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Impact of Triple-A Capabilities on Environmental Performance: Implications for Public Policy

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Abstract

Triple-A Capabilities—comprising "Agility, Adaptability, and Alignment"—are recognized as essential for enhancing "supply chain performance" globally. Existing literature highlights the need for further investigation of the link between "Triple-A Capabilities" and "Environmental Performance", especially within the context of developing nations. Accordingly, this research examines the relationship between these capabilities and "Environmental Performance" in Pakistan's pesticide industry. A quantitative approach was adopted under the positivist research paradigm. Initially, a review of existing literature helped to develop a conceptual framework to understand the interplay between "Triple-A Capabilities" and "Environmental Performance". Subsequently, empirical data were gathered through an online structured questionnaire to test the proposed conceptual framework. The analysis was carried out using SmartPLS 4.0. Findings revealed a significant positive effect between "Triple-A Capabilities" and "Environmental Performance". From a public policy perspective, it is recommended that government agencies promote the integration of Triple-A Capabilities through targeted supply chain training programs and regulatory incentives. Additionally, environmental compliance frameworks should be revised to encourage agility, adaptability, and alignment in operations. Future studies should be conducted across different countries and industrial sectors to increase the generalizability of the findings of current study.

1. Introduction

In recent years, environmental change has become an important issue for under developing countries as well as for emerging nations. South Asia, in particular, has gone through an increasing susceptibility to natural disasters due to the negative impacts of "environmental change". Pakistan is situated in a region where the consequences of environmental change are being felt intensely and Pakistan has been adversely affected due to negative impacts of environmental change. The resultant environmental calamity has had broad negative impacts on the "economy, society, and environment" of Pakistan (Salik et al., 2023). Statistics show that the 2010 and 2012 floods in Pakistan caused loss of homes, injuries, and fatalities for over 20 million people in Pakistan which had devastating

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consequences for the people of Pakistan. Moreover, lengthy periods of heatwaves in Pakistan, where temperatures often exceed 38°C yearly, may result in significant human health issues. Between 1997 and 2015, Pakistan gone through an average of seven heatwaves every year, with a rising trend (Ahsan, 2022; Salik et al., 2023).

Environmental changes in Pakistan have brought about various impacts, influencing the country's ecology, economy, and society. Particularly, changes in climate patterns have resulted in more frequent and “extreme weather” issues like: “floods and droughts” etc. These variations pose a noteworthy threat to the agricultural sector, which is a foundation of Pakistan's economy and the source of revenue of many people of Pakatan. The melting glaciers in the northern regions also contribute to an increased risk of floods, endangering people living there. Biodiversity loss is another consequence, which affects ecosystems and reduces the adaptability of various species. Furthermore, water shortage complexes existing challenges, particularly because of Pakistan's dependence on the Indus River system (Ahsan, 2022; Salik et al., 2023). The impacts of worldwide “climate change” are already visible in Pakistan, with a growing incidence of droughts, floods, unpredictable weather patterns, shifts in agricultural practices, reduced availability of fresh water, and biodiversity loss. Addressing “climate change” involves both “mitigation and adaptation strategies”, and the crucial urgency for the country is to aggressively prepare for familiarising to these “environmental changes” (Pakistan, 2023).

The three dimensions of supply chain, namely “agility, adaptability, and alignment”, are equally important. Lee (2004) given the term "Triple-A," which refers to these three words “agility, adaptability, and alignment”. Moreover, Dwayne Whitten et al. (2012) conducted empirical research and found that the According to (Lee, 2004), having “Triple-A capabilities (agility, adaptability, and alignment)” can significantly improve environmental performance.

