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The Impact of Technological Innovation on Competitive Advantage: The Effect of Business Model Transformation as a Moderator

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Abstract:
This study examines the impact of technological innovation on competitive advantage and investigates the moderating role of business model transformation in this relationship. Using a quantitative research design and data collected through a structured questionnaire, the study analyses the direct and interaction effects among the variables. The results reveal that technological innovation has a strong and significant positive influence on competitive advantage, highlighting its role as a key strategic driver of superior organisational performance. However, the findings also show that business model transformation significantly moderates this relationship in a negative direction, indicating that extensive transformation may reduce the effectiveness of technological innovation in enhancing competitive outcomes. These results underscore the importance of aligning innovation initiatives with carefully managed business model changes to avoid potential disruptions and maximise competitive advantage. The study contributes to the literature by offering empirical evidence on the nuanced interplay between innovation, transformation, and competitiveness.
Keywords: Technological Innovation, Business Model Transformation, Competitive Advantage, Moderation Effect, Organisational Performance, Innovation Strategy

1. Introduction:

In today's rapidly evolving business environment, technological innovation has become a central driver of organisational success. Firms across industries increasingly rely on digital technologies, advanced production systems, and innovative processes to enhance efficiency, improve customer value, and maintain relevance in competitive markets. While technological innovation is widely acknowledged as a source of strategic advantage, its impact varies significantly across organisations, suggesting that innovation alone may not be sufficient to sustain superior performance. This creates a strong rationale for examining additional organisational factors that shape how innovation translates into competitive advantage.

Despite extensive research on innovation and performance, a gap remains concerning the conditions under which technological innovation leads to stronger competitive outcomes. Many firms invest heavily in innovation but fail to realise the expected advantages, raising a key research problem: **Why do some firms extract greater competitive benefits from technological innovation than others?** A potential explanation lies in business model transformation—the changes firms make in how they create, deliver, and capture value. Therefore, this study seeks to answer the following research questions: *Does technological innovation significantly enhance competitive advantage? How does business model transformation influence competitive outcomes? And to what extent does business model transformation moderate the relationship between technological innovation and competitive advantage?*

Based on these questions, the study aims to achieve three core objectives: (1) to examine the direct effect of technological innovation on competitive advantage; (2) to analyse the role of business model transformation in strengthening competitive outcomes; and (3) to test whether business model transformation moderates the relationship between technological innovation and competitive

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advantage. By addressing these objectives, the study contributes to a deeper understanding of how firms can align innovation activities with strategic transformation to maximise competitive success.

2. Literature Review:

2.1. Technological Innovation:

Technological innovation encompasses the processes and systems through which new ideas, products, or methods are developed and implemented to address societal needs and challenges. It is characterised by the interaction of various agents within a specific economic or industrial context, facilitating the generation, diffusion, and utilisation of technology(Ding, 2022; Coccia, n.d.).

Definition and Characteristics

- **Dynamic Network**: Technological innovation operates within a network of agents, including businesses, researchers, and institutions, that collaborate to foster technological advancements (Ding, 2022).
- **Transformation of Ideas**: It involves converting inventions into practical applications, enabling organisations to leverage opportunities and tackle problems (Coccia, n.d.).

Types of Innovation

- **Product Innovation**: Introduction of new products into the market, enhancing consumer choices and experiences(Marziale, 2010).
- **Process Innovation**: Improvements in production methods that increase efficiency and adaptability to market demands(Marziale, 2010).

Societal Impact

- **Wealth Creation**: Technological innovation is crucial for economic growth and societal development, addressing needs and solving problems within communities(Coccia, n.d.).
- **Field and Energy Dynamics**: The innovation process is influenced by the specific field's characteristics and the energy dynamics that drive technological emergence(WEI & ZHU, n.d.).

While technological innovation is often viewed as a positive force for progress, it can also lead to disruptions in existing industries and job markets, raising concerns about the balance between innovation and societal stability.

2.2. Competitive Advantage:

Competitive advantage refers to the attributes or capabilities that enable an organisation to outperform its competitors. This concept encompasses various factors, including access to resources, skilled labour, and strategic positioning. Understanding competitive advantage is crucial for businesses aiming to enhance their market position and achieve long-term success. The following sections elaborate on key aspects of competitive advantage.

Key Attributes of Competitive Advantage

- **Resource Access**: Organisations may gain an edge through access to natural resources, such as high-grade ores or low-cost energy sources (Silveira, 2022; Stumpf, 2022).
- **Skilled Labour**: A workforce with specialised skills can significantly enhance productivity and innovation, contributing to a competitive advantage (Silveira, 2022).
- **Geographic Location**: Proximity to markets or resources can reduce costs and improve service delivery (Silveira, 2022; Stumpf, 2022).
- **Technology**: Access to advanced technology can streamline operations and improve product offerings (Silveira, 2022).

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Strategies for Achieving Competitive Advantage

- **Cost Leadership**: Offering products at lower prices than competitors can attract price-sensitive customers(Ward, 2020).
- **Differentiation**: Providing unique products or services that justify higher prices can create a loyal customer base(Gareche et al., 2019).
- **Niche Marketing**: Focusing on specific market segments can lead to increased profitability and sustainability(Ward, 2020).

While competitive advantages are essential for success, they can also be transient. Market dynamics and technological advancements can erode these advantages, necessitating continuous innovation and adaptation by businesses to maintain their competitive edge.

2.3. Business Model Transformation :

Business model transformation (BMT) refers to the process of reconfiguring a company's business model to adapt to changing market conditions, technological advancements, and evolving consumer behaviours. This transformation is essential for maintaining competitiveness and achieving sustainable growth in a dynamic environment. The process involves a systematic approach that integrates various internal and external factors, emphasising the need for adaptability and strategic coherence.

