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Innovation and technology creation effects on organizational performance☆

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ABSTRACT

The purpose of this study is to analyze the relationships among innovation, technology creation, quality management, information management capability and organizational performance. This study contributes to the research on the effect that diversification has on organizational performance under conditions of uncertainty. Firms benefit from either low levels of diversification due to efficiencies in processing innovation knowledge, or from high levels of diversification due to access to broad information management capabilities that facilitate the solving of complex problems and the ability to direct a firm along different trajectories. The use of comparative methods in this research includes multiple regression analysis (MRA) and fuzzy-set qualitative comparative analysis (fsQCA). These analyses demonstrate that an fsQCA can successfully identify conditions that are adequate for successful organizational performance outcomes. The results indicate that an fsQCA outperforms an MRA and successfully models both types of data with causal complexities. The model looks across industries and across various types of firms; at the same time, the differences among industries and firms are also investigated. This study's findings provide useful insights into how firms' members should reinforce their collaborative behaviors and activities to enhance their competitive advantages.

1. Introduction

Organizational performance and knowledge positively influence a firm's innovation (Jiménez-Jiménez & Sanz-Valle, 2011). Having a greater facility for innovation would aid a firm in the innovation race against competitors, thereby improving organizational performance. A company that encourages innovative products, quality processes, or services may benefit from new innovation (Leal-Rodríguez, Ariza-Montes, Roldán, & Leal-Millán, 2014).

Innovation is a key factor in technology creation and in sustaining an organization's competitive advantage, which in turn improves its overall performance. Innovation enables firms to protect themselves from highly uncertain, unstable scenarios, thus making them more capable of seeking new opportunities and efficiently exploiting existing ones (Matzler, Abfalter, Mooradian, & Bailom, 2013). A team's absorptive capacity enables a firm to turn knowledge into new product quality management, services, or processes to support innovation (Cepeda-Carrión, Cegarra-Navarro, & Leal-Millán, 2012). To generate product quality value, organizations should sustain capabilities by infusing new innovation into their operations, a process that requires multiple competences and skills (Zahra, Abdelgawad, & Tsang, 2011).

Innovation is indispensable to contemporary organizations. An organization's technology creation and its ability to identify, share and apply knowledge directly affect its competitive advantage (Alavi & Leidner, 2001). Firms are often considered to be an important building block in today's information-based economy (Cummings, 2004). As such, organizations have made significant investments in implementing an information management capability that is specifically designed to support the sharing of information management capability among firm members in an organization.

Information management capability, with regard to organizational performance, could potentially provide a competitive advantage for firms. For an organization to achieve a competitive advantage, all functions must be interrelated. The operational function adds value by using an organization's resources effectively and by producing goods and services that satisfy the needs and requirements of customers (Singh, 2008).

Competitive advantage can be considered to be an advantage, condition, or position that facilitates more efficient operation and higher quality management of products and services for an organization. Competitive advantage is the ability to increase earnings despite competitive pressures; this is one aspect of gaining competitive advantage (Singh, 2008).

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The study adopts the relational view of the resources-based theory (RBT) and the resource-based view theory (RBV) of the firm to explain the effects of innovation, technology creation, quality management, and information management capability on organizational performance. From a resource complementarity perspective, information management capability encompasses the routines or practices that complement innovation, technology creation, and quality management to deliver value to an organization. The relational view of the resources-based theory argues that the resources generating competitive advantage can span an organization's boundaries and become embedded in inter-organizational relations. Information management capability is the capacity exercised by the board, executives, and information technology management to control the implementation of an information technology creation strategy (Van Grembergen, 2002).

This study suggests moving beyond reliance on the dominant logic of multiple regression analysis (MRA) and using algorithms to advance and test theories in accounting, firm management, and marketing. This study includes an example of testing an MRA model for fit and predictive validity. The same data used for the MRA are used to conduct a fuzzy-set qualitative comparative analysis (fsQCA) (Woodside, 2013).

The contribution of this study is to strengthen and clarify the relationship between the four factors and organizational performance by investigating Taiwanese business firms. Moreover, this study indicates that the fsQCA method performs better than conventional regression analysis.

