International Journal of Technology 14(5) 972-981 (2023)
Received February 2023 / Revised March 2023 / Accepted March 2023

International Journal of Technology

http://ijtech.eng.ui.ac.id

# Impacts of COVID-19 on the Automotive Industry in Vietnam

Nguyen Duc Bao Long[1,2*], Ian Mackechnie[3], Pit Tatt Ooi[4], Nguyen Ngoc Huy[5], Tran Thi Bich Hao[6], Le Thi Hai Duong[7]

[1]*Charisma University, School of Business, #44 Salt Mills Plaza, Grace Bay, Providenciales, TKCA 1ZZ, Turks and Caicos Islands*
[2]*Nguyen Tat Thanh University, 300A Nguyen Tat Thanh Street, Ward 13, District 4, Ho Chi Minh City, Vietnam*
[3]*Charisma University, School of Business, #44 Salt Mills Plaza, Grace Bay, Providenciales, TKCA 1ZZ, Turks and Caicos Islands*
[4]*Oxford Journal of Technology, Arts, Sciences and Knowledge, 11, Cangkat Minden Jalan 1, 11700 Gelugor, Pulau Penang, Malaysia.*
[5]*Ho Chi Minh City University of Banking, Graduate School, 36 Ton That Dam Street, Nguyen Thai Binh Ward, District 1, Ho Chi Minh City, Vietnam*
[6]*University of Economics Ho Chi Minh City, Graduate School, 59C Nguyen Dinh Chieu Street, District 3, Ho Chi Minh City, Vietnam*
[7]*Hong Bang International University, School of Economics and Business, 215 Dien Bien Phu Street, Ward 15, Binh Thanh District, Ho Chi Minh City, Vietnam*

**Abstract.** This study aimed to determine the impact of COVID-19 on the automotive industry in Vietnam. Another objective was to promote some potential recovery scenarios after economic shocks. Finally, the study examined a solution to overcome COVID-19 and lead Vietnam's automotive industry towards the "new normal." Qualitative research was used in conjunction with questionnaires and document reviews to achieve the above objectives. In the qualitative stage, in-depth interviews were conducted with 32 experts in the industrial sector to explore the impact of COVID-19 on the automotive industry in Vietnam. Structural Equation Modelling (SEM) with Partial Least Squares (PLS) and Statistical Package for the Social Sciences (SPSS) were used to explore and measure the impact of factors affecting the automotive industry with 620 respondents for a study regarding the industry that prevents the author from having more actionable recommendations. The findings revealed that five identified factors, which are business effects, supply chain and manufacturing, response and imperatives, leadership, government, and regulatory intervention, could be components of the impact of COVID-19 on the automotive industry in Vietnam. Two recommendations that were pointed out include conducting the 4RE Solution and applying the integration Block-chain leadership model to help Vietnam overcome the crisis and take this pandemic as a chance to restructure for a renewed automotive industry.

*Keywords:* 4RE Solution (Respond, Reset, Recover, and Reshape); Block-chain leadership; COVID-19 response; Resilience; Vietnam automotive industry

## 1. Introduction

In March 2020, the WHO declared COVID-19 a global pandemic, intensifying the IMF's worries about a global economic downturn (Van Barneveld *et al.,* 2020).

*Corresponding author's email: info@javihi.net, Tel.: +84-28-35920016; Fax: -84-28-35920021
doi: 10.14716/ijtech.v14i5.6383

Researchers and marketers are equally interested in COVID-19 due to its severe business-related effects on the global automotive sector. By supplying the need for transportation and fostering the growth of ancillary sectors, the automotive industry greatly contributes to the promotion of national economic development (Long, Tan, and Tran, 2015). Numerous automotive companies have placed a high priority on addressing the decline in demand caused by health issues. Consequently, to understand and illustrate the challenges faced in enhancing the automotive sector, it is crucial to focus on studying the impacts of COVID-19, along with other relevant factors.

