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MARKETING AND INNOVATION MANAGEMENT CAPABILITIES IN SCIENCE AND TECHNOLOGY-BASED ENTERPRISES

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SUMMARY

The enterprises, which are science and technology-based (STBEs), work in a highly dynamic and knowledge-intensive environment where long-lasting competitiveness is determined by the success in matching innovation and marketing potential. Although these capabilities have been studied separately in previous research, a noticeable lack of empirical research has incorporated these two capabilities into a single framework that explains their combined effect on innovation performance. The paper is a comparative study that empirically explores the boundary of innovation management capabilities and marketing capabilities on innovation performance in STBEs, with absorptive capacity discussed as a mediating effect. The survey design that was used was quantitative, cross-sectional, and data were gathered among managers of science and technology-based enterprises. The relationships proposed were tested with the help of structural equation modeling. These findings suggest that there is a strong positive impact of the innovation management capabilities on innovation performance (0.32, $p < 0.001$) and the marketing capabilities have a strong positive impact on innovation performance (0.29, $p < 0.001$). It was established that innovation management capabilities ($\beta = 0.14$, $p < 0.001$) and marketing capabilities (= 0.13) have significant indirect effects, mediated by absorptive capacity (0.001). Besides, the innovation performance has a critical positive impact on the firm performance (= 0.47, $p < 0.001$). The model describes 58 % of the innovation performance and 44 % of the firm performance variance. The results

are a reflection of the significance of combining innovation management, marketing, and knowledge-based capabilities to improve the effects of innovation within science and technology-based businesses.

Key words: *innovation management capabilities, marketing capabilities, absorptive capacity, innovation performance, firm performance, science and technology-based enterprises.*

INTRODUCTION

The enterprises that are based on science and technology (STBEs) exist within very dynamic and knowledge-heavy environments where the ability to stay competitive is highly reliant on the efficiency with which the innovation and marketing capabilities are implemented. The innovations cannot be converted into market value without proper marketing strategies and commercialization processes, and technological improvements are not enough to create better results. According to previous researchers, innovation management capabilities have a great impact on the innovation performance and marketing performance of firms, especially in the case of technology-based firms and science park ecosystems [1][3]. In the same fashion, marketing competencies like market sensing, customer relationship management, and commercialization are also very important in value capture of innovation investments [4][6]. Although it is accepted that both domains of capability are important, the current body of research seems to focus on the relevant issues of innovation management and marketing capabilities separately. Researchers on standardized innovation systems, innovation management capability, as well as organizational performance generally concentrate on internal workings and technology practices [9][11], whereas marketing-based research concentrates on customer orientation and responsiveness of the market, but less on the innovation management mechanisms [7][8]. Such disaggregated treatment gives an incomplete picture of how the firm incorporates its internal innovation efforts with its external market-facing efforts, especially in science and technology-based firms, where uncertainty and knowledge intensity are high.

Recent reviews and empirical studies also point to gaps in the literature on capabilities. Though the capability of innovation has been deeply researched, the results are inconclusive as to the role played by a combination of various capabilities of organizations in determining the outcome of innovations [19]. Furthermore, the open innovation and knowledge management studies indicate that the capacity of companies to obtain, integrate, and utilize the external knowledge, usually referred to as absorptive capacity, is important in the relationship between innovation and marketing activities and performance results [20]. Nevertheless, there is little empirical research that explicitly uses the absorptive capacity as a process linking innovation management and marketing capabilities, particularly in the case of STBEs [2][4]. To fill these gaps, the current study will empirically investigate the combined impacts of innovation management capabilities and marketing capabilities on innovation performance in science and technology-based enterprises, with or without including the mediating role of absorptive capacity. With the capability-based viewpoint, which is based on the resource-based perspective and the dynamic capabilities theory, this study aims to answer not only whether the capabilities are important, but also how they interrelate in increasing the innovation outcomes. By doing it, the study responds to the demands of conducting more integrative and mechanism-oriented studies in the field of innovation and marketing capability studies [10][13]. The marketing and innovation management strengths of science and technology-based firms are a crucial factor in bridging science to market gap, providing a great chance to the students to enrich their learning and education material through real-world business concepts and innovative technological development [21].

