

**Fostering Ambidextrous Innovation in Infrastructure Projects
Differentiation and Integration Tactics of Cross-Functional Teams**

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1 **Fostering ambidextrous innovation in infrastructure projects: differentiation and integration**

2 **tactics of cross-functional teams**

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12 **Abstract :** In infrastructure project practice, balancing and maximizing the combined effect of
13 exploratory and exploitative innovation have attracted increasing attention, but it is still unclear how to
14 foster ambidextrous innovation in infrastructure projects. To address this gap, we draw on the
15 "differentiation–integration" framework of ambidexterity theory to deconstruct tactics for fostering
16 ambidextrous innovation in infrastructure projects. A total of 313 observations were collected from
17 infrastructure under construction, and the path hypotheses were tested by hierarchical regression. The
18 findings suggest that in infrastructure projects, task conflict and expertise integration of diverse cross-
19 functional teams provide powerful and complementary tactics for fostering ambidextrous innovation.
20 The moderating effect of team autonomy support on the impact of team diversity on differentiation and
21 integration tactics presents three different results. This study not only enriches the literature on how to

22 foster ambidextrous innovation in infrastructure projects, but also expands the ambidexterity research
23 at the cross-functional team level and in infrastructure project contexts.

24 **Keywords:** Ambidextrous innovation; Cross-functional team; Team diversity; Task conflict; Expertise
25 integration; Team autonomy support

26 **Introduction**

27 Those using innovative practices in infrastructure projects often face a dilemma. To reduce
28 uncertainty and the risk of cost and schedule overruns, owners are inclined to choose exploitative
29 innovations, such as simple improvements to tested techniques and established routines (Davies et al.
30 2014; van Marrewijk et al. 2008). However, the uniqueness and complexity of infrastructure projects
31 necessitate exploratory innovations that involve the development of new technologies and the adoption
32 of new processes (Beliz and Kutluhan 2017; Christian et al. 2016). Therefore, both exploitative and
33 exploratory innovations merit consideration in infrastructure projects. While excessive attention to
34 exploitative innovation can lead to a short-term “success trap” and fail to achieve long-term success
35 (Gupta et al. 2006), excessive attention to exploratory innovation can lead to endless “failure cycles”
36 (Petro et al. 2019). In summary, both exploitative and exploratory innovation are needed in infrastructure
37 projects, without either being ignored or over-used. As such, care must be taken in infrastructure
38 practices to balance these two innovation types and maximize their combined effects, which is a concept
39 known as ambidextrous innovation (Andriopoulos and Lewis 2009).

40 Whereas many studies of infrastructure innovation have focused on one or another exploratory or
41 exploitative innovation (e.g., Turnheim and Geels (2019) and van den Hoogen and Meijer (2015)
42 focused on exploratory innovation; Brooks et al. (2011) and Gil and Beckman (2007) focused on

43 exploitative innovation), far less attention has been given to the simultaneous use of exploratory and
44 exploitative innovations. In addition, many studies have reported that projects provide the best context
45 for contextualizing ambidextrous innovation (Petro et al. 2019; Turner et al. 2014, 2015), yet the study
46 of most ambidextrous innovation projects have been based on product design projects (e.g.,
47 Andriopoulos and Lewis 2009), manufacturing projects (e.g., He and Wong 2004) and IT projects (e.g.,
48 Turner et al. 2016). As noted above, ambidextrous innovation is critical in infrastructure project
49 practice, but there is scant research on ambidextrous innovation in infrastructure projects. Several
50 scholars have emphasized the importance of ambidextrous innovation in infrastructure projects (e.g.,
51 Wang et al. 2009) and its positive impact on infrastructure project performance (Liu and Leitner 2012).
52 However, very little is known about how to foster ambidextrous innovation in infrastructure projects, a
53 gap crisply summarized by Liu and Leitner (2012), who claimed that few studies have examined how
54 ambidextrous innovation can be achieved in infrastructure projects.

55 To address this gap, we draw on the "differentiation–integration" framework of ambidexterity
56 theory to deconstruct tactics for fostering ambidextrous innovation in infrastructure projects.
57 Ambidexterity theory suggests that the differentiation and integration of diverse teams provide powerful
58 and complementary tactics for fostering ambidexterity (Andriopoulos and Lewis 2009; Jansen et al.
59 2009). Whereas team diversity helps to identify multiple inconsistencies and conflicts, exploratory and
60 exploitative innovations must be differentiated, coordinated, integrated, and applied (Jansen et al. 2009).
61 On this basis, here, we examine how differentiation and integration mediate the relationship
62 between team diversity and ambidextrous innovation in infrastructure projects.

63 Specifically, we take cross-functional teams as the research object. Many scholars have emphasized
64 the critical role of cross-functional teams in fostering ambidextrous innovation (Jansen et al. 2009;
65 Strese et al. 2016), but more importantly, they have stated that cross-functional teams play a vital role
66 in infrastructure projects. Cross-functional teams are the central aspect of the infrastructure project
67 network (Love and Roper 2009). These teams connect high-level decision-making with low-level
68 implementation, and promote interaction between different functional departments (Laurent and Leicht
69 2019). In this study, we apply the "differentiation–integration" framework to the infrastructure project
70 context. As cross-functional team members represent different functional departments, they have
71 different understandings of the project task assignments and the prioritization of project goals, which
72 can trigger task conflicts (Wu et al. 2020). In addition, expertise from different departments must be
73 integrated to gain a comprehensive understanding at the cross-functional team level, and a more
74 comprehensive knowledge base for ambidextrous innovation (Sheng et al. 2018). This study also differs
75 from previous research based on the "differentiation–integration" framework, which has generally been
76 validated at the top management team level (e.g., Jansen et al. 2009). Since cross-functional teams are
77 middle-level entities in infrastructure projects, the impact of the team member diversity on its
78 differentiation and integration tactics may be affected by the degree of autonomy accorded its members
79 (Rico et al. 2007). Fig. 1 shows the research model we established for this study.

