

Uncertain Supply Chain Management

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Impact of supply chain 4.0 and supply chain risk on organizational performance: An empirical evidence from the UAE food manufacturing industry

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ABSTRACT

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This research aims to empirically assess the impact of supply chain 4.0 and supply chain risk on organizational performance in the food manufacturing industry in the United Arab Emirates (UAE). Based on empirical evidence, only a few empirical research in supply chain 4.0 have been conducted. Additionally, they stress the significance of supply chain risk management assistance in enhancing organizational effectiveness. A quantitative technique with convenient cluster sampling was used to evaluate the variables. Data from 54 food manufacturing companies based in Ajman, UAE, was used. A sample size of 289 respondents was used for statistical analysis. The research findings revealed a strong link between the significant impact of supply chain 4.0 and supply chain risk to improve organizational performance. The use of supply chain 4.0 in manufacturing organizations was the main focus of this study. The model can be modified to reflect other businesses worldwide, for instance, the retail or service sectors. The findings aid businesses in making better-informed decisions about adopting supply chain 4.0. According to the research findings, food manufacturing companies should initiate and advance their transition to supply chain 4.0 for them to be competitive, effective, and productive.

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1. Introduction

In recent years, technological advances have made many business processes more efficient. One of the technologies that have helped supply networks become more efficient is the emergence of supply chain 4.0 using advanced technologies based on the Internet of Things, robotics and Big Data analytics applied to supply chain management (Gawankar et al., 2020). Supply Chain 4.0 seeks to improve performance and customer satisfaction by placing sensors in all aspects of the supply chain and creating networks everywhere (Ivanov et al., 2019). This has reduced supply chain risks associated with supply chain security, especially information (Fernando et al., 2022). It is significant for organizations to ensure that they provide the necessary security to their supply chain-based vulnerabilities (Qader et al., 2022). Identifying vulnerabilities can lead to security threats by exposing IT resources to accidental or illegal access (Zhu et al., 2022; Ageron et al., 2020).

Modern digital waste must be eliminated, and new technologies must be used as the primary lever to improve supply chain operational efficiency (Pandey et al., 2021). Over the next two to three years, Supply Chain 4.0 has the potential to have a significant impact (Fatorachian & Kazemi, 2021). It is anticipated to reduce operating costs by 30%, reduce lost revenue by 75% and reduce inventory by up to 75% while increasing the supply chains' agility in organizational operations.

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According to Javaid et al. (2022), “The technical integration into manufacturing and logistics and use of the Internet of Things and Services in industrial processes define industry 4.0. It will affect value creation, business models, downstream services and work organization”. New drivers allow production processes to generate and distribute products across activities throughout the operation, which researchers define as the fourth industrial revolution's transition from a purely physical manufacturing industry to one in which the two are closely linked (Tiwari, 2020). However, the supply chain risk is better managed in food manufacturing companies, enabling the safe delivery of food by maintaining hygiene, customer satisfaction, and fear of false delivery or product expiration. The following research provides a detailed review of the literature on the "Impact of Supply chain 4.0 and supply chain risk on Organizational Performance". Three research variables are considered to explore empirical evidence, and gaps in the literature were addressed using a systematic literature review approach to appropriately guide this investigation. Supply chain 4.0 and organizational performance were studied to understand the impact of supply chain risk in the food manufacturing industry based in the UAE.

2. Theoretical framework

2.1 Supply chain 4.0

As mechanization, electricity, and information technology (IT) propelled the previous three industrial revolutions, the advent of smart manufacturing technologies (also known as “Industry 4.0”) has ushered in the fourth (Tjahjono et al., 2017). Technological improvements in Industry 4.0 have led to the decentralization of business operations. IoT, M2M, Cyber-Physical Systems, AI, and Big Data Analytics are just a few technological advances that have created this innovation period, according to the report (Wang et al., 2020; Bayramova et al., 2021). As part of the “Industry 4.0” concept, CPSs and the Internet connect employees, machines, devices, and business systems. This IR has paved the way for smart process management and new paradigms in industrial management (Moeuf et al., 2018). Furthermore, these technology improvements have enabled "efficient utilization of resources, making sustainable performance a significant part of smart factories”.