The automotive industry plays an important role in many developed economies. However, the sector has been dealing with serious issues because of the rising demand for electric vehicles even before the pandemic started (Kaitwade, 2021). The automobile business is crucial for the global economy and the wealth that results in many ways, including ties to other industries, employment, and the economy. Despite the challenging situation, OEMs that can quickly deploy their COVID-19 response and take action will be better off after the occurrence and more resilient going ahead (Accenture, 2020). COVID-19 has had varying degrees of economic impact on the industrial structure of countries and economies. The unprecedented pandemic, COVID-19, has brought about an external shock that is compelling the automotive sector to reassess its operations and address emerging challenges. The immediate and significant impact of COVID-19 on the globally interconnected automotive industry is expected to lead to an upsurge in Merger and Acquisition (M&A) activities. This increase is driven by the growing opportunities for strategic alliances and consolidation within the sector, particularly for private equity players.

Automotive OEMs and players have been particularly badly impacted, which has led to changes in the macroeconomic climate, organizational structures, innovative thinking, and consumer behaviours (Hausler *et al.,* 2020). According to the decline in the Manufacturing Production Index (MPI) in April 2020, which was about 82% per year, COVID-19 measures had the most pronounced negative impact on Thailand's manufacturing sector. The industries with the greatest negative effects were the automotive, petroleum and petroleum products, malts and malt beverages, air conditioning systems, and sugar (UNIDO, 2020).

The COVID-19 pandemic has resulted in a semiconductor shortage, affecting the automobile industry in Vietnam (MOIT, 2022). The COVID-19 pandemic poses risks to Vietnam's automotive sector and businesses due to its dynamic nature. Understanding the industry's current state is crucial for developing effective recovery plans. This study aims to analyze the impact of COVID-19 on Vietnam's automobile sector, which plays a vital role in the country's economic growth.

The study proposed to answer several research questions related to the automotive industry in Vietnam during COVID-19. The questions encompass various aspects of the industry, such as its current status, the impact factors of COVID-19 on the automotive industry, potential recovery scenarios, recommendations for overcoming the crisis, and strategies to leverage the impacts of COVID-19 as an opportunity for development.

## 2. Literature Review

### *2.1. Impact Factors of COVID-19 on the Vietnam Automotive Industry*

#### 2.1.1. Business Effects

The automotive industry has faced significant challenges during the COVID-19 pandemic. Suppliers with liquidity problems may destabilize the entire global automotive manufacturing ecosystem, leading to disastrous effects (Deloitte, 2020). Thai businesses

face a scarcity of raw materials due to lockdowns and other restrictions (UNIDO, 2020). Original Equipment Manufacturers (OEMs) had to halt production due to a lack of parts, decreased workforce, and quarantine procedures (Accenture, 2020). The decline in sales, politically-enforced production closures, layoffs, and reduced output have resulted in a general decline in consumer confidence, revenue, and profitability. Additionally, the pandemic has caused a sudden and widespread slowdown in economic activity, forcing workers to stay at home and supply lines to deteriorate. The closure of production facilities in Europe is anticipated to have a significant impact on approximately 14 million jobs, including both direct and indirect employment. Additionally, about 50% of contract employees are facing imminent and long-term risks as a result of these closures (ILO, 2020). Despite the challenges, the pandemic presents opportunities for the industry to reevaluate its underperforming global markets and vehicle segments and take steps toward sustainable recovery.

#### 2.1.2. Supply and Demand

The 2020 coronavirus outbreak strained OEMs and auto parts suppliers. Anticipated declines in new vehicle sales reduced revenue and disrupted production and supply (UNIDO, 2020). The interconnected nature of the industry's supply chain forced OEMs and component suppliers to halt or delay production, increasing the risk of a capital crisis. Prolonged disruptions to consumer demand may trigger a global recession, impacting automaker revenues and profitability (Deloitte, 2020).