80 *(Please insert Fig.1 here)*

81 This study enriches the literature on how to foster ambidextrous innovation in infrastructure
82 projects. Specifically, we validate the "differentiation–integration" framework within the ambidexterity
83 theory from the perspective of the cross-functional teams in infrastructure projects, which extends the

84 existing theory of project ambidexterity, and provides a novel interpretation of the role of cross-
85 functional teams in fostering ambidexterity. The results of this study also provide insights into
86 infrastructure practices that executives and cross-functional teams can use to develop tactics and avenues
87 for fostering ambidextrous innovation.

88 **Literature Review and Hypotheses**

89 *Team Diversity and Ambidextrous Innovation*

90 Ambidexterity theory suggests that the differentiation and integration of diverse teams provide
91 powerful and complementary tactics for fostering ambidexterity (Andriopoulos and Lewis 2009; Jansen
92 et al. 2009). Because a diverse team has more discussions and knowledge collisions before reaching
93 consensus, and better integrates different expertise and viewpoints from various departments (Kearney
94 et al. 2009), thus it can make more comprehensive, rational, and creative decisions than homogeneous
95 teams (Stewart 2006), and can better achieve ambidextrous innovation (Jurni et al. 2015). In
96 infrastructure project practice, the cross-functional teams are often diverse teams, and the team members
97 have different work experience, professional background, and educational level (Sheng et al. 2018). In
98 particular, the cross-functional team members of infrastructure projects are often leaders of different
99 functional departments, so that the cross-functional team can coordinate cross-functional work (Li et al.
100 2018), thereby facilitating infrastructure projects achieve ambidextrous innovation (Liu and Leitner
101 2012). Therefore, the following hypothesis is developed.

102 *Hypothesis 1: In infrastructure projects, cross-functional team diversity has a positive impact on*
103 *ambidextrous innovation.*

104 *Mediating Role of Task Conflict*

105 In the "differentiation-integration" framework, both differentiation and integration are core
106 elements in the ability to pursue exploratory and exploitative activities simultaneously (Jansen et al.
107 2009), and conflict can be a good representation of differentiation (Andriopoulos and Lewis 2009).
108 Team conflict is generally divided into task conflict and relationship conflict (Jehn et al. 2008). Task
109 conflict emphasizes the expression of differences in perspectives directly related to the team task (Jehn
110 1995; Jehn et al. 2008), and it typically refers to disagreements among team members about the content
111 of decisions in the collective decision-making process (Simons and Peterson 2000). While, relationship
112 conflict, also known as affective or interpersonal conflict, is characterized by tension, suspicion, friction
113 and distrust (Simons and Peterson 2000). Existing studies have confirmed the positive impact of task
114 conflict on team performance, ambidexterity and innovation (De Dreu 2006; Martin et al. 2019), while
115 the impact of relationship conflict on team outcomes tends to be negative (Simons and Peterson 2000;
116 Tjosvold et al. 2014). Therefore, if we consider "conflict" in general and do not distinguish the types of
117 conflicts, the impact of these two conflicts may be offset, more importantly, compared with relationship
118 conflict, task conflict can better characterize the "differentiation" in the process of cross-functional
119 teams pursuing ambidextrous innovation, so this study only considers task conflicts.

120 Team members with different backgrounds often have different views on team tasks, which
121 inevitably induces task conflicts (Chen et al. 2012). Conversely, if members of a team are highly
122 homogeneous in their backgrounds, then most members have overlapping knowledge bases, and they
123 may have fewer task conflicts since they do not provoke opposing views (Li et al. 2016). Task conflict
124 can not only help teams collide to produce creative and more effective insights, and integrate these
125 diverse insights into creative and high-quality decisions, thus helping teams achieve both exploratory

126 and exploitative innovation (Camelo-Ordaz et al. 2015; Martin et al. 2019). It can also prevent premature
127 consensus and stimulate more critical thinking (De Dreu 2006), which will promote ambidextrous
128 innovation. In infrastructure project practice, because the cross-functional team members come from
129 different functional departments, they have different views of the project plan and priorities of the
130 project objectives, which will lead to task conflicts (Wu et al. 2020). Besides, Liu and Leitner (2012)
131 also emphasized that conflict is one of the antecedents of ambidexterity in complex engineering project
132 teams. Based on the above discussion, we propose the following hypothesis.

133 *Hypothesis 2: In infrastructure projects, task conflict mediates the relationship between cross-functional*
134 *team diversity and ambidextrous innovation.*

135 ***Mediating Role of Expertise Integration***

136 In the "differentiation-integration" framework, differentiated exploratory and exploitative expertise
137 need to be mobilized, coordinated, integrated, and applied (Jansen et al. 2009). Expertise integration
138 refers to the process by which individual professional knowledge are integrated into comprehensive
139 expertise at the team level in the accomplishment of team tasks (Tiwana and Mclean 2005). Different
140 from knowledge transfer or knowledge sharing, expertise integration not only requires sharing
141 individual expertise with other members of the team, but also requires the utilization of this shared
142 expertise at the team level (Faraj and Sproull 2000).

143 Although expertise is held at the individual level, its value can only be realized if it is integrated
144 into team knowledge base (Okhuysen and Eisenhardt 2002). Team members with different backgrounds
145 have different expertise, and the interactions of diverse teams tend to integrate a better pool of expertise
146 than those of more homogeneous teams, which in turn creates more positive outcomes (Liang and Picken

147 2011). Integrating individual expertise at the team level can inspire ambidextrous innovation (Jansen et
148 al. 2009). Because individuals usually make suggestions for the implementation and decision-making
149 of the project based on their own expertise, but this expertise is often one-sided and limited (Tiwana and
150 Mclean 2005). While when expertise is integrated, team members can access, explore, and use project-
151 related expertise, which makes it easier to reach a consensus that is more holistic and better balanced
152 between exploratory and applied innovation (Halevi et al. 2015). In infrastructure project literature, it is
153 also emphasized that enhancing the specialization and complementarity of infrastructure project cross-
154 functional teams can create greater value (Lehtinen et al. 2019). Therefore, the following hypothesis is
155 developed.

