Causal Analysis of Company Performance and Technology Mediation in Small and Medium Enterprises During COVID-19

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Abstract
The COVID-19 pandemic has caused significant changes in companies and affected the operational capacity of small and medium enterprises (SMEs) around the world, pushing them further towards technology adoption and innovation. However, the extent to which the impact of use of e-commerce, technology, and digitalization on companies’ sales, operations, customer satisfaction, and their overall performance during COVID-19 has not been investigated. The aim of this study is to conduct a path analysis assessment of performance and technology mediation in SMEs during the pandemic. The path analysis suggests existence of statistically significant partial mediation by the mediator variables (SMEs’ digitalization, use of technology, and use of e-commerce during COVID-19) between independent variables (SMEs’ operation, sales, and customer satisfaction) and the dependent variable (SMEs’ performance). Operation, sales, and customer satisfaction directly affected SMEs’ performance during COVID-19. There was also an acceleration in the SMEs’ technology transformation during this period.

Keywords Path analysis · Mediation analysis · Small and medium enterprises · COVID-19 · Technology adoption · E-commerce

Introduction
The growth of a country’s economy is heavily reliant on its SMEs (Belsito & Reutzal, 2019; Didonet & Diaz-Villavicencio, 2020; Na-Nan & Wongsuwan, 2020; Rafiki, 2020). Evidence shows that SMEs contribute over 55% of GDP and
over 65% of total employment in high-income countries, whereas they contribute over 60% of GDP and over 70% of total employment in low-income countries, according to Zafar and Mustafa (2017). SMEs account for 95% of total employment and roughly 70% of GDP in middle-income nations; however, the COVID-19 pandemic has had a detrimental impact on small and medium businesses around the world. The restricted movement, reduced demand, and reduced purchasing power have resulted in massive financial losses and even the liquidation of some businesses. According to a recent study conducted in the USA that assessed COVID-19’s effect on SMEs, despite fundamental attempts from governments, SMEs face an uncertain future (Bartik et al., 2020a, b): the number of active SMEs in the USA decreased by 22% in the short period of 3 months between February to April 2020 (Fairlie, 2020).

The ability of SMEs to adapt to new challenges and bring innovation that allows them to achieve a competitive advantage in the global market is critical in the COVID-19 era (Baporikar & Shikokola, 2020). With the support of Amazon, Google Cloud, Facebook, Microsoft Azure, Zoom, Netflix, and Slack, consumers were still able to carry out many of their regular activities even though businesses were under lockdown. Abed (2021) conducted a comprehensive analysis of the literature on COVID-19’s effects and the role of technology in lowering its negative impact on businesses. The researcher concluded that technology was a critical component in SMEs’ survival. However, the number of studies investigating technology’s role and its impact on SMEs during the pandemic are limited and there is an even larger research gap in developing countries (Amornkitvikai & Lee, 2020; Hassen et al., 2019). Marin Bustamante (2020) researched the literature on the role of technologies in business (big data and analytics, artificial intelligence, mobile payments, internet of things, and block chain), and according to his review, there are few studies on the impact of new technologies on businesses in the context of the COVID-19.

Unfortunately, several companies in developing countries like Oman have been forced to close temporarily or even permanently because of the indirect and direct effects of the coronavirus (Afifi & Negm, 2020). The study on SMEs and technology mediation during this period in the developing countries of MENA and the GCC is rare, according to Abed (2021). Surprisingly, there has also been limited empirical research globally on SMEs and technology adoption during COVID-19 (Billore & Billore, 2020; Doyle & Conboy, 2020; Salem & Nor, 2020).

The study aims to determine the major business factors that influenced SMEs’ performance during COVID-19 and determine whether the mediators in the path analysis have any potential causal relationships, by conducting a case study of a developing country. In this regard, the study incorporated crucial features of small and medium-sized businesses from the literature available and developed a hypothesis. Our study is probably one of the first empirical studies to cover this area by seeking to answer the research question: To what extent has the SMEs’ performance been affected by sales, operations, and customer satisfaction, and mediated by their use of e-commerce, technology, and digitalization during COVID-19? This is the first study of its kind in a developing country like Oman. The findings will aid SMEs in better understanding the notion of technology and its impact on business success.
The findings will also benefit the developing countries’ governments, who may use them in formulating better strategies and policies to assist their SMEs.

There are five sections in this study: “Theoretical Background” communicates the literature review, “Research Method and Findings” describes the research method and findings; “Discussion” offers discussion, and the last section summarizes the findings and suggests recommendations.

Theoretical Background

COVID-19 lockdowns have affected a wide range of enterprises, including restaurants, supermarkets, fitness centers, traditional food markets, cinemas, vehicle dealerships, and other companies that require physical space rather than internet markets. The pandemic has directly and indirectly impacted sales, supply chain management, business operations, overall businesses performance, and technology transformation.

Effect of SMEs’ Operation on SMEs’ Performance Mediated by Digitalization, Use of Technology, and Use of E-Commerce

A qualitative study using interviews, conducted by Nyanga and Zirima (2020), found that SMEs encountered disrupted operations and employees’ layoffs due to COVID-19. Bartik et al. (2020b) surveyed over 5800 small companies to understand the pandemic’s impact and their findings revealed mass layoffs, closures, and financial losses. Several empirical examinations through online surveys found that lockdowns adversely affected SMEs’ daily operations. Small and medium-sized enterprises in Scotland reported a loss of revenue and the need for financial help for businesses at risk of insolvency or closure (Brown, 2020). Overall performance was affected by the reduced operations during COVID-19.