2. Literature review and hypotheses

2.1. Innovation

Innovation and organizational performance have increasingly become key determinants of firms' competitive advantages (Crone & Roper, 2001). Innovation plays a vital role when a customer is building a relationship with a company and is a relatively stable and conscious tendency of the relationship a customer creates with retailers of a particular product category (Wulf, Odekerken-Schroder, & Lacobucci, 2001). Innovation is a critical team process based on combined knowledge without which the cognitive resources available within a team remain underutilized (Argote, 1999). Innovation is a key component of knowledge management, as it helps in codifying the repository of available knowledge in organizational performance ability, and increases over time (Liebowitz, 1999).

Innovation is a process for creating, acquiring, sharing and utilizing knowledge to develop organizational performance and learning; it encompasses innovation and acquisition, modification, utilization, storage and protection, transfer and sharing, translation and repurposing, as well as accessing and disposing of knowledge.

Innovation and organizational performance ability predispose partners to be more inclined to commit managerial resources in terms of time and effort to inter-firm relationships (Johnson & Sohi, 2001). Therefore, this study includes the number of innovations as a variable.

2.2. Technology creation

Technology creation is an industry's willingness to place strong emphasis on new products, improve product lines and advance technologically. The most prominent dimensions of creation include radical, incremental, product, process, administrative, and technology creation, as well as organizational performance ability (Camison-Zomoza, Lapiedra-Alcami, Segarra-Cipres, & Boronat-Navarro, 2004). Technology creation firms enjoy high growth and survival potential based on their innovations (Mas-Verdú, Ribeiro-Soriano, & Roig-Tierno, 2015). Ongoing technology creation increases an enterprise's competitiveness, a major factor in market survival and business success (Lee & Jeong, 2010).

Technology creation varies in complexity and can range from minor changes to existing products, processes, or services to the development of breakthrough products, processes or services that introduce novel features that perform exceptionally well (Khade, 2007). Numerous studies attest to the impact of technology creation capabilities on business success. Empirical analysis shows that increased research and development (R&D) investment has a positive effect on sales revenue, profit, productivity and research, as well as on how R&D capabilities influence new technology and new product development.

Organizational performance entails the application of newly developed technologies to the organization's facilities, processes, systems, services and programs. This study therefore includes technology creation as a research variable.

2.3. Quality management

Quality management requires satisfying customer expectations and meeting global quality requirements (Case, 2002). Pertinently, quality management plays an important role in determining next-generation quality management (DeFeo & Fanssen, 2001). Hence, a multinational or global quality manager must grow in the international arena. Furthermore, with the evolution of advanced technologies in various industries, quality experts must adapt to these new conditions to remain competitive in global markets (Elshennawy, 2004).

Today, businesses must be certain of their quality management and organizational performance ability, and that they bring high quality, safe, and competitively priced products to the market if they want to sustain growth in the global market.

Quality management is a widely used concept that has become one of the most important agenda items for the majority of organizations. Quality management is necessary for businesses to compete and face the challenging forces of globalization. Global competition demands that organizations across borders initiate efforts to ensure their products achieve the highest standard of quality management. To emphasize the importance of quality management perspectives in firm management, the concept of firm quality management as the formal organizational performance ability and integration of business procedures within the firm's processes. This study therefore includes quality management as a research variable.

2.4. Information management capability

Information management capability is the capability to provide data and information to users with appropriate levels of connectivity, confidentiality, security, reliability, timeliness, access and accuracy, as well as the ability to tailor these in response to changing business needs and directions. Technology-supported information management enables higher-order business capabilities, which in turn influence organizational performance (Sambamurthy, Bharadwaj, & Grover, 2003).

Information management capability can play an important role in leveraging knowledge resources in organizations (Sambamurthy & Subramani, 2005). Organizations often implement information systems that are specifically designed to support various aspects of information management activities (Alavi & Leidner, 2001).

Effective information management can minimize process variability by providing a common blueprint for all workers to use in carrying out their tasks, which in turn enhances organizational performance.

Information management capability is a critical enabler of a firm's customer management capabilities. Firms with a greater ability to plan and integrate their information technology resources and provide timely, accurate and reliable information to key stakeholders are more effective in improving customer service and customer relationships.

Better information management capabilities enable firms to gather information about customers and disseminate relevant information to customers through the internet, virtual communities and personalized information channels (Nambisan, 2002a). A high level of information

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management capability enables organizations to design metrics and analytics that provide visibility for the real time performance of various processes, integration between processes, and advance warnings of performance degradation in processes (Kalakota & Robinson, 2003). This study therefore includes information management capability as a research variable.