156 *Hypothesis 3: In infrastructure projects, expertise integration mediates the relationship between cross-*
157 *functional team diversity and ambidextrous innovation.*

158 ***Task Conflict and Expertise Integration***

159 Previous studies have confirmed that collaborative response to task conflict will facilitate expertise
160 integration (Amason 1996; Chen et al. 2012). Because task conflict triggers different task-related
161 viewpoints of team members, and these viewpoints convey their different expertise (Amason 1996).
162 Through positive interaction, team members tend to use their expertise to prove their opinions or to
163 refute the dissenters' opinions (Hempel et al. 2009). In view of this, task conflicts provide conditions
164 for integrating various expertise. In infrastructure projects, in order to effectively solve various complex
165 problems in engineering construction, the cross-functional team needs to hold regular meetings. During
166 this process, task conflicts are inevitable, and through a series of discussions, expertise will be integrated
167 within the team (Sheng et al. 2018). Therefore, the following hypothesis is developed.

168 *Hypothesis 4: In infrastructure projects, the cross-functional team task conflict has a positive effect on*
169 *expertise integration.*

170 ***Moderating Role of Team Autonomy Support***

171 The "differentiation-integration" framework has generally been validated at the top management
172 team level (e.g., Jansen et al. 2009). Since cross-functional teams are middle-level entities in
173 infrastructure projects, drawing on previous studies of middle-level teams, we added the moderating
174 variable "team autonomy support" to the original framework. Team autonomy support refers to the
175 degree of freedom and discretion that the team provides to team members in their work (Liu et al. 2011).
176 In teams with high team autonomy support, team members can largely determine the pace and method
177 of their works (Volmer et al. 2012), determine implement specific actions and solutions on their own
178 (Gonzalez and de Melo 2018). In the past two decades, team autonomy has gradually become an
179 important topic in team research (Gonzalez and de Melo 2018; Liu et al. 2011). It is worth noting that
180 Gil and Pinto (2018) have emphasized the importance of team autonomy support in infrastructure project
181 management. More and more scholars call for taking team autonomy support as a moderator to explore
182 how it affects various team processes (Chang 2016). In particular, Rico et al. (2007) have emphasized
183 that team autonomy may strongly influence the diversity effects in teams.

184 With higher team autonomy support, team members have more initiative and freedom to plan and
185 execute their tasks (Gonzalez and de Melo 2018), which may enhance the effect of team diversity, and
186 lead to more task conflicts (Chang 2016). On the contrary, with lower team autonomy support, team
187 members are subject to many restrictions in completing tasks, which leads to their habitual passive

188 acceptance and a corresponding reduction in task conflict (Volmer et al. 2012). Therefore, the following
189 hypothesis is developed.

190 *Hypothesis 5a: Team autonomy support moderates (reinforces) the effect of cross-functional team*
191 *diversity on task conflict.*

192 In a team with high autonomy support, it creates a better communication and collaboration
193 atmosphere (Chang 2016), which can make full use of the diversity of team members, integrate their
194 expertise, and thus promote the development of high-quality solutions (Rico et al. 2007). In contrast,
195 teams with low autonomy support require team members to follow specific guidelines, which will limit
196 the flow of internal information and knowledge (Lee and Choi 2003), thus weakening the benefits of
197 team diversity and hindering the integration of expertise (Gonzalez and de Melo 2018). In particular,
198 Gil and Pinto (2018) have mentioned that autonomy may facilitate the interactions and integrations in
199 infrastructure project teams. Therefore, the following hypothesis is developed.

200 *Hypothesis 5b: Team autonomy support moderates (reinforces) the effect of cross-functional team*
201 *diversity on expertise integration.*

202 Team autonomy support can promote knowledge exchange and creative thinking, make full use of
203 the benefits of team diversity, and thus create conditions for the realization of both exploitative and
204 exploratory innovation (Chung et al. 2018). In a team with high autonomy support, team members have
205 more opportunities to implement their new ideas into tasks (Wang and Cheng 2010). Conversely, in a
206 team with low autonomy support, team members have less freedom of action and discretion, they have
207 fewer opportunities to implement their new ideas, and correspondingly fewer team innovations (Volmer
208 et al. 2012). Therefore, the following hypothesis is developed.

209 *Hypothesis 5c: Team autonomy support moderates (reinforces) the effect of cross-functional team*
210 *diversity on ambidextrous innovation.*

211 **Methods**

212 *Sample and Data Collection*

213 In order to make the measurement items modified based on classic management scales suitable for
214 measurement in the context of infrastructure projects, a two-round pilot survey was conducted. In the
215 first round, we invited five scholars to check whether the items in the questionnaire were well articulated
216 and could be understood in the context of infrastructure projects. According to the opinions of scholars,
217 we adjusted the original questionnaire. One of the authors of this paper is deeply involved in the
218 Shanghai Pudong International Airport Phase IV construction project. After a cross-functional team
219 meeting, our second round pilot survey was conducted with 11 cross-functional team members of this
220 airport project. These experienced cross-functional team members answered all the questionnaire items
221 and provided feedback about the questionnaire's design. We finally determined the formal questionnaire
222 based on their feedback.

223 As emphasized above, given the crucial role that cross-functional teams play in fostering
224 ambidextrous innovation in infrastructure projects, this study focuses on cross-functional teams.
225 Correspondingly, the respondents are members of these cross-functional teams, and they are usually the
226 heads of various functional departments in infrastructure projects. Because of this, simple random
227 sampling is not applicable to this study, because this method cannot guarantee that the respondents are
228 the heads of functional departments. This study adopted a purposeful sampling approach (Miles and
229 Huberman 1994). Specifically, we distributed the questionnaire in two ways. First, the two authors of

230 this study, as well as the director of the Urban and Rural Planning Bureau we thank in our
231 "Acknowledgment," provided a wealth of reliable contact information of the infrastructure project
232 leaders (such as project managers, top management team members). Through sending the online
233 questionnaire link targeted to these infrastructure project leaders, and asking them to send this
234 questionnaire to their cross-functional teams, we ensured that the respondents met our research design.
235 Second, surveys were collected on-site in several infrastructure project sites. From November 2019 to
236 May 2020, 50 infrastructure project cross-functional teams/361 team members joined our study. Since
237 team diversity is a team-level property, we excluded teams with fewer than three valid questionnaires
238 (see also in Van Veelen and Ufkes, 2019). Finally, 39 teams/313 respondents were considered valid,
239 with an effective rate of 86.7%. The distribution of infrastructure projects and respondents are shown in
240 Table 1.