2. Literature Review and Hypothesis Development

2.1 Triple-A Capabilities

Although having an efficient and profitable supply chain is crucial for businesses, it is not sufficient to ensure sustainable competitive advantage. To achieve long-term success, supply chains must also possess flexibility, adaptability, and alignment with the organization's strategic goals. This necessitates the ability of companies to promptly react to market shifts, adjust their supply chain to meet evolving customer requirements, and ensure that the supply chain is completely integrated with their overall business strategy. Through achieving these objectives, companies can not only achieve short-term success but also ensure their long-term viability in a dynamic market (Lee, 2004). The supply chain's three dimensions, namely “agility, adaptability, and alignment”, are equally essential. Lee (2004) introduced the term "Triple-A," which refers to these three A-letter words. Meanwhile, Dwayne Whitten et al. (2012) conducted empirical research and found that the “Triple-A capabilities” have a considerable positive impact on “environmental performance”. Lee (2004) asserted that the capability of the entire supply chain to react to changing customer demands, adapt to shifting market and economic conditions, and harmonize “production, marketing, and financial strategies throughout the supply chain” is essential for the success of each organization within the “supply chain”. To enhance the supply chain and organizational performance, Lee suggested creating a supply chain that is agile, adaptable, and aligned, which he coined as the Triple-A supply chain. Through his consulting experience with various companies, Lee contended that attaining the Triple-A capabilities can lead to improved supply chain performance.

2.2 Agility

Agility refers to an organization's capability to respond speedily to market changes, both inside the organization and in conjunction with its main suppliers and customers. This involves being able to quickly adapt the supply chain to meet changing customer demands

and market fluctuations while ensuring that the supply chain remains aligned with the overall business strategy (Braunscheidel & Suresh, 2009). When there are unexpected disruptions, such as natural disasters, supplier bankruptcy, or sudden changes in customer demand, the agility of the supply chain becomes crucial. The ability to quickly respond and adapt to these disruptions can help mitigate the impact on the organization's operations and minimize the risk of losing customers or market share. Agile firms can face such a situation and successfully meet the changing supply and demand.

Agility can be increased in the supply chain by adopting the following principles (Lee, 2004):

i. There should be a match between real-time movement of supply and demand figures;
ii. There should be good relationship with all vendors for co-operation;
iii. It is recommended to design products that are flexible and to establish standardized processes that allow for postponement. Postponement refers to the practice of customizing a product until it is at its final stage in the supply chain network (Feitzinger & Lee, 1997);
iv. Firms should maintain reasonable stock of low-cost, non-bulky but important items to escape the unfavourable situation, which may become a bottleneck;
v. Firms should concentrate to ensure the dependable logistics system or supply chain partners; and,
vi. Firms should formulate emergency procedures with the help of a risk management team.

Agility refers to the ability of an organization to quickly adapt to changes and respond to market demands and opportunities. Environmental performance, as mentioned earlier, refers to the entity's performance in terms of environmental sustainability and reducing its environmental impact.

A company with high agility may not necessarily have good environmental performance, but it can use its agility to quickly adapt to new regulations and customer demands for environmentally friendly products and practices. On the other hand, a company with poor environmental performance may struggle to respond to market pressure for sustainability, potentially impacting its long-term viability and competitiveness.

There can be a relationship between agility and financial performance, as an agile organization may be better equipped to quickly adjust to changes in the market and capitalize on new opportunities, leading to improved financial performance. However, other factors such as market conditions, competition, and overall strategy also play a significant role in a company's financial performance.

2.3 Adaptability

Adaptability is defined as an organizations' success in reacting to a dynamic environment where conditions are changing on a continuous basis (Walker Jr & Ruekert, 1987). While agility is to respond to short-term change, adaptability is a long-term fundamental adjustment to react against a structural change in the "market environment" or revised strategies. Adaptable organizations can identify patterns and trends, and restructure a whole supply chain base promptly. Adaptability can be promoted in the supply chain by taking the following principles into consideration (Lee, 2004):

i. Identify new markets or suppliers by focusing on global economies;
ii. Recognize demands of not only immediate customers but also end consumers;
iii. Find new suppliers and logistics partners that supplement existing ones through intermediaries;
iv. Ensure flexibility in product design; and,

v. Track that at which stage the product is from the perspective of the product and technology life cycle.