Key Aspects of Business Model Transformation

- **Drivers of Transformation**: BMT is influenced by rapid technological, economic, and social changes, necessitating a flexible approach to change management(Trostianska, 2025).
- **Types of Business Models**: Three archetypes are identified: customer partnership models, operational efficiency models, and integrated value creation models, each requiring different transformation strategies(Nahara, 2023).
- **Mechanisms and Strategies**: Effective BMT involves structured phases, including initiation, implementation, and evaluation, often utilising frameworks like the Business Model Canvas(Trostianska, 2025; Maslak et al., 2022). Strategies may focus on digitalisation, ecosystem integration, or enhancing operational capabilities("Business model transformation: possible...", 2023).
- **Importance of Dynamic Capabilities**: Companies must develop dynamic capabilities—sensing, seizing, and transforming—to navigate the complexities of BMT successfully(Trostianska, 2025).

Conversely, while BMT is crucial for adaptation, some argue that not all businesses require radical transformations; incremental changes can also yield significant benefits in existing markets without necessitating a complete overhaul of the business model(Maslak et al., 2022).

2.4. Review of relevant prior research and scholarly works:

2.4.1. The relationship between Technological Innovation and Competitive Advantage:

The relationship between technological innovation and competitive advantage is multifaceted, with empirical evidence highlighting its significance across various industries. Technological innovation catalyses firms to develop unique resources and capabilities that are essential for achieving and sustaining competitive advantage. This relationship is influenced by factors such as leadership, organisational culture, and market dynamics.

Mechanisms of Competitive Advantage

- **Resource-Based View (RBV)**: Firms leverage technological innovations to create valuable, rare, and inimitable resources, which are crucial for competitive advantage(Mandung et al., 2025).

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- **Performance Enhancement**: Studies indicate that technological innovation positively impacts firm performance and competitive advantage, particularly in sectors like telecommunications(Wanaswa et al., 2021)(Kumera et al., 2024).
- **Strategic Leadership**: The role of strategic leadership is critical, as it moderates the relationship between technological innovation and competitive advantage, enabling firms to navigate competitive landscapes effectively(Wanaswa et al., 2021).

Importance of Organisational Culture

- **Innovation Culture**: Fostering a culture of innovation is essential for overcoming resistance to change and enhancing competitive positioning(Mandung et al., 2025).
- **Employee Development**: Investment in employee skills and capabilities is vital for sustaining innovation and competitive advantage(Mandung et al., 2025).

While technological innovation is a key driver of competitive advantage, it is important to recognise that not all firms may successfully leverage it due to varying organisational capabilities and market conditions. This suggests that a nuanced approach is necessary to understand the complexities of this relationship.

First hypothesis (H1): There is no statistically significant positive relationship between Technological Innovation **and** Competitive Advantage **at a 5% significance level.**

2.4.2. The relationship between Business Model Transformation and the relationship of Technological Innovation to Competitive Advantage:

The relationship between Business Model Transformation (BMT) and Technological Innovation (TI) in achieving Competitive Advantage (CA) is increasingly significant in today's dynamic business environment. BMT is often driven by TI, which catalyses reshaping operational frameworks and enhancing competitive positioning. The following sections elaborate on this relationship.

Business Model Transformation and Technological Innovation

- **Catalyst for Change**: TI enables organisations to reevaluate and innovate their business models, allowing them to adapt to market demands and technological advancements(Minz et al., 2023).
- **Dynamic Capabilities**: Firms that successfully integrate TI into their BMT processes develop unique resources and capabilities, which are essential for sustaining CA in competitive markets(Wibisono & Supoyo, 2023)(Mandung et al., 2025).
- **Digital Transformation**: The integration of digital technologies enhances BMT, facilitating the creation of innovative business models that respond to changing consumer needs and competitive pressures(Tetteh et al., 2025).

Competitive Advantage through Technological Innovation

- **Resource-Based View**: TI contributes to the development of valuable, rare, and inimitable resources, which are crucial for achieving sustained CA(Mandung et al., 2025).
- **Organisational Culture**: A culture that fosters innovation and agility is vital for leveraging TI effectively, enabling firms to navigate challenges and seize opportunities in a competitive landscape(Mandung et al., 2025).
- **Strategic Orientation**: Companies that align their strategic orientations with TI are better positioned to innovate their business models and maintain a competitive edge(Tetteh et al., 2025).

While the integration of TI into BMT is essential for gaining CA, it is also important to recognise that not all technological advancements lead to successful transformations. Companies may face challenges such as resistance to change and misalignment of resources, which can hinder the potential benefits of TI in achieving a competitive advantage.

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Second Hypothesis (H2): There is no significant role for Business Model Transformation **in reducing the relationship between** Technological Innovation **and** Competitive Advantage **at a 5% significance level.**

2.5. Gaps in existing literature :

1. Limited Integration of Technological Innovation and Business Model Transformation in One Framework

Although previous research has separately examined technological innovation (TI) and business model transformation (BMT), few studies combine both constructs to understand how they jointly influence competitive advantage (CA). The literature lacks a unified model that explores TI's impact on CA while considering BMT as a strategic moderator.

2. Insufficient Empirical Evidence on the Moderating Role of Business Model Transformation

Most studies highlight the importance of BMT but do not empirically test its *moderating effect* on the TI–CA relationship. Existing works tend to describe BMT as an outcome of innovation or as a driver of performance, but rarely examine whether transforming the business model *strengthens or weakens* the performance effects of technological innovation.