2.5. Organizational performance

In a continuous learning organization, employees are constantly encouraged to acquire new knowledge, to try to solve problems in novel ways, to obtain feedback and learn new behaviors as a result of their experiences (Goh, 2002). The organization must move from its current state to a desired future state that has the characteristics of a learning organization: clarity of mission and vision; leadership commitment and employee empowerment; experiences and rewards; effective knowledge acquisition; teamwork and group problem-solving (Goh, 2002).

In fact, to successfully implement a competitive advantage, firms need to redesign their organization and orient their firms to the demand. Thus, strategy, organizational performance structure and business processes all need to be transformed to implement competitive advantage because success in the initiative will depend on creating the right synergy among processes, people and technological systems.

Human resources and time have important influences on competitive advantage. Organizational performance is the only sustainable source of advantage, so managers must link their core competence to different types of strategies across time. This study therefore includes organizational performance as a research variable.

2.6. Hypotheses

From a review of the marketing and supply chain literature, preliminary in-depth interviews with 25 managers, and exploratory factor analysis (EFA), four groups of concepts emerged as influencers of organizational performance: innovation, technology creation, quality management, and information management capability. The following hypotheses capture the influence of these constructs; Fig. 1 shows the relationships. The dependent variable is organizational performance. In accordance with the research purpose, this study develops four hypotheses to explore the effects of the relationships. A description of these hypotheses appears below.

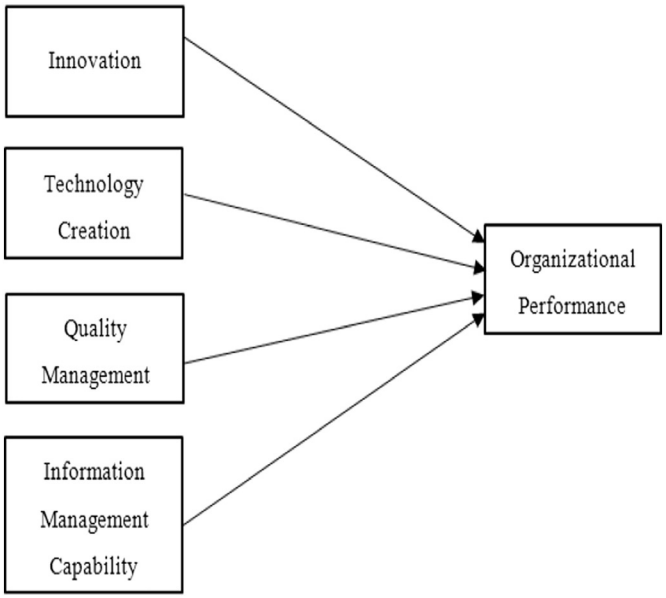

Fig. 1. Research Model.

H1. Innovation has a positive effect on organizational performance.

H2. Technology creation positively influences organizational performance.

H3. Quality management positively influences organizational performance.

H4. Information management capability positively influences organizational performance.

3. Research method

3.1. Data collection procedure

Questionnaires were distributed to 32 businesses, after a revision and consulting with a reference scholar and 23 operators (managers); other comments were aggregated again after revision. A pretest and pilot test were performed to validate the instrument before conducting the survey. Companies manufacturing electronic parts and components served as the main source of response collection (50%), as Taiwan's electronics industry is famous worldwide. A pretest on the questionnaire comprising 25 items was carried out with the help of academic researchers to improve the content and appearance of the instrument, as well as to conduct factors analysis. SAS Enterprise Guide 4.3, SPSS statistics 21, Fs/QCA software was used to carry out exploratory factor analysis (EFA) and path analysis of all constructs. More than 250 valid questionnaires were collected and Cronbach's α value reached 0.7, which was suitable for factor analysis. Their responses suggest that only minor cosmetic changes were required and that all statements could be retained. In addition, a pilot test was performed.

In the current method, 25 items capture innovation, technology creation, quality management, information management capability, and organizational performance. Employ a five-item scale to measure innovation. The four-item scale in study offers a good tool to measure technology creation. The present study uses a four-item instrument to measure quality management. Present a five-item instrument to determine information management capability. Six-item scale provides a suitable tool to measure organizational performance. Table 1 shows item details. Using these same scales report that they have strong psychometric properties with acceptable reliability and validity.

