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The Impact of Sustainable Supply Chain Management, Service Innovation, and Product Innovation on Customer Satisfaction with Competitive Advantage as a Mediating Variable in a Telecommunications Company

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Abstract **-** This study aims to analyze the influence of Sustainability Supply Chain Management (SSCM), Service Innovation, and Product Innovation on Competitive Advantage and Customer Satisfaction at PT X, as well as to evaluate the role of Competitive Advantage as a mediating variable in these relationships. The population for this research consists of PT X customers from 2019 to 2023 a total of 239 customers, with a sample size of 70 respondents selected using purposive sampling. Data analysis was performed using Partial Least Squares-Structural Equation Modeling (PLS-SEM). The results of the study indicate that SSCM has a significant positive effect on Customer Satisfaction but does not have a significant effect on Competitive Advantage. Service Innovation does not have a significant effect on either Competitive Advantage or Customer Satisfaction. Conversely, Product Innovation was found to have a significant negative effect on Competitive Advantage, but a significant positive effect on Customer Satisfaction. Competitive Advantage mediates the relationship between Product Innovation and Customer Satisfaction, but does not mediate the relationships between SSCM and Customer Satisfaction, or between Service Innovation and Customer Satisfaction. These findings suggest that while Product Innovation has a direct impact on Customer Satisfaction, its effect is enhanced by Competitive Advantage. Meanwhile, SSCM and Service Innovation require further attention in terms of communication and implementation to maximize their impact on Customer Satisfaction. This study recommends that PT X focus on developing Product Innovation that can enhance Competitive Advantage, while strengthening communication about sustainability and Service Innovation to improve customer satisfaction and market competitiveness.

Keywords: Sustainability Supply Chain Management (SSCM), Service Innovation, Product Innovation, Competitive Advantage, Customer Satisfaction, Mediation

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I. INTRODUCTION

In the Fourth Industrial Revolution, sustainability has become a central focus in modern business practices. Companies are not only striving to achieve economic profits but are also increasingly committed to positively contributing to the environment and society, which, in turn, enhances customer satisfaction. This shift is attributed to the growing consumer appreciation for responsible companies that are committed to sustainability (Yuwanda et al., 2024). Sustainability has become a core agenda in the Sustainable Development Goals (SDGs), with 17 goals and 169 targets agreed upon by 193 countries, including Indonesia (Indriyani Rachman & Retnowati, 2023). The Indonesian Sustainable Development Goals Indicators 2024 report highlights that the SDGs implementation has entered the Decade of Action, with only six years remaining to achieve the 2030 targets (BPS, 2024). Both the government and the business sector are increasingly investing in the circular economy and sustainable supply chains to ensure inclusive and environmentally friendly economic growth.

The commitment to sustainability within the SDGs framework has grown stronger with the increased involvement of various stakeholders, including governments and businesses, in the circular economy and sustainable supply chains. This trend is reflected in the 2024 Impac Survey, which shows that 75% of consumers prefer products from companies with clear sustainability programs, and the 2024 IBM Report reveals

that 49% of companies have set sustainable supply chain targets, while 70% are investing in the circular economy to reduce environmental impact. However, this phenomenon has two sides. On one hand, the PricewaterhouseCoopers (PwC) Survey revealed that 80% of global consumers are willing to pay more for sustainable products, and 78% are willing to pay extra for recyclable products. On the other hand, 57% of investors demand clarity and consistency in sustainability reporting, reflecting the challenges in the transparency of sustainability claims, which are not yet fully trusted (PwC, 2023).

The telecommunications industry in Indonesia has also undergone a sustainability transformation. The APJII Survey (2024) reported that the internet penetration rate in Indonesia reached 79.5%, an increase of 1.4% from the previous period, indicating the growing demand for more efficient and environmentally friendly telecommunication services. Furthermore, the Ministry of Communication and Information (2024) recorded 1,498 telecommunication service providers, highlighting the importance of implementing sustainability practices within this sector to ensure sustainable and inclusive technological development.

Although the telecommunications industry is increasingly oriented towards sustainability, it still faces significant challenges, particularly in electronic waste management and energy consumption. The International Telecommunication Union (ITU) reported that the telecommunications sector contributes approximately 2% of global greenhouse gas emissions, with a projected 45% reduction by 2030 to achieve the net-zero target (Recommendation, 2020). However, many companies have not fully adopted environmentally friendly practices, which may affect their image and customer satisfaction.

