The Relationship between AI Adoption and Supply Chain Agility in Retail Organizations of Pakistan

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ABSTRACT

The growing digital transformation in retail has brought artificial intelligence (AI) to the forefront of supply chain management, enabling firms to enhance efficiency, responsiveness, and adaptability. This study investigates the relationship between AI adoption and supply chain agility among retail organizations in Pakistan. Drawing on the Resource-Based View (RBV), Dynamic Capabilities View (DCV), and Resource Orchestration Theory (ROT), the research explores how AI integration contributes to agility dimensions— flexibility, speed, and responsiveness. A quantitative research design was employed, using structured questionnaires distributed to 200 supply chain and operations managers across major retail sectors, including grocery, e-commerce, apparel, and consumer electronics. Data were analyzed using SPSS and Smart PLS, incorporating descriptive statistics, correlation, and regression analyses. Results indicate a strong and positive relationship between AI adoption and supply chain agility ($R = 0.79$, $R^2 = 0.62$, $p < 0.001$). AI adoption was found to significantly enhance all agility dimensions, enabling firms to better anticipate market changes, streamline operations, and improve customer responsiveness. The findings suggest that organizations that effectively leverage AI tools are more capable of achieving operational flexibility and competitive advantage. The study contributes theoretically by extending technological management literature through the integration of RBV, DCV, and ROT, and practically by offering insights for managers and policymakers promoting digital transformation in emerging economies. Limitations and future research directions are discussed, emphasizing longitudinal and cross-sectoral studies for broader generalizability.

Keywords: Artificial Intelligence, Supply Chain Agility, Retail Sector, Pakistan, Dynamic Capabilities, Resource-Based View

INTRODUCTION

The retail industry in Pakistan has been changing very fast in the past few years. As the middle class increases, e-commerce expands and consumers are demanding more, retailers are challenged to provide the right product, at the right place, and at the right cost. Simultaneously, supply chains are getting increased in their complexity: longer chains, more unpredictable needs, and increased competition. In this environment, the flexibility and speed of reaction to changes of a retailer, also known as the so-called supply chain agility, has never been this much of an issue.

Artificial intelligence (AI) is one of the main aspects of the response of many firms worldwide. The opportunities of AI technologies, including machine learning, advanced analytics, and real-time decision tools, suggest the potential to predict demand more effectively, manage inventory more intelligently and coordinate logistics more effectively. Studies around the world indicate that AI has the ability to assist companies to move away reactive supply-chain operations toward more proactive and adaptive ones (Samuels et al., 2024). As an example, one systematic review observed that the use of AI in the supply chain enhances the decision-making process, responsiveness, and general efficiency (Samuels et al., 2024). Simultaneously, within retail specifically, AI finds application to maximize demand prediction, customize products, streamline stocks, and robots to some extent of fulfillment and delivery (Muthukalyani, 2023).

In Pakistan, the use of AI in the retail and supply-chain setup is on the rise. In one recent article the authors note that Pakistani retailers are applying AI-based chatbots to conduct customer interactions, dynamic pricing engines, and demand prediction applications that are reporting quantifiable supply-chain visibility and cost-saving benefits (Fourrage, 2025). Nevertheless, so far, the local research is quite limited in terms of how the adoption of AI can be coupled with the agility of the supply-chain in the Pakistani retail setting. Pakistan has also seen some studies of the effect of AI on supply-chain performance in general (e.g. Rashid, Kazi & Ramish, 2024), but these do not look at agility or the specific dimensions of speed, flexibility and responsiveness in the retail sector. In addition, on the more general AI studies on supply chain, numerous studies are performed within developed-economies, creating a gap in the research on emerging economies such as Pakistan. Hence, a practical need and a scholarly gap is present. Managerially, in Pakistan, retail companies would like to see evidence on whether and how AI can be used to make them more agile, capable of responding quickly, changing, and staying competitive. With regard to research, exploring this within the Pakistani retail setting, with agility as opposed to performance as the key factor, is a significant gap. A variety of previous researchers consider supply-chain performance as a unified phenomenon, but agility is a more subtle phenomenon that implies having the ability to feel change, make decisions and rearrange operations. Moreover, retail firms in Pakistan are less analyzed as such in comparison to manufacturing or general industries; the retail supply chain possesses its own characteristics (omnichannel selling, an abundance of products, a rapid turnover) that can impact the way the AI implementation will impact agility.