Based on the previous research, the Supply Chain 4.0 methodology is still in its infancy in academia and is now being studied more thoroughly by practitioners than academics. Academic research and novel contributions are needed in Supply Chain 4.0, which has the potential to disrupt and revolutionize conventional supply chains (Tjahjono et al., 2017). Competitive advantage can be achieved via product availability, pricing, cost reduction, and market share growth (Kurdi et al., 2022). Some authors pointed out an overall cost reduction of 30% and a 75% reduction in inventory and missed sales, which supports this claim. Even though these new technologies will fundamentally change supply chain operations, they must be linked with client expectations (Hamadneh et al., 2021). Other authors back this argument claiming that implementing Supply Chain 4.0 successfully requires knowledge of how conventional supply networks have evolved in the era of Supply Chain 4.0. Similarly, it has been argued that Supply Chain 4.0 projects require a progressive shift in supply chain management practices. Food manufacturing companies often focus on the potential problems of Supply Chain 4.0 adoption, particularly in delivery perfection. A managerial perspective done by Wang et al. (2016) urges a study to assess the maturity of Supply Chain 4.0 to comprehend the evolution of Supply Chain 4.0 adoption.

2.2 Organizational Performance

The most crucial construct in research on the effective supply chain is organizational performance (Kurdi et al., 2022). The emphasis on performance sets strategic management apart from other supply chain management study areas (Lee et al., 2022). This focus aims to improve knowledge of the factors influencing organizational performance and illuminate managerial strategies for achieving superior performance (Fletcher, 2020). The social and economic results from the interaction of an organization’s traits, actions, and environment have generally been described as the organizational performance domain. Due to this, the field of strategic management needs to grow by amassing knowledge about the theories that help explain organizational performance and outline how managers can modify their plans to improve organizational performance (Shamout et al., 2022).

Research into "organizational effectiveness" by organizational theorists can be linked to earlier attempts to define organizational performance. When an organization achieves its stated objectives, it is considered effective. However, objectives such as profitability and growth, higher employee compensation and lower prices often conflict (Walker et al., 2011; Hamadneh et al., 2021). The satisfaction of stakeholders with competing goals is also a part of organizational effectiveness. Organizational theorists have found it challenging to empirically distinguish between effective and ineffective organizations by including the satisfaction of conflicting goals and stakeholder demands within the construct's definition. Researchers have little agreement on how to best measure effectiveness (Cole et al., 2019).

2.3 Supply chain risks

SCM research is increasingly focusing on supply chain risk (Baryannis et al., 2019). Managing SCRs is essential for businesses in today's extremely volatile and unpredictable environment. Due to various factors, such as an increase in outsourcing operations, global competition, increased requirements for on-time delivery, and the fast advancement of technology, SCR management (SCRM) has become more important. Since 2000, many publications have published special issues on SCRM, including production and operations management (2005). As practitioners and manufacturers begin to recognise SCRM as an important field of study, empirical research on the subject remains limited (Baryannis et al., 2019).

Depending on the research topic, risk has many distinct definitions (Wagner et al., 2017). Since this research focuses on risk management and the overall impact on supply chain effectiveness that affects organizational performance, the definition of risk is "fluctuation in distribution of likely outcomes, probability, subjective values." For example, failure to meet consumer expectations or compromising their safety are examples of negative outcomes often associated with risk, as noted by (Zsidisin, 2003).

2.4 Operational Definitions

The following summarizes the definition of each variable involved in our survey.

| Variables | Definition | Reference |
|-----------------------------------|---|--------------------------|
| Supply Chain 4.0 | <i>The upgraded supply chain, known as supply chain 4.0, uses several Industry 4.0 technologies, including IoT, AI, cloud computing, and Big Data. To dramatically enhance supply chain management, it blends cutting-edge AI algorithms, business intelligence tools, data sciences, and other next-generation technology.</i> | (Tjahjono et al., 2017) |
| Supply Chain Risk | <i>Exposures, threats, and vulnerabilities related to the goods and services moving through the supply chain and the supply chain are included in the category of supply chain risks.</i> | (Baryannis et al., 2019) |
| Organizational Performance | <i>The ability of an organization to achieve its objectives and maximize its results is known as organizational performance. Organizational performance in the modern workforce can be summed up as a company's ability to reach objectives in the face of ongoing change.</i> | (Fletcher, 2020) |

2.5 Food Manufacturing Industry Description

To protect consumer rights, the UAE government has implemented stringent rules. Leading food manufacturing businesses in the UAE must adhere to the best health and safety practices and provide outstanding, completely safe products. According to statistics, the UAE's national non-resource industry accounts for about 47% of food goods and food industry production. Experts believe there is still room for manufacturers to grow in this market.