Papadopoulos et al. (2020) presented an opinion paper and discussed research on the role of digital technologies in improving operation and performance of SMEs. In a case study by Jha (2020), the leaders of 15 Indian hi-tech start-ups from various industries were interviewed about the role of technology in business survival. The outcome implies that new technology is being accepted and playing a vital role in operations. Hussain et al. (2021) assessed the impact of technological (relative advantage and technology readiness), organizational (cost of adoption and top management support), and environmental (government support and competitive pressure) factors on B2B e-commerce for manufacturing SMEs in Pakistan. The multi-group analysis of the collected data predicted a significant impact of technological factors on B2B e-commerce. Companies are embracing social media and online strategies to disseminate product information, predict revenue trends, and distribute product information for sales (Lv et al., 2020). The efficiency of a social network-based e-business strategy is determined by how well customers connect with the company’s advertisements through retreats, likes, and shares and social networking is utilized in advertising and promotional efforts (Sathishkumar et al., 2020), as well as online marketing (Kumari et al., 2020). SMEs, on the other hand, tend to be
unaware of the advantages of conducting business online and lack the requisite digital skills (Antonescu, 2020). SMEs are more willing, however, to use technology if they understand the benefits and impact on performance (Scupola, 2009; Shah Alam et al., 2011).

Effects of SMEs’ Sales on SMEs’ Performance Mediated by Digitalization, Use of Technology, and Use of E-Commerce

Lu et al. (2020) studied SMEs’ challenges during COVID-19 by distributing online questionnaires and conducting interviews with 4807 SMEs in China. According to their research, these businesses’ sales and operations experienced a financial shock due to decreased market demand, cash flow, lack of resources, and supply chain interruptions. Belghitar et al. (2021) looked at the performance of 42,401 SMEs across 28 industries in the UK and reported negative earnings to 59% of the UK SMEs unless the government provided emergency funds. The small and medium enterprises in Pakistan encountered lower sales, higher costs of production, and slow growth due to pandemic lockdowns (Javed & Ayaz, 2020). Similar situations emerged in other countries, including SMEs in Serbia (Beraha & Duricin, 2020) and in Romania (Antonescu, 2020). Reduced sales affected the overall SMEs’ performance during COVID-19.

As defined by Alharbi and de Doncker (2019) and Taleby Ahvanooey et al. (2020), commerce and business entail a transaction of goods and services between buyers and sellers, but e-business is defined as an Internet-based transaction (Galindo-Martín et al., 2019). During the pandemic, e-commerce sites grew in popularity, and people went online to look for vital items. Technology, according to Fletcher and Griffiths (2020), is the best answer for corporate sustainability during the pandemic. This view is supported by Doyle and Conboy (2020) stating that companies should not view COVID-19 as a barrier, because adoption of online digital platforms can help them promote and sell more products. Each firm, large or small, is critical to the economy, and thus its long-term viability, as evidenced by technological adoption, is critical in the current and future climates (Ameen et al., 2021). With the use of a multiple case study comprising seven manufacturing businesses, Priyono et al. (2020) explored changes and digital transformations in the Indonesian SMEs’ business model. The findings revealed varying degrees of digital transformation among small and medium businesses with a high level of digital maturity, those with a low level of digital maturity who are suffering liquidity concerns, and those with a very low level of digital literacy.

Effects of SMEs’ Customer Satisfaction on SMEs’ Performance Mediated by Digitalization, Use of Technology, and Use of E-Commerce

The supply chain disruptions and thus timely delivery of goods to customers were identified as the primary challenges in a survey of 748 Malaysian SMEs conducted by Ratnasingam et al. (2020). Untaru and Han (2021) conducted research on customer satisfaction and how disparities in gender, age, education, and income level
affect businesses, concluding that merchants should establish distinct communication techniques for different customer segments. In Sri Lanka, Robinson and Kengatharan (2020) interviewed 14 SMEs and discovered material and human resource shortages led to untimely delivery of products and thus unsatisfied customers. After proposing a digital transformation and sustainability framework for SMEs to handle pandemics, Winarsih et al. (2021) reported a lack of knowledge amongst the enterprises on the benefits of digital skills.

FinTech companies aided workers, enterprises, and entire economies during the COVID-19 crisis, with Smeets and Zeisberger (2020) arguing the benefits and use of FinTech in Latin America. In Bangladesh, 665 consumers were polled by Akter and Sultana (2020) regarding their attitudes to internet marketing of branded cosmetics: they discovered that consumers had a favorable view toward online marketing. Big data analytics enables new and customer-centric post-sale services, as well as providing input for improved product design and marketing (Akpan et al., 2020). Luo (2021) published a study that used deep recurrent neural network (DRNN) on clickstream data to investigate the impact of social networks and online shopping behavior on e-business performance during the pandemic. The model was able to improve the profitability ratio by 98.5%, the performance ratio by 97.5%, the accuracy ratio by 96.7%, the prediction ratio by 97.9%, and give less error rate than the other approaches by 11.3%, indicating that this deep learning technique is effective in modeling consumer behavior.

Research Method and Findings

In this study, we have applied path analysis methods on the data collected from the survey questionnaires for in-depth understanding of the influence of predictors and mediators on SMEs’ performance during COVID-19. The path analysis model provides causal relationships between predictors and outcome variables.

Research Objective and Hypotheses

The following are the study’s objectives:

1. To determine the major business factors that influenced SMEs’ performance during COVID-19.
2. To determine whether the mediators in the path analysis have any potential causal relationships.