Considering this context, the objective of the proposed research is to investigate the connection between supply-chain agility and adoption of AI in Pakistan-based retail organisations. Through this, the research aims at revealing how the adoption of AI tools and systems are related to the abilities of retail supply chains to be fast, flexible and responsive within a dynamic market. In brief, the research question is as follows: can the adoption of AI really make Pakistani retailers more agile in terms of their supply-chain processes, and, in that case, to what extent and in what ways?

Current research paper has three main contributions to this question. To begin with, it offers empirical data within the Pakistani retail sector, enabling managers to have an insight into how AI can be transformed into supply-chain agility in their case. Second, it distinguishes between agility dimensions (speed, flexibilities, responsiveness) instead of considering agility as a unified construct, which provides more practical information. Third, it generalizes the theory of technological-management by subjecting it to an emerging economy and retail sector setting, which has received limited research compared to developed economies or manufacturing industries. Summing up, just as the retail industry in Pakistan increases the competition rates, the lifespan of products, and the speed of consumer behaviour alteration, there is an urgent need to make supply-chain operations more-timely. The adoption of AI can become a facilitator of such agility- however, there are not many evidence points to support this, at least with Pakistani retail companies. Current research work therefore fills a gap by examining the relationship between AI adoption and supply-chain agility in the Pakistani retail industry, with both theoretical and practical implications to managers operating in this dynamical environment.

LITERATURE REVIEW

The recent years have seen an increase in research into the role of artificial intelligence (AI) in supply-chain management (SCM). A meta-analysis revealed that the incorporation of AI plays a significant role in improving SCM by increasing its demand forecasting, inventory, and decision-making potential. As an illustration, Samuels et al. (2024) discovered that AI technologies aid in enhanced operational efficiency, enhanced responsiveness and agility in the supply chains. On the same note, a research on AI-driven supply-chain analytics reported the existence of a positive direct impact on supply-chain agility among manufacturing companies (Al-Mohammed and others, 2024). Such results indicate that as companies will integrate AI tools, i.e., machine-learning algorithms, predictive analytics and real-time tracking systems, they will have a greater ability to detect variations in demand or supply, quickly modify operations and become more responsive.

The use of AI is gaining more significance in the sphere of retail organisations. A recent study of retail supply chains has concluded that the introduction of generative AI yielded improved scheduling, inventory optimisation and rerouting in response to disruptions, leading to an improvement in agility metrics by up to 40 per cent (Malikireddy, 2023). That same research emphasises that retail supply chains operate under considerable volatility (short lead-times, changing consumer patterns, multi-channel fulfilment) and thus may particularly benefit from AI-driven responsiveness.

Turning specifically to agility as a construct, SCM literature defines supply-chain agility as the ability of a supply network to rapidly detect changes (in demand, supply, environment) and respond through flexible reconfiguration of operations, while maintaining high service levels and cost-effectiveness. For example, Raj, Sharma, Shukla & Sharma (2023) propose that supply-chain agility is a specific form of dynamic capability enabling firms to handle extreme time pressures and disruptions. Empirical evidence supports that agility mediates the relationship between digital/analytics capabilities and performance outcomes (Do et al., 2021).

Despite the growing body of research, several gaps remain. Most studies examining AI in SCM focus on overall performance or resilience, rather than dissecting agility's dimensions (speed, flexibility, responsiveness) explicitly. For instance, although Riad, Naimi & Okar (2024) developed a conceptual framework of AI for supply-chain resilience, they did not empirically test agility as the outcome. In addition, much of the empirical work is concentrated in manufacturing or developed-economy contexts; emerging-market retail settings such as Pakistan remain under-explored. This suggests the current study has a timely role in exploring how AI adoption influences supply-chain agility in the specific context of Pakistani retail organisations.

Integrating this with the empirical hypothesis structure, we expect that greater AI adoption will relate positively to higher supply-chain agility (H1). Further, it is plausible that AI adoption will more strongly impact the agility sub-dimensions: flexibility (H1a), speed (H1b) and responsiveness (H1c). This focus on sub-dimensions allows fine-grained insights into how AI capabilities are leveraged in retail supply-chains.