The key contributions include: First, it contributes to the literature on innovation management by empirically combining innovation management and marketing capabilities into a single explanatory model, instead of an isolated analysis. Second, it develops the capability-based theory by showing how the absorptive capacity is an important mechanism in converting the organizational capabilities to performance in innovation. Third, the study offers context-specific empirical findings absent in the study so far by specializing in science and technology-based businesses. Lastly, the findings provide some useful information to managers and policymakers about the ways of aligning innovation and marketing capabilities to enhance innovation results in the knowledge-intensive firms.

The rest of the paper is structured in the following way. Section 2 consists of a brief literature review on the topic. In section 3, a conceptual framework and research hypotheses are formulated. The methodology of the research is described in Section 4. The empirical results are found in Section 5. Section 6 explains the implications of the findings with reference to work done by previous researchers and implications for managers. Section 7 summarizes the paper with important insights, limitations, and future research directions.

LITERATURE REVIEW

Innovation Management Capabilities

Innovation management capabilities are the capability of a firm in managing technological resources, R and D activities, and innovation processes systematically in order to produce new products, services, or processes. The abilities are especially important in science and technology-based businesses, where change in technology is very fast, and uncertainty is high. There is empirical evidence that companies that have greater innovation management capabilities report higher innovation and better marketing performance as they are in a position to transform technology knowledge into a marketable outcome [1][3]. Research done in science parks and knowledge-based companies further reiterates the importance of an organized process of innovation and integration of technology in increasing innovative performance [3][5]. Nevertheless, previous studies have largely been based on the internal aspects of innovation management, including the formal system, routines, and technological capabilities, without paying much attention to the interaction of these capabilities with market-oriented functions [5][9]. Consequently, the innovation management capabilities have been treated as isolated organizational capabilities as opposed to being part of a larger configuration of capabilities that determines innovation outcomes.

Marketing Capabilities

Marketing capabilities refer to the capacity of a firm to feel changes in the market, control customer relationships, and commercialize innovations. These skills can help companies to match their innovation activities with customer requirements and competitive forces. The existing literature demonstrates that marketing capabilities have an important impact on the commercialization of innovations and performance, especially concerning small and medium-sized and technology-intensive companies [4][7]. The processes of market sensing and customer relationship management have been noted to be among the key ways in which companies gain value out of the innovation processes. Notwithstanding such findings, the marketing literature tends to analyze marketing capabilities without any association with the processes of innovation management. Although other research recognizes the role of strategic marketing in the success of innovation, few empirical models consider marketing capabilities and internal innovation management processes in a cohesive model [6][8]. Such a division restricts the knowledge of the complementary nature of marketing capabilities and innovation management capabilities to the performance of innovation.

Absorptive Capacity, Knowledge, and Digital Capabilities

The capacity of firms to obtain, internalize, and use external knowledge, known as absorptive capacity, has been widely accepted as one of the key facilitators of innovation. According to research, the absorptive capacity enhances the effectiveness of both innovation and marketing capabilities because it allows integration of knowledge as well as learning [4][20]. The practices in knowledge management and customer knowledge use also contribute to the innovation capabilities of firms in supporting informed decisions and identification of opportunities [13]. Recent literature also points to the increasing role of digital and smart technologies in building organizational capabilities. Digitalization will help firms reorganize resources, increase coordination, and hasten the innovation processes, especially in technology-intensive settings [14][18]. Nonetheless, although digital and knowledge-based capabilities are being variously talked about, their involvement in the connection between innovation management and marketing capabilities in the context of innovation results is under-researched in empirical studies.

Innovation performance is the efficiency of innovation operations within a firm and is often defined using product innovation, process innovation, and speed-to-market. There is previous literature showing a positive correlation between the performance of innovation and expanded organizational performance, such as market and financial performance [9][16]. There should be strategic alignment between value creation and value capture mechanisms in order to guarantee that efforts to create innovation are reflected in tangible performance gains [12]. Also, the involvement of stakeholders and entrepreneurial orientation has been indicated to facilitate innovation management by promoting coordination among internal and external stakeholders [15][17]. Despite their usefulness, these studies tend to take very specific views, which fail to reflect the combined effects of several organizational capabilities comprehensively. Consequently, the channels via which the marketing capabilities and innovation management combine to produce the appropriate impact on innovation performance have not been explicated fully, especially in science and technology-driven enterprises.