The survey questionnaire and interviews were designed to meet the research objective and designed in a manner to conduct the analysis and hypotheses testing. The study seeks to tests the following hypotheses.
Hypothesis 1: SMEs’ digitalization is a mediating variable in the relationship between sales and performance.

Hypothesis 2: SMEs’ use of technology is a mediating variable in the relationship between sales and performance.

Hypothesis 3: Use of e-commerce by SMEs is a mediating variable in the relationship between sales and performance.

Hypothesis 4: SMEs’ digitalization is a mediating variable in the relationship between customer satisfaction and performance.

Hypothesis 5: SMEs’ use of technology is a mediating variable in the relationship between customer satisfaction and performance.

Hypothesis 6: Use of e-commerce by SMEs is a mediating variable in the relationship between customer satisfaction and performance.

Hypothesis 7: SMEs’ digitalization is a mediating variable in the relationship between operation and performance.

Hypothesis 8: SMEs use of technology is a mediating variable in the relationship between operation and performance.

Hypothesis 9: Use of e-commerce by SMEs is a mediating variable in the relationship between SMEs’ operation and SMEs performance.

In addition, we seek answers to the following questions: What level of digitization do SMEs have now? What Industry 4.0 technologies do SMEs aim to adopt in the future? How satisfied are the businesses with the quality of their e-Service? What is the satisfaction rate of the client with the quality of the company’s e-Service?

Path Analysis and Statistical Models for Hypothesis Testing

Path Analysis

A multivariate technique for identifying relationships between observable (measured) variables is path analysis. It is a method used to identify the causal types of relationships between the variables under investigation. This method was first illustrated by Sewall Wright in 1930 and is still widely used in the research environment (MacCallum & Austin, 2000). Path analysis is similar to a regression model in the sense that both are linear statistical models with certain assumptions. Path analysis, however, is both flexible and comprehensive (Streiner, 2005). This methodology can be used to investigate achievement, economic trends, health difficulties, family and peer dynamics, self-concept, exercise, self-efficacy, depression, psychotherapy, and
other concerns. The basis of mediation is that the effect of an independent variable on a dependent variable is transmitted by a mediating variable. Mediation analysis is a statistical procedure for determining whether the effect of an independent variable \( X \) on a dependent variable \( Y \) (i.e., \( X \rightarrow Y \)) can be explained, at least partly, by a chain of effects of the independent variable on an intervening mediator, variable \( Z \), and of the intervening variable on the dependent variable (i.e., \( X \rightarrow Z \rightarrow Y \)) (MacKinnon, 2012). In the social sciences, the term moderation is used to stress the circumstances in which an independent variable causes changes in a dependent variable. Only when the interaction between the predictor and the suggested moderator is significant does moderation occur (Nichita et al., 2019). The methods used for moderation analysis include analysis of variance, structural equation modeling, and multiple regressions. The present study has used multiple regressions for moderation analysis.

**Path Coefficient**

The path coefficient reveals the independent variable’s direct effect on the dependent variable. It equals the correlation coefficient if the model has only one independent to dependent variable. Path coefficients are equal to partial correlation coefficients in models with more than two variables (independent to dependent variable) and are standardized (Beta) or unstandardized \( (B) \) or \( (\beta) \) regression coefficients. For example, consider a network has a path connecting variables \( A \) and \( B \). With an unstandardized path coefficient \( B \) of 0.81, if variable \( A \) rises by one unit, variable \( B \) should increase by 0.81 unit while the rest of the variables remain constant. With a path coefficient \( B \) of −0.16, if variable \( A \) rises by one unit, variable \( B \) should decrease by 0.16 units while the rest of the variables remain constant. The standardized path coefficients are not correlation coefficients. For instance, take a network with a path connecting variables \( A \) and \( B \). The standardized path coefficient Beta (e.g., 0.81) has the following meaning: variable \( B \) would be predicted to increase by 0.81 standard deviation from its own mean if variable \( A \) increased by one standard deviation from its mean while all other relevant variables remained constant. With a path coefficient of −0.16, if variable \( A \) moves one standard deviation away from its mean, variable \( B \) should move 0.16 standard deviations away from its own mean while all other relevant variables remain constant. The effect-size estimations are standardized estimates. If an inadequate model fit is discovered, the model could be updated if the changes are significant. Model change entails modifying a stated and estimated model by either freeing or fixing parameters that were previously fixed. A small influence may be indicated by standardized path coefficients with absolute values less than 0.10, a medium effect by values around 0.30, and a large effect by values larger than 0.50.

**Model Fit Indices**

The examination of various tests (e.g., chi-square, comparative fit index (CFI), root-mean squared error of approximation (RMSEA)) is the best technique for evaluating model fit. The chi-square test determines how much the expected and observed
covariance matrices differ: a chi-square score close to 0 suggests that the expected and observed covariance matrices are almost identical. Furthermore, when the chi-square statistic is close to zero, the probability threshold must be bigger than 0.05 (Barrett, 2007). The discrepancy function, adjusted for sample size, is equal to the comparative fit index (CFI). The CFI is a numerical value that goes from 0 to 1, with a higher value suggesting a better model fit. A CFI value of 0.90 or higher indicates an acceptable model fit (Hu & Bentler, 1999). The residual in the model is connected to the RMSEA. The range of the RMSEA values is 0 to 1, with a lower RMSEA value suggesting a better model fit. An RMSEA score of 0.06 or below indicates an acceptable model fit (Hu & Bentler, 1999). A higher cut-off of 0.95 goodness of fit index (GFI) is more appropriate (Shevlin & Miles, 1998), Adjusted Goodness of Fit Index (AGFI) also ranges between 0 and 1 while 0.90 or greater indicate well-fitting models (Tabachnick et al., 2007). The parameter estimations are examined if the model fit is adequate. The \( z \) statistic is used to represent the ratio of each parameter estimate to its standard error, and it is significant at the 0.05 level if it exceeds 1.96, and at the 0.01 level if it exceeds 2.56 (Hoyle, 1995).

