Decision-making Logic, Business Model Innovation on Enterprise Performance of Digital Transformation Enterprises in Environmental Uncertainty

Ma Chaoping[1] and Busaya Vongchavalitkul[2]
Southeast Bangkok University, Thailand
Corresponding Author, Email: superma@gzgs.edu.cn[1]

Received: 2024-10-27; **Revised:** 2024-12-6; **Accepted:** 2024-12-9

Abstract

This study aimed to analyze 1) the direct influence of decision-making logic (causation and effectuation) on business model innovation 2) the direct influence of decision-making logic (causation and effectuation) on enterprise performance 3) the direct influence of business model innovation on enterprise performance and 4) the moderating role of environmental uncertainty on decision-making logic (causation and effectuation) and business model innovation. Research methodology were quantitative method, total sample size 454 furniture manufacturing enterprises in Guangzhou, Guangdong Province, collected data by online survey. PLS-SEM was used to evaluate the reflective and structural models to test the hypotheses.

Research results 1) causation and effectuation not only have a direct positive impact on enterprise performance, but also can have a positive impact on enterprise performance by influencing business model innovation. Business model innovation plays a role as a "connector" between decision-making logic and enterprise performance 2) the impact of causation on enterprise performance (β=0.355, $p<0.01$) is slightly greater than that of effectuation (β=0.321, $p<0.01$) 3) the impact of effectuation on business model innovation (β=0.317, $p<0.01$) is greater than that of causation (β=0.181, $p<0.01$) and 4) Environmental uncertainty negatively regulates causation and business model innovation (β=-0.142, $p<0.01$), but positively regulates effectuation and business model innovation (β=-0.214, $p<0.01$). This study not only enriches the research on decision-making logic outcome variables, but also enriches the research on antecedent variables of enterprise performance, and clarifies the influence degree of causation and effectuation. By understanding these relationships, enterprises can choose wise decision-making logic based on their actual situation to enhance their core competitiveness, improve their performance, and achieve sustainable development.

Keywords: Decision-Making Logic, Business Model Innovation, Enterprise Performance, Digital Transformation, Environmental Uncertainty

Introduction

The fourth industrial revolution, represented by digital technology, is leading the transformation of production models and organizational methods. Driven by artificial intelligence, enterprises accelerate organizational change and process reengineering, reshape business structure and ecosystem, constantly innovate business models, effectively build core competitiveness, and continuously improve enterprise performance (EP) (Dong et al., 2024; Harms et al., 2021).

Business model innovation (BMI) is the core and key to enhancing performance of enterprises. The digital transformation of enterprises not only involves the application of digital technology, but also the transformation and upgrading of business processes and business models. Enterprises use digital technologies such as big data and artificial intelligence to embed or build digital business ecosystems (Spieth et al., 2023), expand the scope of cyberspace functions and resource allocation, integrate industrial chain transformation organizational structures, optimize production operations, broaden revenue channels, and drive enterprise innovation to improve performance (Essen et al., 2023).

The new business model is guided by strategic decision-making logic. Causation (CA) emphasizes prediction, driven by goals, and based on competitive & market analysis, innovates business models according to the principle of maximizing expected returns (Racat et al., 2024; Shirokova et al., 2020), and seeks new profit paths. Effectuation (EF) emphasizes control, driven by existing means, strengthening partner cooperation, trying and discovering opportunities within the scope of affordable loss (Harms et al., 2021), and continuously optimizing and improving business models in dynamic change. Scholars have conducted some research on business model innovation from the perspective of effectuation, but they have neglected the impact of causation and the multidimensional attributes of causation and effectuation on business model innovation (Xu et al., 2024).

Objectives of the study

1. To analyze the direct influence of decision-making logic (causation and effectuation) on business model innovation.

2. To analyze the direct influence of decision-making logic (causation and effectuation) on enterprise performance.

3. To analyze the direct influence of business model innovation on enterprise performance.

4. To analyze the moderating role of environmental uncertainty on decision-making logic (causation and effectuation) and business model innovation.

Literature Review

Causation and Effectuation

Causation and effectuation are two basic logical methods for decision makers in resource constraints and environmental uncertainty (EU) (Racat et al., 2024; Broekhuizen et

al.,2021). Causation is a structured approach to decision-making that relies on well-prepared plans, predefined goals, and required resources. Effectuation is another structured approach to decision-making that relies on with the aim of achieving the best possible strategic results from leveraging the available resources and controlling the environmental uncertainty through creating new markets, products, and opportunities (Racat, 2024; Gilbers, 2024).

Causation and effectuation differ significantly in terms of thinking styles, decision-making principles, and analytical dimensions. Causation assumes that decision makers are rational, goals-driven, and focused on predicting specific outcomes. Effectuation assumes that decision makers are limitedly rational, means-driven, and focused on the process of controlling existing resources (Gilbers, 2024). Causation has been described in terms of four key dimensions, goals-driven, expected returns, competitive & market analysis, and avoiding the unexpected. Correspondingly, effectuation has been described in terms of means-driven, affordable loss, partnerships, and acknowledge unexpected (Pater, 2024; Shirokova et al., 2020).

Business Model Innovation

The essence of business model is to create what value and how to create value. It embodies the systematic composition elements of the enterprise and the logical relationship between profit acquisition (Ancillai et al., 2023). Business model innovation is the process of exploring, adjusting, improving, redesigning, modifying, creating, developing, adopting, and transforming business models, which reflects the changes in the value carrier of enterprises (Spieth et al., 2023). Essen et al. (2023), and White et al. (2022) studied the key elements of business models from different perspectives. Business model innovation refers not only to products, production processes, distribution channels, and markets, but also to exchange mechanisms and transaction architectures (Fernandes & Rozenfeld, 2024). This innovation can be either one or more elements and their relationship innovation, or the introduction of new business models or the fundamental reconstruction of existing business models (Dong et al., 2024). It includes three primary dimensions: value offering innovation, value architecture innovation, and revenue model innovation (Haftor et al., 2023).

Enterprise Performance

Performance is a comprehensive indicator of achievement and effectiveness (Singh et al., 2021). Enterprise performance is defined as the performance achieved by the enterprise in a certain period of time. In other words, enterprise performance refers to the operational efficiency and performance of the enterprise's managers over a specific period of time. Business performance includes profitability, asset operation level, solvency and follow-up development capacity. The performance of operators mainly reflects the achievements and contributions made by operators in the operation, growth, and development of enterprises (Dağıdır & Özkan, 2024).

The balanced score card (BSC) is a performance evaluation tool that transforms corporate strategy into actionable metrics and specific target values (Hristov et al., 2024). It

mainly includes four dimensions: financial indicators, customer indicators, learning & growth indicators, and internal process indicators (Meng, 2024), that interrelated and influence each other, forming a complete performance management system. It reflects the balance between financial and non-financial measurement methods, between long-term and short-term goals, between external and internal factors, between results and processes, and between management performance and operational performance (Jaiswal & Thaker, 2024).