Moreover, the Global Action Plan estimates that the information and communication technology (ICT) industry has the potential to surpass the aviation industry in CO2 emissions, with a continually increasing contribution (Bank & ITU, 2024). Without significant mitigation efforts, the environmental impact of this sector will continue to grow. Therefore, telecommunication companies need to accelerate their transition to renewable energy and more sustainable operational systems to ensure the industry's growth remains aligned with sustainability principles.

PT. X, a leading telecommunications service provider in Indonesia, is committed to sustainability and innovation. As a service provider, the company implements sustainable supply chain management (SSCM) with a focus on reducing environmental impact through energy efficiency and the use of environmentally friendly technologies. PT. X also continues to develop innovations in services and products, such as AI-based applications for 24-hour customer service and modular devices that allow component replacements without replacing the entire unit. Despite achieving some progress, the company still faces challenges in accelerating service speed and improving transparency in sustainability management, which remains a key focus in improving overall customer satisfaction.

Furthermore, the sustainability of the company is highly dependent on customer satisfaction, which is a critical factor in maintaining competitiveness and customer loyalty. Customer satisfaction plays a crucial role in business sustainability, as satisfied customers are more likely to make repeat purchases and recommend products or services to others (Adnan et al., 2024). In the context of Sustainable Supply Chain Management, customer satisfaction is closely related to sustainable supply chain strategies, where companies focus not only on cost and operational efficiency but also on social and environmental responsibility. The successful implementation of SSCM can increase transparency, reduce environmental impact, and ensure the availability of high-quality products, thereby enhancing customer trust and satisfaction (Djogo & Resty Ismawanti, 2024).

Moreover, service innovation and product innovation also play important roles in enhancing customer satisfaction and improving the company's competitive advantage (Saragih, 2024). Innovations in service, such as customer service digitalization and personalized user experiences, enable companies to provide more responsive and efficient experiences. Meanwhile, product innovations focused on sustainability, such as the use of environmentally friendly materials and energy efficiency improvements, can attract consumers who are increasingly concerned about the environmental impact of the products they consume.

Based on the company's internal reports, only 30% of customers feel that the company has adequate commitment to sustainability. This assessment highlights the need for a more visible sustainability strategy to customers. In addition, customer satisfaction decreased by 15% in 2023, primarily due to dissatisfaction with service speed and lack of product innovation. Internal data from PT. X shows that customer satisfaction dropped

from 85% in 2022 to 70% in 2023. Therefore, improvements in service speed and product innovation are required to improve the company's image and overall customer satisfaction.

The internal data aligns with the results of a pre-survey conducted with 30 PT. X customers, which gathered information on customer perceptions regarding Sustainable Supply Chain Management, service innovation, product innovation, and competitive advantage. From the pre-survey results, it can be concluded that there are still several areas needing improvement, particularly in terms of service speed and customer understanding of sustainability. In light of these issues, this research aims to address the gap in understanding how Sustainability Supply Chain Management (SSCM), service innovation, and product innovation impact PT. X's competitive advantage and customer satisfaction. The study will also investigate whether competitive advantage mediates the relationships between these factors and customer satisfaction. The findings are expected to provide valuable insights into how PT. X can improve its sustainability strategies, enhance its competitive advantage, and increase customer satisfaction, which are essential for the company's long-term success in a rapidly evolving market.

Sustainability has become a key focus in business, especially during the Fourth Industrial Revolution, where companies are expected to generate economic profit while contributing to environmental and social well-being. PT. X, a major telecommunications provider in Indonesia, aims to integrate sustainability into its strategies but faces challenges in ensuring transparency and improving customer satisfaction, which has declined due to slow service and limited product innovation.

The company's adoption of Sustainability Supply Chain Management (SSCM), service innovation, and product innovation are crucial for its competitive advantage and customer satisfaction. However, little is known about how these factors interact, especially regarding the mediating role of competitive advantage. This research investigates the impact of SSCM, service innovation, and product innovation on PT. X's competitive advantage and its effect on customer satisfaction, and explores whether competitive advantage mediates these relationships. The findings will offer insights to improve PT. X's sustainability strategies, enhance its competitive edge, and increase customer satisfaction, all vital for long-term success in a changing market

II. LITERATURE REVIEW

A. Sustainability Supply Chain Management (SSCM)

Sustainability Supply Chain Management (SSCM) refers to managing the flow of information, materials, and finances across the supply chain, from upstream to downstream, and among various parties within the chain, focusing on collaboration to achieve sustainability's three pillars: economic, social, and environmental (Octaviani et al., 2023). SSCM is defined as the development of an organized supply chain system through voluntary collaboration that considers economic, environmental, and social aspects, integrated with key business processes across organizations to efficiently and effectively manage material flows, procurement, production, and distribution (Nagari et al., 2024).