The literature reviewed illustrates that innovation management capabilities, marketing capabilities, absorptive capacity, and knowledge-based mechanisms all play their respective part in innovation outcomes. Nevertheless, the existing studies investigate such capabilities in single-subject (or fragmented) theoretical contexts. Minimal empirical studies of integrating innovation management and marketing capabilities, combined with expressly considering absorptive capacity as an intervention connecting the capabilities with innovation performance, exist, particularly when science and technology-based companies are considered. The necessity of such a unified, capability-based framework that empirically investigates their relationships supports the idea behind this gap, which is the focus of the current study.

CONCEPTUAL FRAMEWORK AND HYPOTHESES

Conceptual Framework Development

This research takes a capability-based approach in exploring the role of innovation management and marketing capabilities in science and technology-based firms in terms of innovation performance. Innovation management capabilities indicate the capability of the firm to organize, integrate, and deploy resources based on technology and innovations, whereas marketing capabilities are the capability of the firm to detect the needs of the market, corporate relationships, and commercialization of innovations. These capabilities are not independent in knowledge-intensive settings; instead, they are limited by how well the firm can receive, integrate, and utilize knowledge, which can be viewed as absorptive capacity.

The structural model presented in Figure 1 demonstrates innovation management capabilities and marketing capabilities as antecedents of innovation performance, absorptive capacity as an intervening variable, and innovation performance as the antecedent of firm performance. The conceptual framework proposed assumes that the innovation performance may depend directly on the innovation management capabilities and marketing capabilities. Secondly, the concept of absorptive capacity is introduced as one of the driving forces mediating the performance of these capabilities on innovation because it allows the successful integration of knowledge and learning. Lastly, innovation performance is supposed to play a positive role towards the overall firm performance through improvement of the market outcomes and standing in the market. The integrative framework can be used to conduct a detailed analysis of the role of internal innovation processes and external market-oriented activities in innovation results in enterprises based on science and technology.

