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Role of Open Innovation Strategies in Creating and Enhancing Sustainable Performance in the Hospitality Sector in Pakistan. A Mediated, Moderated Model

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ABSTRACT

The hospitality industry in Pakistan is under pressure to innovate and optimize resources in developing sustainable environmental performance (SP). As a result, this paper examines the antecedents of SP, namely, Open Innovation (OI), Organizational Dynamic Capabilities (DC), and Innovative Culture (IC). The main aim of this study is to analyse the direct effect of OI on DC, the effect of DC on SP, the mediating effect of DC on the relationship between OI and SP, and the moderating influence of IC on the effect of DC on SP. Quantitative research was conducted and data was obtained through a structured questionnaire developed for the study and distributed through Google Forms targeting the hospitality sector in Pakistan. Among the 450 distributed questionnaires, 375 questionnaires were accepted for analysis using the SmartPLS software. The study showed that OI had a direct positive effect on DC which also resulted in a positive effect on SP. Furthermore, it was found that DC acted as a mediator in the OI–SP relationship, while IC mediated the relationship between DC and SP. Therefore, the study is useful in helping hospitality managers understand how to implement OI to build DC, support IC and achieve sustainable SP and competitive advantage in a world where sustainability has become imperative.

Keywords: *Open innovation, organizational dynamic capabilities, innovative culture, hospitality sector, Pakistan.*

INTRODUCTION

Due to higher multifaceted environmental pressures and dynamically changing markets, hospitality industries are in search of ways to maintain the balance between innovation and sustainability (Lucas et al., 2024). Open innovation, whereby firms look for knowledge outside the organization and build partners with other organizations in the business world, has emerged as a strategic approach to help firms work towards sustainability and innovation to remain relevant in the market (Sarango-Lalangui et al., 2023). However, translating the idea of open innovation into realities and tangible improvements to the environment is not an easy task. This challenge stems from the proposition that a firm is not able to effectively address the acquisition, translation and integration of externally sourced knowledge into

environmentally sustainable strategies and practices (Phonthanukitithaworn et al., 2023). In this regard, dynamic capabilities are essential for sensing opportunity, making the most out of it, and re-configuring resources to embrace sustainability (Hajiheydari et al., 2023). Organizational innovation refers to the process of implementing change in culture and encourage risk-taking, experimentation, and learning (Mogaji & Dimingu, 2024). Scholars suggest that firms with an innovative culture and climate foster knowledge sharing, accept failure in achieving sustainable goals, and cultivate green innovation investment (Hao et al., 2024).

While open innovation and sustainability have attracted a lot of research attention, extant knowledge does not offer insights into how dynamic capabilities influence the creation of sustainable environmental value from open innovation efforts. Although prior studies have touched on open innovation, dynamic capabilities, and sustainability separately (Hajiheydari et al., 2023; Sarango-Lalangui et al., 2023), few have explored their interrelations, especially the mediating role of dynamic capabilities between open innovation and environmental performance in the hospitality sector. Furthermore, there is a lack of research investigating how organizational innovative culture acts as a moderator and how it can be utilized to improve capability deployment and green innovation outcomes. This gap points towards the direction of research that seeks to bring the concepts together to develop a coherent framework that can be applied by the hospitality sector that is interested in pursuing sustainable innovation strategies. Addressing this gap can provide useful information to both theorists and practitioners who seek to pursue sustainable strategies amid growing intensity and market maturity.

Despite growing research on open innovation (Rumanti et al., 2023), the relationship between open innovation and dynamic capabilities necessary for managing external knowledge among hospitality organizations remains unclear. Thus, the first objective of this study is to analyse the role of an open innovation approach in enhancing the dynamic capabilities within hospitality industries and allowing them to foster sustainable internal structures. Further, while dynamic capabilities are acknowledged as significant (Hajiheydari et al., 2023), very few studies have specifically addressed their role in environmental sustainability. Therefore, the other objective is examining this relationship to give a better understanding of how capabilities can be utilized to attain the objectives of organizations about the environment. Furthermore, it is still unclear whether dynamic capabilities mediate the relationship between open innovation strategy and sustainable environmental performance. This way the study expatiates on how innovation strategies lead to sustainability outcomes. Lastly, there are analyses on organizational innovative culture (Al-Khatib et al., 2022), whereas the moderating effect of this construct on dynamic capabilities has not received adequate scholarly attention. Studying this relationship will contribute to relating the dynamics capabilities to the organizational culture that supports sustainability in organizations.