Table 2 shows the survey instrument in the form of a questionnaire submitted to the function managers of manufacturing firms in Taiwan. These firms are listed in the Business Weekly (Taiwan's leading business magazine) as the top 500 manufacturing firms of 2015. The first round yielded 172 effective responses and the second round yielded an additional 78 responses, resulting in 250 effective responses. The total response rate was 50%. Additionally, 193 respondents (77% of the 250 effective responses) were function managers or other managers on the senior management team, such as general manager, vice president, or CEO.

This study sets the alpha coefficient at 0.6. Innovation is Cronbach Coefficient Alpha Standardized 0.86. Technology creation is 0.80. Quality management is 0.80. Information management capability is 0.82. Kaiser's Measure of Sampling Adequacy: Overall MSA = 0.88 > 0.5; all of the individual MSA values 0.83–0.94 > 0.5, which are suitable for factor analysis. The eigenvalue is greater than or equal to 1 and can be divided into four factors. The eigenvalue value is 7.11, 1.93, 1.58, and 1.43. Test of appropriate of correlation matrix (50% R value >0.3).

To check for potential bias of a single informant, the consistency between the data collected from managers and senior managers was verified. Consistent with past research (Weil, 1992), interrater reliabilities (James, Demaree, & Wolf, 1984) are calculated to show the

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Table 1
Profiles of participating manufacturing firms.

Construct	Source
Innovation	
IS1	Our team members provide their manuals and innovation methodologies for other team members.
IS2	Our team members share their experience or innovation know-how from work with other team members.
IS3	Our team members apply innovation knowledge learned from experience.
IS4	Our team members use innovation knowledge to solve new problems.
IS5	Our team members apply innovation knowledge to solve new problems.
Technology creation	
TC1	Our team members have specialized technology creation knowledge of some aspects of our task.
TC2	Our team members trust that other members' technology creation knowledge about the project is credible.
TC3	Our team members are confident of relying on the information that other team members bring to the discussion.
TC4	Our team members know each other and have the ability to work together in a well-coordinated fashion.
TC5	Our team members have the technology creation capability to respond to the task-related problems smoothly and efficiently.
Quality management	
QM1	Improvements identified in productivity, service levels and efficiency.
QM2	Uses technology to underpin quality management assurance and enhancement.
QM3	Intense competition in supply chain requires assessment of customer views and attention to quality management processes.
QM4	Customer satisfaction affected by perceived quality.
Information management capability	
IMC1	Our team is provided with information management support for collaborative work regardless of time and place.
IMC2	Our team is provided with information management support for communicating among team members.
IMC3	Our team is provided with information management support for searching and accessing necessary information.
IMC4	Our team is provided with information management support for systematic storing.
IMC5	Our team members share their work information reports and official documents with other team members.
Organizational performance	
OP1	The team's deliverables were of excellent quality.
OP2	The team managed time effectively.
OP3	The team met important deadlines on time.
OP4	Performance indicators linked to strategy and management; otherwise can be dysfunctional.
OP5	Focus on organizational performance management and evaluation.
OP6	Scorecard can be used to manage rather than simply monitor organizational performance.

Table 2
Profiles of participating manufacturing firms.

Demographic profile	Number of firms	Percentage
Industry type		
Electrical machinery/cable	31	12.2
Machinery and equipment	23	9.3
Electronic parts and components	71	28.5
Transport equipment	18	7.2
Chemical/plastics	37	14.7
Textiles/fiber	10	4.2
Basic metal industries	11	4.5
Printing and related support activities	6	2.4
Food/beverage	22	8.7
Non-metallic mineral products	9	3.5
Others	12	4.8
Total sales revenue (NT$)		
$below $2 billion	39	15.6
$2.1 billion to below $5 billion	59	23.6
$5.1 billion to below $10 billion	56	22.5
$10.1 billion to below $20 billion	42	16.7
$20.1 billion to below $50 billion	39	15.6
$50.1 billion and above	15	6.0
6ears of establishment		
Less than 5 years	31	12.5
6–10 years	24	9.6
11–15 years	33	13.4
16–20 years	27	10.6
21–25 years	40	15.8
26–30 years	59	23.7
Over 31 years	36	14.4
Position of respondent		
Higher than production manager	128	51.2
Production manager	65	26.0
Lower than production manager	57	22.8

agreement level between function managers and other senior managers. A Chi-square analysis of the industry distribution of the respondents shows no difference from the industry distribution of all the firms used in the survey. This suggests that there is no non-response bias in the returned questionnaires.