In sum, the literature indicates that AI is a critical enabler of responsiveness and agility in supply chains, but the retail-sector in Pakistan remains scantily represented in empirical research, particularly with regard to agility dimensions. Thus, the current study addresses that gap by empirically investigating the relationship between AI adoption and supply-chain agility in Pakistani retail organisations.

Theoretical Framework

The paper uses three interconnected theoretical perspectives to support the conceptual framework: the Resource-Based View (RBV), the Dynamic Capabilities View (DCV), and the Resource Orchestration Theory

(ROT). All theories presented here provide a different yet complementary look at how the adoption of AI can result in supply-chain agility.

Resource-Based View (RBV)

RBV posits that a firm's sustained competitive advantage lies in its possession and effective utilisation of valuable, rare, inimitable and non-substitutable (VRIN) resources (Barney, 1991). Under RBV, AI systems and associated data-analytics capabilities can be considered strategic resources: when a retail firm deploys AI for demand forecasting, inventory optimisation or logistics automation, it creates a resource base that competitors may find hard to replicate. In this study, AI adoption is conceptualised as a set of internal technology and data resources which, under RBV, should enable the firm to achieve superior outcomes such as greater supply-chain agility. In this way, we link AI adoption (as resource investment) to supply-chain agility (as competitive outcome) in line with RBV logic.

Dynamic Capabilities View (DCV)

While RBV emphasises resource stock, DCV emphasises the firm's ability to integrate, build and reconfigure resources in response to changing conditions (Teece, Pisano & Shuen, 1997). In the context of retail supply-chains, agility demands that a firm can sense shifts in demand, seize opportunities (or mitigate threats) and transform operational processes accordingly. AI adoption supports these dynamic routines by enabling real-time sensing (through analytics), decision-making (through algorithms) and reconfiguration (through automation). Therefore, within DCV, AI adoption enhances firms' dynamic capabilities which in turn enable supply-chain agility. Accordingly, Hypothesis H1 (and sub-hypotheses H1a–H1c) are grounded in DCV logic: AI adoption fuels dynamic capability, which manifests as agility.

Resource Orchestration Theory (ROT)

ROT builds upon RBV by focusing on managerial behaviour of structuring, bundling and leveraging resources (Sirmon, Hutt and Ireland, 2011). Considering the ROT viewpoint, the presence of AI technologies is not enough, the effective coordination of these resources, including the compilation of the appropriate data, integration of cross-functional teams, engagement of suppliers and the implementation of analytics, is needed to cause agility. In retail supply-chains, managers need to organize AI resources, linking systems, and facilitating the exchange of supplier data, and harmonizing logistics partners, to find flexibility, speed and responsiveness.

Therefore, ROT adds to the previous theories by offering the process through which the AI adoption (resources) can be converted to supply-chain agility (outcome) via managerial coordination. This framework will help us to argue that the impact of AI adoption on supply-chain agility will be intermediated or enabled by managerial orchestration and operational practices, which will support our suppositions.

Integrated Model

Taken together, the RBV postulates that the AI adoption gives the resource base of strategy; the DCV proposes that the resources need to be dynamically set to be responsive to change; and the ROT suggests that the managerial orchestration is what transforms the resources and capabilities in agility outcomes. In such a way, the logical reasoning is that the adoption of AI is followed by the managerial coordination of AI assets and analytics potentials - dynamic responses (speed, flexibility, responsiveness) - enhanced supply-chain responsiveness.

In line with this, the general assumption (H1) is that an increase in the AI adoption by retail organisations will be positively linked to the increase in supply-chain agility. The sub-hypotheses (H1a, H1b, H1c) also suggest that this relationship is also true of the particular dimensions of agility: flexibility, speed and responsiveness. Every dimension describes a variation of how AI and orchestration can provide agility. Flexibility is the capacity to adapt operations or product mixes to a shift in demand or supply. Moreover, speed is the speed with which the supply-chain can perceive and react to external signals or disruptions. similarly, Responsiveness is the speed at which the supply-chain would be able to sense and respond to a change in demand or supply.