Adaptability refers to the ability of a system or entity to adjust and respond to changing conditions and circumstances. Environmental performance refers to how well an entity performs in terms of reducing its environmental impact and promoting sustainability. Adaptability can be important for an entity's environmental performance as it allows it to respond to changing regulations and societal demands for more sustainable practices, as well as changes in the natural environment that may impact its operations. An entity that is adaptable is better positioned to maintain good environmental performance over time (Lee, 2004).

There is a relationship between adaptability and financial performance, as organizations that are able to adapt to changes are often more likely to maintain or improve their financial performance. An organization that is not adaptable may struggle to keep up with changes in the market and face declining financial performance (Lee, 2004).

2.4 Alignment

Alignment in the supply chain context means pulling interest of all organizations in the supply chain to the same direction (Narayanan & Raman, 2004). Prioritizing its own interests will cause an increase in the overall cost of the supply chain (Lee, 2004). Misalignment induces deteriorated performance of the supply chain due to excessive inventory, stock-outs, and inaccurate forecast (Narayanan & Raman, 2004). Alignment in the supply chain can be enhanced by taking the following principles into consideration (Lee, 2004):

i. Interchange “information and knowledge” with suppliers and customers actively
ii. Define clear roles and responsibilities of each partner in the “supply chain”
iii. Divide risks, costs, and incentives equally among partners in the entire “supply chain”

Information and knowledge sharing is important to prevent misalignment (Narayanan & Raman, 2004). Lack of communication and distrust among supply chain partners is a barrier to successful implementation of alignment (Matthyssens & Vandenbempt, 2008). Well-defined roles, activities, and responsibilities must be shared among all chain partners (Petersen et al., 2005). Alignment in incentives will assurance mutual gains to supply chain partners (Simatupang & Sridharan, 2002).

Alignment in the context of environmental performance refers to the degree to which an entity's actions, policies, and strategies are consistent with environmental sustainability goals and values. Environmental performance refers to how well an entity performs in terms of reducing its environmental impact and promoting sustainability. Alignment with environmental sustainability goals can contribute to better environmental performance, but the two are not synonymous. An entity can have high environmental performance but may not be fully aligned with environmental sustainability goals, or vice versa (Lee, 2004).

Alignment refers to the consistency or congruence between different elements, such as objectives, strategies, processes, etc. In the context of finance, alignment refers to the relationship between an organization's financial goals and its overall strategy (Lee, 2004).

2.5 Triple-A Capabilities and Environmental Performance

Lee (2004) proposed the concept of a “Triple-A supply chain”, which includes “agility, adaptability, and alignment” as essential components to improve both supply chain and overall organizational performance. The author drew on his consulting experience with several companies to argue that implementing Triple-A capabilities could result in better environmental performance. Lee emphasized that establishing an agile, adaptable, and aligned supply chain is critical for organizations to quickly and efficiently respond to changing market conditions and customer demands while aligning their production, marketing, and financial strategies.

Dwayne Whitten et al. (2012) carried out an empirical investigation and found that there is data to corroborate the concept that executing "Triple-A capabilities", such as "agility, adaptability, and alignment", has a noteworthy and favorable influence on environmental performance.

The success of a modern supply chain depends on its ability to demonstrate the triple-A characteristics of agility, adaptability, and alignment (Feyissa & Sharma, 2016). The authors also found a strong relationship between the triple-A characteristics of supply chains and environmental performance. The study further highlights the significance of establishing a supply chain that is agile, adaptable, and aligned to enhance environmental performance.