### Pearson Correlation and Paired \( t \)-Test

The Pearson correlation coefficient (bivariate correlation) measures the linear correlation of two sets of data. It not only displays the presence or absence of a correlation between two variables but it also aids in determining its strength (Rice, 2006) and assesses if the correlation is negative or positive, as well as the direction of connection. The \( r \) values are as follows: 0.00–0.19 very weak, 0.20–0.39 weak, 0.40–0.59 moderate, 0.60–0.79 strong, and 0.80–1.0 extremely strong (Evans, 1996). In 1908, William Sealy Gosset introduced the \( t \)-test, an inferential statistical analysis method used to determine whether the means of two groups that are somehow related differ (Kendall, 1946). Any difference between two paired samples is examined using a paired \( t \)-test \((t\text{-test with correlation})\) and the difference in the sample means used for a paired \( t \)-test should be 0. When the samples are made up of matched pairs of similar units, or when there are repeated measures, this method is applied. It is feasible, for example, that the same object or entity will be evaluated more than once: both before and after a treatment. When the samples are connected or have similar characteristics, this approach might be applied. The formula to calculate a paired \( t \)-test for two sample groups (1 and 2) is as follows:

\[
t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{S_1^2 + S_2^2 - 2\rho S_1 S_2}{n}}}
\]

where \( n \) is the sample size, \( \overline{X}_1, \overline{X}_2 \) are the means of samples, and \( S_1^2, S_2^2 \) are variances.
Data Collection and Descriptive Analysis

The primary data was collected from small and medium enterprises operating in Oman. Both online and offline modes were used in the survey questionnaire distribution from February 10, 2021, to April 20, 2021. The respondents were briefed on the purpose of the study, and they were assured of complete confidentiality of their personal data. The collected data were cleaned for missing and incomplete values. The total number of relevant samples used for the analysis was 214. The SPSS 26.0 and AMOS 22.0 software packages were used in model designing and path analysis to establish the relationships between predictor, outcome, and mediator variables.

A wide variety of companies and respondents were approached for our data collection. Most of these companies are more than 10 years old (40.19%), some 3 to 5 years (27.57%), 6 to 10 years (19.63%), and less than 2 years (12.62%). They serve the public (49.53%), business-to-consumer (37.85%), and business-to-business (12.62%). There are 67.76% male respondents and 32.24% female, their positions in the companies varying from director, CEO, general manager, HR manager, finance manager, operation manager, to employee. Most of the SMEs have a low level of digitization such as payment via VISA card. Levels of digitization range from high at 8.4% (e.g., using a cloud system, online payment, and no printing), moderate at 22.9% (e.g., a cloud system, online payment, and less printing), and low at 68.7% (e.g., traditional ways of communicating, and cash/VISA payment only). The main

| Table 1  | Characteristics of survey participants and companies |
|----------|------------------------------------------------------|
| Gender   | Percent        | Business operation | Percent    |
| Male     | 67.76         | Oil and gas        | 0.93       |
| Female   | 32.24         | Electricity service| 0.93       |
| Total    | 100.00        | Marine and fishing | 0.93       |
| Position | Percent       | Percent            |            |
| Director | 41.59         | Manufacturing      | 5.61       |
| CEO      | 16.82         | Finance            | 0.93       |
| General manager | 14.49 | Healthcare         | 1.40       |
| HR manager | 1.40      | Education           | 3.27       |
| Finance manager | 1.40    | Travel and tourism | 3.74       |
| Operations manager | 0.93 | Social clubs      | 12.15      |
| Employee | 6.54          | Media and entertainment | 2.80 |
| Other    | 16.82         | Construction       | 14.02      |
| Total    | 100.00        | Logistics and supply chain | 1.87 |
| Number of offices | Percent | Percent       |
| One      | 60.28         | ICT                | 1.40       |
| Two to five | 33.18      | Wholesale (food and others) | 2.34 |
| Six to ten | 3.74       | Consultancy        | 2.80       |
| More than ten | 2.80     | Home business      | 7.94       |
| Total    | 100.00        | Other              | 25.23      |

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characteristics and percentages of valid responses of the survey participants are explained in Table 1.

Additionally, the observed exogenous/predictor variables are SMEs’ sales, operations, and customer satisfaction. The mediators are use of e-commerce by SMEs, digitalization, and use of technology. The SMEs’ performance is the outcome variable. Table 2 shows the descriptive analysis of predictor, mediator, and outcome variables.