Environmental Uncertainty

Environmental uncertainty refers to the rate of change and the uncertainty of change and is usually associated with high risk (Lissillour et al., 2024). Environmental uncertainty is categorized into demand and technology uncertainty based on its source (Xu & Liu, 2024; Chen et al., 2021). The uncertainty of demand reflects the dynamic and unpredictable nature of customer preferences, requirements, and demands in the market (Griffin & Grote, 2023). The uncertainty of digital technology reflects the impact of technological turbulence on the path, speed, and stability of enterprises' digital transformation (Drnevich & West, 2023). The level of uncertainty in external business environments has been theorized as an important determinant of impactful causation and effectuation. Effectuation is particularly suitable for highly uncertain and risky environments where the costs of information-gathering outweigh the benefits.

The Impact of Decision-making Logic on Business Model Innovation

The antecedents or driving factors of business model innovation are influenced by the causation or effectuation decision-making thinking of enterprise managers (Khan et al., 2024). Causation emphasizes prediction and focuses on goals-driven (Harms et al., 2021). Through market research and competitive analysis, it allocates core resources and optimizes value creation processes based on the principle of maximizing expected returns, reconstructs business logic, and promotes business model innovation (Koguta et al., 2023; Click, 2023). Business model innovation is accompanied by risks, so effectuation emphasizes control, focusing on means-driven (Gilbers, 2024; Harms et al., 2021). Key resources are allocated according to the principle of affordable loss and strategic alliances are formed with stakeholders to obtain external resources. This expands innovation capabilities, reduces risks (Ryman & Roach, 2024; Codini et al., 2023), and identifies opportunities through trial and error. The business model is iteratively developed dynamically and continuously (Racat et al., 2024).

Based on the above analysis, the following hypotheses are proposed (Objective 1):

H1a: Causation has a positive impact on business model innovation.

H1b: Effectuation has a positive impact on business model innovation.

The Impact of Decision-making Logic on Enterprise Performance

Under the causation decision-making thinking, enterprises acquire the required resources according to the established goals (Shirokova et al., 2020), identify customer needs through market research and competitive analysis, and develop new products or technologies in a targeted manner to improve behavioral effectiveness (Baghersad et al., 2022). Formulate production and operation plans based on the principle of maximizing expected returns, reduce the impact of

uncertain factors, and reduce transaction costs (Koguta et al., 2023). At the same time, we should constantly implement and promote business plans, effectively ensure progress, reduce errors, improve production efficiency (Chetty et al., 2024; Kamble et al., 2023), and thus enhance enterprise performance. Effectuation is oriented towards means, integrating resources within an affordable loss range, limiting the input of elements, and improving resource utilization. Establish a mechanism for risk sharing, benefit sharing, and value co-creation with stakeholders (Yoon & Cho, 2023), acquire new knowledge through low-cost experimentation and trial and error, accumulate experience and expand corporate resources (Karami & Hossain, 2024) and enhance enterprise performance. At the same time, we should focus on capturing potential opportunities in change, creating opportunities, gaining sustainable competitive advantages and thus improving enterprise performance.

Based on the above analysis, the following hypotheses are proposed (Objective 2):

H2a: Causation has a positive impact on enterprise performance.

H2b: Effectuation has a positive impact on enterprise performance.

The Impact of Business Model Innovation on Enterprise Performance

Business model innovation is not only an important means for enterprises to adapt to market changes, but also a key factor in improving enterprise performance. Through business model innovation, enterprises can explore new ways of value creation, better adapt to market demands, improve core competitiveness, and thus enhance enterprise performance. Firstly, optimizing the way of value creation and acquisition can directly generate economic benefits for enterprises. Business model innovation continuously improves the quality of products and services of enterprises, increases market share (Filatrovi et al., 2024) and thus enhances the core competitiveness and profitability of enterprises. Secondly, business model innovation and technological innovation promote each other. Through continuous iteration of business model innovation and technological innovation (Dong & Wang, 2022) enterprises are increasingly adapting to market changes, continuously meeting customer needs to develop new products or provide new services (Yu & Wang, 2023) and thus affecting technological innovation performance. In the end, business model innovation can improve operational efficiency, optimize resource allocation, reduce costs, increase revenue, and achieve performance improvement goals through opportunity identification and resource, capability, and process restructuring (Salfore et al., 2023).

Based on this, the following hypotheses are proposed (Objective 3):

H3: Business model innovation has a positive impact on enterprise performance.

The Moderating Role of Environmental Uncertainty

Environmental uncertainty poses challenges to corporate strategic decision-making. The causation formulates enterprise strategic plans based on market research and puts them into action. When the environmental uncertainty is low, it is easier to obtain information from outside, which is conducive to making correct decisions and controllable results (Chen et al., 2019). Effectuation emphasizes means-driven, acquiring the latest knowledge and technology through

strategic alliances, and conducting multiple low-cost trial and error in the short term based on the principle of affordable loss (Pathak et al., 2022), effectively reducing the negative impact of environmental uncertainty and continuously, dynamically, and orderly promoting business model innovation (Xu et al., 2022). In the case, effectuation promotes radical innovation of enterprises by stimulating organizational creativity (Wu et al., 2020), enabling rapid resource acquisition and exploration (Chen & Liu, 2022) and generating receptivity to serendipitous opportunities (Prashantham et al., 2019).

Based on this, the following hypothesis is proposed (Objective 4):

H4a: Environmental uncertainty negatively moderates the impact of causation on business model innovation.

H4b: Environmental uncertainty positively moderates the impact of effectuation on business model innovation.

Conceptual Framework

Based on an extensive literature review and hypothesis of the relationship between variables, can contribute the conceptual framework for this research as shown in Figure 1.