#### 2.1.3. Manufacturing and Supply Chain

The automotive sector is undergoing transformative changes driven by connected vehicles, autonomous driving, shared mobility, and electrification (Long, Huy, and Van, 2022). The COVID-19 pandemic has exacerbated challenges, impacting supply chains, manufacturing, and demand. Studies have examined the pandemic's effects on logistics flow through Italian ports (Caballini, Ghiara, and Persico, 2022) and organizations' response to disruptions in product-based service supply chains (Gatenholm and Halldórsson, 2022). Big data analytics has shown promise in enhancing supply chain resilience compared to other Industry 4.0 technologies. This research informs investment decisions and explores the potential of underutilized enabling technologies. The pandemic highlights the need for resilience and adaptability in the automotive industry amidst technological and economic shifts (Spieske and Birkel, 2021).

#### 2.1.4. Response and Imperatives

Young businesses are more susceptible to negative consequences during a crisis compared to established ones. The family-oriented nature of SMEs amplifies the detrimental effects of COVID-19 on their operations. Family firms perceive themselves as operationally vulnerable to external shocks like the pandemic, hindering their ability to adapt to changing conditions (García-Pérez-de-Lema, Madrid-Guijarro, and Duréndez, 2022). This may lead to accelerated strategic decisions to exit unprofitable markets and vehicle segments, resulting in significant output reductions.

#### 2.1.5. Leadership

The leadership practices for adapting to the COVID-19 pandemic will focus on the agility of business leaders to sense, anticipate, and adapt to a rapidly changing VUCA (Volatile, Uncertain, Complex, and Ambiguous) world. Modern leaders will need to be able to adapt to overcome obstacles that develop as a result of any unanticipated crisis that affects the firm as well as foresee other challenges that may arise in the future. To adapt to VUCA, Long *et al.* (2022) suggested Blockchain leadership with the following skill set. "In order to develop multiple competencies in digital literacy, critical thinking, negotiation,

innovation, decision-making, conflict handling, cross-culture communication, cross-culture management, multi-generation management, business strategy, supply chain management, accounting and finance, emotional intelligence and global economics, leaders should be exposed to a variety of different learning experiences in the key areas of STEM (Science, Technology, Engineering, Mathematics) and managing global organizations." (Long *et al.,* 2022).

2.1.6. Government Policy

According to research by the United Nations Thailand, tax rate reductions or deferrals and reduced social contributions are the most preferred government support measures for auto firms in Thailand. Lowering operating costs, such as rent and electricity bills, and improving loan terms are also favored. The study recommends targeted support programs for micro and small businesses, extended tax exemptions and loan deferrals, and employee retention initiatives. Leveraging industrial development facilities, repurposing manufacturing, and embracing the fourth industrial revolution are also advised (UNIDO, 2020).

*2.2. Literature Gap*

The COVID-19 pandemic is one of the worst automotive industry disruptions and has challenged practitioners, policymakers, and scholars to improve its performance. Another thinking is that considering the crisis as a chance offers new opportunities for automotive manufacturers. The crisis offers a positive opportunity that offers firms a chance to break past experiments and replace them with new approaches. Recent technological progress, especially Industry 4.0, indicates possibilities to mitigate business effects, supply chain and manufacturing, response and imperatives, leadership, and government and regulatory intervention risks during the COVID-19 pandemic. However, the literature lacks an analysis of the link between the aforementioned factors. Based on a categorization of it, the research presents a comprehensive framework analyzing the current scenario while illustrating the relationship between both areas.

## 3. Research Methodology

This quantitative research utilized a Likert-scale survey with 620 respondents from various sectors, including the auto industry, to examine the relationship between variable factors and Vietnam's automotive industry. The study employed Smart-PLS 3.0 and SPSS 20 for correlation analysis, construct quality measurement, discriminant validity, crosstabulation, and path coefficients analysis. Long *et al.* (2022) proposed Blockchain leadership with characteristics such as agility, creativity, innovation, rapidity, flexibility, and resilience to navigate the VUCA environment. Another study highlighted Vietnam's industry components, including supporting industries, supply base, human resources, research and development, and government policy (Long, Tan, and Tran, 2015). The research framework aimed to assess the relationship between dependent and independent variables within the proposed framework.