In the light of literature stated above, "conceptual framework (Figure 1)" of current study is as under:

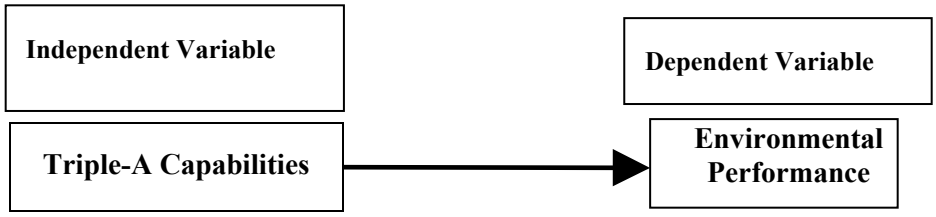

Figure 1. Conceptual Framework

As depicted in Figure 1, following research hypothesis was proposed:

***H_1**: Triple-A capabilities have significant positive effect on environmental performance.*

3. Research Methodology

A quantitative approach was adopted under the positivist research paradigm. Initially, a review of existing literature helped to develop a conceptual framework to understand the interplay between "Triple-A Capabilities" and "Environmental Performance". Subsequently, empirical data were gathered through an online structured questionnaire to test the proposed conceptual framework. The analysis was carried out using SmartPLS 4.0. Fifty two, corporate level pesticide firms, are working in Pakistan. Correspondence email addresses were obtained from Pakistan Crop Protection Association (PCPA) website (PCPA, 2023). Emails were sent to corporate level pesticide firms containing Google Form link. It was requested through email to share the email and data collection link with the senior level managers of their own firm and with the senior level managers of other pesticide firms. Google form link was also shared with the help of WhatsApp with the "senior managers of pesticide firms of district Multan, Pakistan" after paying personal visits. It was requested to share the data collection link in pesticide industry managers WhatsApp groups. Two sampling techniques were used in this study i.e. (1) Purposive sampling, and (2) Convenience sampling. It was revealed in personal visits that every firm has, on average, 40 members in their middle and top-level management, hence the target population of this study was 2080 managers. Out of 2080 managers 343 of them responded to the survey questionnaire. Therefore, the response rate was 16.49%. Informed consent was taken and confidentiality of the identity of the respondents was assured.

4. Results and Discussions

Results regarding "Triple-A Capabilities (agility, adaptability, alignment)" and "Environmental Performance" are given below:

Table 1. Latent Variable Correlations

"Variables"	EP	TAC
EP	**1.000**	0.633
TAC	0.633	**1.000**

"Table 1 shows the Latent Variable Correlations of each variable". All measures of "Triple-A Capabilities (agility, adaptability, and alignment) are found to be highly correlated with Environmental Performance, which means that Triple-A Capabilities (agility, adaptability, and alignment)" are having a "strong relationship" with "Environmental Performance". So, current study findings are consistent with the findings of (Whitten et al., 2012; Feyissa & Sharma, 2016).