The importance of this study lies in building a balanced understanding of open innovation, dynamic capabilities, and organizational innovative culture while examining their role in improving a firm's sustainable environmental performance according to the Technology-Organization-Environment (TOE) model. The results will aid the hospitality firms to co-ordinate the innovation process with sustainability objectives to provide clear steps on creating sustainable, competitive and environmentally conscious organizations.

LITERATURE REVIEW

Theoretical Background

The Technology-Organization-Environment (TOE) framework is a theoretical model that offers an understanding of how organizations enable and incorporate technological innovations depending on the contexts of technology, organization, and the environment (Malik et al., 2021). From the analysis of the external and internal environment, the TOE framework helps to identify dynamic capabilities and manage them toward deriving value to achieve the benefits that result in sustainable returns. As for the technological aspect, the availability and advancement of technology define a firm's open innovation readiness (Li et al., 2022). This includes the actualization of new technologies as well as a technology integration strategy, that aims to enhance organizational environmental accountability and effectiveness, such as green technologies, environmentally conscious production processes, and digital tools for engaging with other stakeholders (Rehman Khan et al., 2022). The organizational context entails factors that exist within the organizational environment that can support or undermine innovation and sustainability. Dynamic capabilities like recognizing the opportunity, partaking in the opportunity, and re configuring resources play a vital role in enhancing the execution of open innovation and enhancing environmental performance (Linde et al., 2021).

Also, there is a role in an organizational innovative culture for the development of dynamic capabilities with the help of the components of the culture of an organizational innovation willingness to take risks and sustainably innovate (Alateeg & Alhammadi, 2024). Besides, the environmental context includes challenges like legal requirements, competition, and customer expectations of sustainable business operations. These external forces lead firms to pursue open innovation strategies and improve dynamic capabilities to remain competitive while conforming to environmental requirements (Ma et al., 2025). Thus, by applying the TOE framework, the researcher elaborates on how technology, organization, and environment jointly influence how dynamic capabilities mediate between open innovation and sustainable environmental performance within hospitality industries; however, it is equally important to acknowledge that developing an innovative organizational culture enhances the connection between the factors by fostering a positive internal context for change and Eco-innovation.

Open Innovation Strategy and Organizational Dynamic Capabilities

Open innovation strategy has a highly significant and positive correlation with organizational dynamic capabilities as the latter are built around the acquisition, integration, and exploitation of external knowledge in the face of dynamic environments. Through the open innovation concept, organizations engage external stakeholders including suppliers, customers, research institutions, and even rivals to improve innovation processes (Adamides & Karacapilidis 2020). This type of external engagement fosters the enhancement of the key dynamic capabilities essential for perceiving opportunities, leveraging them to achieve competitive advantage, and rearranging organizational resources for advantage. Open innovation is compatible with dynamic capability requirements because it allows organizations to develop a broader pool of knowledge and be ready for new technologies, customers' needs, and unpredictable external events (Pundziene et al., 2022). Moreover, it also enables an organization to identify relevant business opportunities and introduce perspectives from other individuals more effectively and quickly, as well as adapt the organization's internal environment to ensure its continued feasibility (Settembre-Blundo et al., 2021).

Notably, open innovation enables learning, which fosters the development of effective routines that improve knowledge acquisition and application, which is fundamental for long-term competitiveness. The

current world provokes not only internal adaptation but also an extensive web of relationships facilitating constant movement and change (Lepore et al., 2023). In this way, firms work to increase their flexibility while operating in shifting market environments and responding to stakeholder expectations (Costa & Matias, 2020). Altogether, open innovation works as a driving force for dynamic capabilities and emphasizes agility, collaboration, and appropriate management of internal and extra-organizational knowledge to sustain competitiveness in fluctuating settings (van Lieshout et al., 2021).

Previous literature establishes that open innovation enhances dynamic capabilities; however, the previous research has given limited attention to the sustainability implications of competitive advantage and technology. There is little understanding of how organizational culture sustains this process. This paper addresses these gaps by exploring how dynamic capabilities transform open innovation into improved environmental performance and how culturally open innovation amplifies this effect on sustainable development. Thus, in light of the above discussion, the following hypothesis can be formulated:
H1: Open innovation strategy has a significant relationship with organizational dynamic capabilities.