Five hypotheses have been developed for this research:

- H1: There is a significant positive relationship between Vietnam's automotive industry during COVID-19 and business effects.
- H2: There is a significant positive relationship between Vietnam's automotive industry during COVID-19 and supply chain and manufacturing.
- H3: There is a significant positive relationship between Vietnam's automotive industry during COVID-19 and response and imperatives.

- H4: There is a significant positive relationship between Vietnam's automotive industry during COVID-19 and leadership.
- H5: There is a significant positive relationship between Vietnam's automotive industry during COVID-19 and government and regulatory interventions.

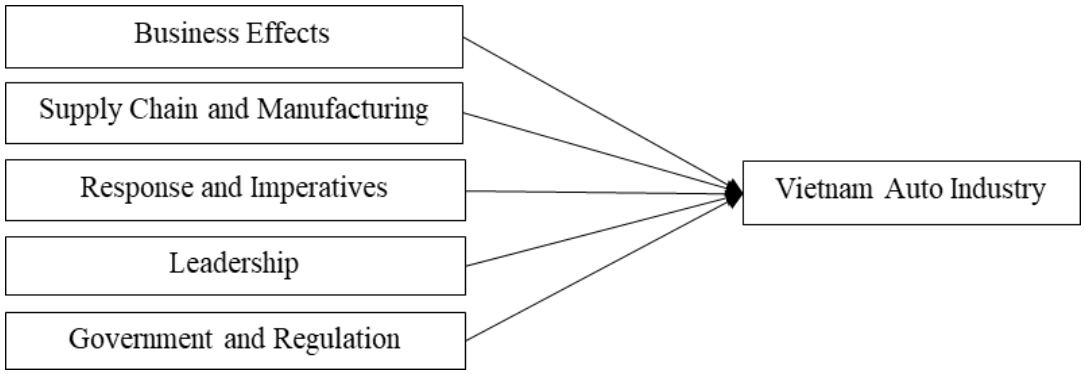


**Figure 1** Vietnam automotive industry during COVID-19 theoretical framework

## 4. Results and Discussion

### *4.1. Demographic Profile*

The study included 620 individuals from various organizations, industries, positions, and recovery scenarios. The diverse demographic profile of the study population indicates a varied representation of stakeholders with different perspectives and experiences in the automotive industry.

**Table 1** Demographic Profile

| | Category | Frequency (N = 620) | Percent (%) |
|---|---|---|---|
| Organization | Local | 76 | 12.3 |
| | State-owned | 255 | 41.1 |
| | Foreign | 111 | 17.9 |
| | Joint venture | 178 | 28.7 |
| Industry | Manufacturing | 245 | 39.5 |
| | Service | 105 | 16.9 |
| | Policy maker | 196 | 31.6 |
| Position | State officer | 218 | 35.2 |
| | Enterprise manager | 334 | 53.9 |
| | Researcher | 43 | 6.9 |
| | Vehicle user | 25 | 4 |
| Potential Recovery Scenarios | Scenario 1: Optimistic, Quarter 4-2022 | 64 | 10.3 |
| | Scenario 2: Realistic, Quarter 2-2023 | 242 | 39 |
| | Scenario 3: Pessimistic, Quarter 2-2024 | 130 | 21 |
| | Scenario 4: Other, Quarter 2-2026 | 184 | 29.7 |

### *4.2. SPSS and PLS Structural Model Results*

#### 4.2.1. Construct Quality Measurement

Factor loadings in Table 2 range from above 0.775 to 0.869, indicating components converged satisfactorily. Composite Reliability (CR) values of all constructs are greater than 0.7, demonstrating that they are adequate according to the standards and complete all the minimum requirements of the specific items.