Approximately 57% of the total investments in the industry are made in this sector. The increase in the production of bottled water and other food products has been only one factor in the rise in investment. The major prerequisites continue to be the UAE's rapidly expanding local population and the market's increasing demand for food items.

3. Literature review

3.1 Relationship and Impact of supply chain 4.0 on Organizational Performance

Performance is a contentious issue in the supply chain management literature. Quality, responsiveness, adaptability, reliability, and asset management are considered when evaluating supply chain performance. In a previous study, these four features were considered: diversity, creativity, speed, affordability, and accessibility, which can be used to evaluate an organization's performance (Ghadge et al., 2020, 2022). Supply chain management and performance are heavily dependent on information transmission. As companies invest in technological improvements that enable better communication channels and collaboration mechanisms, supply chain performance can be enhanced via better information sharing (Zu'bi et al., 2012). Successful business operations require high-level process integration. Supply chain efficiency can only be improved if all parties and activities are linked together (Lee, 2021). An increase in integration might substantially impact costs, quality, variety, and service (Joghee et al., 2021; Karimi & Rafiee, 2014).

Furthermore, supply chain collaboration and integration aid in improving the organization's performance because integration provides several advantages, including the ability to share information effectively (Roosbeh Nia et al., 2021). This can lead to increased operational adaptability and responsiveness. In terms of supply chain performance in food manufacturing companies, supply network agility and resilience have a significant impact since these attributes enable better risk management in supply chains. Supply chain transparency and openness are expected to significantly influence operational performance. One may overcome the integration problem by integrating Industry 4.0-enabled technology into supply chain management. Improved supply chain performance is envisaged due to increased connection and thorough integration of these technologies (Ali, 2022).

Frank et al. point out that a sophisticated supply chain refers to the digital platforms utilized by suppliers, retailers, customers, and other business partners across the supply chain (2019). Shared information and synchronized actions among SC partners

save overall costs and increase the overall efficiency and agility of SCs (Lyons & Ma'Arum, 2014). The more open and collaborative the SC network is, the more trust and closeness it fosters among its members. The value chain can be enhanced, and risks decreased using Industry 4.0-enabled capabilities, such as highly organized interconnection and the ability to monitor and control SC parameters in real-time, which can help improve customer interaction and trust. Based on previous studies, a hypothesis is developed to empirically investigate this research (Liu et al., 2021).

H₁: *Supply Chain 4.0 has a significant impact on Organizational Performance.*

3.2 Relationship and Impact of supply chain risks and Organizational Performance

Initially, efforts were made to operationalize and verify supply chain risk (SCR) measures and empirically study the links between environmental elements and supply disruption risk concerning supply chain integration. Risks in today's supply chains are exacerbated by the increasing complexity of supply networks and global threats (such as financial crises and terrorist acts) (Wagner et al., 2017). Thus, managers prioritize the development of support systems that facilitate the selection of appropriate solutions to reduce such risks. Furthermore, the risk management approach (broad terms: identifying and evaluating risks, identifying priorities for mitigation actions) is applied to the supply chain environment (Pournader et al., 2020). Managers may take a more methodical approach to risk by prioritizing measures based on available resources and desired outcomes. On the other hand, the contributions imply that the supply chain risk management approach should be more qualitative and informal, as this strategy is also widely used in practice.

According to previous research, each risk's frequency and severity depend on the present supply chain procedures under review. "Vulnerability" can be described as a supply chain's risk of being lost due to its current organizational or functional practices or circumstances. This concept is strongly associated with supply chain vulnerability" (Wagner et al., 2017). Supply chain procedures are influenced by mitigation strategies, leading to a decrease in the likelihood and severity for risks under consideration." A budget is set aside by the decision-maker to implement mitigation measures. In the event of supply chain interruption, additional costs may be incurred by the supply chain; however, these costs would be included in the overall effect of the disruption rather than in the preventative budget. The proven studies show the proposed hypothesis of this research regarding the relationship between SCR and Organizational Performance.