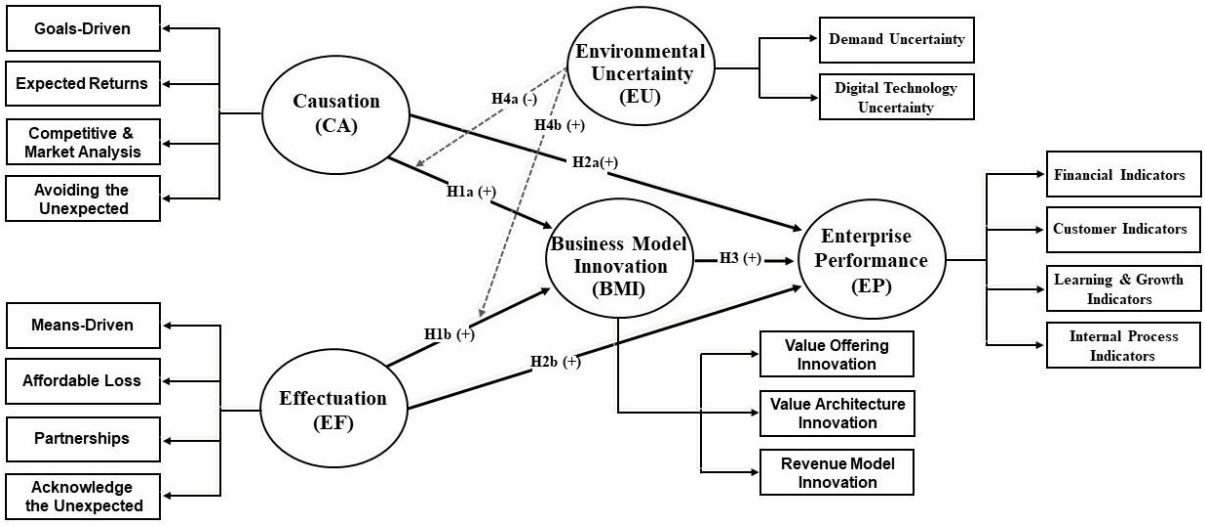

Figure 1 A conceptual framework for this research

Research methodology

Research design

Using a robust quantitative research design, this study examines the complex relationships between causation, effectuation, business model innovation, and enterprise performance under environmental uncertainty. This research selected furniture manufacturing enterprises whose registered address is in Guangzhou city, Guangdong province, China, and which are undergoing or have completed digital transformation as samples.

Population and Sample

Guangzhou city has 1865 enterprises of furniture manufacturing enterprises About 60% (1119 enterprises) of enterprises have implemented digital transformation (Guo, 2023).

According to Bentler & Chou's (1987) and Yamane's formula (1967), there were at least 295 enterprises samples based on population calculations. Therefore, 454 samples in this study are sufficient.

Measurement Tools

This research used questionnaire for this study, which mainly includes causation (19 items), effectuation (19 items), business model innovation (15 items), enterprise performance (20 items), and environmental uncertainty (10 items). The items were measured on a 5-point Likert scale (from strongly disagree "1" to strongly agree "5").

First, combined with the context of digital transformation, a causation and effectuation measurement scale were designed based on the scales of Chandler et al. (2011). According to Spieth & Schneider (2016) designed a measurement scale for business model innovation. According to Palacios-Marqués et al. (2019), Singh et al. (2021) designed a scale to measure enterprise performance. The measurement scale of environmental uncertainty is designed according to the scale of Chen et al. (2019). Secondly, the revised draft questionnaires were then sent to three experts for assessment Index of item objective congruence (IOC) between the content and questionnaires used in the study. Questions with an index of consistency falling within the range of 0.67 to 1.00 were selected. Finally, in order to evaluate the survey's validity, a pilot test was conducted with 70 participants. Each question item had a value greater than 0.8. Therefore, the questionnaire was confirmed to be valid and reliable.

Data Collection

To ensure the accuracy and objectivity of data collection, senior managers who have participated in corporate decision-making and worked in the company for more than one year are required to answer the questionnaire.

Data Analysis Method

This study, PLS-SEM was used to analyze the conceptual model. First, the model fit was evaluated by comparing the saturated model with the estimated model. Secondly, indicator loading, internal consistency reliability, convergent validity, discriminant validity, and variance inflation factor (VIF) were used to assess reflective measurement model. Thirdly, the coefficient of determination value (R^2), predictive relevance (Q^2), and PLSpredict were evaluated for predictive power. Finally, the results of analyzing the structural model and effects among the five constructs, affirming, or refuting the research hypotheses initially proposed.

Research Results

Descriptive Analysis

The characteristics of the respondents in the 453 sample were shown in Table 1.

Table 1 Characteristics of the samples

Measure	Value	Frequency	Percentage
Years of service	1-3 years	115	25.33%
	3-5 years	160	35.24%
	5-10 years	130	28.63%
	More than 10 years	49	10.79%
Enterprise age	1-3 years	63	13.88%
	3-5 years	151	33.26%
	5-10 years	166	36.56%
	More than 10 years	74	16.30%
Enterprise size	Less than 50 people	72	15.86%
	51-300 people	207	45.59%
	301-1000 people	160	35.24%
	More than 1000 people	15	3.30%
Enterprise Region	Main urban area	291	64.10%
	Sub center	39	8.59%
	Peripheral urban areas	124	27.31%

Model Fit Assessment

The model fit was evaluated by comparing the saturated model with the estimated model. The standardized root mean residual (SRMR) represents the average difference between the observed correlation and the predicted correlation of the model. The closer the SRMR value is to 0, the better the fit is generally considered to be SRMR < 0.08 (Imjai et al., 2024). In this study, the SRMR values of the saturated model and estimated model are 0.054 and 0.055, respectively, indicating a good fit. The normalized fit index (NFI) indicates the comparison between the selected model and the null model, where no relationships are assumed among the variables. A higher NFI value closer to 1 indicates a better fit, and it is generally considered that NFI>0.8 (Imjai et al., 2024). In this study, The NFI values of the two models were 0.824 and 0.819, respectively, indicating a good fit. In addition, the unweighted least squares discrepancy (d_ULS), geodesic discrepancy (d_G), and Chi-square values of the two models are very close. Based on the model fit assessment results, it can be concluded that the model had a good fit, as shown in Table 2.

Table 2 Model fit assessment

	SRMR	d_ULS	d_G	Chi-square	NFI
Saturated model	0.054	0.443	0.205	573.786	0.824
Estimated model	0.055	0.461	0.211	590.942	0.819

Model Evaluation

First of all, the evaluation of internal consistency reliability. The results of the reflective measurement model evaluation are shown in Table 3. All factor loadings were greater than

0.708 (Hair et al., 2022), which was examined to ensure that the construct could explain over 50% of the indicator variance. The values of Cronbach's **α**, reliability coefficient (rho_a) and composite reliability (rho_c) for each variable were between 0.807-0.827, 0.810-0.830 and 0.877-0.919, respectively, all greater than the standard value of 0.7 (Akbar et al., 2024). Additionally, VIF are measures of multicollinearity, the extent to which independent variables are correlated. In this study, the VIF values for all dimensions are between 1.000 and 1.963. The VIF is lower than 3 (Hair et al., 2022), indicating that there is no serious multicollinearity problem. The research results show that the internal consistency of the questionnaire structure is good.

Secondly, evaluation of convergent validity. From Table 3, the average variance extracted (AVE) values are between 0.650 and 0.850, all greater than 0.5 (Yıldız et al., 2024; Hair et al., 2022), therefore, the construct could explain over 50% of the variance of its indicators. Therefore, the questionnaire has good convergent validity.