Organizational Dynamic Capabilities and Sustainable Environmental Performance

Organizational dynamic capabilities are indispensable to sustainable environmental performance to help organizations adapt, create new solutions, and effectively manage environmental issues. Perceiving opportunities and threats in the environment, as well as green innovation opportunities and resource mobilization towards sustainability, help organizations align their procedures with the overall environmental objectives (Bari et al., 2022). The global society and markets today require companies to minimize their effects on the environment, following demands from the regulations, shareholders and the markets. Thus, identifying dynamic capabilities enables the discovery of cleaner production options, better energy utilization, reduced waste, and the development of sustainable goods and services. These capabilities enable the optimization and creation of sustainable solutions in response to various business issues, in the long-term pursuit of environmental change rather than short-term revolution (Akhtar et al., 2020).

Moreover, dynamic capabilities involve external factors such as suppliers, customers, and research institutions to develop sustainable solutions. This facilitates the acquisition of new innovative technologies and practices in the realm of sustainability to support the process of attaining a sustainable world (Sun & Zhang, 2022). Furthermore, dynamic capabilities can assist in evolving the current organizational practices or architecture based on new benchmarks for effectiveness and sustenance of competitive advantage. Sustainability integration as a performance measure in strategic choices and regular business activities enables organizations to harmonize financial profitability with environmental management (Akhtar et al., 2020). Therefore, dynamic capabilities offer the flexibility, cognition, and resources needed to advance innovative solutions while maximizing utility to implement them profitably and sustainably (Gyemang & Emeagwali, 2020). Therefore, the following hypothesis can be proposed:
H2: Organizational dynamic capabilities have a significant impact on sustainable environmental performance.

Mediation of Organizational Dynamic Capabilities

Organizational dynamic capabilities mediate the relationship between open innovation strategy and sustainable environmental performance. While open innovation allows organizations to acquire external knowledge, technologies, and partnerships necessary for sustenance and growth, dynamic capabilities create the robust mechanism that bridges the gap between the external environment and an organization's ability to utilize outside knowledge to achieve environmental goals and objectives (Buzzao & Rizzi, 2021). Thus, if firms lack dynamic capabilities, the possibilities of open innovation will not be

sufficiently realized because firms are unable to integrate external ideas into their internal environment or adjust them to sustainability objectives. The dynamic capability makes sure that the knowledge gained from open innovation gets implemented on the ground and leads to improved performance in the environment. It allows organizations to respond to environmental signals, optimize processes, and incorporate sustainability into products or services (Linde et al., 2021). In this way, dynamic capabilities operationalise the innovation and sustainability between the technological and environmental contexts, while ensuring that open innovation leads to both, improved technologies and more sustainable environments. It also shows the relevance of integrating dynamic capabilities for enhancing sustainability outcomes of open innovation (Pundziene et al., 2022). Therefore, the following hypothesis can be proposed:

H3: Organizational dynamic capabilities mediate the relationship between open innovation strategy and sustainable environmental performance.

Moderation of Organizational Innovative Culture

Organizational innovative culture moderates the relationship between organizational dynamic capabilities and sustainable environmental performance. While dynamic capabilities allow firms to detect opportunities, capture greener innovations, and reconfigure assets for sustainability, the strengths of these capabilities depend on the organizational culture for innovation (Teece, 2020). A culture of innovation that embraces change, creativity, risk, and learning facilitates the accumulation and application of dynamic capabilities and enhances their positive impact on the environment. That is, employees in innovation-cultured organizations are more supportive of initiatives for sustainability, willing to try out solutions that can minimize the effects of their actions on the environment and have more efforts to find new ways of working that will have a positive impact on the environment. This cultural support elevates the dynamic capability as it creates the right attitude and perspective towards translating sustainability themes into tangible outcomes (Wang et al., 2022). In contrast, in organizations with a weak culture of innovation, the full potential of developing dynamic capabilities might not be sufficient as a lack of change mentality can negatively impact the achievement of environmental objectives. Hence, dynamic capabilities receive support from the organizational innovative culture that fosters and amplifies the improvement of sustainable environmental performance on innovations, including green growth that not only identifies but also implements and sustains such innovations (Singh et al., 2022).

Much of the prior research acknowledges the importance of innovative culture in promoting sustainability, however, limited studies focus on the moderating role of innovative culture between dynamic capabilities and sustainable environmental performance. This research therefore seeks to fill this gap by examining how the culture of innovation enhances the efficiency of dynamic capabilities to support the development and implementation of sustainability solutions for environmental gains. Thus, in light of the above discussion, the following hypothesis can be formulated:

H4: Organizational innovative culture moderates the relationship between organizational dynamic capabilities and sustainable environmental performance.