### Path Analysis and Findings

The study aims to determine the major business factors that influenced SMEs’ performance during COVID-19 and determine whether the mediators in the path

| Variables                        | N  | Missing | Mean     | Median   | SD  | Minimum | Maximum |
|----------------------------------|----|---------|----------|----------|-----|---------|---------|
| Use of technology by SMEs        | 214| 0       | 0.1480   | 0.1429   | 0.0738 | 0.0476  | 0.2857  |
| Use of e-commerce by SMEs        | 214| 0       | 0.1211   | 0.0952   | 0.0738 | 0.0476  | 0.2857  |
| SMEs’ digitization               | 214| 0       | 0.0389   | 0.0333   | 0.0115 | 0.0111  | 0.0556  |
| SMEs’ customer satisfaction      | 214| 0       | 0.1433   | 0.1429   | 0.0607 | 0.0476  | 0.2857  |
| SMEs’ sales                      | 214| 0       | 0.1206   | 0.1000   | 0.0593 | 0.1000  | 0.4000  |
| SMEs’ performance                | 214| 0       | 0.0653   | 0.0545   | 0.0416 | 0.0182  | 0.1818  |
| SMEs’ operations                 | 214| 0       | 0.0695   | 0.0545   | 0.0443 | 0.0182  | 0.1818  |

![Diagram](image_url)
analysis have any potential causal relationships in Oman. In this regard, the study incorporated crucial features of SMEs’ operations from the literature and developed the hypotheses, which the researchers then used to develop the conceptual model, represented in Fig. 1. The independent variables are SMEs’ sales, operations, and customer satisfaction, whereas use of e-commerce by SMEs, digitalization, and use of technology are mediators, and SMEs’ performance is the outcome variable. In the path analysis the proposed model consists of SMEs’ performance ~ SMEs’ digitalization + use of technology by SMEs + use of e-commerce by SMEs + SMEs’ operations + SMEs’ sales + SMEs’ customer satisfaction. The path analysis model is mediated by SMEs’ digitization + use of technology by SMEs + use of e-commerce by SMEs.

The impact of predictor variables on the outcome variable are measured as direct and indirect effects mediated by mediator variables. There are three mediator models (m1, m2, and m3), a full model (m4), and indirect effects (IE1, IE2, IE3, IE4, IE5, IE6, IE7, IE8, and IE9). Table 3 shows the mediator models, full model, and indirect effects.

Mediation Estimate in SMEs’ Sales and SMEs’ Performance

The direct and indirect effects of predictors (SMEs’ sales) on the outcome (SMEs’ performance) variable through mediators (SMEs’ digitalization, use of technology, and use of e-commerce) are calculated. The direct effect of SMEs’ sales on SMEs’ performance mediated by SMEs’ digitalization is statistically significant ($Z = 4.964, p < 0.001$). The direct effect of SMEs’ sales on SMEs’ performance mediated by SMEs’ use of technology is statistically significant ($Z = 4.9658, p < 0.001$). The direct effect of SMEs’ sales on SMEs’ performance mediated by use of e-commerce by SMEs is statistically significant ($Z = 4.68, p < 0.001$). Table 4 shows the mediation estimate between SMEs’ sales and SMEs’ performance through mediators.

Mediation Estimate in SMEs’ Customer Satisfaction and SMEs’ Performance

The direct and indirect effects of predictors (SMEs’ customer satisfaction) on the outcome (SMEs’ performance) variable through mediators (SMEs’ digitalization, use of technology, and use of e-commerce) are calculated. The direct effect of customer satisfaction on SMEs’ performance mediated by SMEs’ digitalization is statistically significant ($Z = 3.5598, p < 0.001$). The direct effect of customer satisfaction on SMEs’ performance mediated by SMEs’ use of technology is statistically significant ($Z = 3.597, p < 0.001$). The direct effect of customer satisfaction on SMEs’ performance mediated by SMEs’ use of e-commerce is statistically significant ($Z = 3.21, p = 0.001$). Table 5 shows the mediation estimate between SMEs’ customer satisfaction and SMEs’ performance through mediators.

Mediation Estimate in SMEs’ Operation and SMEs’ Performance

The direct and indirect effects of predictors (SMEs’ operation) on the outcome (SMEs’ performance) variable through mediators (SMEs’ digitalization, use of...
Table 3 Mediation model information

| Effects               | Variables                                                                 |
|-----------------------|---------------------------------------------------------------------------|
| Mediator models       |                                                                           |
| m1                    | SMEs’ digitization ~ SMEs’ operation + SMEs’ sales + SMEs’ customer satisfaction |
| m2                    | Use of technology by SMEs ~ SMEs’ operation + SMEs’ sales + SMEs’ customer satisfaction |
| m3                    | Use of e-commerce by SMEs ~ SMEs’ operation + SMEs’ sales + SMEs’ customer satisfaction |
| Full model            |                                                                           |
| m4                    | SMEs’ performance ~ SMEs’ digitization + use of technology by SMEs + use of e-commerce by SMEs + SMEs’ operation + SMEs’ sales + SMEs’ customer satisfaction |
| Indirect effects      |                                                                           |
| IE 1                  | SMEs’ operation ⇒ SMEs’ digitization ⇒ SMEs’ performance                  |
| IE 2                  | SMEs’ operation ⇒ use of technology by SMEs ⇒ SMEs’ performance           |
| IE 3                  | SMEs’ operation ⇒ use of e-commerce by SMEs ⇒ SMEs’ performance           |
| IE 4                  | SMEs’ sales ⇒ SMEs’ digitization ⇒ SMEs’ performance                       |
| IE 5                  | SMEs’ sales ⇒ use of technology by SMEs ⇒ SMEs’ performance               |
| IE 6                  | SMEs’ sales ⇒ use of e-commerce by SMEs ⇒ SMEs’ performance               |
| IE 7                  | SMEs’ customer satisfaction ⇒ SMEs’ digitization ⇒ SMEs’ performance      |
| IE 8                  | SMEs’ customer satisfaction ⇒ use of technology by SMEs ⇒ SMEs’ performance |
| IE 9                  | SMEs’ customer satisfaction ⇒ use of e-commerce by SMEs ⇒ SMEs’ performance |


technology, and use of e-commerce) are calculated. The direct effect of SMEs’ operation on SMEs’ performance mediated by SMEs’ digitalization is statistically significant ($Z=8.971$, $p<0.001$). The direct effect of SMEs’ operation on SMEs’ performance mediated by SMEs’ use of technology is statistically significant ($Z=8.911$, $p<0.001$). The direct effect of SMEs’ operation on SMEs’ performance mediated by SMEs’ use of e-commerce is statistically significant ($Z=8.857$, $p<0.001$).