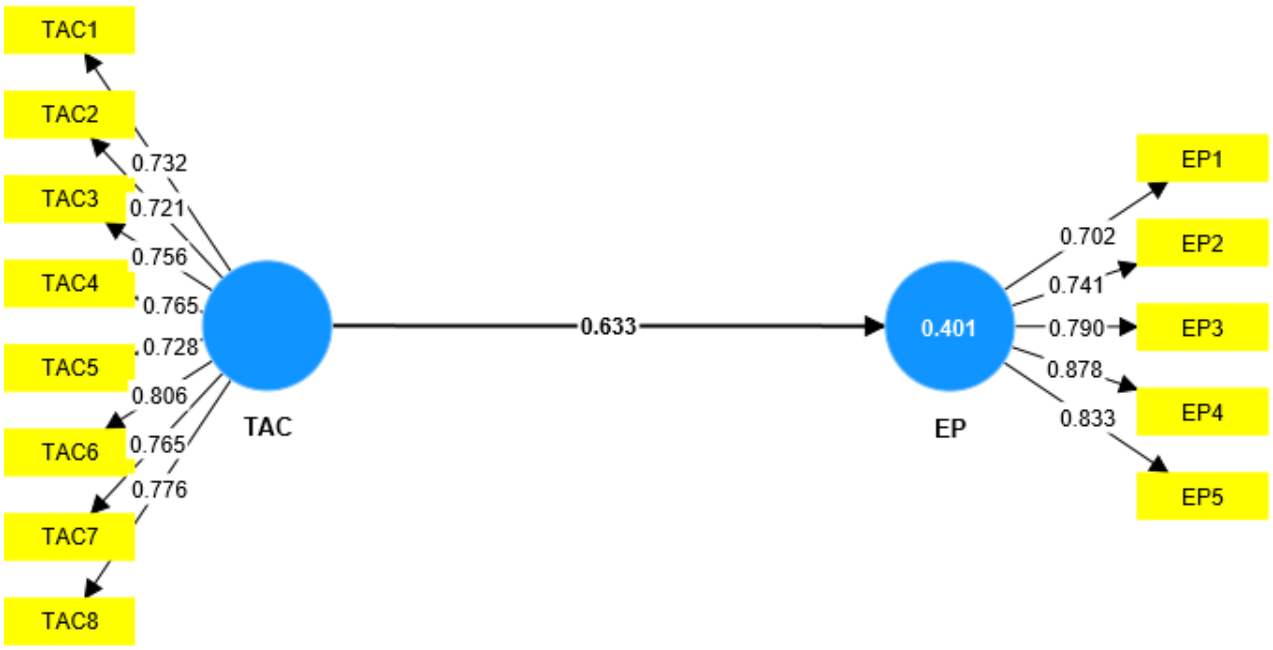

Figure 2. "PLS Algorithm" Results for "Triple-A Capabilities" and "Environmental Performance"

Figure 2 displays the "PLS Algorithm Results" of the "Triple-A (agility, adaptability, alignment)" and "Environmental Performance" with the "outer loadings of the each of the measure > 0.70" and showing the "Path coefficients (β) value of the relationship".

"Construct (variable) and indicators (measures) reliability is described through the computations of Cronbach's Alpha and Composite Reliability", whereas "convergent validity is described through the computations of Average Variance Extracted (AVE)" and "discriminant validity" is described through "Fornell-Larcker Criterion" which are given in "Table 2 to Table 3".

Table 2. Quality Criteria for "Triple-A Capabilities" (TAC) and "Environmental Performance" (EP)

"Variables"	"Measure"	"Measure's Outer Loading"	"Cronbach's Alpha"	"Composite Reliability"	"AVE"
"TAC"	"TAC1"	0.732	0.893	0.896	0.572
	"TAC2"	0.721			
	"TAC3"	0.756			
	"TAC4"	0.765			
	"TAC5"	0.728			
	"TAC6"	0.806			
	"TAC7"	0.765			
	"TAC8"	0.776			
EP	EP1	0.702	0.849	0.856	0.626
	EP2	0.741			
	EP3	0.790			
	EP4	0.878			
	EP5	0.833			

"Table 2" shows "Quality Criteria for Measures Assessments". As a "rule of thumb all outer loadings for all measures (indicators) should be more than 0.70", "Cronbach's Alpha values should be more than "0.70", "composite reliability should also be more than 0.70", whereas all values of "AVE (convergent validity) should be more than 0.50" "(Hair Jr et al., 2019)." It is obvious from "Table 2" that results were as per well-known criteria for checking the "reliability and validity"; so, the results were "reliable as well as valid".

Table 3. Fornell-Larcker Criterion

Variables	EP	TAC
EP	**0.791**	
TAC	**0.633**	**0.757**

"Discriminant validity" was measured through the "Fornell-Larcker Criterion" with the help of a "rule of thumb (Fornell & Larcker, 1981)" which stated that the "square root of average variance extracted of each variable must be greater than the correlation value of the other variables used in the same study". Table 3 shows "the square root values of average variance extracted of all variables" (shown in bold font), were higher than the "correlation values" of the other variables used in this study, hence discriminant validity of both variables of this study was established.