Table 3 Measurement model evaluation

Construct and Indicators	Loading	VIF	α	rho_a	rho_c	AVE
Causation (CA)			0.827	0.830	0.885	0.658
Goals-driven (CA_GD)	0.799***	1.734				
Expected returns (CA_ER),	0.801***	1.663				
Competitive & market analysis (CA_CM)	0.844***	1.905				
Avoiding the unexpected (CA_AU)	0.800***	1.737				
Effectuation (EF)			0.814	0.815	0.877	0.641
Means-driven (EF_MD)	0.808***	1.702				
Affordable loss (EF_AL)	0.802***	1.673				
Partnerships (EF_PS)	0.781***	1.621				
Acknowledge unexpected (EF_AU)	0.812***	1.682				
Business model innovation (BMI)			0.807	0.810	0.886	0.722
Value offering innovation (BMI_VOI)	0.864***	1.782				
Value architecture innovation (BMI_VAI)	0.838***	1.704				
Revenue model innovation (BMI_RMI)	0.846***	1.775				
Enterprise performance (EP)			0.820	0.820	0.881	0.650
Financial indicators (EP_FI)	0.813***	1.732				
Customer indicators (EP_CI)	0.806***	1.731				
Learning & Growth indicators (EP_LG)	0.838***	1.948				
Internal process indicators (EP_IP)	0.765***	1.524				
Environmental uncertainty (EU)			0.824	0.825	0.919	0.850
Demand uncertainty (EU_DU)	0.925***	1.963				
Digital technology uncertainty (EU_DT)	0.919***	1.963				

Note: *** $p < 0.001$, one-tailed test.

Finally, evaluation of discriminant validity. The discriminant validity assessment ensured that the different constructs measured different characteristics, as shown in Table 4, the highest value of HTMT in this study was 0.801, which is below the threshold level of 0.900

(Silva et al., 2024). Therefore, findings suggest that each construct in the model measured different characteristics, the discriminant validity of each latent variable was good. In the Fornell-Larcker matrix, the diagonal values (in bold italics) representing the square root of the AVE of latent constructs were more significant than their correlations, which indicates that they possess discriminant validity.

Table 4 Discriminant validity

Constructs	HTMT					Fornell-Larcker Criterion				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
1) CA						***0.811***				
2) EF	0.383					0.316	***0.801***			
3) BMI	0.545	0.454				0.445	0.371	***0.849***		
4) EP	0.667	0.626	0.601			0.552	0.512	0.49	***0.806***	
5) EU	0.467	0.038	0.418	0.317		0.385	0.024	0.343	0.261	***0.922***

Structural Model

For the predictive power of the structural model, three instruments were evaluated R^2, Q^2, and PLSpredict, as shown in Table 5.

The R^2 value is used to measure the explanatory power or goodness of fit model of the model. It can be seen as follows, R^2>0.67 is considered to have a strong relationship, R^2=0.33-0.67 is considered to have a moderate relationship, and R^2>0.19 is considered to have a weak relationship (Hair et al., 2022). In this study, The R^2 of business model innovation and enterprise performance are 0.346 and 0.465 respectively. Adjust R^2 eliminates the influence of the number of independent variables, correcting the exaggerated effect of R^2 on the overall explanatory power of independent variables on the variation of dependent variables, resulting in better accuracy. In this study, the Adjust R^2 values were 0.339 and 0.461, respectively. In summary, the model structure of this study has a moderate explanatory power.

The Q^2 value measures the in-sample explanatory power and out-of-sample predictive power of the model in order to assess the PLS path model's predictive accuracy. Q^2>0.5 indicates that the model has high predictive validity, Q^2=0.25-0.5 indicates that the model has moderate predictive validity, and Q^2=0-0.25 indicates that the model has low predictive validity (Hair et al., 2022). In this study, The Q^2 of business model innovation and enterprise performance are 0.365 and 0.459 respectively, both greater than 0.25. The findings of Q^2 showed that the predictive accuracy was medium.

Table 5 Assessing structural model

Construct and Indicators	R^2	Adjust R^2	Q^2	Q^2predict (PLS-SEM)	PLSpredict	
					MAE (PLS-SEM)	MAE (LM)
BMI	0.346 (moderate)	0.339 (moderate)	0.324 (moderate)		All PLS-SEM less than LM (high)	
BMI_VOI				0.264	0.573	0.753
BMI_VAI				0.212	0.574	0.757
BMI_RMI				0.222	0.623	0.831
EP	0.465 (moderate)	0.461 (moderate)	0.432 (moderate)		All PLS-SEM less than LM (high)	
EP_FI				0.300	0.542	0.731
EP_CI				0.251	0.565	0.743
EP_LG				0.280	0.565	0.760
EP_IP				0.289	0.535	0.702

Considering the highly asymmetric distribution of prediction errors, PLSpredict compared the mean absolute error (MAE) values between PLS-SEM and the naive benchmark (linear regression model, LM). The findings of PLSpredict, all MAE values less than LM for PLS-SEM, which showed that the predictive power of business model innovation and enterprise performance were high.

Hypothesis Testing

An analysis using the PLS-SEM method was conducted to evaluate the hypotheses we established. This examined the relationships and impacts among causation, effectuation, business model innovation, enterprise performance, and environmental uncertainty, as depicted in Fig. 2.

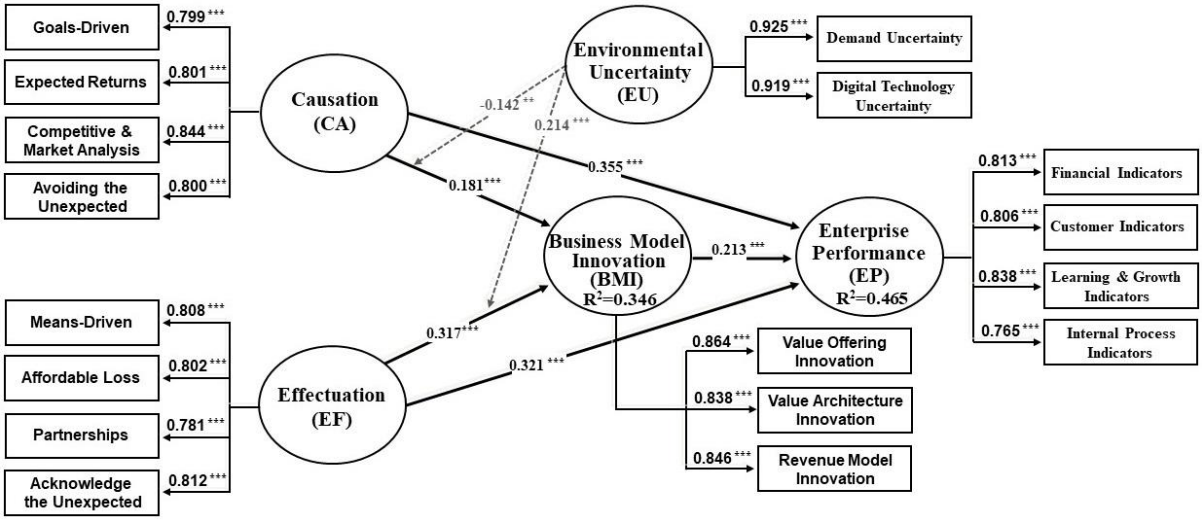

Figure 2 The structural model

H1a (CA ⟶ BMI): Causation has a significant positive impact on business model innovation (β=0.181, t=3.225, and p=0.001). Therefore, H1a is supported.