**Table 2** Construct Quality Measurement

| Construct | Item | Mean | Outer Loadings (CR ≥ 0.7) | Composite Reliability (CR ≥ 0.7) |
|---|---|---|---|---|
| Automotive Industry (AI) | AI1 | 3.45 | 0.823 | 0.918 |
| | AI2 | 3.17 | 0.830 | |
| | AI3 | 3.20 | 0.775 | |
| | AI4 | 3.32 | 0.848 | |
| | AI5 | 3.29 | 0.881 | |
| Business Effects (BA) | BA1 | 3.32 | 0.875 | 0.924 |
| | BA2 | 3.14 | 0.819 | |
| | BA3 | 3.21 | 0.869 | |
| | BA4 | 3.56 | 0.781 | |
| | BA5 | 3.33 | 0.866 | |
| Government and Regulatory Interventions (GR) | GR1 | 2.98 | 0.876 | 0.921 |
| | GR2 | 3.03 | 0.842 | |
| | GR3 | 3.09 | 0.807 | |
| | GR4 | 3.11 | 0.801 | |
| | GR5 | 3.09 | 0.858 | |
| Leadership (LS) | LS1 | 3.45 | 0.825 | 0.920 |
| | LS2 | 3.45 | 0.799 | |
| | LS3 | 3.55 | 0.836 | |
| | LS4 | 3.73 | 0.840 | |
| | LS5 | 3.50 | 0.870 | |
| Response and Imperatives (RI) | RI1 | 3.58 | 0.810 | 0.914 |
| | RI2 | 3.64 | 0.805 | |
| | RI3 | 3.59 | 0.802 | |
| | RI4 | 3.98 | 0.828 | |
| | RI5 | 3.68 | 0.880 | |
| Supply Chain and Manufacturing (SM) | SM1 | 3.30 | 0.803 | 0.918 |
| | SM2 | 3.67 | 0.861 | |
| | SM3 | 3.65 | 0.850 | |
| | SM4 | 3.19 | 0.766 | |
| | SM5 | 3.46 | 0.877 | |

4.2.2. Convergent and Discriminant Validity

The minimum acceptable Average Variance Extracted (AVE) is 0.50 or higher. All AVE values are higher than the critical threshold value of 0.50, providing support for the measures' convergent validity.

**Table 3** Convergent and Discriminant Validity

| Construct | AVE ≥ 0.5 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Automotive Industry | 0.693 | | | | | | |
| Business Effects | 0.710 | 0.562 | | | | | |
| Government and Regulatory Interventions | 0.701 | 0.502 | 0.269 | | | | |
| Leadership | 0.696 | 0.635 | 0.423 | 0.184 | | | |
| Response and Imperatives | 0.681 | 0.473 | 0.379 | 0.088 | 0.392 | | |
| Supply Chain and Manufacturing | 0.693 | 0.511 | 0.320 | 0.316 | 0.228 | 0.103 | |

4.2.3. Scenario Crosstabulation

Table 4 summarizes the scenario choices of state officers, enterprise managers, researchers, and vehicle users. Scenario 2 (Realistic) was the most selected scenario, with 242 respondents, followed by Scenario 4 (Other), with 184 respondents. Scenario 1 (Optimistic) was selected by 64 respondents, while Scenario 3 (Pessimistic) was selected by 130 respondents. Scenario 3 was more popular among researchers, while Scenario 4 was

more popular among enterprise managers. Vehicle users only selected Scenario 3. Overall, Scenario 2 was the most popular, followed by Scenarios 4, 3, and 1.

**Table 4** Scenario Cross Tabulation

| Position | Scenario | | | | Total |
|---|---|---|---|---|---|
| | Scenario 1: Optimistic ⇒ Quarter 4-2023 | Scenario 2: Realistic ⇒ Quarter 2-2024 | Scenario 3: Pessimistic ⇒ Quarter 2-2025 | Scenario 4: Other ⇒ 2026 | |
| State officer | 64 | 154 | 0 | 0 | 218 |
| Enterprise manager | 0 | 88 | 130 | 116 | 334 |
| Researcher | 0 | 0 | 0 | 43 | 43 |
| Vehicle user | 0 | 0 | 0 | 25 | 25 |
| Total | 64 | 242 | 130 | 184 | 620 |