Table 4. Collinearity Statistics (VIF)

"Indicators (Measures)"	"VIF"
TAC1	1.883
TAC2	1.656
TAC3	1.896
TAC4	1.987
TAC5	1.772
TAC6	2.249
TAC7	1.894
TAC8	1.935
EP1	1.493

EP2	1.574
EP3	1.860
EP4	2.897
EP5	2.406

Table 4 demonstrations the "Collinearity Statistics (VIF) values of all measures". A "rule of thumb" states that the "VIF values should be lessor than 3.00" (Hair et al., 2011; Hair Jr et al., 2019). It is obvious from Table 4 that all vales are less than 3.00, so, there was no issue of "multicollinearity in terms of Triple-A Capabilities and Environmental Performance", and further analysis was conducted using "PLS-SEM".

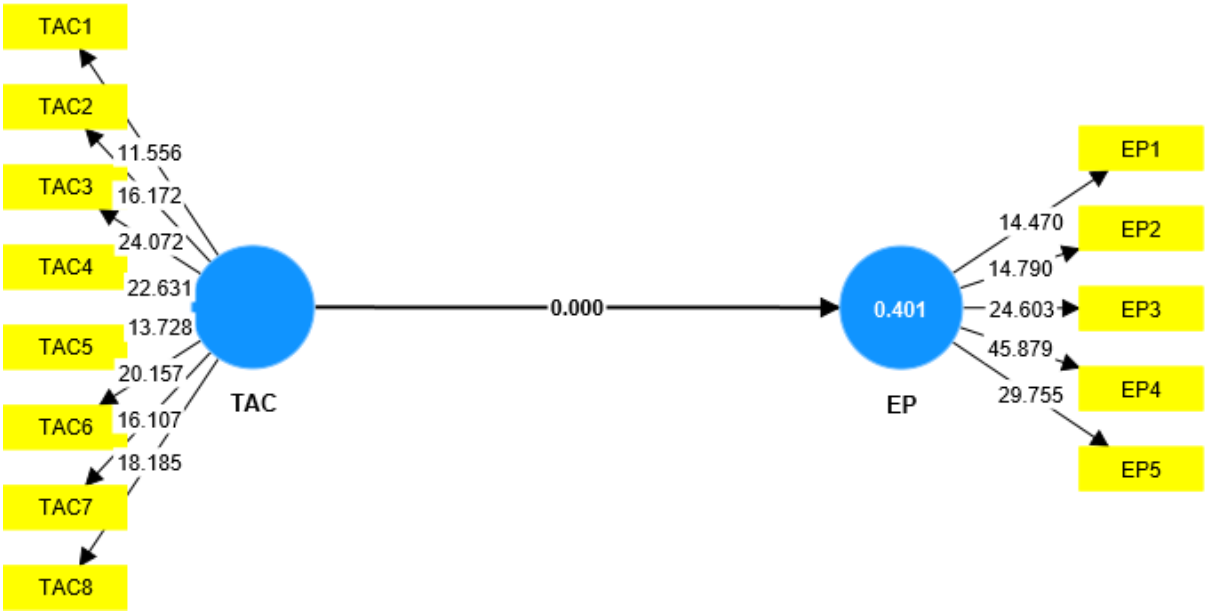

Figure 3. "Bootstrapping Results" for "Triple-A Capabilities" and "Environmental Performance"

Five thousand should be the minimum number of bootstrap samples (Hair et al., 2011), consequently, the "bootstrapping was done using 5,000 samples". "Figure 3, Bootstrapping Results for Triple-A capabilities and Environmental Performance, shows the results for t-values". As a "rule of thumb", the "t-values should be > 1.96" (Joe F Hair et al., 2011). Figure 3 depicts that all "t-values" were > 1.96.