H₂: *Supply Chain Risk has a significant impact on Organizational Performance.*

3.3 Relationship and Impact of supply chain 4.0 and Supply chain risks on organizational performance

Over the past two decades, the scientific community has become increasingly interested in SC risk management. Numerous model-based research has mushroomed in the last decade, as evidenced by surveys of quantitative approach applications to SC disruption risk and resilience. According to research by (Pulevska-Ivanovska & Kaleshovska, 2013), several problem types have been identified, and datasets will be discussed. Some operational parameters (such as capacity) can be tweaked to determine if there is a disruption in organizational performance, and analytical methods are used to determine how this impacts costs, productions or sales. Strategic decision-making may benefit from this research. However, these models are constrained by the dynamics of inventory, sourcing, and shipping control. An SC 4.0 behavior can be studied over time, a disruption's performance effect can be calculated, and a robust SC design can be recommended based on thorough and real-time financial, customer, and operational performance measures.

However, simulation models consider an additional logical and randomness restriction, such as the unpredictability of interruptions and the progressive degradation of capacity and its recovery. This is in addition to the more comprehensive data of optimization models. In this class, simulation is the primary method for solving difficulties (Wu & Olson, 2008). Industry 4.0 in the food sector is gradually being replaced by Industry 5.0, which is already planned. The Japanese government was the first to introduce this new paradigm, known as Society 5.0. Unlike Industry 4.0, which only applies to the manufacturing industry, Society 5.0 uses technology to address general societal problems, specifically human factors. Industries are now at a crossroads in considering the future of manufacturing within the fifth industrial paradigm, which promises the use of technology for more sustainable, resilient, and equitable cyber-physical systems. This is in addition to the urgent environmental issues and human components. Previous studies have not provided enough evidence of supply chain 4.0 and SCR's impact on organizational performance. Therefore, a hypothesis has been developed to examine the literature and strengthen knowledge for future research.

H₃: *Supply chain 4.0 and Supply chain risk significantly impact organizational performance.*

3.5 Problem Statement & Research Gap

Although supply chain activities cross functional boundaries, it is not easy to address the challenges mentioned above and improve organizational performance (Lee et al., 2022). Ali (2022) points out that the use of technology, such as information technology, has enabled many companies to overcome this issue due to the need for exploration. There is a growing need for innovative and creative technologies that can be used to enhance the integration of business processes and analytical abilities in many manufacturing organizations, such as food manufacturing. Evaluating the impact of supply chain 4.0 and its integration in manufacturing companies by managing supply chain risks and their impact on organization performance can fill the gap identified by previous researchers (Ali, 2022; Gurtu & Johny, 2021). Fig. 1 shows the structure of the proposed study.

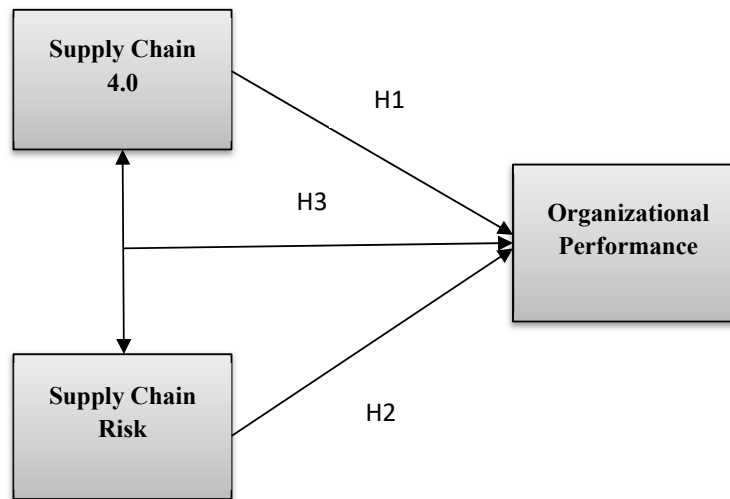


Fig. 1. The proposed study

3.6 Research Methodology and Design

To measure Supply Chain 4.0, Supply Chain Risk and Organisational performance, a quantitative technique with cluster sampling was applied using a descriptive, causal and analytical research design. The need for empirical evidence necessitated collecting data from food manufacturing companies through an online survey.