H1b (EF ⟶ BMI): Effectuation has a significant positive impact on business model innovation (β=0.317, t=6.883, and p=0.000). As a result, H1b is supported.

H2a (CA ⟶ EP): Causation has a significant positive impact on enterprise performance (β=0.355, t=7.890, and p=0.000). Therefore, H2a is supported.

H2b (EF ⟶ EP): Effectuation has a significant positive impact on enterprise performance (β=0.321, t=8.003, and p=0.000). Therefore, H2b is supported.

H3 (BMI ⟶ EP): Business model innovation has a significant positive impact on enterprise performance (β=0.213, t=4.692, and p=0.000). Therefore, H3 is supported.

H4a (EU x CA ⟶ BMI): Environmental uncertainty has a significant negative moderating effect on causation and business model innovation (β= -0.142, t=3.105, and p=0.001). Therefore, H4a is supported.

H4b (EU x EF⟶BMI): Environmental uncertainty has a significant positive moderating effect on effectuation and business model innovation (β=0.214, t=4.360, and p=0.000). Therefore, H4b is supported.

All the hypotheses tested in this research, showcases the definite relationships among the various variables, as shown in Table 6.

Table 6 Summary results

Hypothesis	Relationships	Path coefficients (β)	t-Statistics	p-values	Results
H1a	CA ⟶ BMI	0.181***	3.225	0.001	Supported
H1b	EF ⟶ BMI	0.317***	6.883	0.000	Supported
H2a	CA ⟶ EP	0.355***	7.890	0.000	Supported
H2b	EF ⟶ EP	0.321***	8.003	0.000	Supported
H3	BMI ⟶ EP	0.213***	4.692	0.000	Supported
H4a	EU x CA ⟶ BMI	-0.142**	3.105	0.001	Supported
H4b	EU x EF ⟶ BMI	0.214***	4.360	0.000	Supported

Note: ** p < 0.01, and *** p < 0.001, one-tailed test.

Results pertaining to indirect relationships. This study explores the indirect role of business model innovation. The details are as follows:

CA ⟶ BMI ⟶ EP: Business model innovation plays an indirect mediating role between causation and enterprise performance (β=0.039, t=2.722, and p=0.003).

EF ⟶ BMI ⟶ EP: Business model innovation plays an indirect mediating role between effectuation and enterprise performance (β=0.068, t=3.871, and p=0.000).

EU ⟶ BMI ⟶ EP: Business model innovation plays an indirect mediating role between environmental uncertainty and enterprise performance (β=0.037, t=2.903, and p=0.002).

EU x CA ⟶ BMI ⟶ EP: Environmental uncertainty indirectly affects enterprise performance through negative regulation of causation and business model innovation (β= -0.030, t=2.555, and p=0.005).

EU x EF ⟶ BMI ⟶ EP: Environmental uncertainty indirectly affects enterprise performance through positive regulation of effectuation and business model innovation (β=0.045, t=3.088, and p=0.001).

Overall, all of the indirect relationships in this study are supported, as shown in Table 7.

Table 7 Indirect relationship

Relationships	Path coefficients (β)	t-Statistics	p-values
CA ⟶ BMI ⟶ EP	0.039**	2.722	0.003
EF ⟶ BMI ⟶ EP	0.068***	3.871	0.000
EU ⟶ BMI ⟶ EP	0.037**	2.903	0.002
EU x CA ⟶ BMI ⟶ EP	-0.030**	2.555	0.005
EU x EF ⟶ BMI ⟶ EP	0.045**	3.088	0.001

Note: ** p < 0.01, and *** p < 0.001, one-tailed test.

Discussion

Objective 1: To analyze the direct influence of decision-making logic (causation and effectuation) on business model innovation (H1a, H1b).

The study found that both causation and effectuation positively affect business model innovation. The influence effect of effectuation (β=0.317, p<0.01) is greater than that of causation (β=0.181, p<0.01). The results show that in the context of digital technology updates and iterations, effectuation continuously and dynamically accelerates organizational change and process reengineering based on external environments, which is more conducive to promoting business model innovation.

Causation analyzes market competition with a goals-driven approach, promotes the transformation of value activity systems, and facilitates business model innovation. Firstly, goals-driven is the foundation of business model innovation. Enterprises are guided by clear goals, formulate plans to improve resource utilization (Gilbers, 2024), and stimulate organizational innovation (Codini et al., 2023). Secondly, expected returns are the goal of business model innovation. Enterprises deeply integrate digital technology and production factors, reconfigure core resources, and optimize value creation processes (Gilbers, 2024; Chen et al., 2022). Thirdly, competitive & market analysis is an effective measure for business model innovation. Enterprises analyze market dynamics to identify business opportunities, restructure business logic, and reduce the premium cost of digital transformation (Racat et al., 2024; Karami & Read, 2021). Finally, avoiding the unexpected provides safeguards for business model innovation. Enterprises actively avoid risks and uncertainties, promote iterative upgrading of new products, and provide new services (Pater, 2024).

Effectuation is oriented towards means, dynamically optimizing the value creation process and achieving business model innovation. Firstly, means-driven is the prerequisite for business model innovation. Guided by the resources currently available, enterprises acquire new knowledge to develop, test, and iterate business models (Gilbers, 2024; Karami et al.,

2022). Secondly, affordable loss is the key to business model innovation. In a resource-constrained environment, enterprises reorganize fragmented resources within an affordable loss range to improve resource utilization (Pater, 2024). Thirdly, partnerships are an important support for business model innovation. Enterprises should establish mechanisms for risk allocation, benefit sharing, and value co-creation, and expand their innovation capabilities and methods (Racat et al., 2024; Codini et al., 2023). Finally, acknowledge unexpected is an opportunity for business model innovation. Reduce inertia thinking and path dependence, and enterprises should use unexpected opportunities to find new ideas (Click, 2023), new concepts, discover new opportunities and resources, develop new tools and methods, and apply new methods to solve new problems.

Objective 2: To analyze the direct influence of decision-making logic (causation and effectuation) on enterprise performance (H2a, H2b).