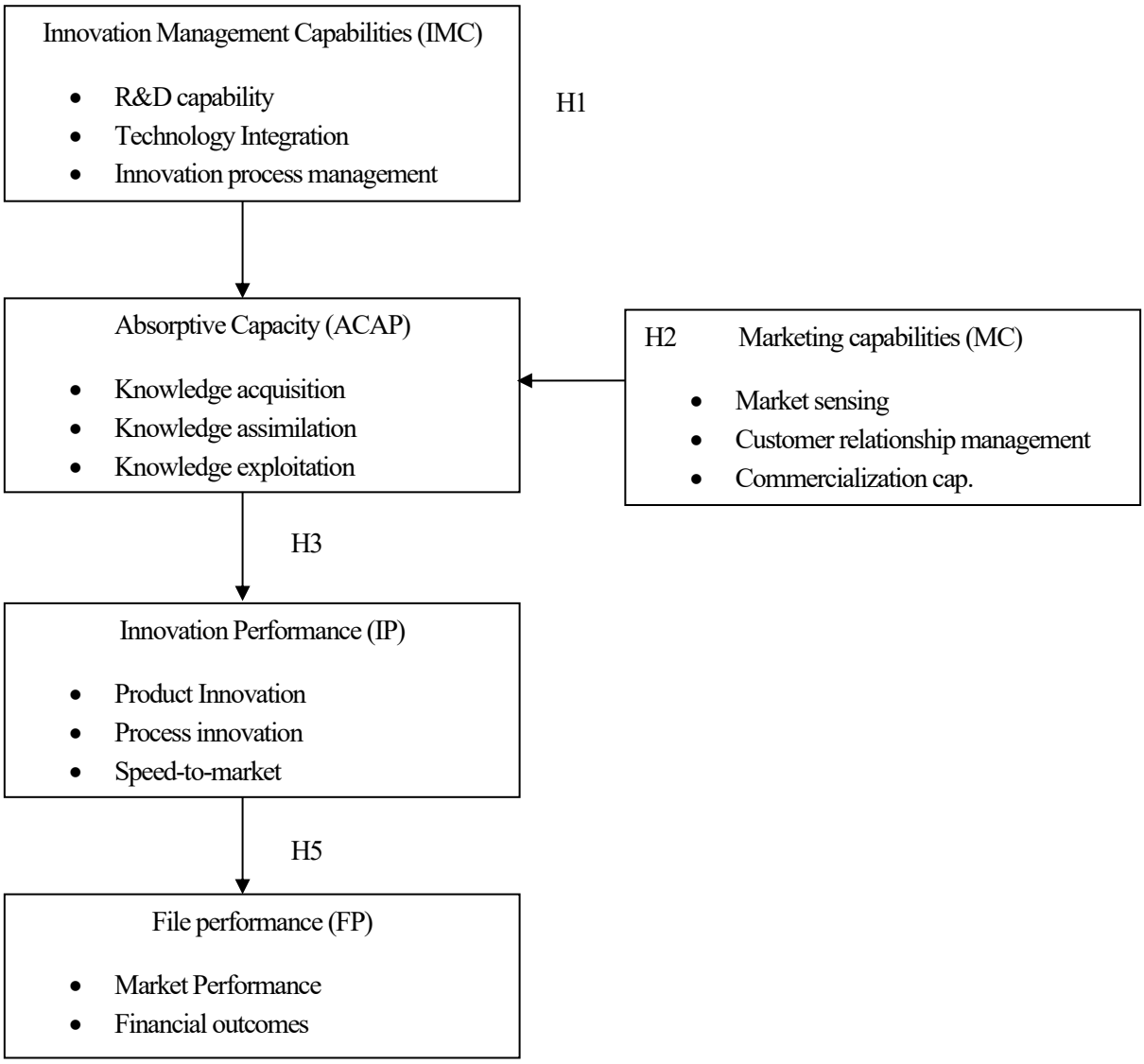

Figure 1. Conceptual Framework of the Study

Hypothesis Development

Innovation Management Capabilities and Innovation Performance

The innovation management capabilities allow the firms to manage the activities of R&D in a systematized manner, integrate technologies, and coordinate the innovation processes. Companies with high innovation management performance are in a better position to create and execute new ideas in an effective manner, leading to better innovation performance. In this respect, therefore, the impact of innovation management capabilities is found to be positive on innovation performance.

H1: There exists a positive and significant impact of innovation management capabilities on innovation performance.

Marketing Capabilities and Innovation Performance

The marketing capabilities facilitate the identification of customer needs, the matching of innovation activities to market needs, and the successful commercialization of new products and services. Companies that have high marketing abilities will have a greater chance of success when introducing innovations and higher rates of innovation.

H2: Marketing capabilities are significantly positively related to performance in innovation.

Mediating Role of Absorptive Capacity

Absorptive capacity increases the capacity of a firm to make the most out of the internal and external knowledge, which intensifies the process of transforming organizational capabilities into the results of innovation. Absorptive capacity is supposed to be developed due to the innovation management and marketing capabilities, and, therefore, enhances better innovation performance. Therefore, absorptive capacity is put forward as a mediating process between these abilities and the consequences of innovations. H3: Absorptive capacity mediates the relationship between the innovation management capabilities and innovation performance. H4: There is a mediating relationship between marketing capabilities and innovation performance (through the absorptive capacity).

Innovation Performance and Firm Performance

The innovation performance is a measure of how well a firm is performing in its innovation activities and is likely to lead to greater performance of the organization. Companies that perform better in terms of innovation have a better chance of improving their market stance and performance. H 5: There exists a strong positive impact of innovation performance on the performance of firms.

RESEARCH METHODOLOGY

Research Design

The research design used in this study is a quantitative and cross-sectional type of research design that empirically tests the relationships between innovation management capabilities, marketing capabilities, absorptive capacity, innovation performance, and firm performance of science and technology-based enterprises. The survey approach is used since it provides the opportunity to collect data systematically and reach a significant number of firms, which makes it possible to test complicated relationships between latent constructs. The firm is regarded as the unit of analysis because the constructs studied are organizational-level capabilities and results.