All measures of the survey instrument are developed from the literature. Where appropriate, the manner in which the items were expressed is adjusted to the context of supply chains. The items measure the subjects' responses on a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5).

3.2. Regression analysis criteria

R^2 ranges between 0 and 1, indicating the magnitude of the independent variables' effects on changes as exhibited by the dependent variable. Values closer to 1 indicate that more of the estimate variance is determined by the XY influence (Draper & Smith, 1981), but do not prove a causal relationship. The coefficient of determination (R^2) expresses the goodness of fit between a model and its data (Neter & Wasserman, 1974). The regression coefficient evaluates the relationship between individual independent and dependent variables. This study uses ($p < 0.05$) as its significance interval.

3.3. FsQCA calibration

To analyze whether combinations of variables are necessary and/or sufficient to influence outcomes, the fsQCA analyzes all the antecedents and uses a membership function to express the relationships between combinations and outcomes (Huang & Huarng, 2015: Woodside & Zhang, 2012). Ragin (2008) shows that calibration is possible using three breakpoints for qualitative norms, for example, full membership (= 1.0), entirely non-members (= 0.0), and the maximum ambiguity cross point (= 0.5).

3.4. FsQCA consistency and coverage

Values exceeding 0.75 are representative of the observed phenomena, but they must exceed 0.9 before claiming a definitive relationship between antecedents and outcomes. The coverage index is analogous to R^2. The index assesses the extent to which cause or causal combination accounts for an outcome (Ragin, 2006). The FsQCA uses a consistency and coverage index to evaluate antecedents and their combinations (Ragin, 2008; Wu, 2015). A consistency index is analogous to a correlation, and represents a subset of the relation of antecedent(s) to outcome(s) (Ragin, 2006: Huang & Huarng, 2015).

4. Results

4.1. MRA results

Table 3 shows the results of the data model analysis. The Model Summary shows the explanatory power of independent variables.

Table 3
The multiple regression model.

Model summary[b]

Model	R	R square	Adjusted R square	Std. error of the estimate
1	.426[a]	.182	.168	.56335

Change statistics

R square change	F change	df1	df2	Sig. F change
.182	13.612	4	245	.000

a. Predictors: (constant), I S, T C, Q M, I M C.
b. Dependent variable: O P.

Anova[b]

Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	17.280	4	4.320	13.612	.000a
	Residual	77.753	245	.317		
	Total	95.034	249			

a. Predictors: (constant), IN, T C, Q M, I M C.
b. Dependent variable: O P.

Coefficients[a]

	Unstandardized coefficients		Standardized coefficients		t	Sig
Model	B	Std. error	Beta			
1	(Constant)	2.586	.259		9.991	.000
	IN	.095	.073	.098	1.303	.194
	TC	.387	.065	.408	5.921	.000
	QM	−.112	.070	−.117	-1.616	.107
	IMC	.003	.064	.003	.043	.966

Unstandardized coefficients		Correlations			Collinearity statistics	
Lower bound	Upper bound	Zero-order	Partial	Part	Tolerance	VIF
2.076	3.095					
−.049	.238	.073	.083	.075	.584	1.721
.258	.516	.412	.354	.342	.705	1.419
−.250	.025	.096	−.103	−.093	.642	1.559
−.124	.103	.158	.003	.002	.614	1.628

a. Predictors: (constant), innovation, technology creation, quality management, information management capability.
b. Dependent variable: organizational performance.

The $R^2 = 0.18$ indicates that they explain the 18% of observed variation in the dependent variable. In a post-hoc test for the effectiveness of independent variables, only technology creation $= 0.000 < 0.05$ attains the required significance level. All other independent variables demonstrate no significant effect on the dependent variable. Multiple regression analysis results reach a significant level, but only 18% of the predictive power of explanatory power, which represents the regression model; this is insufficient to predict organizational performance. Therefore, this study employs FsQCA to verify the consistency coverage of the model.

Table 4
FsQCA results.