The study found that both causation and effectuation have a positive impact on enterprise performance. The impact of causation on enterprise performance (β=0.355, p<0.01) is slightly greater than that of effectuation (β=0.321, p<0.01). This suggests that the direct impact of causation and effectuation on enterprise performance is very small. Therefore, when making decisions and taking actions, enterprises can focus on different decision-making logics based on their life cycle and actual situation.

Causation is based on research and prediction, with clear goals and paths for digital transformation. It deeply explores management potential during the implementation of plans and helps improve enterprise performance. Firstly, goals-driven is the driving force for improving performance. Goals are instructive and leading, and clarifying goals provides clear direction and motivation to help companies improve efficiency (Chetty et al., 2024). Secondly, expected returns are a key measure to improve performance. Enterprises allocate key resources according to the principle of maximizing returns, continue to build core technology barriers, accurately iterate and upgrade products and services to provide differentiated high-quality products, reduce costs and improve efficiency to enhance enterprise performance. Thirdly, competitive & market analysis is a key factor in improving performance. Enterprises can grasp the competitive situation through competitive & market analysis, understand potential risks and opportunities, develop development strategies that are in line with the actual situation of the enterprise, and enhance the core competitiveness and performance of the enterprise (Kamble et al., 2023). Finally, avoiding the unexpected is a powerful guarantee for improving enterprise performance. Avoiding the unexpected helps reduce the uncertainty faced by enterprises, thereby ensuring stable operations and enhancing profitability (Click, 2023; Baghersad et al., 2022).

Effectuation starts from existing means, integrates and reorganizes resources within the affordable loss range, and improves enterprise performance. Firstly, the means-driven is the optimal path for improving enterprise performance. Starting from existing resources, we can improve the fault tolerance rate through low-cost, short-cycle trial and error (Chetty et al., 2024),

find more new business opportunities, and enhance enterprise performance. Secondly, affordable loss is the fundamental principle to improve the performance of the enterprise. Enterprises control possible negative outcomes based on the principle of loss tolerance, improve the integration effect and utilization rate of resources, create higher value (Karami & Hossain, 2024), and enhance enterprise performance. Thirdly, partnerships are an effective way to improve enterprise performance. Collaborative sharing enhances partnerships, optimizes resource utilization, increases supply chain transparency, reduces inventory risks , and improves enterprise performance. Finally, acknowledge unexpected is a new opportunity to improve enterprise performance. Accept the occasional events and take them as an opportunity to seize the opportunity to find new business opportunities, improve production flexibility (Kamble et al., 2023; Baghersad et al., 2022), and enhance enterprise performance.

Objective 3: To analyze the direct influence of business model innovation on enterprise performance (H3).

The study found that business model innovation has a significant positive impact on enterprise performance (β=0.213, p<0.01). From the paths "CA ⟶ BMI ⟶ EP" and "EF ⟶ BMI ⟶ EPB", the specific indirect effect values are 0.039 (p<0.01) and 0.068 (p<0.01), respectively. Therefore, in the process of digital transformation, the causation and effectuation not only have a direct impact on enterprise performance, but also can influence enterprise performance through business model innovation. Business model innovation plays a role as a "connector" between decision-making logic and enterprise performance.

Firstly, value offering innovation is a means for enterprises to stay ahead of their competitors. Enterprises provide new products and services, tap potential customers and customer needs (Fernandes & Rozenfeld, 2024; Jia & Shen, 2024), and improve enterprise performance through organizational change and process reengineering (Jean et al., 2024; Wang et al., 2023). Secondly, value architecture innovation is the key to the formation of value carriers. Enterprises explore and apply new combinations of resources and capabilities, allocate core resources more rationally (Salfore et al., 2023), improve resource utilization, efficiency, and customer satisfaction (Dong et al., 2024; Wang & Zhou, 2021), and thereby enhance enterprise performance. Finally, revenue model innovation is an important way to transmit value, and it is the foothold and destination for business model innovation and performance improvement. Enterprises improve traditional channels, build new business logic, channels, and profit models (Haftor et al., 2023), and efficiently deliver products or services to customers, attracting new customers and improving customer loyalty (Filatrovi et al., 2024), increasing profits and improving enterprise performance.

Objective 4: To analyze the moderating role of environmental uncertainty on decision-making logic (causation and effectuation) and business model innovation (H4a, H4b).

The study found that environmental uncertainty negatively moderates causation and business model innovation (β= -0.142, p<0.01), with a negative indirect effect on enterprise performance (β= -0.030, p<0.01). However, environmental uncertainty positively moderates

causation and business model innovation (β=0.214, p<0.01), with a positive indirect effect on enterprise performance (β=0.045, p<0.01)

With the continuous innovation, penetration, diffusion, integrated application and rapid updating and iteration of digital technologies such as artificial intelligence, big data, blockchain and cloud computing, enterprises are facing increasingly environmental uncertainty (Lissillour et al., 2024). New technologies, new industries, new formats, and new models emerge in an endless stream, and the impact of information asymmetry is further amplified, which has a negative impact on the scientific and effective nature of corporate decision-making and forecasting, greatly increasing the difficulty of decision-making and affecting the value-added of corporate value. Therefore, in this context, it is difficult for enterprises to obtain effective external information, and causation cannot effectively help enterprises make correct predictions and decisions, resulting in deviations in performance goals, low feasibility of implementation plans, and potential loss of control during the execution process. This is not conducive to the innovation of business models and the improvement of enterprise performance (Xu & Liu, 2024; Chen et al., 2021). Effectuation emphasizes means-driven, focusing on the control process of existing resources, and conducting multiple low-cost trial and error within the affordable loss range to find the optimal solution (Pathak et al., 2022). It repeatedly adjusts and optimizes the goals to adapt to environmental uncertainty, and continuously promotes business model innovation dynamically.

The empirical research of PLS-SEM found that causation and effectuation s not only have a direct positive impact on enterprise performance, but also can have a positive impact on enterprise performance by influencing business model innovation. The impact of causation on enterprise performance is slightly greater than that of effectuation, but its impact on business model innovation is less than that of effectuation. Environmental uncertainty has a negative moderating effect on causation and business model innovation, while it has a positive moderating effect on effectuation and business model innovation.

Conclusion

This study has three main research contributions. Firstly, enrich the research on decision-making logic outcome variables. Based on the multidimensional attributes of causation and effectuation concepts, and reveals the cognitive factors of entrepreneurial decision-making from the perspective of decision-making logic. Secondly, enrich the research on the antecedents of enterprise performance. On the one hand, we re-examine the important role of decision-making logic of enterprise managers in improving enterprise performance, and empirically analyze the antecedents that directly affect enterprise performance: decision-making logic. On the other hand, with business model innovation as the mediating variable, decision-making logic influences business performance by affecting the value provision innovation, value architecture innovation, and revenue model innovation of business models. Finally, the extent of influence of causation and effectuation is clarified. Compared with causation, effectuation has a more obvious impact on business model innovation, while there is no significant difference in its impact on enterprise

performance. Environmental uncertainty has a negative moderating effect on causation and business model innovation, while it has a positive moderating effect on effectuation and business model innovation.