Population, Sample, and Data Collection

Its target population is science and technology-based (STBE) businesses that are located in technology parks, innovation hubs, and knowledge-intensive industrial zones (table 1). The main features of these enterprises are the high level of R&D, the use of technological knowledge, and unceasing innovation. The purposive sampling method is employed by ensuring that the respondents have enough information on the innovation and marketing practices of their firms. The data will be gathered by senior managers, innovation managers, R&D managers, and marketing managers since these people are directly engaged in the strategic decision-making regarding innovation and commercialization. Questionnaire delivery is done through online and direct distribution to enhance the response rates. A pilot study is done before full-scale data collection is undertaken; it involves a small sample of the respondents in order to ensure that the items are clear, relevant, and the context is appropriate. The pilot study results enable feedback to make minor changes to the wording so as to improve the understanding.

Table 1. Characteristics of the responding firms and participants

Characteristic	Category	Frequency	%age
Firm size	Small	78	34.5
	Medium	96	42.5
	Large	52	23.0
Firm age	Less than 5 years	64	28.3
	5–10 years	91	40.3
	More than 10 years	71	31.4
Industry type	Manufacturing	112	49.6
	Services	78	34.5
	Hybrid	36	15.9
Respondent role	Top management	98	43.4
	Middle management	128	56.6

Measurement of Constructs

Multi-item perceptual scales are used to measure all constructs because they are suitable for capturing organizational capabilities and performance results. The respondents are left to provide their answers based on a five-point Likert scale (between 1, which is strongly disagree, and 5, which is strongly agree). The innovation management capabilities are assessed using items that indicate the R&D capability, integration, and management of technology in the innovation process. The indicators based on the evaluation of marketing capabilities include market sensing, customer relationship management, and commercialization effectiveness. The item of the knowledge acquisition, assimilation, and exploitation measures the absorptive capacity. The performance of an organization is measured in terms of innovation performance with respect to product innovation, process innovation, and speed-to-market, and firm performance is measured in terms of market and financial performance metrics that are represented in Table 2.

Table 2. Measurement constructs and indicators

Construct	Code	Indicator Description
Innovation Management Capabilities	IMC1	Effectiveness of R&D activities
	IMC2	Integration of new technologies
	IMC3	Formalization of innovation processes
	IMC4	Coordination of innovation projects
Marketing Capabilities	MC1	Ability to sense market trends
	MC2	Effectiveness of customer relationship management
	MC3	Product commercialization capability
	MC4	Market responsiveness
Absorptive Capacity	AC1	Acquisition of external knowledge
	AC2	Assimilation of new knowledge
	AC3	Exploitation of knowledge for innovation
Innovation Performance	IP1	Success of new products
	IP2	Improvement in innovation speed
	IP3	Process innovation effectiveness
Firm Performance	FP1	Market share growth
	FP2	Sales growth
	FP3	Overall financial performance

Data Analysis Technique

The tests are performed using structural equation modeling (SEM), which is suitable for testing relations between and among various latent constructs and to test mediating effects. The analysis is done in two stages. The measurement model is evaluated first in order to determine the reliability and validity of the constructs. Cronbach's alpha and composite reliability are used to determine the reliability, whereas average variance extracted (AVE) is used to determine the convergent validity. The Fornell-Larcker criterion is used to test discriminant validity. During the second stage, the structural model is tested to test the hypotheses. A bootstrapping process with resamples that are large in number is used to get the path coefficients, t-values, and p-values to provide a robust significance test. The absorptive capacity is considered a mediating factor by measuring the importance of the indirect effects. The model is assessed in terms of its explanatory power based on the values of the coefficient of determination (R^2). In the market, there exists a common method bias assessment that is referred to as 4.5.

Common Method Bias Assessment

Various procedural remedies are adopted in order to reduce the possible common method bias. The respondents will be confident about their anonymity and confidentiality to minimize apprehension about the evaluation. The instructions are very clear, and the items are formulated in such a way that they are not ambiguous. Besides this, statistical tests are performed in the analysis of data to determine the existence of common method bias. The findings reveal that common method bias is not a major issue that can affect the validity of the findings.