241 *(Please insert Table 1 here)*

242 **Measures**

243 Team Diversity. The measurement dimensions of team diversity include age diversity, work
244 experience diversity, education level diversity and functional diversity. The questionnaire provides the
245 range options for age, work experience, and education level (see Table 1 for the specific categories),
246 and the functional departments require the respondents to fill in according to their actual situation. Team
247 diversity was calculated using Blau's index (Blau 1977), the calculation formula is: $H = 1 - \sum p_i^2$. In
248 the formula, i refers to the number of different categories, and p refers to the proportion of team members
249 in each category. Age diversity, work experience diversity, etc. can be calculated by Blau's index
250 respectively, and the average of these items is the team diversity index. And the higher the team diversity

251 index, the greater the team diversity. It is worth noting that team diversity is a team-level index, within
252 the same team, although each team member has different demographic characteristics, their team
253 diversity index is equal.

254 Task Conflict. Based on the study of Tjosvold et al. (2006) and Jehn (1995), four items were
255 adopted to measure the frequency and extent of the task conflict within the team, such as “have frequent
256 conflicts about ideas,” “have a large extent difference of opinion,” etc. These items were measured on
257 a seven-point Likert scale, ranging from 1 “completely disagree” to 7 “completely agree.”

258 Expertise Integration. Following the study of Tiwana and Mclean (2005), expertise integration was
259 assessed with four dimensions: the degree to which team members integrate personal expertise at the
260 project level; the degree to which team members’ expertise is applied in the project development; the
261 degree to which the project is understood from a systemic perspective; the degree to which team
262 members combine their expertise with project-level knowledge. The rating scale ranged from 1
263 “completely disagree” to 7 “completely agree.”

264 Team Autonomy Support. To measure the team autonomy support, four measurement items
265 developed by Liu et al. (2011) were used. Specifically, these items involve the degree of team support
266 for members’ individual perspectives, the degree to which the team gives members choice, the degree
267 of team restriction and flexibility. We adopted 1 “completely disagree” to 7 “completely agree” to
268 evaluate these items.

269 Ambidextrous Innovation. In the ambidexterity theory, there is a consensus that ambidextrous
270 innovation is simultaneously pursuing exploratory innovation and exploitative innovation (March 2013;
271 Tushman and O’Reilly 1996). However, there are two different viewpoints. One is that ambidextrous

272 innovation needs the balance between these two innovations (He and Wong 2004), and the other is that
273 ambidextrous innovation needs to maximize the combined effect of these two innovations (Gibson and
274 Birkinshaw 2004; Lubatkin et al. 2006). Cao et al. (2009) synthesized these two viewpoints and
275 developed an operable method for calculating ambidextrous innovation, which has been widely
276 recognized by subsequent ambidexterity studies (e.g., Junni et al. 2013; Lavie et al. 2010). Specifically,
277 Cao et al. (2009) unpacked ambidextrous innovation into two dimensions: balance dimension (BD) and
278 combination dimension (CD). Among them, BD is related to the relative magnitudes or balance of
279 exploratory innovation and exploitative innovation, while CD is related to the combined magnitude of
280 exploratory innovation and exploitative innovation. BD and CD can be respectively calculated by the
281 following formulas: $BD = 5 - |\textit{explorative innovation} - \textit{exploitative innovation}|$, $CD =$
282 $\textit{explorative innovation} \times \textit{exploitative innovation}$ (Cao et al. 2009).

283 In the questionnaire, exploratory innovation and exploitative innovation should be measured
284 respectively, and then BD and CD can be calculated based on the above formula to represent
285 ambidextrous innovation (Cao et al. 2009). The scales developed by He and Wong (2004) for
286 exploitative and exploratory innovation are classic. Based on their scale, and combining some studies
287 on the classification of infrastructure innovation (e.g., Mohammadali et al. 2019), we modified the
288 expression of these scale measures. In the specific questionnaire, respondents were asked to evaluate
289 how their cross-functional team allocates attention and resources between the following innovative
290 activities and goals, and evaluate these items on a scale from 1 “strongly disagree” to 5 “strongly agree.”
291 In the questionnaire, items related to exploratory innovation include: “we prefer to apply new facilities
292 or materials,” “we prefer to develop new technologies,” “we prefer to adopt new services” and “we

293 prefer to adopt innovative processes.” Exploitative innovation includes “we prefer to improve existing
294 facilities, technologies and processes,” “we are concerned about the improvement of the quality of
295 infrastructure projects,” “we are concerned about the reduction in the cost of infrastructure projects,”
296 “we are concerned about the acceleration of infrastructure project progress.” In the current research
297 sample, the exploratory innovation and exploitative innovation scale presented Cronbach’s alphas of
298 0.781 and 0.672, respectively.

299 Control variables. A number of other factors have the potential to impact infrastructure
300 ambidextrous innovation, but are not variables of interest in this study. We control for infrastructure
301 type, investment and cross-functional team size. Infrastructure type was transformed into a categorical
302 variable before being added into the model (there are four categories, as shown in Table 1). Most of the
303 projects we investigated are under construction, and infrastructure investment was measured by the
304 amount of planned investment. The size of a cross-functional team was measured by the number of
305 members.

306 **Results**

307 First, we evaluated the reliability, internal consistency, and construct validity of the measures
308 (measurement model) (Hair et al., 2016). Second, we divided the conceptual model in Fig.1 into three
309 sub-models and tested the hypotheses path through hierarchical regression. Specifically, we used the
310 PROCESS tool developed by Hayes to perform hierarchical regression (Hayes 2017). Among three sub-
311 models, model TC is the model with task conflict as the dependent variable (mainly testing H2a, H5a),
312 model EI is the model with expertise integration as the dependent variable (mainly testing H3a, H4, and
313 H5b), and model AI is the model with ambidextrous innovation as the dependent variable (mainly testing

314 H1, H2b, H3b, and H5c). The moderating effect was tested by constructing the interaction between the
315 independent variable and the moderating variable. In addition, the bootstrapping approach (5000
316 resamples) was used to examine the effect and get robust standard errors for parameter estimates.