3. Overemphasis on Direct Effects and Lack of Moderated/Conditional Analyses

The majority of empirical studies focus on direct relationships:

- TI → CA
- BMT → performance

However, research seldom investigates **conditional relationships** such as:

- *When* (under what conditions) TI leads to a stronger competitive advantage
- *How* BMT changes the nature of the TI–CA relationship

This leaves a gap in understanding the *boundary conditions* of innovation effectiveness.

4. Limited Consideration of Organisational Capabilities and Structural Changes

While prior research emphasises dynamic capabilities, innovation culture, and strategic leadership, it does not fully explore how structural changes in the business model affect firms' ability to exploit technological innovation. The interaction between internal transformation processes and innovation outcomes remains underexplored.

5. Lack of Research in Emerging and Developing Market Contexts

Much of the existing literature is based on technologically advanced industries and developed economies. There is a scarcity of studies examining:

- How firms in developing markets leverage TI for CA
- How BMT enables these firms to overcome environmental, technological, and resource constraints

This gap limits the generalizability of previous findings.

6. Ambiguity in Explaining Why Some Firms Benefit More from Technological Innovation

Existing studies acknowledge that firms experience different levels of success from innovation but do not clarify why.

There is limited empirical work investigating whether:

- Firms with transformed business models benefit more from innovation
- Traditional models weaken the ability of innovation to generate competitive advantages

Thus, the mechanism through which BMT enhances or reduces innovation outcomes is not well demonstrated.

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7. Lack of Longitudinal or Comprehensive Evidence on TI-Driven Transformation

While TI is recognised as a catalyst for business model change, research seldom provides:

- Evidence on how TI gradually drives transformation
- How these transformations translate into long-term competitive advantage
- Whether certain types of innovation (product vs. process) interact differently with BMT

This creates a gap in understanding the *temporal and strategic alignment* between TI, BMT, and CA.

8. Conceptual Gaps Regarding the Types and Depth of Business Model Transformation

Although literature identifies different types of business models (customer partnership, operational efficiency, integrated value creation), there is limited analysis on:

- Which type of BMT moderates the TI–CA link more effectively
- Whether firms need incremental vs. radical transformation to capitalise on innovation

This leaves room for studies that classify different levels of BMT and measure their moderating effect.

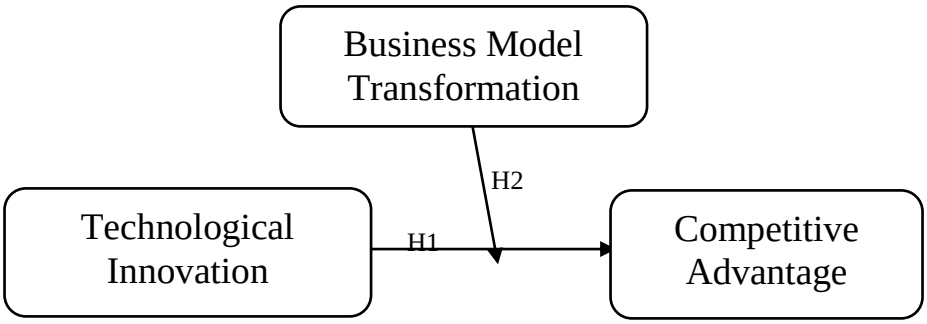

Figure 1. Theoretical framework.

3. Methodology:

3.1. Research Design and Approach

This study adopts a quantitative research design utilising a cross-sectional survey approach to examine the relationships among technological innovation, business model transformation, and competitive advantage. A quantitative approach is appropriate because the objective is to measure the strength and direction of relationships between variables using numerical data and statistical analysis. The research design enables the testing of the proposed hypotheses, specifically the direct impact of technological innovation on competitive advantage and the moderating effect of business model transformation.

The study follows a hypothetico-deductive approach, beginning with the development of theoretical assumptions derived from existing literature and subsequently testing them empirically using statistical techniques. This approach allows for generalizable findings across firms in various industries that integrate technological innovation within their operational and strategic activities.

3.2. Data Collection Methods

Data will be collected using a structured questionnaire distributed to managers, supervisors, and decision-makers in firms operating in manufacturing, services, ICT, and technology-related sectors. These respondents are suitable because they possess relevant knowledge about organisational innovation practices, business model changes, and competitive strategies.

The questionnaire consists of four main sections:

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1. Demographic Information: firm age, size, sector, respondent position.
2. Technological Innovation: measured using validated Likert-scale items related to product innovation, process innovation, and technology adoption.
3. Business Model Transformation: measured through items assessing changes in value creation, value delivery, and value capture mechanisms.
4. Competitive Advantage: measured using items related to differentiation capability, cost efficiency, market responsiveness, and customer value creation.

Primary data collection will utilise online distribution channels (e.g., email, Google Forms) and direct distribution where applicable. A purposive sampling technique will be employed to target firms that have undergone innovation initiatives or digital transformation processes. The minimum required sample size will be determined using power analysis or the SEM rule of thumb (minimum 10 responses per measurement item).

3.3. Rationale for the Chosen Methods

The use of a quantitative cross-sectional survey is justified for several reasons:

1. Suitability for Testing Causal Models

The study seeks to examine causal pathways and test a moderation effect. Quantitative surveys, combined with regression or Structural Equation Modelling (SEM), provide robust tools for testing such relationships and evaluating the strength, direction, and significance of effects.

2. Ability to Capture Organisational-Level Constructs

Variables such as technological innovation, business model transformation, and competitive advantage are abstract and multidimensional. A structured questionnaire allows for standardised measurement across multiple organisations, ensuring consistency and comparability.

3. Practicality and Efficiency

Cross-sectional surveys allow for collecting large amounts of data in a relatively short time, which is essential when dealing with managers from different industries. Online distribution increases accessibility and response rate while reducing administrative costs.