Ethical Considerations

The strict ethical standards are respected in the research process. The surgery will be voluntary, and the respondents will be aware of the study objective. No personally identifiable data is gathered, and all responses are only utilized in the course of academic research. The data have been kept safely and analyzed in an aggregated form to keep it confidential.

RESULTS

Measurement Model Assessment

The first criterion that was tested using the measurement model was internal consistency reliability, where the model was tested to identify convergent and discriminant validity. The evaluation of internal consistency was done through Cronbach's alpha and composite reliability (CR). Table 3 shows that all constructs have Cronbach alpha values of above 0.80 and CR values of above 0.88, which means a high level of internal consistency. The average variance extracted (AVE) was used to test convergent validity. Via all the AVE values are found to be beyond the recommended threshold of 0.50, which verifies that the indicators are sufficient to reflect the latent constructs they are intended to measure.

Table 3. Reliability and convergent validity

Construct	Cronbach's Alpha	Composite Reliability (CR)	AVE
Innovation Management Capabilities (IMC)	0.87	0.90	0.69
Marketing Capabilities (MC)	0.85	0.89	0.67
Absorptive Capacity (ACAP)	0.83	0.88	0.71
Innovation Performance (IP)	0.86	0.91	0.73
Firm Performance (FP)	0.84	0.88	0.70

The Fornell-Larcker criterion was used in estimating discriminant validity. Table 4 shows that the square root of the AVE of every construct (diagonal value) is higher than the inter-construct correlations, which is satisfactory evidence of discriminant validity.

Table 4. Discriminant validity (fornell–larcker criterion)

Construct	IMC	MC	ACAP	IP	FP
IMC	0.83				
MC	0.56	0.82			
ACAP	0.61	0.58	0.84		
IP	0.64	0.62	0.67	0.85	
FP	0.52	0.55	0.57	0.66	0.84

Structural Model Assessment

Once the sufficiency of the measurement model was established, the structural model was tested to test the hypotheses that were proposed, as illustrated in Figure 2. Table 5 presents the standardized path coefficients, t-values, and level of significance found with the use of bootstrapping. The findings show that innovation management capabilities positively influence innovation performance greatly (= 0.32, $p < 0.001$), and uphold the H1. Innovation performance is also affected positively by marketing capabilities (0.29, $p < 0.001$), which has a positive impact on H2. Moreover, innovation management capabilities as well as marketing capabilities have a very strong impact on absorptive capacity, which contributes to H3 and H4. The positive impact of absorptive capacity on innovation performance is strong, and innovation performance is a powerful factor affecting the firm's performance, thus proving H5.

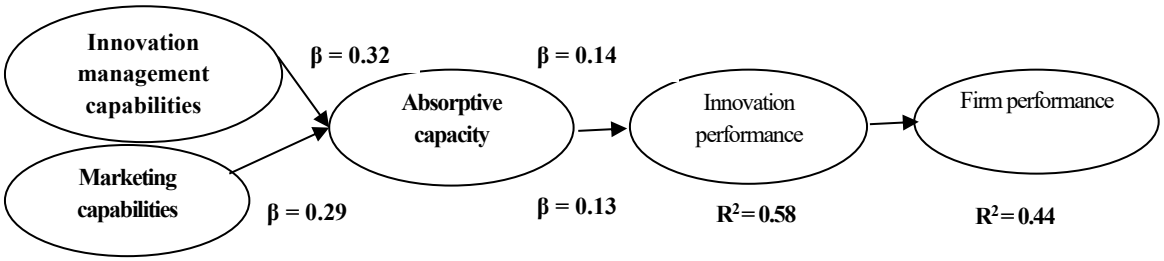

Figure 2. Structural Model with Standardized Path Coefficients

Table 5. Structural model results and hypothesis testing

Hypothesis	Path	β	t-value	p-value	Result
H1	IMC → IP	0.32	4.78	<0.001	Supported
H2	MC → IP	0.29	4.21	<0.001	Supported
H3	IMC → ACAP	0.41	6.12	<0.001	Supported
H4	MC → ACAP	0.38	5.67	<0.001	Supported
H5	ACAP → IP	0.35	5.09	<0.001	Supported
H6	IP → FP	0.47	7.34	<0.001	Supported

Mediation Analysis

The mediating role of the absorptive capacity was studied through the analysis of the indirect effects of the innovation management capabilities and the marketing capabilities on the innovation performance. As indicated in Table 6, both of the indirect effects are positive and significant. Having considered that the direct effects are still important, it is necessary to include the mediator; absorptive capacity is found to be a partial mediator in the two relationships.