Practical Implications First, from the perspective of enterprise performance, decision-making logic is an important factor that affects the improvement of enterprise performance. Both causation and effectuation can help directly or indirectly improve enterprise performance, but companies need to choose a decision-making logic that fits their own development stage, decision-making ability, resources and goals, logical preferences and characteristics, and other factors. If the causation is chosen as the main decision-making logic, enterprises should clarify their development goals, task indicators, and implementation paths, formulate development strategies that meet their own characteristics and needs, promote intelligent production, management, and services, and continuously improve product quality, efficiency, and innovation capabilities. If the choice of effectuation is the main decision-making logic, then we should start from existing resources, capabilities, and connections, establish strategic alliances with stakeholders, share resources, share risks, collaborate on innovation, adjust strategies in a timely manner based on external environment and internal conditions, and seize new opportunities to solve new problems.

Secondly, from the perspective of environmental uncertainty, enterprises should combine their own actual situation and develop corresponding prevention and response measures based on the logic decision they have chosen. When environmental conditions are complex and have a large degree of uncertainty, companies should prioritize using effectuation when making decisions. If the enterprise has chosen the causation, it is necessary to develop corresponding prevention and response measures to minimize the negative impact of uncertainty. For example, we should strengthen training and communication, improve the ability to predict and respond to uncertainty in demand, and improve the matching, reliability, and effectiveness of digital technology for digital transformation through testing, evaluation, and optimization.

Third, from the perspective of business model innovation, enterprises should give priority to adopting effectuation. Empirical research has found that the effect of effectuation on business model innovation is greater than the effect of causation on business model innovation. Therefore, enterprises should prioritize the use of effectuation in their decision-making process, optimize the allocation of core resources, improve and optimize business processes, reconstruct business logic, continuously develop new products or provide new services, and enhance their core competitiveness to achieve sustainable development.

Limitation and Future Research

Although the research has obtained some meaningful conclusions and enlightenment, there are still some limitations that need further research. On the one hand, the research data is cross-sectional data obtained through questionnaires, which cannot reflect the evolutionary process of decision-making logic. It is suggested that future research can collect time series data

for dynamic research, so as to explore the relationship between decision-making logic, business model innovation, and enterprise performance more deeply and accurately. On the other hand, this study did not conduct in-depth analysis of the relationship between various variable dimensions. Future research can further explore this to gain a deeper understanding.

References

Akbar, M., Rashid, A. & Sheikh, M. R. (2024). Socioeconomic Determinants of Genetic Disorder in Disabled Persons of Punjab, Pakistan. *Bulletin of Business and Economics (BBE)*, *13*(1), 29-41.

Ancillai, C., et al. (2023). Digital technology and business model innovation: A systematic literature review and future research agenda. *Technological Forecasting and Social Change*, *188*, 122307.

Baghersad, V., Davari, A. & Farrokhmanesh, T. (2022). Effectuation, Causation and the Performance of Entrepreneurial Businesses. *Management Research in Iran*, *26*(1), 88-110.

Bentler, P. M. & Chou, C. P. (1987). Practical issues in structural modeling. *Sociological methods & research*, *16*(1), 78-117.

Chandler, G. N., et al. (2011). Causation and effectuation processes: A validation study. *Journal of business venturing*, *26*(3), 375-390.

Chen, J. X., et al. (2019). Demystifying the impact of CEO transformational leadership on firm performance: Interactive roles of exploratory innovation and environmental uncertainty. *Journal of Business Research*, *96*, 85-96.

Chen, J. & Liu, L. (2022). Effectuation, SME service innovation, and business customers' value perception. *The Service Industries Journal*, *44*(15-16), 1-36.

Chen, Y., Liu, H. & Chen, M. (2022). Achieving novelty and efficiency in business model design: Striking a balance between IT exploration and exploitation. *Information & Management*, *59*(3), 103268.

Chen, Y., et al. (2021). On the road to digital servitization–The (dis) continuous interplay between business model and digital technology. *International Journal of Operations & Production Management*, *41*(5), 694-722.

Chetty, S., Martín, O. M., & Bai, W. (2024). Causal foreign market selection and effectual entry decision-making: The mediating role of collaboration to enhance international performance. *Journal of Business Research*, *172*, 114385.

Click, N. A. (2023). *Understanding the Effects of Decision-Making Logics on Small Business Relative Profitability* (Doctoral dissertation). The University of North Carolina at Charlotte.

Codini, A. P., Abbate, T. & Petruzzelli, A. M. (2023). Business Model Innovation and exaptation: A new way of innovating in SMEs. *Technovation*, *119*, 102548.

Dağıdır, B. D., & Özkan, B. (2024). A comprehensive evaluation of a company performance using sustainability balanced scorecard based on picture fuzzy AHP. *Journal of Cleaner Production*, *435*, 140519.

Dong, Y., Feng, T.& Sheng, H. (2024). Digital-based business model design and firm performance: the mediating role of ambidextrous innovation. *Journal of Business & Industrial Marketing*, *39*(11), 2309-2324.

Drnevich, P.L. & West, J. (2023). Performance implications of technological uncertainty, age, and size for small businesses. *Journal of Small Business Management*, *61*(4), 1806-1841.

Essen, A., Frishammar, J. & Cenamor, J. (2023). Entering non-platformized sectors: The co-evolution of legitimacy debates and platform business models in digital health care. *Technovation*, *121*, 102597.

Fernandes, S.D.C. & Rozenfeld, H. (2024). Business model innovation through the design of circular product‐service system value propositions: A method proposal. *Business Strategy and the Environment*, *33*(6), 5325-5345.

Filatrovi, E. W., Darmastuti, I. & Srivastava, A. (2024). How to Business Model Innovation Bridges the Gap Between Digital Transformation and Performance?. *International Business and Accounting Research Journal*, *8*(1), 51-65.

Gilbers, M. A. (2024). *Causation versus Effectuation: Exploring the Impact of Educational Background on Entrepreneurial Decision-Making Strategies* (Master's Thesis, Business Administration). University of Twente.

Griffin, M. A. & Grote, G. (2020). When is more uncertainty better? A model of uncertainty regulation and effectiveness. *Academy of Management Review*, *45*(4), 745-765.

Guo, J. C. (2023, August 17). *Report on the Development of China's Digital Economy Industry (2023)*. Retrieved March 1, 2024, from https://jg-static.eeo.com.cn/article/info?id=13696b50f251282ac844ea1f4635e363&channelUuid=undefined

Haftor, D. M. & Costa, R. C. (2023). Five dimensions of business model innovation: A multi-case exploration of industrial incumbent firm's business model transformations. *Journal of Business Research*, *154*, 113352.