317 ***Measurement Model***

318 As shown in table 2, Cronbach's α were greater than 0.7 (Hair Jr et al. 2016) in all scales except
319 for the team diversity scale, which was 0.681, indicating an internal consistency. Among 18 items, the
320 loadings of 13 items were higher than 0.7, and 5 items were around 0.6, higher than the threshold of 0.5
321 (Hair Jr et al. 2016). The values of construct reliability (CR) of each construct exceed 0.8, and were
322 higher than the 0.7 threshold (Bagozzi and Yi 1988), indicating the structural reliability was satisfactory.
323 The AVE values of all constructs were higher than the 0.5 cutoff (Fornell and Larcker 1981), indicating
324 a good convergence validity.

325 *(Please insert Table 2 here)*

326 ***Structural Model***

327 Table 3 reports the results of hierarchical regression with bootstrapping of 5,000 subsamples.
328 Model TC is a model with task conflict as the dependent variable, and mainly test H2a and H5a. The
329 results show that team diversity has a significant positive effect on task conflict ($\beta = 0.7192$, $p < 0.001$),
330 supporting H2a. While the moderating effect of the team autonomy support on the relation between
331 team diversity and task conflict is not significant ($\beta = -0.0013$, n.s.), not supporting H5a. Model EI is a
332 model with expertise integration as the dependent variable, and mainly test H3a, H4, and H5b. The
333 results show that team diversity has a positive impact on expertise integration ($\beta = 0.2774$, $p < 0.01$),
334 supporting H3a. Task conflict has a positive impact on expertise integration ($\beta = 0.3209$, $p < 0.001$),

335 supporting H4. In addition, we estimated the moderating effect of the team autonomy support on the
336 relation between team diversity and expertise integration ($\beta = -0.1686$, $p < 0.01$), which is contrary to
337 H3b. That is to say, team autonomy support negatively moderates the effect of team diversity on
338 expertise integration. Model AI is a model with ambidextrous innovation as the dependent variable, and
339 mainly test H1, H2b, H3b, and H5c. The results show that team diversity has a significant positive effect
340 on ambidextrous innovation ($\beta = 0.4769$, $p < 0.001$), supporting H1. However, the relationship between
341 task conflict and ambidextrous innovation is not significant ($\beta = 0.0691$, n.s.), not supporting H2b. The
342 relationship between expertise integration and ambidextrous innovation is positive ($\beta = 0.1762$, $p <$
343 0.01), supporting H5. These show that task conflict cannot directly mediate the relationship between
344 team diversity and ambidextrous innovation, and the relationship between them needs to be mediated
345 through expertise integration or other team processes. In addition, we estimated the moderating effect
346 of the team autonomy support on the relation between team diversity and ambidextrous innovation ($\beta =$
347 0.628 , $p < 0.05$), supporting H5c. This suggests that high levels of team autonomy support strengthen
348 the positive relationship between team diversity and ambidextrous innovation.

349 *(Please insert Table 3 here)*

350 We conducted sample slope analysis on H5b and H5c respectively to further interpret the
351 moderating effect (Fig. 2A). Fig. 2A shows that when the level of team autonomy support is high, the
352 positive impact of team diversity on expertise integration is weakened. In contrast, the positive impact
353 of team diversity on ambidextrous innovation is enhanced. However, slope analysis can only show the
354 indirect effect under two different values of the moderating variable, and cannot fully reflect the overall
355 picture of the indirect effect. In order to overcome this shortcoming, this study draws on the practice of

356 some recent studies (Preacher et al. 2007), and used the Johnson-Neyman technique to plot the indirect
357 effect with an accompanying 95% confidence band (Fig. 2B). As shown in Fig. 2B, high levels of team
358 autonomy support weaken the effect between team diversity and expertise integration, strength the effect
359 between team diversity and ambidextrous innovation.

360 *(Please insert Fig. 2 here)*

361 **Discussion**

362 Overall, the results indicated that the differentiation and integration of diverse teams provide
363 powerful tactics for fostering ambidextrous innovation in infrastructure projects. Specifically, team
364 diversity was found to have a significant positive impact on ambidextrous innovation of the cross-
365 functional team in infrastructure construction projects (H1). The same results were obtained by Li et
366 al. in a survey of high-tech firms (Li et al. 2016). The differences in the team members' age, work
367 experience, education level, and the functional departments they work in will affect their attentions
368 and preferences. Many team decisions, including the choice between exploratory innovation and
369 exploitative innovation, stem from the conflict and integration of these differences (Junni et al. 2015).
370 Therefore, to achieve ambidextrous innovation, when assembling the cross-functional team, it is
371 important to focus not only on the choices of individual team members, but also on the diversity of the
372 entire team (Liu and Leitner 2012).

373 In the cross-functional team of infrastructure projects, team diversity has a positive impact on task
374 conflict (H2a). This is particularly true in the practice of infrastructure projects, where cross-functional
375 team members often represent different functional departments, and they have different understandings
376 of the assignment of project tasks and the prioritization of project goals, which can trigger task conflicts

377 (Wu et al. 2020). Expertise integration partially mediates the relationship between team diversity and
378 ambidextrous innovation in the cross-functional teams of infrastructure projects (H3a, H3b). This is
379 consistent with the results obtained by Tiwana and Mclean (2005) in the information systems
380 development project. In infrastructure project practice, team members with different demographics have
381 different expertise, and diverse teams are better at integrating expertise than homogeneous teams
382 (Lehtinen et al. 2019). Kardes et al. (2013) have also emphasized the high diversity of global
383 megaproject teams, which will promote the integration of expertise. And such teams are more likely to
384 pursue exploratory and exploitative innovations simultaneously (Halevi et al. 2015).