Table 6. Mediation analysis results

Mediated Relationship	Indirect Effect (β)	t-value	p-value	Mediation Type
IMC → ACAP → IP	0.14	3.98	<0.001	Partial mediation
MC → ACAP → IP	0.13	3.61	<0.001	Partial mediation

The coefficient of determination (R^2) was used to test the explanatory power of the model. The model accounts 58 % of the innovation performance variance and 44 % of the firm performance variance, which is a moderate to strong predictive power. The findings indicate that innovation management capabilities, marketing capabilities, and absorptive capacity have a significant combined influence on the explanation of innovation outcomes and firm performance of science and technology-based businesses.

DISCUSSION

Interpretation of Key Findings

The findings reveal that innovation management ability and marketing ability are rankable in terms of innovation performance in science and technology-based companies. The beneficial impact of the innovation management capabilities proves that well-designed R&D operations, technology incorporation, and organized innovation are required to produce better innovation results. Equally, the high impact of marketing capabilities accentuates the relevance of market sensing, customer relationship management, and successful commercialization in transforming technology innovations into market success. The overall findings all reveal that the maximization of innovation performance is achieved when the internal innovation processes are highly coordinated with the external market-oriented activities.

Role of Absorptive Capacity

One of the major findings of this paper is a partial mediating action of absorptive capacity. These findings indicate that absorptive capacity enhances the influence of both innovation management and marketing capabilities on innovation performance because it helps to acquire, assimilate, and exploit knowledge effectively. This observation highlights the significance of organizational learning processes in a knowledge-based setting, where the capacity to incorporate and transfer both internal and external knowledge defines the efficacy of innovation and marketing skills.

Managerial Implications and Recommendations

On the managerial level, the findings highlight the necessity of a combined capability development strategy. Innovation management and marketing functions should be in line with each other, and this should be achieved by the managers using cross-functional teams, common performance measures, and aligned decision-making processes. Also, organizations are advised to invest in the development of absorptive capacity through encouraging practices of continuous learning, internal knowledge sharing, and partnering with external organizations. Such measures can enhance the performance of innovation and eventually lead to the performance of firms that would be stronger because innovations are not only technologically strong but also market-oriented.

CONCLUSION

This paper has discussed the joint impacts of innovation management capabilities and marketing capabilities on innovation performance in science and technology-based businesses, with the mediating variable being absorptive capacity. The findings of the research are very supportive of the model that was put forward. The innovation management capabilities (0.32, $p < 0.001$) and the marketing capabilities (0.29, $p < 0.001$) were observed to have significant positive impacts on the performance in the context of innovation performance, which validates the significance of integrating internal innovation processes with market-oriented activities. Moreover, there are some partial mediating roles of the absorptive capacity, which had significant indirect influences on both innovation management capabilities (= 0.14, $p < 0.001$) and marketing capabilities (= 0.13, $p < 0.001$). There was also the strong positive influence of innovation performance on firm performance (= 0.47, $p < 0.001$). All in all, the model was found to explain 58 % of the variance in innovation performance and 44 % of the variance in firm performance, which means that it has moderate to strong explanatory power. Irrespective of these contributions, the study is faced with some limitations. To start with, the research design is cross-sectional, and thus it cannot be used to make causal inferences. Second, perceptual and self-reported measures might have caused bias in the responses, although procedural and statistical solutions have been used. Third, the attention paid to science and technology-based businesses in a particular setting might limit the overall applicability of the results. Future studies can focus on these limitations by using longitudinal designs to help determine how organizational capabilities and innovation results evolve dynamically. External validity could be further increased by comparing researchers across industries or nations. Also, the contextual variables that may be included in future work include environmental turbulence, digital maturity, or organizational culture in order to analyze the boundary conditions that affect the effectiveness of the innovation and marketing capabilities.

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