The following figure represents the conceptual framework of the study:

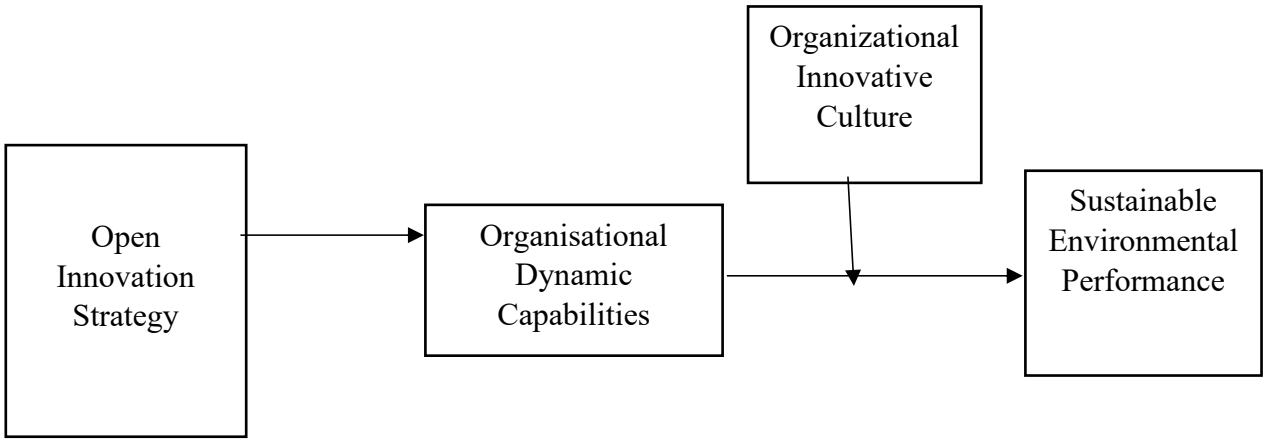

Figure 2.1. Conceptual Framework

(Source: Author-Generated)

METHODOLOGY

Research Type

This research used a quantitative research design to test the study variables. This type was chosen because it allows for the systematic determination of relationships between variables to test hypotheses and to obtain generalized results in a larger population (Duckett, 2021). The structured methods of data collection including surveys ensure the analysis of the results is done objectively so the proposed model can be statistically tested (Ghanad, 2023).

Participants and Data Collection Method

The participants of this study were the employees of the hospitality sector in Pakistan. Table 3.1 shows that the study has 35 items. According to the Item Response Theory, the target number of questionnaires should be 350 (Şahin & Anıl, 2017). Due to missing values in some of the surveys, 450 questionnaires were distributed to employees in the hospitality sector in Pakistan. Among these, 400 were returned, which point towards a good response rate. Thus, excluding the questionnaires that were either incomplete or invalid, 375 valid responses were obtained. So, the sample size of the study was 375.

The data for this study was gathered through Google Forms, an online survey instrument. Google Forms was chosen because it is cost-efficient, easily accessible, and could be completed from the comfort of the participants' homes. Also, it centralizes data and response management and eliminates human error through self-reporting, which makes it a practical tool for obtaining large-scale structured data in quantitative research (Khan, 2024).

Data Analysis Procedure

Data was analyzed using SmartPLS, a preferred software used in Structural Equation Modelling (SEM). SmartPLS was chosen because of its suitability in analyzing models with multiple constructs in the context of small to medium-sized samples. It is especially beneficial for exploratory research to examine the association of variables and for testing measurement models while yielding accurate estimates of reliability (Subhaktiyasa, 2024).

Instrumentation

All items were measured using a five-point Likert scale ranging from "strongly disagree" to "strongly agree". The following table contains the constructs, number of items, and sources of scales:

Table 3.1. Number of Items and Sources of Scales

Construct	Number of Items	Source
Innovative Culture	8	Jegerson et al. (2024), adapted from Tellis et al. (2009) and Martensen et al. (2007)
Dynamic Capabilities	12	Jie et al. (2025), adapted from Lin and Wu (2014)
Open Innovation	7	Tra et al. (2024), adapted from Hameed et al. (2018)
Sustainable Environmental Performance	8	Roscoe et al. (2019), adapted from Montabon et al. (2007)