385 Interestingly, our results show that in infrastructure projects, cross-functional team task conflict
386 has no direct impact on ambidextrous innovation (H2b). However, task conflict can indirectly affect
387 ambidextrous innovation through expertise integration (H4). The result of H2b is in contrast to previous
388 related studies, Wu et al. (2017) found a positive relationship between task conflict and the performance
389 of construction projects in China, Khosravi et al. (2020) found a negative relationship between task
390 conflict and the performance of large-scale infrastructure projects. Regarding H2b, previous studies
391 have also shown that the impact of task conflict on team outcomes is ambiguous, indeed, there is
392 empirical evidence show a positive (e.g., De Clercq et al. 2009), negative (e.g., Camelo-Ordaz et al.
393 2015), nonsignificant (Liu et al. 2009) association between task conflict and team outcomes. Some
394 studies suggest that different effects of task conflict on team outcomes depend on different responses to
395 the conflict, which can be roughly divided into cooperative and competitive responses (Deutsch et al.
396 2011). The cooperative responses to task conflict tend to increase the desirable team outcomes, such as
397 team cooperation, satisfaction, innovation, and team performance (Hempel et al. 2009). While the

398 competitive responses may induce relationship conflicts, suspicions and mistrusts, which often
399 negatively impact team outcomes (Simons and Peterson 2000). These are also consistent with our
400 empirical findings that task conflict positively affects ambidextrous innovation through expertise
401 integration. Therefore, in infrastructure projects, cross-functional teams should encourage team
402 members to take cooperative responses to task conflict, and to fully exert the positive impact of the task
403 conflict on the ambidextrous innovation through positive processes such as expertise integration.

404 Surprisingly, the moderating effects of team autonomy support on the relationship between team
405 diversity and task conflict (H7a, not significant moderation), team diversity and expertise integration
406 (H7b, negative moderation), team diversity and ambidextrous innovation (H7c, positive moderation)
407 present three different results. Correspondingly, ecology theory, agency theory, and strategic choice
408 theory have also proposed contradictory predictions about the impact of team autonomy support on team
409 outcomes. Ecology theory holds that the structure or external influences of the team itself are so decisive
410 that the manager cannot have any systemic influence on the team (Hannan and Freeman 1977), so team
411 autonomy support is unrelated to team processes and outcomes (CAZA 2011). Concerning team
412 autonomy support, agency theory argues that principals must pay close attention to the behaviors of
413 agents, because the agents' personal interests are likely to conflict with the principals' interests (Jensen
414 and Meckling 1979). Agency theory assumes that the more autonomy managers have, the more they can
415 shift resources from team performance to their personal goals (Bottom et al. 2006). As a result, team
416 autonomy support may have a negative impact on team processes or outcomes. Unlike agency theory,
417 which assumes that managers will use the team autonomy support to pursue personal interests at the
418 expense of the team performance, strategic choice theory assumes that managers will use their discretion

419 to benefit the team performance (Child 1972). Strategic choice theory takes into account the importance
420 of the issues such as organizational commitment, promotion opportunities, and job dependence, which
421 can motivate managers to prioritize the interests of the entire team when taking actions (Marlin et al.
422 1994). Thus team autonomy may have a positive impact on team processes and outcomes. Therefore,
423 current theory does not seem to provide consistent guidance for team autonomy support in management
424 practice (CAZA 2011).

425 **Conclusions**

426 In order to address the practical need to integrate exploratory and exploitative innovations in
427 infrastructure practice, and to fill the gap in the literature that is still unclear on how to foster
428 ambidextrous innovation in infrastructure projects, this study draw on the "difference-integration"
429 framework of ambidexterity theory to deconstruct tactics for fostering ambidextrous innovation in
430 infrastructure projects. The findings suggest that in infrastructure projects, task conflict and expertise
431 integration of diverse cross-functional teams provide powerful and complementary tactics for fostering
432 ambidextrous innovation. The moderating effect of team autonomy support on the impact of team
433 diversity on differentiation and integration tactics presents three different results.

434 This study makes three contributions to infrastructure project innovation and ambidexterity
435 literature. First, unlike most infrastructure project innovation research, we are not looking at general
436 innovation or one-dimensional innovation, but rather at the comprehensive effect of exploratory and
437 exploitative innovation. As emphasized above, it is urgent to be solved in infrastructure project practice,
438 but existing research only emphasized the importance of ambidextrous innovation in infrastructure
439 projects, and there is a lack of research on how to achieve ambidextrous innovation in infrastructure

440 projects. To bridge this gap, this paper explores tactics for fostering ambidextrous innovation in
441 infrastructure projects by applying the "differentiation-integration" framework to infrastructure projects.
442 In doing so, this study not only enriches the literature on how infrastructure projects foster ambidextrous
443 innovation, but also broadens the application of the "differentiation-integration" framework of
444 ambidexterity theory. Second, previous ambidexterity research mainly focused on the organizational,
445 individual and top management team levels, while in this study, combining the characteristics of
446 infrastructure projects, the cross-functional team was selected as the research object. In this way, this
447 study not only expands the level of ambidexterity research, but also provides a novel interpretation of
448 the role of cross-functional teams in fostering ambidexterity. Third, ambidextrous innovation has
449 traditionally been pursued in relatively permanent organizations (e.g., companies, Worsnop et al., 2016).
450 However, it is because of the one-off, temporary and complex characteristics of infrastructure projects,
451 they need to pursue exploitative and exploratory innovation simultaneously (Davies et al. 2014; Liu and
452 Leitner 2012). Consistent with this, scholars and engineering practitioners are increasingly recognizing
453 that infrastructure projects may be the best context to contextualize ambidexterity into practice (Petro et
454 al. 2019). By responding to this, we have also broadened the application context for ambidexterity
455 research.

456 Our findings also have some practical implications for infrastructure project practice. First, we
457 confirmed the positive impact of team diversity on ambidextrous innovation, so when assembling the
458 cross-functional team, it is important to pay attention not only to the individual characteristics and traits
459 of team members, but also to the diversity of the whole team. That is, not all members of a cross-
460 functional team are as old and experienced as possible, and diverse teams are better at fostering

461 ambidextrous innovation in infrastructure projects. Second, we confirmed the direct and indirect effects
462 of the task conflict and expertise integration on ambidextrous innovation. These suggest that the cross-
463 functional teams don't have to worry about task conflicts, which may inspire more collisions of ideas.
464 And team members need to be actively guided to take collaborative responses to task conflicts, which
465 will better facilitate ambidextrous innovation. In infrastructure project practice, in order to effectively
466 allocate and integrate engineering resources, solve and make decisions on various complex problems,
467 the cross-functional teams need to hold regular meetings or special meetings (Sheng et al. 2018). In this
468 process, task conflicts are inevitable, and it is in this process that expertise can be integrated into team-
469 level and stimulate ambidextrous innovation (Liu and Leitner 2012). Third, it is inconsistent with the
470 results of most studies that team autonomy support will positively moderate the relationship between
471 team diversity and team outcomes. In our study, the moderating effects of team autonomy support appear
472 three different results: non-significant, negative and positive. This may be due to the characteristics of
473 infrastructure projects, or it may be due to the limitations of the current research sample, but it is still
474 worth noting that the degree of autonomy support given to the cross-functional team needs to be
475 considered more carefully based on the characteristics of different infrastructure projects.