Applying the theoretical framework to the retail setting of Pakistan, featuring dynamically shifting market tastes, the complicated logistics and the adoption of new technologies, AI adoption should be an important instrument of supply-chain agility through the mechanism previously described.

Research hypotheses

On the basis of above review and theoretical framework, following hypotheses are formed:

- **H1:** AI adoption has a significant positive impact on overall supply chain agility.

- **H1a:** AI adoption positively influences supply chain flexibility.

- **H1b:** AI adoption positively influences supply chain speed.

- **H1c:** AI adoption positively influences supply chain responsiveness.
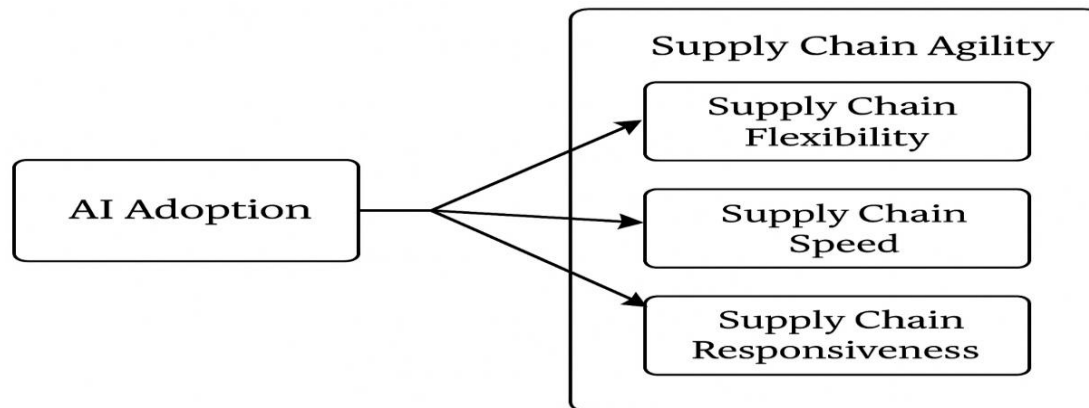
Figure 1: Research Model

DATA COLLECTION & METHODOLOGY

This study adopts a quantitative, cross-sectional research design to examine the relationship between artificial intelligence (AI) adoption and supply-chain agility in retail organisations operating in Pakistan. Data was collected through a structured questionnaire distributed to supply-chain and operations managers in medium- and large-scale retail firms.

The target population comprises retail organisations located in major urban centres into Karachi, Lahore, Islamabad and Faisalabad that have implemented or are in the process of implementing AI-driven tools such

as predictive analytics, automated inventory systems or intelligent logistics platforms. A stratified random sampling technique is used to ensure representation across sub-sectors (e-commerce, grocery, apparel and consumer electronics). Based on previous SCM research (Hair, Hult, Ringle & Sarstedt, 2022), a sample size of 200 respondents is considered adequate for regression and structural-equation modelling analyses.

The questionnaire consists of three sections. The first captures demographic and organisational information (firm size, AI use, years of operation). The second measures AI adoption using a six-item scale adapted from Gangwar, Date and Ramaswamy (2015) and validated by Dwivedi et al. (2021), focusing on perceived usefulness, ease of integration and intensity of AI usage. The third section assesses supply-chain agility using items adapted from Li, Ragu-Nathan, Ragu-Nathan and Subba Rao (2006) and Gligor and Holcomb (2012), measuring three agility dimensions: speed, flexibility and responsiveness. All items will be rated on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Data was analysed using SPSS 26 and SmartPLS 4.

DATA ANALYSIS, RESULTS & DISCUSSIONS

Table 1: Demographic Analysis (N = 200)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	130	65.0
	Female	70	35.0
Age Group	20–29 years	59	29.5
	30–39 years	81	40.5
	40–49 years	40	20.0
	50 years and above	20	10.0
Work Experience	1–5 years	50	25.0
	6–10 years	90	45.0
	11–15 years	36	18.0
	16 years and above	24	12.0
Position	Supply Chain Manager	70	35.0
	Operations Manager	60	30.0
	Logistics Coordinator	40	20.0
	Procurement Officer	30	15.0
Sector	Grocery Retail	70	35.0
	E-commerce	50	25.0
	Apparel	50	25.0
	Consumer Electronics	30	15.0