3.7 Population, Sample & Unit of Analysis

To explore the research variables, the 54 food manufacturing companies based in Ajman UAE were selected as the target population. After screening, a sample of 289 participants was used for statistical analysis. An online questionnaire was emailed to the employees of the company's managerial departments. The survey correspondents were (IT Managers, SC Managers, and Sales and Marketing Managers). A Five-point Likert scale was used in the questionnaire. The questionnaire contained 27 items related to each variable, such as 10 items measuring SC4.0, 9 items measuring Supply chain risk and 8 items measuring organisational performance. Demographic questions were limited to gender specification and job status.

4. Data analysis

4.1 Demographic analysis

In the survey analysis, the research findings revealed a high number of male participants compared to females and a high range of supply chain managers 109. Fig. 2 illustrates the demographic data summary.

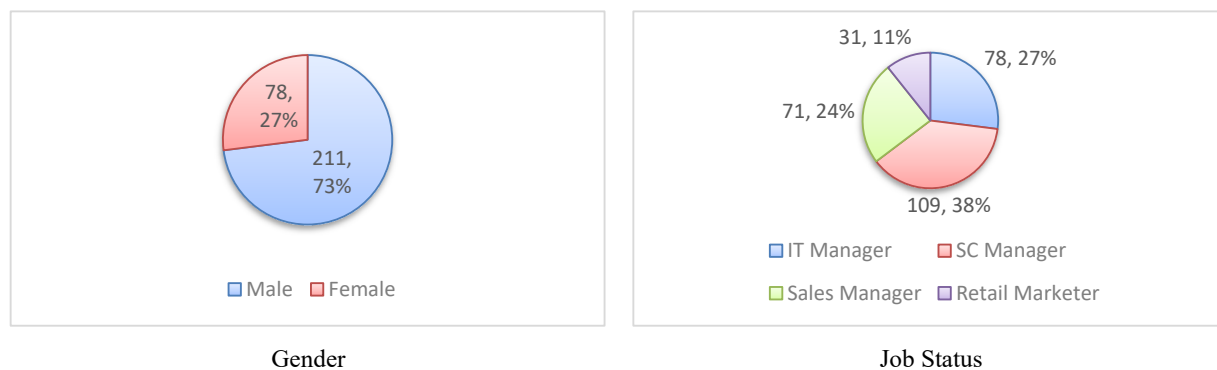


Fig. 2. Personal characteristics of the participants (n = 289)

4.2 Reliability, Descriptive & Correlation

To ensure the data reliability, a reliability test was performed using Cronbach's Alpha, which ranged for the Supply Chain 4.0 =.88, .87 for Supply Chain Risk and .79 for Organizational performance, indicating the validity of the data. On the other hand, the descriptive analysis depicts the results of the Mean value for Supply Chain 4.0 as (M=3.10 & SD=.73), Supply Chain Risk (M=3.07 & SD=.89) and Organizational Performance (M=2.70 & SD=.79) respectively. Table 2 demonstrates the correlation coefficient values that depict a significantly high correlation between SC 4.0 and SCR $r=.83^{**}$, a significant,

highly correlated relationship of SC 4.0 with OP $r=.69$ and SCR with OP as significant and correlated with $r=.78$. Table 1 shows the summarized data.

Table 1

The results of the reliability of the components of the survey

| Construct | No of items | Cronbach's Alpha | Mean | S.D | Supply Chain 4.0 | Supply Chain Risk | Organizational Performance |
|----------------------------|-------------|------------------|------|-----|------------------|-------------------|----------------------------|
| Supply Chain 4.0 | 10 | .88 | 3.10 | .73 | 1 | | |
| Supply Chain Risk | 9 | .87 | 3.07 | .89 | .832** | 1 | |
| Organizational Performance | 8 | .79 | 2.70 | .79 | .696** | .788** | 1 |

Supply Chain 4.0 ($M=3.10$, $SD=.73$), Supply Chain Risk ($M=3.07$, $SD=.89$), Organizational Performance ($M=2.70$, $SD=.79$).