4. Established Use in Strategic Management and Innovation Research

Quantitative survey methods are widely used in prior research on technological innovation, dynamic capabilities, digital transformation, and competitive advantage. Using a similar methodological foundation enhances the reliability, validity, and academic relevance of the study.

4. Data Presentation and Analysis:

First: Assessment of the measurement Model:

In this section, the quality of the expressions utilised in this model is examined through the utilisation of the Smart PLS software. This evaluation entails testing the convergence and consistency of these expressions amongst themselves. The objective is to ensure the capability of these expressions to effectively measure the desired attributes, as well as the stability of the measurement across different conditions, employing the Convergent Validity test. Moreover, an assessment is conducted to determine the logical distinctiveness and absence of overlap among these expressions, employing the Discriminant Validity test.

4.1. Convergent Validity:

Convergent validity is a critical aspect of structural equation modelling (SEM), including Partial Least Squares SEM (PLS-SEM). Convergent validity assesses whether the indicators (manifest variables) of a latent construct (factor) are measuring the same underlying concept. In PLS-SEM, several criteria are commonly used to evaluate convergent validity, including factor loading,

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Cronbach's alpha, composite reliability, and average variance extracted (AVE). Here's an explanation of each criterion:

Factor Loading:

Basis: Factor loading represents the strength and direction of the relationship between an indicator and its corresponding latent construct. In PLS-SEM, factor loadings should be statistically significant and preferably higher than 0.7 to indicate a strong relationship.

Cronbach's Alpha:

Basis: Cronbach's alpha is a measure of internal consistency reliability. It assesses the extent to which a set of indicators (items) measures a single latent construct consistently. In PLS-SEM, a high Cronbach's alpha (typically above 0.7) suggests good internal consistency.

Composite Reliability:

Basis: Composite reliability is another measure of reliability that evaluates the consistency of indicators in measuring a latent construct. In PLS-SEM, composite reliability should ideally exceed 0.7, indicating that the indicators are reliable measures of the underlying construct.

Average Variance Extracted (AVE):

Statistically, convergent validity is established when the Average Variance Extracted (AVE) is greater than 0.50 (Sarstedt et al., 2021). Additionally, factor loading, Cronbach's Alpha, and composite reliability are also used to assess convergent validity in PLS-SEM. Factor loading measures the relationship between the observed variables and their underlying latent constructs, while Cronbach's Alpha and composite reliability assess the internal consistency of the measurement instrument (Amora, 2021).

Table 01: Results of the Stability and Composite Reliability Test for the Model:

variables	Items	Loadings	Cronbach's Alpha	Composite Reliability	Average variance extracted AVE
Technological Innovation	TI_1	0.621	0.877	0.899	0.562
	TI_2	0.816			
	TI_3	0.720			
	TI_4	0.762			
	TI_5	0.824			
	TI_6	0.768			
	TI_7	0.721			
Competitive Advantage	CA_1	0.651	0.888	0.907	0.550
	CA_2	0.775			
	CA_3	0.781			
	CA_4	0.726			
	CA_5	0.772			
	CA_6	0.693			
	CA_7	0.755			
	CA_8	0.771			
Business Model Transformation	BMT_1	0.930	0.893	0.926	0.807
	BMT_2	0.901			
	BMT_3	0.864			

Source: Compiled by researchers based on the outputs of Smart PLS4.

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The results presented in Table 01 indicate that all constructs in the model demonstrate strong reliability and satisfactory convergent validity. For technological innovation and competitive advantage, the factor loadings range from 0.621 to 0.824 and 0.651 to 0.781, respectively, exceeding the acceptable threshold of 0.60, which suggests that all items contribute meaningfully to their underlying constructs. Cronbach's Alpha values for all three variables range between 0.877 and 0.893, well above the recommended minimum of 0.70, confirming internal consistency. Similarly, composite reliability values are high—0.899 for technological innovation, 0.907 for competitive advantage, and 0.926 for business model transformation—indicating that the constructs are measured reliably. The AVE values for technological innovation (0.562) and competitive advantage (0.550) meet the minimum recommended level of 0.50, while business model transformation shows an exceptionally high AVE of 0.807, reflecting strong convergent validity. Overall, these results confirm that the measurement model has robust reliability and validity, making it suitable for further structural analysis.

4.2. Discriminate Validity :

The recommended criteria for analysing the results of the discriminant validity test in the PLS-SEM methodology include the following:

Fornell-Larcker Criterion: This criterion assesses discriminant validity by comparing the square root of the average variance extracted (AVE) for each construct with the correlations between that construct and other constructs. Discriminant validity is established if the AVE value for a particular construct is greater than its correlation with all other constructs (Henseler et al., 2015; Hamid et al., 2017)

Heterotrait-Monotrait Ratio of Correlations (HTMT) Criterion: This criterion is based on the heterotrait-monotrait ratio of correlations and is used to assess discriminant validity in variance-based structural equation modelling. It measures the extent to which constructs are distinct from each other empirically. A threshold of 0.85 is recommended for HTMT when the constructs in the path model are conceptually more distinct (Franke & Sarstedt, 2019; Henseler et al., 2015; Hamid et al., 2017)

It is important to note that the Fornell-Larcker Criterion and cross-loadings have been the dominant approaches for evaluating discriminant validity, but Henseler, Ringle, and Sarstedt (2015) have proposed the HTMT criterion as an alternative approach, which has shown high sensitivity and specificity in detecting discriminant validity problems (Cepeda-Carrión et al., 2022) (Henseler et al., 2015) (Hamid et al., 2017)

In conclusion, when analysing the results of the discriminant validity test in the PLS-SEM methodology, researchers should consider using the Fornell-Larcker Criterion, cross-loadings, and the HTMT Criterion to ensure the distinctiveness of the constructs in the study and to detect any issues with discriminant validity.