Table 4: Mediation estimate between SMEs’ sales and SMEs’ performance through mediators

| Effect                  | Estimate | SE   | Lower       | Upper       | Z       | p        | % mediation |
|-------------------------|----------|------|-------------|-------------|---------|----------|-------------|
| Mediation estimates: SMEs’ sales ⇒ SMEs’ digitization ⇒ SMEs’ performance | Indirect: 1.07e−4, 8.43e−4 | −0.00155, 0.00176 | 0.127, 0.899 | 0.0475 |
|                         | Direct: 0.225, 0.0454 | 0.13630, 0.31413 | 4.964, <0.001 | 99.9525 |
|                         | Total: 0.225, 0.0454 | 0.13641, 0.31424 | 4.967, <0.001 | 100.0000 |

Table 5: Mediation estimate between SMEs’ customer satisfaction and SMEs’ performance through mediators

| Effect                  | Estimate | SE   | Lower       | Upper       | Z       | p        | % mediation |
|-------------------------|----------|------|-------------|-------------|---------|----------|-------------|
| Mediation estimates: SMEs’ customer satisfaction ⇒ SMEs’ digitization ⇒ SMEs’ performance | Indirect: 6.45e−5, 6.99e−4 | −0.00130, 0.00143 | 0.0924, 0.926 | 0.0398 |
|                         | Direct: 0.162, 0.0455 | 0.07279, 0.25112 | 3.559, <0.001 | 99.9602 |
|                         | Total: 0.162, 0.0455 | 0.07285, 0.25119 | 3.560, <0.001 | 100.0000 |

Mediation estimates:

- SMEs’ customer satisfaction ⇒ use of technology by SMEs ⇒ SMEs’ performance
  - Indirect: −0.00250, 0.00522
  - Direct: 0.16452, 0.04574
  - Total: 0.16202, 0.0455

- SMEs’ customer satisfaction ⇒ use of e-commerce by SMEs ⇒ SMEs’ performance
  - Indirect: 0.0133, 0.00455
  - Direct: 0.1487, 0.0463
  - Total: 0.1620, 0.0455
shows the mediation estimate between SMEs’ operation and SMEs’ performance through mediators.

Additionally, the total effect of SMEs’ operation \(\Rightarrow\) SMEs’ performance consists of the measures as estimate = 0.08038, SE = 0.01078, 95% CI [0.05924, 0.10151], \(\beta = 0.52405, Z = 7.4538, p < 0.001\). The total effect of SMEs’ customer satisfaction \(\Rightarrow\) SMEs’ performance has measures as estimate = 0.03920, SE = 0.01253, 95% CI [0.01464, 0.06377], \(\beta = 0.19950, Z = 3.1282, p = 0.002\). The total effect of SMEs’ sales \(\Rightarrow\) SMEs’ performance measures include estimate = 0.13249, SE = 0.02157, 95% CI [0.09022, 0.17476], \(\beta = 0.30736, Z = 6.1428, p < 0.001\). The pandemic has forced SMEs to learn and adopt new technology and many businesses only survived this challenging time because they acquired new technical strategies. For example,

![Fig. 2 Use of technology by SMEs versus (a) SMEs’ performance and (b) SMEs’ operation](image-url)
the business-to-business marketing strategy uses retailers sharing information about stock levels and involves technological collaboration between businesses of similar industrial sectors. The use of technology by SMEs has improved their performances and operations as shown in Fig. 2a, b.

The customers and companies polled show a high level of satisfaction with the e-services used. For instance, the companies’ response rate on satisfaction of e-services are strongly dissatisfied (6.1%), dissatisfied (9.8%), neutral (40.7%), satisfied (28.0%), and strongly satisfied (15.4%), while satisfaction of customers regarding e-services are: strongly dissatisfied (6.1%), dissatisfied (3.7%), neutral (43.0%), satisfied (28.5%), and strongly satisfied (18.7%). Using technology for e-marketing helped companies to reach out to the customers during the lockdown and helped in communication with customers and product advertisements. Figure 3 shows the use of e-commerce by SMEs versus (a) customer satisfaction (b) SMEs’ sales.

![Figure 3](image1.png)

Fig. 3 Use of e-commerce by SMEs versus a customer satisfaction and b SMEs’ sales

![Figure 4](image2.png)

Fig. 4 SMEs’ digitalization versus a use of e-commerce by SMEs and b customer satisfaction
Analysis reveals that the effects of the predictor (SMEs digitalization) on the dependent variable (use of ecommerce by SMEs) were positive (Fig. 4a), while no effects being noticed on (customer satisfaction) (Fig. 4b). In addition, the effects of the predictor (SMEs’ operation) on the dependent variable (SMEs’ performance) at different levels of the moderator (use of e-commerce by SMEs) were measured (Fig. 5a). The result shows a high level of moderation by the mediator use of e-commerce by SMEs (Fig. 5a). Similarly, the effects of the predictor (SMEs’ sales) on the dependent variable (SMEs’ performance) at different levels of the moderator (use of e-commerce by SMEs) also present a high level of moderation by the mediator use of e-commerce by SMEs (Fig. 5b).