According to the United Nations Global Compact (2023), supply chain sustainability involves managing environmental, social, and economic impacts and promoting good governance practices throughout the life cycles of goods and services. This concept highlights the importance of good governance practices across all stages of product and service life cycles, contributing to value creation. Rausch-Phan & Siegfried (2022) further define SSCM as managing material flows to minimize environmental impacts while maintaining economic profitability and contributing to social responsibility.

The main goal of implementing SSCM is to minimize resource use and waste emissions through efficient and sustainable material and energy use. By integrating sustainability principles with supply chain management, SSCM focuses on balancing economic, social, and environmental goals to achieve sustainable business practices (Irawan et al., 2024). Practices within SSCM include eco-friendly procurement, energy-efficient production, green warehousing, and low-emission transportation, aiming to reduce environmental and social impacts while ensuring timely product delivery and minimizing fulfillment costs (Octaviani et al., 2023).

In addition, SSCM emphasizes efficiency and transparency across organizations to achieve long-term sustainability goals, integrating the Triple Bottom Line (TBL) environmental, economic, and social within supply chain processes. This contrasts with Green Supply Chain Management (GSCM), which focuses primarily

on environmental and some economic aspects (Tundys, 2020). As companies like PT. X integrate SSCM, they aim to reduce carbon footprints, improve energy efficiency, and contribute to sustainability through innovative product designs and processes, benefiting both the environment and customer satisfaction.

B. Service Innovation

Service innovation involves the practical application of creative ideas to enhance service offerings and create added value for customers (Mansur et al., 2021). It is defined as the introduction of new or improved services that meet customer needs more effectively. Service innovation can be achieved through changes in the structure and delivery of services, leveraging technology and creative solutions to improve customer experiences (Kotler & Keller, 2021).

Innovations in services can be classified into three levels: incremental, radical, and transformative (Ulum, 2018). Incremental innovations involve minor improvements to existing services, enhancing efficiency and responsiveness without altering the core service structure. Radical innovations introduce entirely new ways of delivering services, often involving high-risk and significant changes. Transformative innovations overhaul organizational structures and business processes, requiring substantial cultural and social shifts within the company (Septiani & Arundinasari, 2023).

Service innovation at PT. X is crucial for enhancing customer satisfaction and competitiveness. Despite implementing SSCM, PT. X faces challenges in transparency and service speed. The adoption of AI-based chatbots, responsive call centers, and mobile applications are steps toward improving service delivery, but further digitalization is necessary. Moreover, communication regarding product innovations, such as modular products, needs improvement to increase customer understanding and satisfaction.

C. Product Innovation

Product innovation is the creation or improvement of products that provide added value, enhanced functionality, or appeal to consumers (Setiawan et al., 2024). It involves stages such as research, concept development, prototype creation, and market testing before mass production. In a highly competitive market, companies must continuously innovate to maintain a competitive edge and meet evolving consumer demands.

At PT. X, product innovation is essential to improve customer satisfaction, strengthen competitive advantage, and optimize production efficiency. Innovations such as modular products, which allow for component replacement without discarding entire units, have been well-received by some customers, though others require better understanding of the product's benefits. Effective communication and further innovation are necessary to ensure the product's success in the market.

D. Competitive Advantage

Competitive advantage refers to the factors that allow a company to outperform its rivals, such as cost efficiency, product uniqueness, or a specific strategic target (Sawlani et al., 2021). For PT. X, competitive advantage is achieved through a combination of innovative products, superior service quality, and operational efficiency. Key indicators of competitive advantage include lower costs, higher product quality, R&D capacity, and the ability to execute strategies that competitors cannot easily replicate (Muisyo et al., 2022). By integrating SSCM, service innovation, and product innovation, PT. X strengthens its competitive position in the telecommunications market, ensuring long-term success. With continuous improvements in operational efficiency, product innovation, and customer service, PT. X can sustain its market leadership and increase customer loyalty.