Table 02: Fornell-Larcker Criterion

variables	BMT	CA	TI
BMT	0.898		
CA	0.538	0.742	
TI	0.614	0.681	0.750

Source: Compiled by researchers based on the outputs of Smart PLS4.

The Fornell–Larcker results in Table 02 indicate that the model demonstrates acceptable discriminant validity, as each construct's square root of the AVE (represented on the diagonal) is higher than its correlations with other constructs. Business model transformation (BMT) shows a strong AVE square root value of 0.898, which is greater than its correlations with competitive advantage (0.538) and technological innovation (0.614), confirming that BMT is empirically distinct. Similarly, competitive advantage (CA) has an AVE square root of 0.742, exceeding its

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correlations with technological innovation (0.681) and BMT (0.538), indicating adequate discriminant validity. Technological innovation (TI) also satisfies this criterion, with its AVE square root (0.750) exceeding its correlations with CA (0.681) and BMT (0.614). Overall, the Fornell–Larcker criterion confirms that each construct measures a unique concept, and the model does not suffer from overlap between latent variables, supporting the reliability of subsequent structural model analysis.

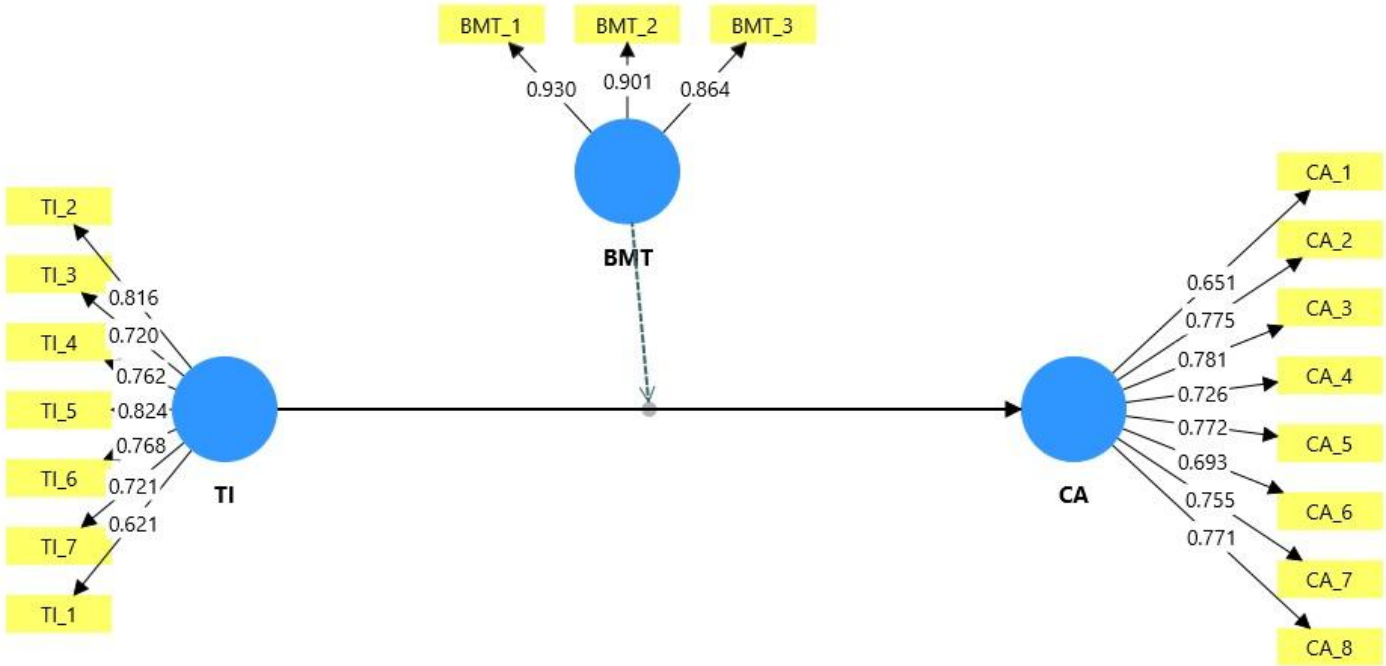
Table 03: the heterotrait-monotrait ratio of correlations (HTMT)

variables	BMT	CA	TI
CA	0.601		
TI	0.706	0.766	
BMT x TI	0.192	0.077	0.154

Source: Compiled by researchers based on the outputs of Smart PLS4.

The HTMT results in Table 03 further confirm the presence of discriminant validity among the study's constructs. All HTMT values fall well below the conservative threshold of 0.85, indicating that none of the latent variables exhibit problematic levels of conceptual overlap. The relationships between business model transformation (BMT) and competitive advantage (CA) (HTMT = 0.601), and between BMT and technological innovation (TI) (HTMT = 0.706), fall within acceptable limits, suggesting that these constructs are empirically distinguishable. Likewise, the HTMT value between competitive advantage and technological innovation (0.766) remains below the threshold, reinforcing their discriminant validity. The interaction term (BMT × TI) shows very low HTMT values with all other constructs (0.192, 0.077, and 0.154), indicating that it is mathematically and conceptually distinct, as expected for a moderation variable. Overall, the HTMT findings support the Fornell–Larcker results and demonstrate that the constructs in the model are sufficiently distinct to proceed with structural analysis.

Figure 2: General Structural Model for the Study



Source: Compiled by researchers based on the outputs of Smart PLS4.