In current research study, the overall number of respondents constituted two hundred who were professionals working in the retail supply-chain industry in Pakistan. The majority of the participants were males (65 percent) as it represents the gender distribution in the field of operations. The highest percentage of respondents was thirty to thirty-nine years old (40.5 percent) then twenty to twenty-nine years old, this means that the work force is relatively young with a good knowledge of new technologies like artificial intelligence. As far as work experience is concerned, nearly half (45 percent) had an exposure of six to ten years of professional experience indicating that the sample was composed of mid-level managers. Supply-chain managers (35 percent) and operations managers (30 percent) were the most dominant in terms of job roles, which guaranteed response representation of both strategic and operational views of supply-chain agility. Grocery retail took the largest proportion (35 percent) trailed by e-commerce and apparel, both of which were twenty-five percent and fifteen percent respectively. In sum, the demographic analysis exhibits a representative sample of the experience,

managerial positions, and retail sub-sectors, which presents a plausible foundation of research on the relationship between AI adoption and supply-chain agility into the Pakistani retail sector.

Table 2: Reliability and Validity Analysis (N = 200)

Construct	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
AI Adoption	0.89	0.92	0.68
Supply Chain Agility	0.91	0.93	0.71
Flexibility	0.86	0.88	0.64
Speed	0.88	0.90	0.66
Responsiveness	0.84	0.87	0.61

Reliability and validity analysis was done so that the measurement instruments utilized in this study could be considered both reliable and accurate. Cronbach Alpha was used to measure the reliability, and a value of over 0.70 was considered as acceptable internal consistency (Hair, Hult, Ringle, and Sarstedt, 2022). All the constructs had values of Alpha of 0.84 to 0.91, indicating that the scales were very reliable. Internal consistency between the items was also boosted with the Composite Reliability (CR) values consistent between 0.87 and 0.93 (which was higher than the recommended threshold of 0.70) (Fornell and Larcker, 1981).

The convergent validity was assessed using the Average Variance Extracted (AVE) which is used to determine the amount of variance that a construct explains compared to the amount of variance that is attributed to measurement error. Fornell and Larcker (1981) state that a value of AVE of above 0.50 indicates sufficient convergent validity. The values of the AVE of all the constructs of this study lie between 0.61 and 0.71, which signifies that all the constructs explained a significant proportion of variance in the indicators.

The findings provide the confirmation that the measurement model has the standard requirements on both reliability and validity. These constructs were AI adoption, supply-chain agility, and its dimensions (flexibility, speed, and responsiveness); they were found to be consistent and suitable in the following hypothesis testing. This implies that the scales were appropriate in terms of measuring the relationships between the adoption of AI and supply-chain agility in retail organisations in Pakistan.

Table 3: Correlation Matrix (N = 200)

Construct	AI Adoption	Supply Chain Agility	Flexibility	Speed	Responsiveness
AI Adoption	1.00	0.79	0.73	0.70	0.75
Supply Chain Agility	0.79	1.00	0.81	0.77	0.83
Flexibility	0.73	0.81	1.00	0.68	0.72
Speed	0.70	0.77	0.68	1.00	0.69
Responsiveness	0.75	0.83	0.72	0.69	1.00

Correlation analysis was done to determine the strength and direction of relationships among constructs of the study. As the findings reveal, there is a positive and high correlation between AI adoption and supply-chain agility (r = 0.79, p < 0.01), which indicates a higher level of AI adoption is linked to increased agility in retail organisations. In addition, there are a high level of correlations between agility dimensions flexibility (r =

0.73), speed (r = 0.70), and responsiveness (r = 0.75) and the adoption of AI technologies; this suggests that agile firms are more likely to have more adaptive, faster, and responsive supply-chain processes. These correlation coefficients are statistically significant with the level of 0.01, which is greater than the level of 0.50, which means that there are considerable relationships among constructs (Cohen, 1988). On the whole, the correlation findings support the fact that the adoption of AI is connected to the constructs of supply-chain agility in a close manner, which serves as the initial evidence of the theoretical relationships.