Model Fit

The minimum was achieved at chi-square = 2.193, degrees of freedom (DF) = 2, and probability level = 0.334 ($p > 0.05$). The DF statistic means four paths have been dropped. The model fitting is good: CMIN is 2.193, DF = 2, $p = 0.334$, CMIN/DF = 1.096, TLI rho2 = 0.985, CFI = 0.999, and RMSEA = 0.021. Table 7 shows the model fit indices of the path analysis model.

In the final model, we also investigated the mediation type. When the direct effects are statistically significant, partial mediation occurs. When the direct effects are not statistically significant, but the indirect effect is, it is called complete mediation. In the relationship between $X_1$ and $Y$, for example, $M$ is a mediating variable. Since the direct influence of $X_1$ on $Y$ is no longer important once $M$ enters the model, this is complete mediation. The indirect effect, on the other hand, is significant and as a result, through the mediator variable $M$, $X_1$ has an indirect effect on $Y$.

The nine hypotheses (H1 to H9) proposed in the study are accepted as partial mediation by mediator variables because the direct effects are statistically significant. Table 8 shows the results of the hypotheses upon testing.

Fig. 5  
(a) Effect of the predictor (SMEs’ operation) on the dependent variable (SMEs’ performance) at different levels of the moderator (use of E-commerce by SMEs).  
(b) Effect of the predictor (SMEs’ sales) on the dependent variable (SMEs’ performance) at different levels of the moderator (use of E-commerce by SMEs).
| Model            | NPAR | CMIN     | DF | P    | CMIN/DF | NFI Delta1 | TLI rho2 | CFI   | RMSEA | LO 90 | HI 90 |
|------------------|------|----------|----|------|---------|------------|----------|-------|-------|-------|-------|
| Default model    | 33   | 2.193    | 2  | 0.334| 1.096   | 0.986      | 0.985    | 0.999 | 0.021 | 0.000 | 0.139 |
| Saturated model  | 35   | 0.000    | 0  |      |         | 1.000      | 1.000    |       |       |       |       |
| Independent model| 14   | 152.330  | 21 | 0.000| 7.254   | 0.000      | 0.000    | 0.000 | 0.171 | 0.146 | 0.197 |
| Hypotheses                                                                 | Accept/Reject          | Reasons                                                                 |
|---------------------------------------------------------------------------|------------------------|-------------------------------------------------------------------------|
| **Hypothesis 1**: SMEs’ digitalization is a mediating variable in the relationship between SMEs’ sales and SMEs’ performance | Accept-partial mediation | Direct effect is statistically significant ($Z = 4.964, p < 0.001$)     |
| **Hypothesis 2**: SMEs’ use of technology is a mediating variable in the relationship between SMEs’ sales and SMEs’ performance | Accept-partial mediation | Direct effect is statistically significant ($Z = 4.9658, p < 0.001$)    |
| **Hypothesis 3**: Use of e-commerce by SMEs is a mediating variable in the relationship between SMEs’ sales and SMEs’ performance | Accept-partial mediation | Direct effect is statistically significant ($Z = 4.68, p < 0.001$)      |
| **Hypothesis 4**: SMEs’ digitalization is a mediating variable in the relationship between SMEs’ customer satisfaction and SMEs’ performance | Accept-partial mediation | Direct effect is statistically significant ($Z = 3.5598, p < 0.001$)    |
| **Hypothesis 5**: SMEs’ use of technology is a mediating variable in the relationship between SMEs’ customer satisfaction and SMEs’ performance | Accept-partial mediation | Direct effect is statistically significant ($Z = 3.597, p < 0.001$)     |
| **Hypothesis 6**: Use of e-commerce by SMEs is a mediating variable in the relationship between SMEs’ customer satisfaction and SMEs’ performance | Accept-partial mediation | Direct effect is statistically significant ($Z = 3.21, p = 0.001$)      |
| **Hypothesis 7**: SMEs’ digitalization is a mediating variable in the relationship between SMEs’ operation and SMEs’ performance | Accept-partial mediation | Direct effect is statistically significant ($Z = 8.971, p < 0.001$)     |
| **Hypothesis 8**: SMEs’ use of technology is a mediating variable in the relationship between SMEs’ operation and SMEs’ performance | Accept-partial mediation | Direct effect is statistically significant ($Z = 8.911, p < 0.001$)     |
| **Hypothesis 9**: Use of e-commerce by SMEs is a mediating variable in the relationship between SMEs’ operation and SMEs’ performance | Accept-partial mediation | Direct effect is statistically significant ($Z = 8.857, p < 0.001$)     |
Discussion

This study involves numerous thought-provoking and potentially beneficial policy recommendations, as well as practical consequences for SMEs. The findings suggest actions based on how small and medium-sized enterprises dealt with and responded to issues posed by the unexpected COVID-19 pandemic shock. The findings show that SMEs acted quickly, adopting strategies such as technology transformation, and product and marketing innovations to avoid economic and societal catastrophe. We discovered that several SME owners and entrepreneurs devised creative solutions to mitigate the consequences of the pandemic on their revenues. The data analysis revealed innovative development in the SME sector in Oman: this is undoubtedly positive progress, in line with some recent studies that argue the pandemic has hastened technology transfer in various economic sectors, including SMEs. Some academics claim that innovative technologies, such as FinTech, a crowdfunding platform, provide not only competitive benefits but also “a means of survival, by improvising current business models” (Akpan et al., 2020: 7).