E. Customer Satisfaction

Customer satisfaction is the emotional response customers have when their expectations are met or exceeded (Rachmat et al., 2023). It is a key measure of how well a company fulfills customer expectations, influencing repeat business and customer loyalty (Antoney & Vazhacharickal, 2021). Satisfaction can be

influenced by factors such as product quality, service quality, emotional factors, price, and convenience (Adhari, 2021). At PT. X, customer satisfaction has been impacted by transparency in sustainability practices and service delivery speed. Despite improvements in services such as 24/7 customer support, there remains room for enhancement in service efficiency and product communication. By addressing these areas, PT. X can improve customer satisfaction, strengthen its competitive advantage, and ensure long-term success.

F. Conceptual Framework

The conceptual framework of the research is a model that relates to various factors identified in the study. This conceptual model is then used as a theoretical foundation related to the variables and factors in the research (Prasetia et al., 2022). Referring to the theoretical foundation and definitions, the conceptual framework for this research is as follows:

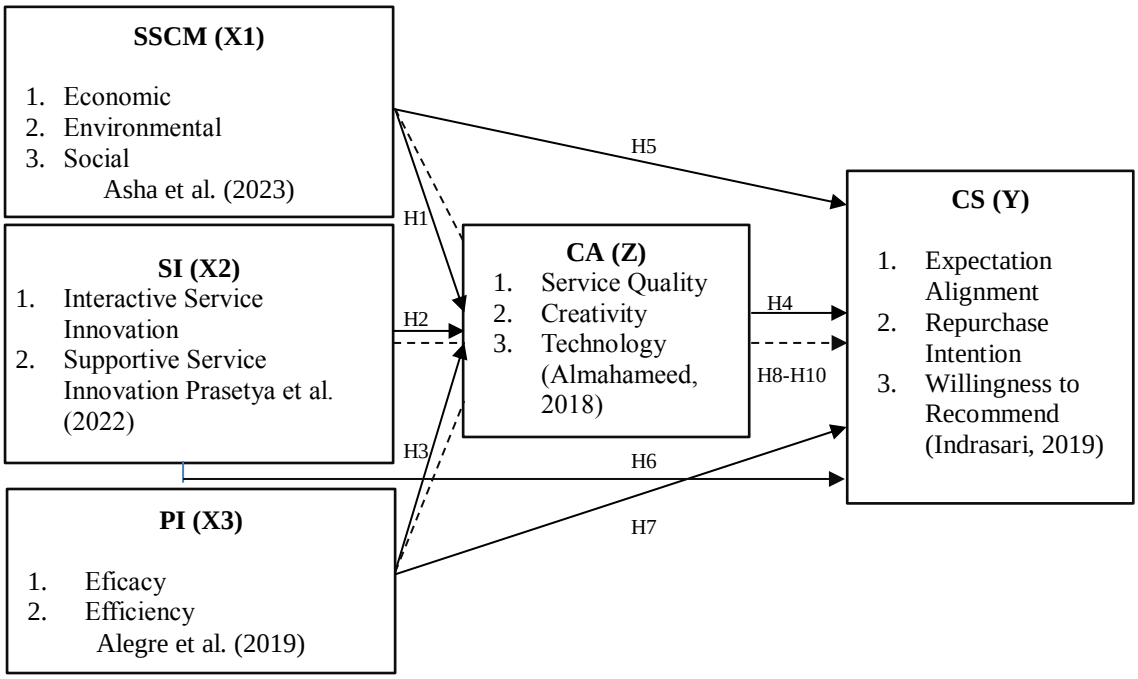

Figure 1. Conceptual Framework

Based on the theoretical review, previous studies, and the conceptual framework above, the following hypotheses are formulated:

Table 1. Hypothesis

Hypothesis		Description
H1	:	There is a positive effect of Sustainability Supply Chain Management on competitive advantage at PT X.
H2	:	There is a positive effect of service innovation on competitive advantage at PT X.
H3	:	There is a positive effect of product innovation on competitive advantage at PT X.
H4	:	There is a positive effect of competitive advantage on customer satisfaction at PT X.
H5	:	There is a positive effect of Sustainability Supply Chain Management on customer satisfaction at PT X.
H6	:	There is a positive effect of service innovation on customer satisfaction at PT X.
H7	:	There is a positive effect of product innovation on customer satisfaction at PT X.
H8	:	Competitive advantage mediates the relationship between Sustainability Supply Chain Management and customer satisfaction at PT X.