Subset/superset analysis			
Outcome: OP			
	Consistency	Coverage	Combined
IN * TC * QM * IMC	0.967891	0.633397	0.791873
IN * TC * IMC	0.967593	0.673159	0.816350
IN * QM * IMC	0.962220	0.662116	0.809627
TC * QM * IMC	0.966465	0.642024	0.797248
IN * TC * QM	0.959588	0.700153	0.832557
IN * IMC	0.955156	0.720322	0.844464
TC * IMC	0.965951	0.683129	0.822373
QM * IMC	0.955559	0.675230	0.817650
IN * TC	0.956726	0.798543	0.889133
IN * QM	0.947997	0.748620	0.856532
TC * QM	0.954977	0.721396	0.845093
IMC	0.946180	0.738804	0.850898
IN	0.931297	0.890874	0.934375
TC	0.949100	0.849387	0.912359
QM	0.929355	0.779333	0.869455

a. Predictors: (constant), innovation, technology creation, quality management, information management capability.
b. Dependent variable: organizational performance.

4.2. FsQCA results

This study uses conventional MRA and fuzzy set qualitative comparative analysis fsQCA to analyze the data. FsQCA is an analytical tool that uses fuzzy set theory and differentiates itself from the conventional statistical methods (Ragin, 2008). Ragin (2008) and Woodside (2013) stress the importance of aiming for high consistency over high coverage. Consistency and coverage test results for fsQCA yield the relationships in Table 4. The results show that (fsQCA) captures relationships better and has better predictive capabilities than MRA does.

This technique differs from conventional statistical methods (Ragin, 2008). Woodside and Zhang (2012) provide more details on how to perform calibrations. This study explores the same variables. To demonstrate predictive validities, this study presents a prediction analysis.

Table 4 lists the results for the analysis of data using fsQCA. The results reveal coverage of 0.63, a combination of 0.79 and consistency of $0.96 > 0.9$. The high consistency score is strong evidence that the antecedent combination is sufficient to produce the outcome (organizational performance). The antecedent combination includes all four independent variables. These analyses demonstrate that the fsQCA successfully identifies conditions sufficient for the organizational performance outcome.

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5. Conclusions and managerial implications

5.1. Conclusions

The prediction of results of the four input variables and the one variable is significant. All other independent variables demonstrate no significant effect on the dependent variable. Multiple regression analysis results reach a significant level, but only 18% of the predictive power of explanatory power, which represents the regression model; this is insufficient to predict organizational performance. Therefore, this study presents the FsQCA to verify the consistency and coverage of the model. The results reveal a coverage of 0.63 with a combination of 0.79 and consistency of 0.96 > 0.9. The high consistency score is strong evidence that the antecedent combination is sufficient to produce the outcome (organizational performance).

The results in Table 4 involve the analyses of the causal paths hypothesis in the structural model. The models support all four hypotheses. Innovation has a positive effect on organizational performance (H1); technology creation has a positive effect on organizational performance (H2); quality management has a positive effect on organizational performance (H3); and information management capability has a positive effect on organizational performance (H4).

The antecedent combination includes all four independent variables. These analyses demonstrate that fsQCA successfully identifies conditions sufficient for the organizational performance outcome. The results indicate that fsQCA outperforms MRA and successfully models both types of data with causal complexities.

This study has some limitations that could create opportunities for future research. For instance, this study only addresses a particular type of firm management within Taiwan. Future research could examine, and even compare, different types of firm managements, and in different geographical areas.

5.2. Managerial implications

This study has five key managerial implications.

(1) The whole process, including applying EFA extraction, exploring the factors impacting organizational performance and building the main construct, confirms the four vital factors regarding organizational performance in the sophisticated relationships among the factors in this study.
(2) Innovation has a positive impact on business organizational performance. Proving new technology for the improvement of existing products and services is a necessary factor for enterprises.
(3) Technology creation is a necessary condition. The results of this study show that businesses with high capability will handle operational problems efficiently. Innovation achievement often shapes the composition of internal and external resources.
(4) Quality management can enhance organizational performance as well as the output performance of firms; intense competition in the supply chain requires assessments of customer views and attention to quality management processes. Firms should integrate technology to underpin quality management assurance and enhancement.
(5) Integrated information systems have various functions, such as the application of information technology and organization performance. Firms can then strengthen the capability of information management and the variety of collaboration among team members.

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