476 Some limitations suggest directions for future research. First, the gap in the literature is that it is
477 not yet clear how ambidextrous innovation can be achieved in infrastructure projects, and in this study,
478 we have only validated that differentiation and integration are powerful tactics. However, there are still
479 many other tactics for fostering ambidextrous innovation, but this study has not covered them, therefore,
480 in-depth case studies are needed to guide infrastructure project practices in a more comprehensive way.
481 Second, for the measurement of ambidextrous innovation, similar to previous studies, it was obtained

482 by calculating questionnaire items, although we have modified the questionnaire measurement items
483 based on the infrastructure project context, this approach is still subjective. In infrastructure projects,
484 innovation may be manifested as patents and technology awards. However, since most of the
485 infrastructure projects investigated in this paper are under construction, we have not yet measured
486 innovation in this more objective way, which is the direction of our next research efforts.

487 **Data Availability Statement**

488 Data generated or analyzed during the study are available from the corresponding author by request.

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Table Captions

Table 1. Profiles of infrastructure projects and respondents

Table 2. Measurement model evaluation

Table 3. Structural model evaluation

Note. 5000 bootstrap samples. LLCI / ULCI: The highest / lowest value of the 95% confidence interval.

TD: Team diversity; TC: Task conflict; EI: Expertise integration; TAS: Team autonomy support; AI:

Ambidextrous innovation. * $<.05$, ** $<.01$, *** $<.001$.

Figure Captions

Fig. 1. Conceptual framework and hypotheses

Fig. 2. Moderating effect test

Table 1. Profiles of infrastructure projects and respondents

Item	Number	Percentage
<i>Infrastructure projects types</i>		
Transportation infrastructures	16	41.0%
Environmental and public facilities	12	30.8%
Energy and hydropower facilities	6	15.4%
Education and health infrastructure	5	12.8%
<i>Respondents information</i>		
Age		
<30	10	3.2%
30-40	90	28.8%
40-50	151	48.2%
>50	62	19.8%
Work experience		
<5	21	6.7%
5-10	60	19.2%
10-15	137	43.8%
>15	95	30.4%
Education level		
High school and below	38	12.1%
Undergraduate	160	51.1%
Master	95	30.4%
Doctor	20	6.4%

Table 2. Measurement model evaluation

Construct/item	Loading	Cronbach's α	CR	AVE
Team diversity (TD)		0.681	0.809	0.518
TD1: Age diversity	0.775			
TD2: Functional diversity	0.663			
TD3: Work experience diversity	0.827			
TD4: Education level diversity	0.590			
Task conflict (TC) (Jehn 1995; Tjosvold et al. 2006)		0.791	0.865	0.617
TC1: Team members have a great deal of disagreement about the work being done.	0.891			
TC2: Team members have frequent conflicts about ideas.	0.741			
TC3: There is a great deal of conflict between the work of team members.	0.748			
TC4: There are a large extent differences of opinion in our team.	0.751			
Expertise integration (EI) (Tiwana and Mclean 2005)		0.704	0.816	0.527
EI1: Members of this team synthesize and integrate their individual expertise at the project level.	0.668			
EI2: Members of this team span several areas of expertise to develop shared project concepts.	0.731			
EI3: Members of this team can clearly see how different pieces of this project fit together.	0.772			
EI4: Members of this team competently blend new project-related knowledge with what they already know.	0.730			
Team autonomy support (TAS) (Liu et al. 2011)		0.716	0.825	0.544
TAS1: Our team is supportive of team members' individual perspectives.	0.842			
TAS2: Our team gives us a great deal of choice.	0.687			
TAS3: Our team is constrained with regard to team members' self-initiation (Reverse coded).	0.637			
TAS4: Our team is flexible.	0.768			
Ambidextrous innovation (AI) (Cao et al. 2009; He and Wong 2004)		0.826	0.917	0.847
Balance dimension of ambidexterity (BD)	0.889			
Combined dimension of ambidexterity (CD)	0.951			

Table 3. Structural model evaluation

Variables	Model TC				Model EI				Model AI			
	Coeff	SE	LLCI	ULCI	Coeff	SE	LLCI	ULCI	Coeff	SE	LLCI	ULCI
TD	.7192***	.0626	.5960	.8425	.2774***	.0783	.1234	.4314	.4769***	.0757	.3279	.6259
TC	—	—	—	—	.3209***	.0597	.2034	.4384	.0691 ^{n.s.}	.0592	-.0475	.1856
EI	—	—	—	—	—	—	—	—	.1762**	.0543	.0694	.2830
TAS	-.0217 ^{n.s.}	.0527	-.1253	.0819	.0999 ^{n.s.}	.0550	-.0084	.2081	.0524 ^{n.s.}	.0524	-.0508	.1556
TD×TAS	-.0013 ^{n.s.}	.0502	-.0999	.0974	-.1686**	.0524	-.2717	-.0655	.0628*	.0505	.0366	.1622
C.Type	.0421 ^{n.s.}	.0466	-.0496	.1338	-.1043 ^{n.s.}	.0488	-.2002	.0084	-.0031 ^{n.s.}	.0466	-.0947	.0886
C.Investment	-.0005 ^{n.s.}	.0004	-.0013	.0002	-.0011**	.0004	-.0019	-.0003	.0003 ^{n.s.}	.0004	-.0004	.0011
C.Team size	.0071 ^{n.s.}	.0174	-.0271	.0412	-.0213 ^{n.s.}	.0181	-.0570	.0143	.0389*	.0172	.0050	.0728
R ²		.5042				.4609				.5168		
F		51.8670				37.2456				40.6424		

Note. 5000 bootstrap samples. LLCI / ULCI: The highest / lowest value of the 95% confidence interval.