4.2.4. Hypothesis Results

R2 Adjusted to measure the model's explanatory power is used and interpreted in the same way as for the regression analysis. The analysis revealed that the structural model explained 60.1% of the variation in the automotive industry, suggesting that the structural model provided an adequate explanation. The Q2 value estimated the structural model's predictive relevance for each endogenous construct. Table 5 also shows that the Q2 values of the automotive industry (0.390) variable were over zero. This result confirmed the model's predictive power is suited for the endogenous latent variable. The f2 function value indicates the extent of influence that a factor has when it is removed from the model. In this case, the effect size f2 values for leadership and government and regulatory interventions are 0.216 and 0.164, respectively. These values, being greater than 0.15, indicate a moderate level of influence within the model. Effect size f2 value of 3 construct business effects, response and imperatives, supply chain, and manufacturing is smaller than 0.15 demonstrating a low level of influence in the model. Table 5 shows that other indices also have the goodness index, such as the VIF ( Variance Inflation Factor) value of all variables in the model being less than 3, so there is no multicollinearity problem. To assess the overall explanatory power of the structural model, the variance explained by the independent variables, and the strength of its paths, each hypothesis corresponds to a specific path within the structural model.

**Table 5** Path Coefficients

| No. | Path Coefficients | R Square Adjusted | Q Square | VIF | f Square | Original Sample (O) | P Values | Results |
|---|---|---|---|---|---|---|---|---|
| | Automotive Industry | 0.601 | 0.390 | | | | | |
| H3 | Leadership ➞ Automotive Industry | | | 1.285 | 0.216 | 0.332 | 0.000 | Supported |
| H2 | Government and Regulatory Interventions ➞ Automotive Industry | | | 1.129 | 0.164 | 0.270 | 0.000 | Supported |
| H5 | Supply Chain and Manufacturing ➞ Automotive Industry | | | 1.168 | 0.139 | 0.254 | 0.000 | Supported |
| H4 | Response and Imperatives ➞ Automotive Industry | | | 1.219 | 0.101 | 0.220 | 0.000 | Supported |
| H1 | Business Effects ➞ Automotive Industry | | | 1.351 | 0.052 | 0.166 | 0.000 | Supported |

Results in Table 5 demonstrate the connection between the automotive industry in Vietnam and its impact factors during the COVID-19 pandemic. Results indicate that five hypotheses in the conceptual model are fully supported. All constructs are significantly related to Vietnam's automotive industry. Variable leadership has the highest significant and positive relationship (O = 0.332, P<0.01) with Vietnam automotive industry.

Government and regulatory interventions (O = 0.270, P<0.01), supply chain and manufacturing (O = 0.254, P<0.01), response and imperatives (O = 0.220, P<0.01), business affects (O = 0.166, P<0.01) respectively have a significant positive relationship with Vietnam automotive industry.

*4.3. Discussion*

During the COVID-19 pandemic, leadership in response to the crisis is the most important factor. Apply Integration Block-chain leadership Model helps Vietnam overcome the crisis (Mean = 3.7) (Dr. Ly Tracy Trang – Nhon Hoa Company Limited). Leadership's priority is to reset the supply chain and operational excellence and the second priority is to renew the sales model and supply chain resilience (Mean = 3.55). Responsive and intelligent leadership is necessary (Mean = 3.5).

Government and regulatory interventions influence Vietnam's automotive industry during COVID-19. Vietnam should have more policies supporting the automotive industry during the crises (Mean = 3.11). The guidance or supporting policies for the sector is limited and not on time. Co-ordinance among the Government, Ministry, and Enterprisers during the COVID-19 pandemic is limited, leading to the Vietnam automotive industry commit difficulty (Mean = 3.09). Government support is expected to reduce the impact of taxes and duties and to help enterprises and the workforce in the financial field. During committing world century crisis, the leading role of the government is essential, including the regulation intervention of guidance and supporting policies of tax/duties as well as financial issues (Dr. Tran Van Ai–vice chairman of Nguyen Tat Thanh University) and industry 4.0 implementation is important (Anh *et al.,* 2022).