Hair, J., et al. (2022). *A primer on partial least squares structural equation modeling (PLS-SEM)* (3rd ed.). Thousand Oaks: Sage.

Harms, R., et al. (2021). Effectuation and causation configurations for business model innovation: Addressing COVID-19 in the gastronomy industry. *International Journal of Hospitality Management*, *95*, 102896.

Hristov, I., et al. (2024). A system dynamics approach to the balanced scorecard: a review and dynamic strategy map for operations management. *Journal of Manufacturing Technology Management*,*35*(4), 705-743.

Imjai, N., Aujirapongpan, S. & Yaacob, Z. (2024). Impact of logical thinking skills and digital literacy on Thailand's generation Z accounting students' internship effectiveness: Role of self-learning capability. *International Journal of Educational Research Open*, *6*, 100329.

Jaiswal, V. & Thaker, K. (2024). Studying research in balanced scorecard over the years in performance management systems: a bibliometric analysis. *International journal of productivity and performance management*, *73*(8), 2558-2582.

Jean, R.J.B., et al. (2024). The effect of business model innovation on SMEs' international performance: The contingent roles of foreign institutional voids and entrepreneurial orientation. *Journal of Business Research*, *175*, 114449.

Jia, R. & Shen, X. (2024). Research on the Impact of Business Model Innovation on Enterprise Performance Based on SPSS Multivariate Linear Regression Analysis. In *Economic Management and Big Data Application: Proceedings of the 3rd International Conference* (pp. 792-800).

Kamble, S., et al. (2023). An effectuation and causation perspective on the role of design thinking practices and digital capabilities in platform-based ventures. *Technological Forecasting and Social Change*, *193*, 122646.

Karami, M. & Hossain, M. (2024). Marketing intelligence and small firms' performance: the role of entrepreneurial alertness and effectuation. *Marketing Intelligence & Planning*, *42*(1), 168-189.

Khan, T. H., et al. (2024). Responsive to Proactive Market Orientations: Unleashing the Potential of Effectuation-Causation Blending for Business Model Innovation. *IEEE Transactions on Engineering Management*, *71*, 14307-14325.

Koguta, C. S., de Mello, R. D. C. & Skorupskib, R. (2023). Combining effectuation and causation approaches in entrepreneurship: A 20+ years review. *REGEPE Entrepreneurship and Small Business Journal*, *12*(3), 1-12.

Lissillour, R., et al. (2024). Value network and firm performance: the role of knowledge distance and environmental uncertainty. *Journal of Knowledge Management*, *28*(1), 44-68.

Meng, B. (2024). The Key Research of Enterprise Performance Evaluation System Based on EVA Comprehensive Balanced Scorecard. In *Economic Management and Big Data Application: Proceedings of the 3rd International Conference* (pp. 376-383).

Palacios-Marqués, D., et al. (2019). Social entrepreneurship and organizational performance: A study of the mediating role of distinctive competencies in marketing. *Journal of Business Research*, *101*, 426-432.

Pater, R. (2024). *Exploring the Impact of Age on Decision-Making Approaches: a study of causation and effectuation* (Bachelor's thesis), University of Twente.

Pathak, B., Ashok, M. & Leng Tan, Y. (2022). Value co-creation in the B2B context: a conceptual framework and its implications. *The Service Industries Journal*, *42*(3-4), 178-205.

Peng, X. B., et al. (2020). The nonlinear effect of effectuation and causation on new venture performance: The moderating effect of environmental uncertainty. *Journal of Business Research*, *117*, 112-123.

Prashantham, S., et al. (2019). Effectuation, network-building and internationalization speed. *International Small Business Journal*, *37*(1), 3-21.

Racat, M., Ricard, A. & Mauer, R. (2024). Effectuation and causation models: an integrative theoretical framework. *Small Business Economics*, *62*(3), 879-893.

Ryman, J.A. & Roach, D. C. (2024). Innovation, effectuation, and uncertainty. *Innovation*, *26*(2), 328-348.

Salfore, N., Ensermu, M. & Kinde, Z. (2023). Business model innovation and firm performance: Evidence from manufacturing SMEs. *Heliyon*, *9*(6), e16384.

Shirokova, G., et al. (2020). Navigating the emerging market context: Performance implications of effectuation and causation for small and medium enterprises during adverse economic conditions in Russia. *Strategic Entrepreneurship Journal*, *14*(3), 470-500.

Singh, S.K., et al. (2021). Top management knowledge value, knowledge sharing practices, open innovation and organizational performance. *Journal of Business Research*, *128*, 788-798.

Spieth, P. & Schneider, S. (2016). Business model innovativeness: designing a formative measure for business model innovation. *Journal of business Economics*, *86*(6), 671-696.

Su, X. H., et al. (2018). Entrepreneurship for money or happiness? An exploring research of entrepreneurial motives, decision-making logic and entrepreneurial performance. *Sci Sci Manag S & T*, *2*, 116-129.

Wang, Z., et al. (2023). Digitalization effect on business performance: role of business model innovation. *Sustainability*, *15*(11), 9020.

White, J.V., et al. (2022). Exploring the boundaries of business model innovation and firm performance: A meta-analysis. *Long Range Planning*, *55*(5), 102242.

Wu, L., Liu, H. & Su, K. (2020). Exploring the dual effect of effectuation on new product development speed and quality. *Journal of Business Research*, *106*, 82-93.

Xu, S., et al. (2022). Entrepreneurial networks, effectuation and business model innovation of startups: The moderating role of environmental dynamism. *Creativity and Innovation Management*, *31*(3), 460-478.

Xu, W. & Liu, C. (2024). External environment uncertainty key resources acquisition and corporate technological innovation. *Managerial and Decision Economics*, *45*(1), 4-18.

Xu, Y., et al. (2024). How does the combination of factors influence entrepreneurs' decision-making logic? A qualitative comparative analysis. *Entrepreneurship Research Journal*, *14*(3), 1461-1484.

Yamane, T. (1967). *Statistics: An introductory analysis.* New York: HarperCollins Publishers.

Yıldız, N. T., Alkan, A. & Külünkoğlu, B. A. (2024). Validity and reliability of the Turkish version of mandibular function impairment questionnaire. *CRANIO®*, *42*(2), 160-170.

Yoon, J. H. & Cho, E. (2023). Effectuation (EF) and causation (CS) on venture performance and entrepreneurs' dispositions affecting the reliance on EF and CS. *Entrepreneurship Research Journal*, *13*(2), 381-408.

Yu, F. & Wang, G. (2023). Assessing the Impact of Business Model Innovation on Firm Performance: Insights from the China Growth Enterprise Market. *International Business Research*, *16*(4), 1-51.