Secondly: Testing the Internal Model (Structural Model)

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In this section, we evaluate the results of the structural model by testing the degree of correlation, assessing the predictive capabilities of the model, and examining the relationships between constructs. Additionally, we conduct the necessary tests to evaluate the model.

1. Validity of the Structural Model:

The recommended criteria for analysing the results of the Validity of the Structural Model test (R^2, F^2) in the PLS-SEM methodology include:

Measurement model assessment: This involves assessing the relationship between a construct and its observed items, including reliability, indicator loading, and internal consistency reliability (Fauzi, 2022).

Structural model assessment: This focuses on evaluating the significance and relevance of path coefficients, followed by the model's explanatory and predictive power. Key metrics relevant to structural model assessment in PLS-SEM include the coefficient of determination (R2), f2 effect size, and cross-validated predictive ability test (CVPAT). (Hair Jr et al., 2021).

New guidelines: In addition to established PLS-SEM evaluation criteria, new guidelines include PLS predict (a novel approach for assessing a model's out-of-sample prediction), metrics for model comparisons, and several complementary methods for checking the results' robustness (Hair et al., 2019).

Table 04: Validity of the Structural Model

Variables	Coefficient of Determination (R2)	Explanatory size (F2)
CA	0.515	/
TI	/	0.419
BMT	/	0.060

Source: Compiled by researchers based on the outputs of Smart PLS4.

The results in Table 04 indicate that the structural model demonstrates acceptable explanatory power and meaningful effect sizes for the key relationships. The coefficient of determination (R^2) for competitive advantage (CA) is 0.515, indicating that technological innovation and business model transformation together explain 51.5% of the variance in competitive advantage—a moderate-to-strong level of explanatory power in social science research. The F^2 values further clarify the contribution of each predictor: technological innovation (TI) shows a substantial effect size of 0.419, indicating that it is a strong predictor of competitive advantage. In contrast, business model transformation (BMT) has a small effect size of 0.060, suggesting that, while it contributes to explaining competitive advantage, its influence is considerably weaker than that of technological innovation. Overall, these results show that the model performs well, with technological innovation emerging as the primary driver of competitive advantage, supported by a smaller but meaningful contribution from business model transformation.

2. Discussion of testing the study hypotheses

When analysing the results of testing study hypotheses in the Partial Least Squares Structural Equation Modelling (PLS-SEM) methodology, there are several recommended criteria to consider. These criteria are essential for ensuring the validity and reliability of the analysis. Here are the recommended criteria for analysing the results of testing this study's hypotheses in the PLS-SEM methodology:

Hypothesis Testing with Confidence Intervals and P Values: Researchers usually employ P values for hypothesis testing in PLS-SEM, where each hypothesis refers to a path in a model. P values may be one-tailed or two-tailed (Kock, 2016).

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Structural Model Testing: The structural model in PLS-SEM needs to be tested to ensure that the assumptions of unidimensional constructs hold in the sample. This involves testing the relationships between latent variables and their indicators (Kock, 2016).

To test the study hypotheses using the structural modelling methodology, we calculate estimates for the relationships in the structural model using the Bootstrap method. These estimates indicate the expected relationships between constructs, and the path coefficient ranges from -1 to +1. Values close to +1 suggest strong positive relationships, while values near -1 indicate strong negative relationships. Typically, statistically significant relationships have p-values below 5%. Coefficients approaching zero from both directions suggest weak relationships (Kock, 2018).

2.1. Hypotheses:

2.1.1. First hypothesis (H1): There is no statistically significant positive relationship between Technological Innovation **and** Competitive Advantage at **a 5% significance level.**

2.1.2. Second Hypothesis (H2): There is no significant role for Business Model Transformation in **reducing the relationship between** Technological Innovation **and** Competitive Advantage at **a 5% significance level.**

Table 5: Testing the Hypotheses for the Study (H_1, H_2)

Hypothesis	Paths	Original Sample	Sample Mean	Standard Deviation	T Statistics	P Values	Decision
H_1	**TI -> CA**	0.571	0.581	0.110	5.183	0.000	Hypothesis Accepted
H_2	**BMT x TI -> CA**	-0.155	-0.156	0.071	2.168	0.030	Hypothesis Accepted

Source: Compiled by researchers based on the outputs of Smart PLS4.

The hypothesis testing results in Table 5 indicate strong empirical support for both proposed hypotheses. For H1, the path coefficient from technological innovation (TI) to competitive advantage (CA) is positive and significant ($\beta = 0.571$, $t = 5.183$, $p = 0.000$), demonstrating that technological innovation has a substantial and statistically significant impact on enhancing competitive advantage. This confirms that firms investing in technological innovation are more likely to achieve superior competitive outcomes. For H2, the interaction term between business model transformation and technological innovation (BMT × TI) shows a negative but statistically significant effect on competitive advantage ($\beta = -0.155$, $t = 2.168$, $p = 0.030$). Although the moderating effect is modest, its significance indicates that business model transformation indeed moderates the relationship between technological innovation and competitive advantage; however, in this case, the moderation is negative, suggesting that higher levels of business model transformation may weaken, rather than strengthen, the positive influence of technological innovation on competitive advantage. Overall, the results confirm both hypotheses while revealing important nuances in how technological innovation and business model transformation interact within the organisational context.