To achieve the best, it is a good idea to apply foreign support such as governmental support, policy, and upper-tier contractor. To be specific, shut down orders from the government and upper-tier contractors. Many OEMs announced a short-time work and overtime reduction; some restarted their production plants, while others shifted to producing medical equipment. "The greater the negative impact on investment and financing, the greater SMEs' demands for policies aimed at improving the competitiveness of companies." (García-Pérez-de-Lema, Madrid-Guijarro, and Duréndez, 2022).

Supply chain and manufacturing are the most important factors in the automotive industry, but not during crises. Recovery of the automotive supply chain will take time (Mean = 3.67). Rebound in export and import of countries will affect (Mean = 3.65). The just-in-time principal is not appropriate in crisis time. A restart will be complex, cost-intensive, and time-consuming. OEMs need to take immediate action to address interruptions, bolster operations to boost future resilience, and get ready for the "new normal" Cross-functional: A corporate control tower offers prompt and practical responses to a situation that is rapidly changing. Rebuild the industry needs to adopt Immersive Technology (ImTech) to get to the "New Normal" era (Baroroh and Agarwal, 2022). COVID-19 caused unimaginable world manufacturing and supply chains. Many factories closed, and motor vehicles were not able to be assembled (Mr. Tran Van Tuan – Director of HD Bank Binh Duong Province Branch).

Business components of the automotive industry comprise parts and components, manufacturing, workforce, capital resources, and sales, which are affected in many aspects. During the COVID-19 pandemic, there were limitations on automotive parts (Mean = 3.32). Manufacturing shut down in many places. Workforce capital liquidation declined (Mean = 3.56), and sales dropped (Mean = 3.33). Purchase of a motor vehicle is not a priority during a pandemic (Mr. Ho Lu Lam Tran – Javihi Hi-tech R&D Center).

The potential recovery scenarios for the crisis were presented in four concepts: optimistic, realistic, pessimistic, and other. State officers tend to be optimistic and realistic,

while enterprise managers and researchers tend to be somewhat realistic and pessimistic. Some respondents even presented the worst-case scenario for recovery.

## 5. Conclusions

These findings have significant implications for managers in the automotive industry, highlighting the importance of adopting the Block-chain leadership Model and implementing the 4RE Solution (Respond, Reset, Recover, and Reshape) to navigate the current crisis and strategically reshape the industry in Vietnam. Future research should aim to replicate these findings in larger and more diverse samples, explore additional external factors influencing the automotive industry's performance, and investigate their impact on specific areas such as supply chain management, innovation, and customer satisfaction. Overall, this study provides valuable insights and recommendations for practitioners in the automotive industry, enabling them to make informed decisions and formulate strategies to address external factors and enhance performance. Additionally, policymakers can leverage these findings to develop effective policies that support the industry's growth and resilience.

## References

Accenture, 2020. COVID-19: Managing Automotive Industry Impact. Available online at: https://www.accenture.com/us-en/insights/automotive/coronavirus-automotive-rapid -response, Accessed on June 07, 2023

Anh, T.D., Binh, T.D., Long, N.D.B., Ai, T.V., Tan, K.S., Van, N.T.L., 2022. Strategic Vision for the Implementation of the Industrial Revolution 4.0 in the Vietnamese Context. *International Journal of Technology*, Volume 13(5), pp. 958–968

Baroroh, D.K., Agarwal, A., 2022. Immersive Technologies in Indonesia Faces. *International Journal of Technology*, Volume 13(3), pp. 633–642

Caballini, C., Ghiara, H., Persico, L., 2022. Analysis of the Impacts of COVID-19 on Selected Categories of Goods Passing Through the Ports of Genoa and Savona, Italy. *Case Studies on Transport Policy*, Volume 10(2), pp. 851–869

