	0.379	0.219	0.392	0.352	0.536	0.536	

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Table 4. Effect size f^2

	<i>CAL</i>	<i>DIS</i>	<i>PF</i>	<i>PP</i>	<i>REL</i>
<i>CAL</i>				0.030	
<i>DIS</i>				0.000	
<i>FUNC</i>	0.010	0.028	0.102	0.009	0.046
<i>PF</i>	0.127	0.048			0.165
<i>PP</i>					
<i>REL</i>				0.047	

Table 5. Direct effect, total effect and indirect effect of relevant paths

Hypothesis	Coeff.	T value	Significance level	p value	Confidence intervals	
					Lower Bound (5%)	Upper Bound (95%)
Direct effect						
H1: <i>FUNC</i> -> <i>PP</i>	0.090	1.414	ns	0.157	-0.013	0.196
Total effect						
H1: <i>FUNC</i> -> <i>PP</i>	0.227	3.215	***	0.001	0.117	0.349
Indirect effect						
H1: <i>FUNC</i> -> <i>PP</i>	0.136	3.970	***	0.000	0.087	0.199
H2: <i>FUNC</i> -> <i>CAL</i> -> <i>PP</i>	0.230	1.142	ns	0.253	-0.001	0.062
H3: <i>FUNC</i> -> <i>REL</i> -> <i>PP</i>	0.058	2.668	***	0.008	0.025	0.096
H4: <i>FUNC</i> -> <i>DIS</i> -> <i>PP</i>	0.001	0.083	ns	0.934	-0.019	0.022
H5: <i>FUNC</i> -> <i>PF</i> -> <i>CAL</i> -> <i>PP</i>	0.023	1.720	*	0.085	0.006	0.049
H6: <i>FUNC</i> -> <i>PF</i> -> <i>REL</i> -> <i>PP</i>	0.031	2.505	**	0.012	0.013	0.055
H7: <i>FUNC</i> -> <i>PF</i> -> <i>DIS</i> -> <i>PP</i>	0.000	0.081	ns	0.935	-0.006	0.010

Note: *, **, *** and ns indicate a significance level of $p < 0.1$, $p < 0.05$, $p < 0.01$ and no significance, respectively based on bootstrapping of 5,000 subsamples.

Table 6. Moderation effects of relevant paths

Path	Moderator	Coeff.	t	Significance	p	Confidence Interval	
						value	level
<i>FUNC -> DIS</i>	Contract value	0.081	2.549	**	0.011	0.043	0.129
<i>FUNC -> REL</i>	Project location	-0.400	2.234	**	0.026	-0.072	0.635
<i>FUNC -> PP</i>	Project duration	0.251	2.406	**	0.017	0.108	0.400
<i>FUNC -> DIS</i>	Project duration	0.296	3.350	***	0.001	0.178	0.456