RESULTS

Measurement Model Estimates

Table 4.1 displays the reliability and construct validity of the study variables, specifically, the convergent validity. Item loadings should be greater than 0.70, CR should be higher than 0.70, and AVE should be higher than 0.50 to ensure the proper reliability and validity of the measures (Ismail et al., 2020; Knekta et al., 2019). For DC, all the item loadings lie between 0.738 and 0.836, suggesting that they satisfy the criteria. The CR of 0.935 and AVE of 0.614 support the internal consistency, reliability, and convergent validity of the construct. Likewise, for IC, loadings range between 0.768 and 0.889, with the CR being 0.943 and AVE at 0.705, meaning the criteria are met. OI has loadings ranging from 0.804 and 0.875, a CR of 0.945 and an AVE of .710 indicating that it is reliable. Finally, for the convergent validity test, SP has estimates ranging between 0.815 and 0.886, CR of 0.955, and AVE of 0.727, all of which are above the threshold levels. These findings support the high construct reliability and convergent validity of the variables, which enables the measurement model to move on to subsequent stages of analysis.

Table 4.1. Construct Reliability and Convergent Validity

Construct	Item	Loading	Composite Reliability (CR)	Average Variance Extracted (AVE)
Dynamic Capabilities (DC)	DC1	0.816	0.935	0.614
	DC2	0.805		
	DC3	0.836		
	DC4	0.782		
	DC5	0.759		
	DC9	0.795		
	DC10	0.738		
	DC11	0.744		
	DC12	0.772		
Innovative Culture (IC)	IC1	0.885	0.943	0.705

	IC2	0.768		
	IC3	0.794		
	IC4	0.824		
	IC5	0.833		
	IC6	0.877		
	IC7	0.889		
Open Innovation (OI)	OI1	0.862	0.945	0.710
	OI2	0.804		
	OI3	0.814		
	OI4	0.833		
	OI5	0.875		
	OI6	0.870		
	OI7	0.840		
Sustainable Environmental Performance (SP)	SP1	0.886	0.955	0.727
	SP2	0.839		
	SP3	0.846		
	SP4	0.863		
	SP5	0.870		
	SP6	0.864		
	SP7	0.838		
	SP8	0.815		

Discriminant Validity Analysis

Table 4.2 tests the discriminant validity using the Fornell and Larcker criterion where the diagonal value (square root of AVE) should always be higher than the off-diagonal value (Abdulla & Al-shami, 2023). The square roots of AVE for DC (0.784), IC (0.840), OI (0.843), and SP (0.853) all exceed their respective inter-construct correlations. This means that the current analysis verified that each construct is significantly different from the other constructs, an indication of acceptable discriminant validity based on the Fornell and Larcker criterion.

Table 4.2. Discriminant Validity Fornell and Larcker Criterion

	DC	IC	OI	SP
DC	0.784			
IC	0.308	0.840		
OI	0.224	0.161	0.843	
SP	0.342	0.299	0.241	0.853

"Dynamic Capabilities = DC, Innovative Culture = IC, Open Innovation = OI, Sustainable Environmental Performance = SP"

Table 4.3 shows discriminant validity through the cross-loadings criterion, which postulates that the loading of each item has to be higher on its construct as compared to its loading on other constructs (Rönkkö & Cho, 2022). From the results presented below, it is clear that all items belonging to DC, IC, OI, and SP have their maximum load on the corresponding constructs. For instance, DC1 has a loading of 0.816 on DC whereas it has a loading of only 0.244 on IC, 0.222 on OI and 0.233 on SP. This serves to confirm discriminant validity and this checks on the uniqueness of the constructs.

Table 4.3. Discriminant Validity (Cross-Loadings Criterion)

	DC	IC	OI	SP
DC1	0.816	0.244	0.222	0.233
DC10	0.738	0.178	0.180	0.295
DC11	0.744	0.189	0.197	0.303
DC12	0.772	0.324	0.181	0.272
DC2	0.805	0.203	0.192	0.203
DC3	0.836	0.315	0.236	0.267
DC4	0.782	0.253	0.145	0.309
DC5	0.759	0.232	0.075	0.271
DC9	0.795	0.223	0.122	0.233
IC1	0.276	0.885	0.126	0.262
IC2	0.249	0.768	0.178	0.142
IC3	0.210	0.794	0.136	0.169
IC4	0.221	0.824	0.113	0.293
IC5	0.291	0.833	0.156	0.242
IC6	0.268	0.877	0.140	0.307
IC7	0.294	0.889	0.127	0.264
OI1	0.282	0.116	0.862	0.222
OI2	0.189	0.158	0.804	0.216
OI3	0.158	0.131	0.814	0.262
OI4	0.097	0.097	0.833	0.214
OI5	0.146	0.077	0.875	0.175
OI6	0.213	0.173	0.870	0.150
OI7	0.192	0.193	0.840	0.155
SP1	0.326	0.266	0.183	0.886
SP2	0.287	0.276	0.213	0.839
SP3	0.271	0.237	0.159	0.846
SP4	0.217	0.230	0.186	0.863
SP5	0.234	0.207	0.242	0.870
SP6	0.315	0.257	0.179	0.864
SP7	0.329	0.300	0.207	0.838
SP8	0.325	0.248	0.261	0.815