-Level of significance at $P<0.05$ **

4.3 Multiple Regression & Hypothesis Testing

Table 2 presents the summary of the regression results. As we can observe from the results, all three coefficients are significant when the level of significance is one percent. Adjusted R-Square is well over 0.60% which means the regression analysis represents, at least, 60% of the changes of the dependent variable.

Table 2

Linear Regression & Hypothesis Testing through ANOVA

| Hypothesis | Regression Weights | Standardized Coefficients | | | Sig | t-value | Hypothesis Supported |
|----------------|--------------------|---------------------------|----------------|-------------------------|------|---------|----------------------|
| | | β | R ² | Adjusted R ² | | | |
| H ₁ | SC4.0→OP | .696 | .684 | .683 | .000 | 2.02 | Yes |
| H ₂ | SCR→OP | .788 | .621 | .619 | .000 | 10.41 | Yes |
| H ₃ | SC4.0×SCR→OP | .791 | .626 | .623 | .000 | 8.48 | Yes |

Dependent variable= Organizational performance *Level of Significance ($\alpha\leq 0.05$)

**Critical t-value (df/p) = 1.64

4. Discussion and the results

Although a statistical analysis defined the hypothesis results, indicating a significant relationship between Supply Chain 4.0 (SC4.0) and Organizational Performance (OP) ($\beta=.69$, $P=.000$, $t=2.02$), positive results of the critical value, as well as the variance, were found as $R^2=68\%$. The results indicate the acceptance of H1. Some authors argue that supply chain 4.0 integrates important business activities from the end-user to the original suppliers that provide products, services, and information that add value to consumers and improve organizational performance (Tjahjono et al., 2017). Additionally, the results for H2 indicate a significant relationship between Supply Chain Risk (SCR) and OP by ($\beta=.78$, $P=.000$, $t=10.41$) and variance prediction as $R^2=62\%$. Previous studies have investigated the SCR impact on organizational performance, and risk management can prevent false delivery risk, loss during transportation, product expiration etc. (Rajesh & Ravi, 2015). The statistical results demonstrate the significant relationship of SC4.0 & SCR on OP by ($\beta=.79$, $P=.000$, $t=8.48$), a significant positive relationship with high variance among the variables as $R^2=62\%$ respectively. The significance level of the two variables (SC4.0 & SCR) on Organizational performance can identify the technological advancement in the supply chain, and supply chain risk management can improve the organizational effectiveness in terms of customer retention, loyalty and repurchase for safety and security purposes. The findings can contribute to the literature and greatly support future research.

6. Conclusion

The research has revealed a strong link between supply chain 4.0 and organizational performance. Additionally, based on the current research evaluation, this research has defined Supply Chain 4.0 as critical to improving organizational performance and reducing risk in the supply chain. Besides, innovative tools and technology are used to transform established industrial processes in the food manufacturing industry 4.0 by enhancing traceability, food quality monitoring and control, safety, manufacturing, automation, and training, predicting sensory and consumer preferences and minimizing losses and waste. Industry 4.0 principles have benefited food processing operations. Supply networks are being modernized, automated, and made more responsive. SC networks employ various digital technologies to produce more effective processes that can also be more adaptive and resilient, including new goods, manufacturing, procurement, planning, shipping, and marketing. Furthermore, the availability of and dissemination of accurate data from every stage of the food supply chain improves food safety, reinforces brand integrity, and fosters consumer loyalty.

7. Recommendations and limitations

By focusing on workforce development for the manufacturing era, higher education in food science can help move the industry from 4.0 to 5.0. Food science and engineering departments need to work together on this with support from the food

sector. While this study makes significant theoretical and practical contributions, there are still some gaps that require additional research. The research offers a theoretical framework and seven assertions that could be tested through quantitative research in the future. This research, however, focused on a certain sector and country. Recognizing that a system's adoption, development, and implementation vary among industries and countries. Thus, this research can be replicated in various situations across industries worldwide, especially in emerging economies, with the implication of supply chain 5.0. The results of this study are consistent with findings of Eslami et al. (2021) and Ali (2022).

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