TD: Team diversity; TC: Task conflict; EI: Expertise integration; TAS: Team autonomy support; AI: Ambidextrous innovation. * < .05, ** < .01, *** < .001.

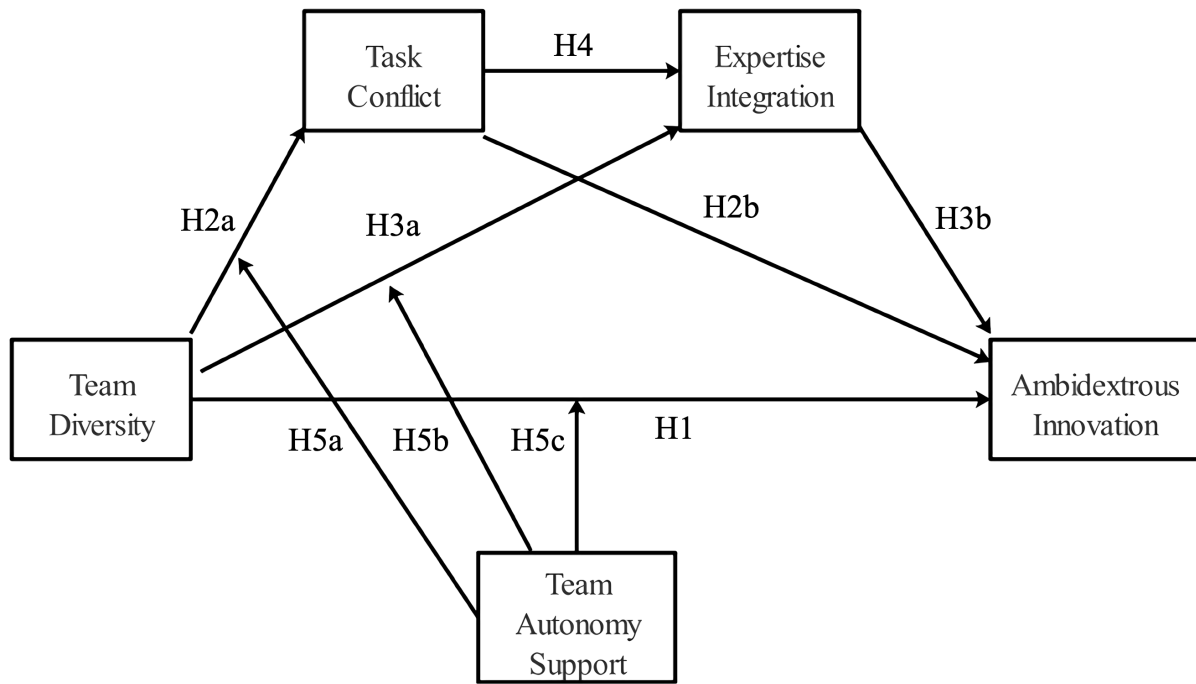
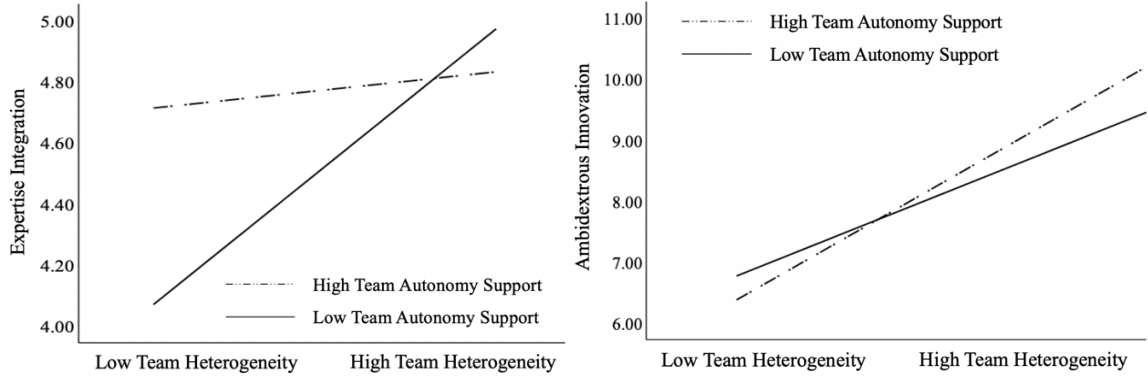
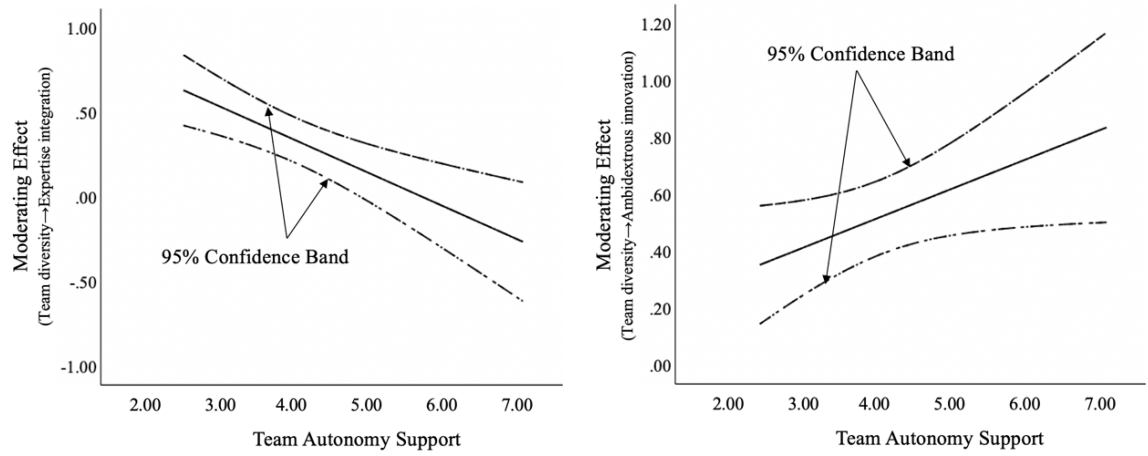


Fig. 1. Conceptual framework and hypotheses.



A. Slope analysis



B. Johnson-Neyman outputs

Fig. 2. Moderating effect test.