Table 5. Outer Loadings

"Path"	"Original Sample (O)"	"Sample Mean (M)"	"Standard Deviation (STDEV)"	"T-Statistics"	"P-Values"
TAC1 <- TAC	0.732	0.724	0.063	11.556	"0.000"
TAC2 <- TAC	0.721	0.721	0.045	16.172	"0.000"
TAC3 <- TAC	0.756	0.757	0.031	24.072	"0.000"
TAC4 <- TAC	0.765	0.766	0.034	22.631	"0.000"
TAC5 <- TAC	0.728	0.721	0.053	13.728	"0.000"
TAC6 <- TAC	0.806	0.802	0.040	20.157	"0.000"
TAC7 <- TAC	0.765	0.759	0.048	16.107	"0.000"
TAC8 <- TAC	0.776	0.772	0.043	18.185	"0.000"
EP1 <- EP	0.702	0.698	0.049	14.470	"0.000"
EP2 <- EP	0.741	0.737	0.050	14.790	"0.000"
EP3 <- EP	0.790	0.788	0.032	24.603	"0.000"
EP4 <- EP	0.878	0.877	0.019	45.879	"0.000"
EP5 <- EP	0.833	0.832	0.028	29.755	"0.000"

"Table 5 shows the Outer Loadings of each measure", where "t-values were > 1.96 and p-values were < 0.05, hence all measures are statistically significant (Joe F Hair et al., 2011)".

Table 6. R-square and f-square

"Dependent Variable"	" R-square"	" f-square"
EP	0.401	0.669

"Table 6 shows the results of R^2 and f^2 for Triple-A Capabilities (agility, adaptability, alignment)" and Environmental Performance. R^2 and f^2 are calculated to check the "adequacy of the model". To measure and evaluate the "structural model", the "coefficient of determination (R^2)" is used. R^2 values of "0.75, 0.50, and 0.25 for dependent variables are considered as substantial, moderate or weak". R^2 value shows the variance in dependent variable due to the influence of independent variables. The results show that Triple-A Capabilities (agility, adaptability, alignment) and Environmental Performance have $R^2 = 0.401$ and $f^2 = 0.669$. Cohen (1988) defined f^2 as a measure of effect size: An f^2 value of 0.02 to 0.14 is considered as having small effect size. An f^2 value of 0.15 to 0.34 is considered as having medium effect size. An f^2 value of 0.35 or higher is considered as having large effect size.

Effect Size (Q^2)

Table 7. Latent Variable Coefficient Q^2

"Endogenous Variable"	"SSO"	"SSE"	"Q^2 (1-SSE/SSO)"
"Environmental Performance" (Dependent Variable)	1715.00	1296.76	0.244

The effect size (Q^2) in the current study is presented below in Figure 4 and Table 7. The outcomes suggest a significant effect between exogenous and endogenous variables. As Q^2 value is > 0, it implies that the model is a suitable fit and has predictive relevance.