Table 4.4 shows the discriminant validity through the HTMT ratio, with the cutoff value set below 0.9 (Yusoff et al., 2020). The HTMT values between DC, IC, OI, and SP range from 0.178 to 0.357, all well below the 0.90 threshold. For example, the HTMT ratio between DC and SP is 0.357, which indicates that each construct is different from the other. Thus, discriminant validity has been achieved using the HTMT criterion.

Table 4.4. Discriminant Validity (HTMT Analysis)

	DC	IC	OI	SP
DC				
IC	0.330			
OI	0.228	0.178		
SP	0.357	0.301	0.250	

Hypotheses Testing

Table 4.5 presents the hypothesis testing results based on standard threshold criteria. A t-value above 1.96 and a p-value below 0.05 indicate statistical significance (Imbens, 2021). For H1, OI → DC is supported with β = 0.224, t = 4.211, and p = 0.000, confirming a significant relationship. For H2, DC → SP is also significant (β = 0.246, t = 4.427, p = 0.000), indicating that DC positively affects SP. Regarding H3, the mediation effect of DC between OI and SP is supported with β = 0.055, t = 2.933, and p = 0.004, meeting the threshold for indirect effects. For H4, the moderating effect of IC on the DC → SP relationship is significant (β = 0.131, t = 2.074, p = 0.039). These results confirm that all proposed hypotheses are statistically supported.

Table 4.5. Hypothesis Testing

Relationship	VIF	Std Beta	Std Error	t-value	P value	R2	F2
OI -> DC	1.000	0.224	0.053	4.211	0.000	0.050	0.053
DC -> SP	1.145	0.246	0.055	4.427	0.000	0.195	0.065
OI -> DC -> SP		0.055	0.019	2.933	0.004		
IC x DC -> SP		0.131	0.063	2.074	0.039		

The following figure depicts the structural model and path coefficients:

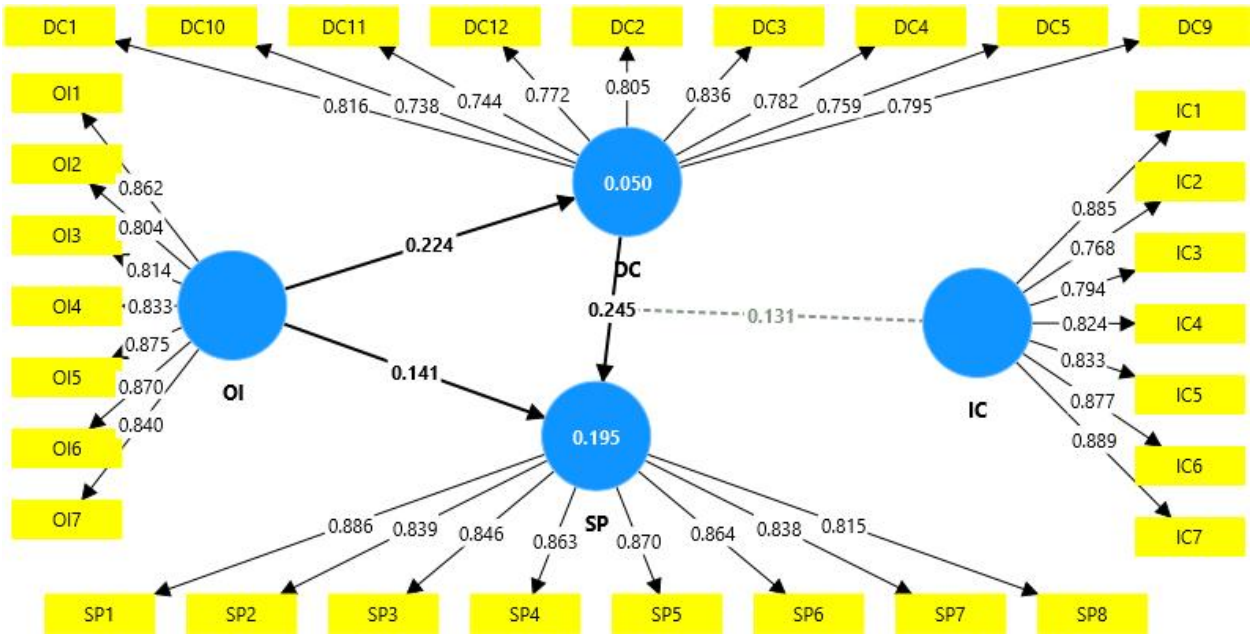

Figure 4.1. Structural Model and Path Coefficients

DISCUSSION

This study reveals that open innovation, innovative culture, dynamic capabilities, and sustainable environmental performance are all interdependent. The results highlight how important dynamic capabilities are as mediators between open innovation and sustainable environmental performance. Environmental outcomes are influenced by the interaction between innovative ideas and flexible abilities as well. Based on the validity and reliability examination of the constructions, all variables exhibit

excellent degrees of internal consistency, with composite reliability (CR) values exceeding 0.90. We can argue that the constructions are valid and convergent since the AVE values exceed the 0.50 limit. The discriminant validity tests which incorporate the Fornell-Larcker criterion, cross-loadings, and HTMT analysis also help to establish the constructions as different with reasonable correlation values. These results indicate that the measuring model is strong and could help to assess hypotheses.

The results of the hypothesis testing help to clarify the interdependence of open innovation, dynamic capabilities, and sustainable environmental performance. Open innovation helps companies to effectively rearrange and use resources; this is shown by the notable beneficial effect on dynamic capacities ($\beta = 0.224$, $p < 0.001$). The findings are consistent with previous research Cheng and Shiu (2020) showing that alliance management capabilities improve Eco-innovation performance in very dynamic environments, therefore augmenting inbound and outward strategies. While it will not help with outward projects, having the capacity to absorb knowledge is a tremendous advantage for inbound projects. Dynamic capabilities ($\beta = 0.246$, $p = 0.001$) likewise influence sustainable environmental performance. Organizations must be able to spot chances, seize resources, and modify their processes to better the environmental sustainability. More dynamic companies, including environmental issues in their business decisions, help to produce better sustainability results. Mediation analysis reveals a partial mediation effect of dynamic capabilities on the association between open innovation and sustainable environmental performance ($\beta = 0.55$, $p = 0.004$). This suggests that open innovation affects sustainability, while the main mechanism by which it does this is the development of dynamic skills. This realization supports the dynamic capabilities perspective and the resource-based view, which underline the need for businesses to develop internal competences to maximize outside information flows. Furthermore, shown by the study is the moderation between dynamic capabilities and sustainable environmental performance ($\beta = 0.131$, $p = 0.039$) by creative culture.

Innovative societies support the acceptance of environmentally friendly laws and practices, the use of modern technologies, and risk-taking. Consequently, companies with a strong innovation culture are more suited than those with a poor culture to convert their dynamic potential into actual environmental benefits. The moderating power of innovative culture emphasizes the additional role organizational culture has in deciding the effectiveness of strategic capabilities. Dynamic capabilities, which are necessary for long-term survival, are enhanced in a society that supports invention, knowledge sharing, and continuous development. Our results are aligned with other studies that indicate that business culture is a major determinant of sustainable innovation. According to the structural equation modeling (SEM) study by Pundziene et al. (2022), a company's open innovation performance influences its competitive performance, which in turn influences its dynamic capabilities and thus its structural performance. This also shows that open innovation moderates, although somewhat, the link between dynamic capabilities and competitive corporate performance.

Furthermore, our study expands on earlier studies Chabbouh and BOUJELBÈNE (2021) by offering empirical data of how linked open innovation could balance the interactions between knowledge management ability, knowledge appropriation capacity, environmental dynamism, and SME performance. The results reveal that sustainable environmental performance is influenced by innovative culture, dynamic capabilities, and open innovation, as well as by other factors. Strong links mean that building dynamic capabilities to enhance sustainability results in an innovative-driven company is vital. The study recommends that companies mix open innovation with internal competencies if they are to maximize their sustainability projects. Businesses that excel in open innovation and apply outside knowledge to their benefit will increase their dynamic abilities and be more suited to meet evolving market needs. However, a strong innovation culture controls the degree of enhanced sustainability derived from these capacities. Although open innovation gives companies access to outside knowledge, organizations should endeavour

to be more flexible and adaptable both strategically and internally to ensure that new practices genuinely improve environmental performance.