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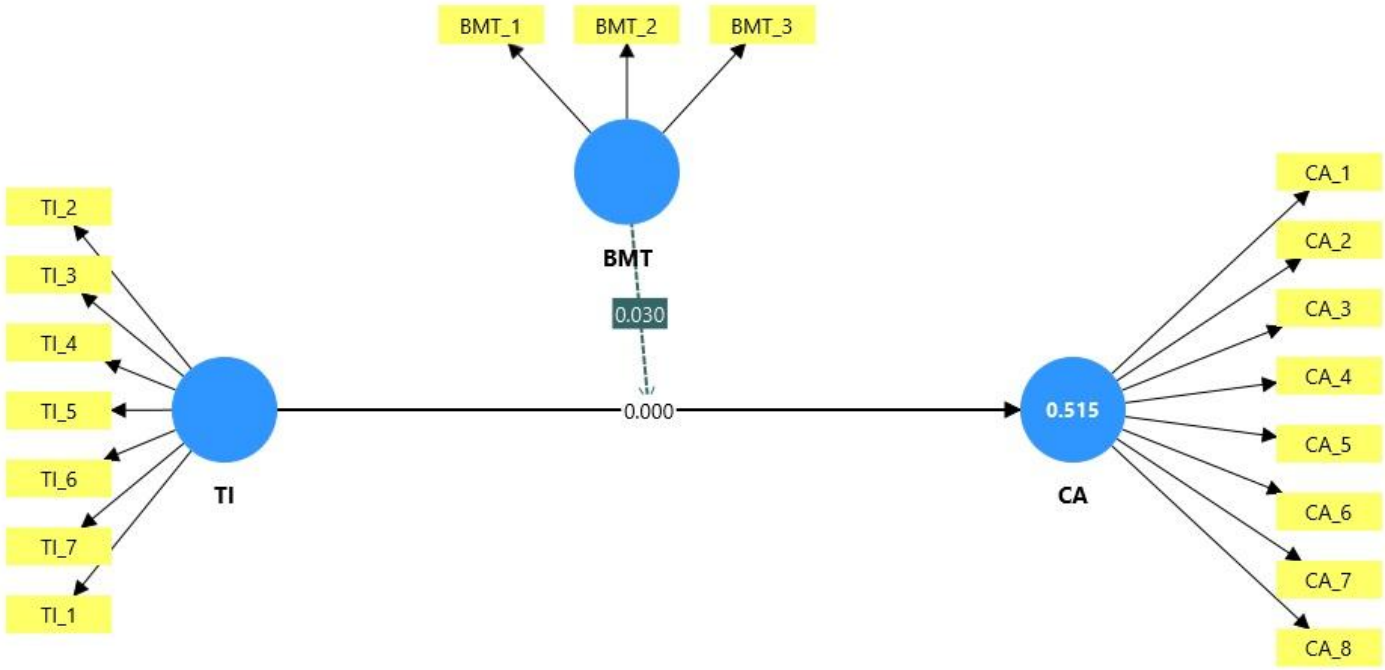
Figure 3: Results of path coefficients



Source: Compiled by researchers based on the outputs of Smart PLS4.

Table 6: Testing the effectiveness of the moderating variable (Business Model Transformation**) in reducing the effect of** Technological Innovation **on** Competitive Advantage

Relationship	Path Coefficient	P Values	Hypothesis
Technological Innovation--------→Competitive Advantage	0.571	0.000	Accepted
The Interaction (Technological Innovation* Business Model Transformation)--> Competitive Advantage	-0.155	0.030	Accepted

Source: Compiled by researchers based on the outputs of Smart PLS4.

The results in Table 6 confirm the effectiveness of business model transformation (BMT) as a moderating variable in the relationship between technological innovation (TI) and competitive advantage (CA). The direct effect of technological innovation on competitive advantage is positive and highly significant (β = 0.571, p = 0.000), indicating that technological innovation plays a strong role in enhancing firms' competitive positioning. However, the interaction term between technological innovation and business model transformation shows a negative and statistically significant effect on competitive advantage (β = –0.155, p = 0.030). This result demonstrates that as business model transformation increases, the positive influence of technological innovation on competitive advantage decreases. In other words, BMT significantly moderates—and specifically reduces—the strength of the relationship between innovation and competitive advantage. Both tested effects are statistically significant, supporting the hypothesis that business model transformation has a meaningful, albeit negative, moderating role in this model.

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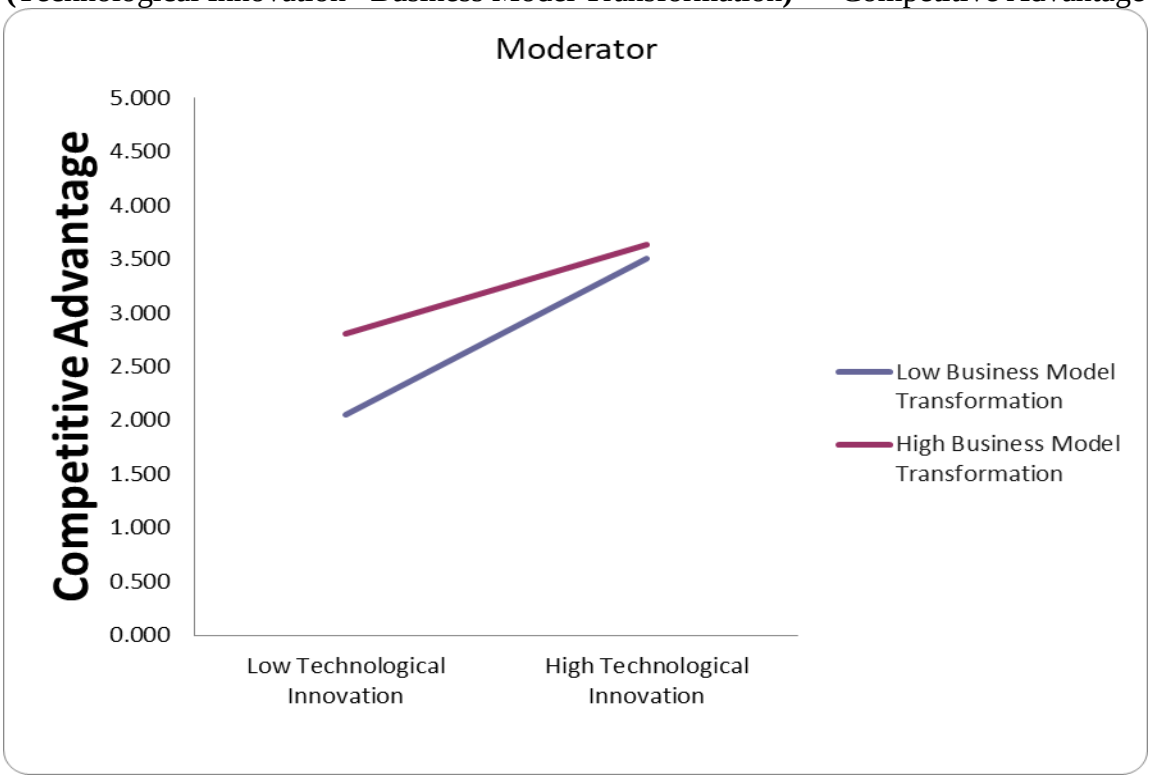
Figure 4: Path coefficients of The Interaction
(Technological Innovation* Business Model Transformation)--> Competitive Advantage