H9	:	Competitive advantage mediates the relationship between service innovation and customer satisfaction at PT X.
H10	:	Competitive advantage mediates the relationship between product innovation and customer satisfaction at PT X.

III. METHOD

A. Research Design and Variable Operationalization

This study employs a quantitative descriptive design with a cross-sectional approach, conducted at a specific point in time. The unit of analysis in this research is the individual, using primary data gathered through individual perceptions to explore the influence of independent variables on the dependent variable. This study examines several key variables, including Sustainability Supply Chain Management (X1), Service Innovation (X2), Product Innovation (X3), with Competitive Advantage as the mediating variable (Z), and Customer Satisfaction as the dependent variable (Y). The operational definitions and their dimensions are as follows:

Table 2. Variable Operationalization

No	Variable Definition	Indicator	Scale
1	Sustainability Supply Chain Management (SSCM)	1. Sustainable design and packaging system	Ordinal
		2. Sustainable production system	
		3. Sustainable transportation system	
		4. Sustainable purchasing system	
		5. Sustainable marketing strategy	
2	Service Innovation (SI)	1. Use of technology in service processes	Ordinal
		2. Active customer involvement	
		3. Improvement in service production processes	
		4. Providing tools for customers	
		5. Quality service management to support new service innovations	
3	Product Innovation (PI)	1. Market acceptance	Ordinal
		2. Market share improvement	
		3. Innovation's contribution to company profits	
		4. Product development cost and time	
		5. Speed and cost of innovation implementation	
4	Competitive Advantage (CA	1. Employee professionalism	Ordinal
		2. Physical facility adequacy	
		3. Service accuracy	
		4. Response to complaints	
		5. Promotional innovation	
		6. Special offers	
		7. Response to feedback	
		8. Digital services	
		9. System modernization	
		10. Transaction notifications	
		11. Technology adaptation	

No	Variable Definition	Indicator	Scale
		12. Online service access	
5	Customer Satisfaction (CS)	1. Product and service meet expectations	Ordinal
		2. Supporting facilities meet or exceed expectations	
		3. Willingness to repurchase due to satisfactory service	
		4. Willingness to repurchase due to adequate facilities	
		5. Willingness to recommend products due to service quality	
		6. Willingness to recommend products due to product value and benefits	

B. Population, Sample and Data Collection Method

The population in this study consists of PT. X customers from 2019 to 2023, totaling 239 customers. Purposive sampling was employed to select the sample, which is based on specific criteria. These criteria include customers who have been subscribed for at least 3 years and those who have used new services or innovative products launched by PT. X in the last 6 months. To determine the sample size, the Slovin formula was used: $n = N / (1 + N(e)^2)$, where n represents the sample size, N is the population size, and e is the margin of error (set at 10%). With a population of 239 customers and a margin of error of 10%, the required sample size is approximately 70 respondents.

For data collection, a closed-ended questionnaire was distributed randomly among the selected respondents. The questionnaire included questions regarding marketing mix, innovation, and sales performance. The responses were measured on a Likert scale, ranging from 1 ("Strongly Disagree") to 5 ("Strongly Agree") for independent and mediating variables, and from 1 ("Very Dissatisfied") to 5 ("Very Satisfied") for customer satisfaction.

C. Data Analysis Methods

Data analysis in this study was conducted using Structural Equation Modeling (SEM) with SmartPLS version 3, which is well-suited for social science research. The analysis was performed in two stages. The first stage involved testing the measurement model, where the reliability and validity of the constructs were validated to ensure the accuracy and consistency of the variables. The second stage focused on testing the structural model, where the relationships between the variables were evaluated using the t-test from the Partial Least Squares (PLS) method. This approach allows for a comprehensive assessment of the hypothesized relationships and provides insights into the significance and strength of the connections between the constructs.