The pandemic has provided small and medium-sized businesses with an opportunity to reinvent themselves by embracing current technologies. Manufacturing enterprises in industrialized countries have shifted to an e-commerce business model as a direct result of COVID-19 (Shahzad et al., 2020), with Oman following suit and implementing technical innovation. In general, the way SMEs use digital technologies for e-commerce has evolved dramatically. In Oman, these enterprises implemented new methods and business models during the COVID-19 era, ensuring their survival and allowing them to promote their products. Many businesses have now shifted to an internet business model, which has helped them stay competitive (Hussain et al., 2021).

The path analysis found statistically significant direct effects of SMEs’ sales, operations, and customer satisfaction on the dependent variable of SMEs’ performance. The use of e-commerce by SMEs, digitalization, and use of technology acted as mediators. The overall mediation is partial. Many retail stores around the world have been obliged to provide online shopping as a result of the lockdown, and it is believed that this trend will continue after the pandemic is over. e-commerce has given businesses a competitive advantage, enhanced efficiency, and made it easier to plan for staffing, advertising, acquisitions, and other expenses. An empirical study by Hussain et al. (2020) claimed that competitive pressure led to e-commerce adoption, an assertion backed up by Ocloo et al. (2018). The Paired t-test for technology use before and during the pandemic shows strong positive correlation ($r = 0.823$, $p < 0.01$) and there is a significant average difference between technology use before and during the pandemic ($t_{213} = -2.153, p < 0.05$). On average, technology use during COVID-19 was 13.1 points higher than technology use before (95% CI [1.1, 25.1]). This indicates that the mean technology use score during COVID-19 ($M = 2.54$) was significantly higher than the mean before ($M = 2.41$). The technology used was independent of the number of branches and age of the company. To bring about the much-needed reforms for SMEs, innovation will be required. Although numerous studies, such as Juergensen et al. (2020) and Pedauga et al. (2021),...
propose government funding, it will be technology that leads SMEs to higher performance and competitive advantage.

Our study results show strong correlations between technology use before and during COVID-19 ($r = 0.823$, $p < 0.01$), technology use during COVID-19 and in future ($r = 0.659$, $p < 0.01$), and technology use before COVID-19 and in future ($r = 0.612$, $p < 0.01$). Nevertheless, according to Oliveira and Martins (2010), an organization’s IT infrastructure and technical capabilities are critical determinants in the success of technology innovation. For technology to be implemented in small and medium-sized businesses, top management support is required (Singh et al., 2019). Fletcher and Griffiths (2020) investigated company digital transformation during COVID-19 and concluded that digital maturity is required; less digitally mature firms are more vulnerable, while higher levels of digital maturity allow for greater flexibility.

Continuous digital transformation is vital to maintain customer satisfaction and gain a competitive advantage. There is also correlation between customer satisfaction and sales ($r = 0.175$, $p < 0.05$) and technology use before COVID-19, during COVID-19, and in future ($r = 0.156$, $p < 0.05$; $r = 0.209$, $p < 0.01$; $r = 0.159$, $p < 0.05$). As the volume of data develops as a result of digitization, the business must build resources for data governance and management. Governments and stakeholders must support SMEs’ digital transformation, but funding with supplemental money for digitization, technical transfer, and innovation cannot be determined because the number of affected SMEs is unknown. To promote domestic producers and local businesses, online venues for these businesses to sell their products must be developed. The survey also questioned the respondents about the current state of Industry 4.0 technology and future use. The business owners’ perceptions of Industry 4.0 technology include planning to invest in the future. The respondents showed a preference for cloud computing (50%), followed by artificial intelligence (25%), and big data (25%). The use of technology has been a survival strategy during the pandemic and highly digitized SMEs are more likely to adopt Industry 4.0 technology.

Several SMEs raised concerns of the high technology costs in terms of implementation and training. In developing countries, adoption cost of technology usage is a substantial factor (Elahi & Hassanzadeh, 2009; Mohtaramzadeh et al., 2018). Typically, businesses deplore this high cost, even though the relative benefit outweighs the disadvantages of traditional business procedures (Shahzad et al., 2020). Government regulatory and financial support from commercial institutions may be able to assist SMEs in accepting and implementing new technology in their operations. Promotion of funding schemes, training, reskilling, and development programs are required, in addition to streamlined financing and support centers for legal and financial guidance, human resources, digitization, and business model innovation at the governorate and regional levels.
Conclusion

As the world prepares for the fourth industrial revolution, technology will become increasingly important. Cutting-edge technology improves existing business models and encourages innovation and reengineering processes, giving them a competitive advantage. The COVID-19 pandemic caused SMEs to take up new strategies that effectively and efficiently added value to their businesses. To understand and assess such strategies, this paper conducted a path analysis assessment of SMEs' functions on performance mediated by SMEs’ digitalization, use of technology, and use of e-commerce.

The study offers substantial contributions to literature on the roles of innovative or advanced technologies to enhance operations activities, create competitive advantages, and enhance growth. These have become the survival means for many businesses which were compelled to adopt technologies due to unusual disruptions in commerce in the COVID-19 period. The lockdowns accelerated, projected, and magnified the impact of technology and we found partial technological mediation. We also found that the use of technology leads to higher satisfaction among customers and SME performances. However, in the developing world, SMEs face several technological obstacles when endeavoring to establish efficiency and sustain their businesses. Infrastructure development, technological investments, technological implementation, and technology adoption are a few examples. To significantly improve the overall technology application and adoption climate, the SMEs will need to address training and workshops, and aggressively follow the persuasion policies.

The study has limitations since COVID-19 strains have been changing continuously and this will take time to conclude the technology acceleration rate, and the positive and negative impacts on small and medium-sized enterprises.

Declarations

Competing Interests  The authors declare no competing interests.

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