Source: Compiled by researchers based on the outputs of Microsoft Excel.

8. Discussion:

1. Interpretation of Findings

The findings of this study provide strong evidence that technological innovation is a significant driver of competitive advantage. The structural model results reveal that technological innovation exerts a substantial positive effect on competitive advantage ($\beta = 0.571$, $p < 0.001$), explaining a considerable portion of the variance in firms' competitive performance. This suggests that organisations that invest in new technologies, enhance their innovation processes, and adopt advanced production or service methods are more likely to outperform competitors. These results support the central argument of this research: technological innovation remains a foundational strategic pillar for achieving differentiation, improving efficiency, and responding effectively to market changes.

However, the moderating analysis yields a more complex insight. While business model transformation (BMT) was expected to strengthen the relationship between technological innovation and competitive advantage, the findings show a negative and significant moderating effect ($\beta = –0.155$, $p = 0.030$). This indicates that higher levels of business model transformation reduce the strength of the positive impact of technological innovation on competitive advantage. One possible interpretation is that extensive or rapid transformation may temporarily disrupt organisational processes, dilute strategic focus, or overstretch resources, thereby diminishing the immediate benefits of innovation. Additionally, firms undergoing substantial transformation may face internal resistance, coordination challenges, or capability gaps that hinder their ability to fully capitalise on technological advancements. This suggests that while BMT is valuable, its timing, scope, and alignment with innovation strategies must be carefully managed to avoid counterproductive outcomes.

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2. Comparison with Prior Research

The positive relationship between technological innovation and competitive advantage aligns with extensive prior research that highlights innovation as a key organisational capability for achieving superior performance. Studies grounded in the Resource-Based View (RBV), such as Mandung et al. (2025) and Wanaswa et al. (2021), similarly emphasise that technological innovation enables firms to develop valuable, rare, and inimitable resources that enhance competitiveness. Research in various sectors, including telecommunications, manufacturing, and digital industries, has consistently shown that innovation leads to improved efficiency, differentiation, and market responsiveness. The present findings reinforce this consensus and further verify the central role of innovation across diverse contexts.

In contrast, the negative moderating effect of business model transformation diverges from much of the existing literature, which generally positions BMT as a facilitator of innovation-driven performance. Several studies, including Minz et al. (2023) and Tetteh et al. (2025), argue that business model transformation strengthens organisational capabilities, supports digital integration, and enhances firms' ability to exploit technological innovations. Similarly, the dynamic capabilities perspective suggests that transforming value creation, delivery, and capture mechanisms should theoretically amplify the competitive outcomes of innovation. However, the findings of the present study offer a different perspective: business model transformation may not always produce reinforcing effects. Instead, under certain conditions, transformation efforts may introduce complexities that hinder the realisation of innovation benefits. This result supports recent emerging research suggesting that transformation can have transitional costs, risks of misalignment, or implementation challenges that may weaken short-term performance gains (Maslak et al., 2022).

9. Conclusion:

This study set out to investigate the impact of technological innovation on competitive advantage and to examine the moderating role of business model transformation in this relationship. The results provide several important insights. First, technological innovation demonstrates a strong and significant positive effect on competitive advantage, confirming its role as a central driver of organisational success. Firms that adopt advanced technologies, innovate their products and processes, and embrace digital advancements are more likely to outperform their competitors. This reinforces the notion that technological innovation is a critical strategic asset that enhances differentiation, efficiency, and market responsiveness.

Second, the findings reveal a significant but negative moderating effect of business model transformation on the relationship between technological innovation and competitive advantage. Although business model transformation is generally viewed as essential for achieving long-term competitiveness, the results suggest that high levels of transformation may weaken the immediate benefits of technological innovation. This indicates that transformative changes—while valuable—can introduce complexity, disrupt existing routines, and temporarily hinder firms from fully leveraging innovation to gain a competitive advantage. Therefore, business model transformation does play an important role, but its influence is nuanced and context-dependent.

Overall, the study highlights the importance of both the independent variable (technological innovation) and the moderating variable (business model transformation) in shaping competitive advantage. Technological innovation emerges as a powerful and consistent contributor to competitive outcomes, while business model transformation provides an important strategic lens through which the effectiveness of innovation can either be enhanced or constrained. These findings underscore the need for firms to balance innovation efforts with carefully planned business model adjustments, ensuring alignment between technological advancement and organisational transformation to optimise competitive performance.

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