Deloitte, 2020. Understanding COVID-19's Impact on The Automotive Sector, Deloitte United States. Available online at: https://www2.deloitte.com/us/en/pages/about-deloitte/articles/COVID-19/COVID-19-impact-on-automotive-sector.html, Accessed on June 07, 2023

García-Pérez-de-Lema, D., Madrid-Guijarro, A., Duréndez, A., 2022. Operating, Financial, and Investment Impacts of COVID-19 in SMEs: Public Policy Demands to Sustainable Recovery Considering the Economic Sector Moderating Effect. *International Journal of Disaster Risk Reduction*, Volume 75, p. 102951

Gatenholm, G., Halldórsson, Á., 2022. Responding to Discontinuities in Product-based Service Supply Chains in the COVID-19 Pandemic: Towards Transilience. *European Management Journal*, Volume 41(3), pp. 425–436

International Labour Organization (ILO), 2020. COVID-19 and the Automotive Industry. Available online at: http://www.ilo.org/sector/Resources/publications/WCMS_741343/lang--en/index.htm, Accessed on June 08, 2023

Kaitwade, N., 2021. COVID-19 Shatters Global Automotive Industry; Sales of Metal Powder Take a Nosedive Amid Wavering Demand. *Metal Powder Report*, Volume 76(3), pp. 137–139.

Long, N.D.B., Huy, N.N., Van, N.T.L., 2022. Vietnam Automotive Business at a Crossroads: A Jump to Future Technology. In: *Oxford Journal of Technology, Arts, Sciences, and Knowledge*

Long, N.D.B., Ooi, P.T., Le, T.V., Thiet, L.T., Ai, T.V., An, L.Q., Hudson, A., Tan, K.S., Van, N.T.L., 2022. Leading in the Age of the Fourth Industrial Revolution – A Perspective from Vietnam. *International Journal of Technology*, Volume 13(5), pp. 949–957

Long, N.D.B., Tan, K.S., Tran, H.L.L., 2015. Vietnam Automotive Industry Toward 2018. *International Journal of Business and Management Studies*, Volume 4(2), pp. 191–204

McKinsey, 2020. The Impact of COVID-19 on Future Mobility Solutions. Available online at: https://www.mckinsey.com/~/media/McKinsey/Industries/Automotive%20and%20Assembly/Our%20Insights/The%20impact%20of%20COVID-19%20on%20future%20mobility%20solutions/The-impact-of-COVID-19-on-future-mobility-solutions-vF.ashx, Accessed on June 08, 2023

Ministry of Industry and Trade (MOIT), 2022. The Automotive Industry was Hardest Hit by Supply Chain Disruptions During the Covid Pandemic. Available Online at: http://moit.gov.vn/tin-tuc/doanh-nghiep/nganh-cong-nghiep-o-to-bi-anh-huong-nang-ne-nhat-boi-su-gian-doan-chuoi-cung-ung-trong-dai-dich-covid.html, Accessed on June 08, 2023

Spieske, A., Birkel, H., 2021. Improving Supply Chain Resilience Through Industry 4.0: A Systematic Literature Review Under the Impressions of the COVID-19 Pandemic. *Computers and Industrial Engineering*, Volume 158, p. 107452

United Nations Industrial Development Organization (UNIDO), 2020. Impact Assessment of COVID-19 on Thai Industrial Sector. Available online at: https://thailand.un.org/en/50830-impact-assessment-COVID-19-thai-industrial-sector, Accessed on June 08, 2023

Van Barneveld, K., Quinlan, M., Kriesler, P., Junor, A., Baum, F., Chowdhury, A., Anis, J., Junankar, P.R., Clibborn, S., Flanagan, F., Wright, C.-F., Friel, S., Halevi, J., Rainnie A.-L., 2020. The COVID-19 Pandemic: Lessons on Building More Equal and Sustainable Societies. *The Economic and Labour Relations Review*, Volume 31(2), pp. 133–157

World Health Organization (WHO), 2020. Coronavirus disease (COVID-19) Pandemic Available Online at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019, Accessed on June 08, 2023