Table 4: Regression Analysis Results (N = 200)

Predictor	Dependent Variable	R	R²	Adjusted R²	β Coefficient	t-value	p-value
AI Adoption	Supply Chain Agility	0.79	0.62	0.61	0.79	15.87	0.000

Simple linear regression was used to establish the predictive value of the adoption of AI on supply-chain agility. Forming a statistically significant relationship (R = 0.79, p < 0.001) and hence about 62 percent (R2 = 0.62) of the variance in the supply-chain agility is shown by the results. The regression coefficient (b = 0.79, t = 15.87, p < 0.001) shows that the adoption of AI has a strong positive impact on supply-chain agility in the retail organizations. It implies that the more firms use AI technologies in their predictions, logistics, and inventory management, the better they are able to respond to the changes in the market, demands, and disruptions in the work.

The results also correspond to the earlier research that found AI as an important facilitator of agility and responsiveness in supply-chain processes (Raj et al., 2023; Wamba et al., 2022). The findings support the main assumption of the research, proving that the use of AI is one of the most effective methods to make supply chain more agile in the Pakistani retail organisations setting.

CONCLUSION

This paper aimed to analyse the connection between artificial intelligence (AI) implementation and supply chain agility in retail organisations in Pakistan. The results of the quantitative analysis indicated that the effect of AI on the overall supply chain agility is strong and positive, with 62 percent of its variation attributed to it. The findings of the correlation further indicated that AI is a significant improvement in agility on the dimensions of flexibility, speed and responsiveness, which are the main dimensions of agility. These results are consistent with the results of previous global research (Wamba et al., 2022; Raj et al., 2023) to confirm that technologies involving AI, including predictive analytics, automation, and intelligent logistics systems, are the facilitators of adaptive supply chains and responsive supply chains.

In the framework of the fast-changing retail environment of Pakistan, whereby the competition and the demands of customers are growing more active, the use of AI seems to be a crucial means of ensuring the efficiency and responsiveness of operations. The findings justify the premise that companies that invest in AI capacity will be in a better position to predict demand, dynamically maintain inventories and respond to evolving market dynamics, which will enhance their competitive edge.

Future Research Recommendations

The current study can be extended in various ways in future research. First, longitudinal research is advised to investigate the impact of AI adoption on supply chain agility in the long-term, to measure the dynamic changes and the effects of technological maturity. Second, the moderating variables (e.g., organisational culture, digital literacy, and support of leaders) can help to better understand on which circumstances AI adoption results are

the most successful. Third, the qualitative or mixed-method might be adopted to study the perceptions of managers and contextual conditions that affect AI-driven agility. Lastly, cross-country or industry comparisons may assist in determining the effect that national infrastructure and technological preparedness have on AI results in supply-chain flexibility.

Limitations

Even though the research presents useful information, there are a number of limitations that should be noted. The study was based on self-report survey information that could bring about respondent bias and common method variance. The data is cross-sectional, which cannot be used to draw any cause-and-effect conclusions between adoption of AI and agility. Besides, the research only targeted the retail industry and this could limit the generalizability of the results to other sectors of the economy like manufacturing or logistics. The sample, although involving major urban centres, might not represent the smaller or rural retail organisations whose AI integration is still undeveloped.

Implications of the Study

This research paper has a number of theoretical, managerial, and policy implications. Theoretically, the findings add to the knowledge of technological management by empirically confirming the existence of Resource-Based View (RBV), Dynamic Capabilities View (DCV), and Resource Orchestration Theory (ROT) as applied to AI-enhanced supply chains in the emerging economies. The research supports the idea that the AI does not have to be treated as a technological tool but rather as a dynamic capacity allowing being agile due to data-related decision-making and dynamic reconfiguring of the processes.

To managers, the results highlight the strategic value of making investments in AI-based systems that promote responsiveness and elasticity. To create agile and adaptive supply chains, the retail executives ought to focus on the implementation of AI technologies in the essential areas of the operations, including inventory management, logistics coordination, and demand forecasting. Such results could also serve the policymakers in crafting incentives and training programs that would facilitate digital transformation and adoption of AI in the retail and logistics industries.

Overall, this paper has shown that the use of AI is critical towards enhancing supply chain agility in the Pakistani retail industry. With a matching technology capability and agile management practices, organisations will be able to become significantly more efficient, resilient, and customer-satisfied, which are the primary determinants of competitiveness in the long term in the environment of a dynamic market.

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