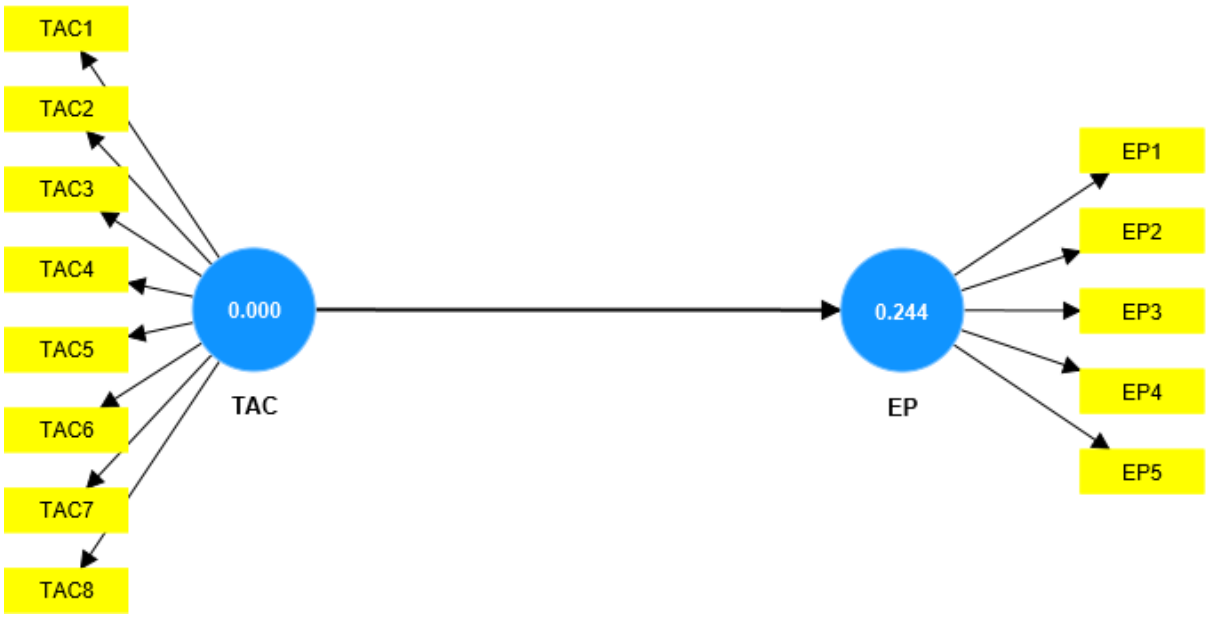

Figure 4. Structural Model: Blindfolding

Table 8. Hypotheses Testing Results and Decision

"Hypothesis"	**"Path / Relationship"**	**"Original Sample (O"**	**"Sample Mean (M)"**	**"Standard Deviation (STDEV"**	**"T-Statistics"**	**"P-Value"**	**"Decision"**
H_1	TAC -> EP	0.633	0.634	0.067	9.487	0.000	"Supported"

"Critical value for t > 1.96, and P-Value (significance value) is < 0.05"

"Table 8 shows the Hypotheses Testing Results and Final Decision for Triple-A Capabilities (agility, adaptability, alignment) and Environmental Performance". Results for **H1** (TAC -> EP) indicate a "path coefficient" (β) = 0.0.633, "T-Statistics" = 9.487, and "P-Value" = 0.000. Therefore, our H1 is supported with "T-Statistics > 1.96 and P-Value < 0.05" (Joe F Hair et al., 2011; Joseph F Hair et al., 2019). "*Hence, there is a positive and statistically significant relationship between* Triple-A Capabilities (agility, adaptability, alignment) and Environmental Performance*"*. Study findings are consistent with the findings of (Dwayne Whitten et al., 2012; Feyissa & Sharma, 2016).

5. Conclusion

The quantifiable data findings showed that "Triple-A Capabilities (agility, adaptability, alignment)" have "statistically significant" effect on Environmental Performance in the pesticide sector of Pakistan. It shows that "pesticide sector of Pakistan" is practicing Triple-A Capabilities. Based on the study findings, it is recommended that "Triple-A capabilities" should be observed and given attention for better Environmental Performance.

From a public policy perspective, it is recommended that government agencies promote capacity building for agility through workshops on rapid response and risk management. This can be achieved by training manufacturers, distributors, and logistics personnel to handle supply chain disruptions caused by climate change, policy shifts, or market fluctuations. Adaptability-oriented training should also be provided, focusing on sustainable alternatives and green practices. This involves educating producers on the use of alternative raw materials, biodegradable pesticides, and adaptive farming inputs. Alignment-focused training should be offered through collaborative supply chain management programs. This can be done by promoting initiatives that help firms better align their goals with those of suppliers, farmers, and regulators.

The government should provide various financial incentives to pesticide firms that are working to improve their environmental performance by adopting sustainable practices. For instance, green subsidies could include tax breaks or grants for companies that implement environmentally friendly supply chain practices. Additionally, performance-based incentives such as rewards for measurable improvements in emission reductions, waste management, and eco-friendly product innovation should also be considered. Regulatory incentives should be offered as well, including faster approval processes for companies that meet environmental benchmarks and public recognition through environmental certifications for compliant firms. Moreover, the government should encourage large buyers to prioritize sourcing from environmentally responsible pesticide manufacturers.

Future studies may focus on longitudinal data to provide insight into the sustainability and effectiveness of these capabilities over time. Moreover, future studies may be conducted across different countries and industrial sectors to increase the generalizability of the findings of current study.

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