CONCLUSION

The emphasis of this study was sustainable environmental performance, innovative culture, dynamic capabilities, and open innovation. The results suggest that by raising dynamic capacities, open innovation is absolutely essential for enhancing environmental performance. The mediation analysis indicates that dynamic capabilities are the key that opens the door for businesses to employ open innovation to acquire external information and transform it into actual sustainable results. Promoting internal talents and working with outside partners will help to bring about long-term environmental benefits. Furthermore, the study reveals that culture dynamic skills have a more impact on environmental performance. Organizations should create a culture that promotes innovation, risk-taking, and information exchange if they are to maximize their dynamic potential for long-term sustainability. Apart from funding open innovation initiatives, this indicates that companies should create an internal environment that supports adaptation and ongoing growth. This implies that sustainability is driven by cooperation among innovation, competencies, and culture. Businesses must have dynamic skills and an innovative culture if they want to properly implement sustainable practices; open innovation just provides access to outside knowledge. These results add to the body of knowledge on strategic management and environmental sustainability by stressing the need for both internal and external elements in deciding organizational performance. Companies that wish to improve their sustainability performance should ultimately adopt a whole strategy including open innovation, develop dynamic capabilities, and advance an innovative culture. By implementing this, they may create a stronger and flexible system to attain environmental sustainability in a market that is getting more controlled and competitive.

IMPLICATIONS

This study significantly theoretically advances the field of sustainable environmental performance by increasing our knowledge of the interactions among open innovation, dynamic capabilities, and innovative culture. The results support the dynamic capabilities perspective and the resource-based view (RBV) by demonstrating that businesses must develop internal competencies to maximize outside knowledge (Lubis, 2022). The study adds to the body of knowledge on sustainability and innovation by stressing dynamic capabilities as a mediator and creative culture as a moderator. Although open innovation helps acquire resources from outside sources, these results highlight the need of the firm's capacity to absorb, reorganize, and apply these resources for sustainable success. The pragmatic insights of the study will be much valued by managers and legislators. First of all, businesses can deliberately include open innovation into their strategic objectives by supporting alliances with outside parties such as academic institutions, vendors, and industry associations. Still, businesses need to increase their dynamic capacities in order to properly convert outside inputs into sustainable initiatives; they cannot rely only on outside expertise. Second, the results stress the need to create an innovative culture. Managers should fund initiatives aimed at helping staff members develop as leaders, give them training, and create incentives motivating them to be creative thinkers. Businesses must create an innovative culture that motivates staff members to think creatively if they are to enjoy the environmental advantages of innovation. Finally, legislators might use these results to create rules that support open innovation among companies as well as investments in internal ability-building and cultural reform. Including sustainability objectives in their corporate plans helps companies to develop a competitive edge and improve their surroundings.

Limitations and Future Research

This study provides valuable insights on clarifying the relationships among open innovation, dynamic capabilities, innovative culture, and sustainable environmental performance despite several limitations. One limitation of the study is that, using cross-sectional data, it cannot establish a cause-and-effect link. Future research could employ longitudinal designs to track changes across time and generate more robust causal conclusions. Second, as the study focused on specific businesses, the findings might not be relevant outside of the stated sector or geographic area. Expanding research to other fields or sectors would help one to have a better understanding of these connections. Data may also have certain limitations since it is prone to bias depending on personal opinions or societal demands. Future research could add objective performance measures or outside evaluations to support the conclusions even more. The regulatory environment is another contextual element that could affect the effectiveness of open innovation and dynamic capacity in supporting sustainability. The study also takes into account organizational structure, leadership style, and creative culture among other elements. Future studies looking at these other moderating factors could help us to better grasp the fundamental processes. Furthermore, not explored in this study are other mediating components like technology innovations, digital transformation, or corporate social responsibility initiatives; rather, the focus is on dynamic capacities. Future research should concentrate on looking at these mediators if we are to better grasp how companies could enhance their sustainability performance. Notwithstanding these limitations, the study creates a strong foundation for more research on the interactions among innovation, skills, culture, and sustainability. More pragmatic advice and theoretical frameworks addressing these constraints in future research will help companies try to combine innovative strategies with environmental sustainability goals.

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