Measurement Outer Model

In the measurement model testing, validity and reliability tests were conducted to ensure the quality of the measurement instruments. Convergent validity measures the extent to which the indicators adequately represent the construct. Convergent validity testing was performed through outer loading, where values above 0.70 are accepted, as well as the Average Variance Extracted (AVE) value, which in this study ranged from 0.58 to 0.779, indicating good convergent validity (Ghozali, 2018). Meanwhile, discriminant validity ensures that each construct can be clearly distinguished from others. This test was conducted through cross-loading, where each indicator had the highest value on its own construct, and the Fornell-Larcker criterion was used to ensure that the AVE is greater than 0.5 and the correlations between constructs are low, indicating that discriminant validity is satisfied (Ghozali, 2018).

To test reliability, Construct Reliability (CR) and Average Variance Extracted (AVE) were used. CR measures the reliability and consistency of the data, where a CR value greater than 0.6 is considered acceptable. The AVE test was conducted to examine the average variance extracted among indicators of a latent variable, with values greater than 0.5 meeting the criteria (Ghozali, 2018).

Measurement Inner Model

The structural model test aims to examine the correlation between measured constructs using t-tests from Partial Least Squares (PLS). The bootstrapping method, a resampling technique, is used to estimate the statistical sample distribution by repeatedly sampling from the original data. This technique tests path significance and provides confidence intervals for parameter estimates. Bootstrapping involves multiple resampling (e.g., 5000 times), estimating the model for each sample, calculating confidence intervals, and testing significance by checking if the interval includes zero. Bootstrapping is robust against normal distribution assumptions and provides accurate estimates for small samples.

Model Fit Test

The Goodness of Fit (GOF) index is used to assess the overall fit of the Structural Equation Modeling (SEM) model, measuring how well the model represents the relationships between variables. A high GOF value indicates that the model accurately reflects the observed data, while a low value suggests that the model may need adjustments. According to Haryono (2019), a value greater than 0.36 indicates a good fit, while values lower than 0.02 suggest a weak model that requires improvement.

R-squared (R^2) is utilized to measure how much variance in the dependent variables is explained by the independent variables. A higher R^2 indicates better model fit. Chin (1998) suggests that R^2 values of 0.67, 0.33, and 0.19 represent high, moderate, and low explanatory power, respectively. Additionally, Predictive Relevance (Q^2) is calculated to validate the model's predictive capability. A Q^2 value greater than 0 suggests that the model can predict the variance in the dependent variable, while a value less than 0 indicates a lack of predictive relevance (Haryono, 2019).

F-Square is used to measure the strength of the relationship between independent and dependent variables. Ramayah et al. (2018) indicate that F-Square values closer to 1 signify a stronger relationship, with values between 0.02 and 0.15 indicating a moderate relationship, and values of 0.35 or higher suggesting a strong relationship. These indicators are essential for determining the effectiveness and robustness of the model in explaining and predicting the relationships between the variables (Ramayah et al., 2018).

Hypothesis Testing

t-tests are used to assess whether each independent variable significantly affects the dependent variable at a 5% significance level. If the probability > 0.05, the independent variable is not significant (H0 accepted, Ha rejected). If the probability < 0.05, the independent variable is significant (H0 rejected, Ha accepted) (Ramayah et al., 2018).

IV. RESULT AND DISCUSSION

A. Result

Descriptive Statistic

In the first stage, the results of this study will describe the characteristics of the respondents, which can be seen in the table below:

Table 3. Descriptive Statistics of Respondent Characteristics

Variable	Frequency	Percent
Gender		
Female	28	39.40%
Male	43	60.60%
Total	71	100.00%
Age		
Under 25 years	1	1.40%
26-35 years	31	43.70%
36-45 years	32	45.10%
Over 45 years	7	9.90%
Total	71	100.00%
Education		

High School or Equivalent	3	4.20%
Bachelor's Degree	62	87.30%
Postgraduate	6	8.50%
Total	71	100.00%
Subscription Duration		
3 years	25	35.20%
4 years	31	43.70%
Over 4 years	15	21.10%
Total	71	100.00%

Source: Primary Data Processed (2025)

Based on the table above, the majority of respondents are in the age groups of 26-35 years (43.7%) and 36-45 years (45.1%), indicating that most participants in this study are young adults and productive individuals responsible for managing collaborations related to PT X's services. This age group is typically more engaged with the latest technological developments, influencing their understanding and assessment of the company's product and service innovations.

The data also shows a gender imbalance, with 60.6% of respondents being male and 39.4% female. This trend reflects the demographic characteristics of the telecommunications industry, where men may be more involved in decision-making or responsible for managing collaborations involving technology and related products. As the respondents were selected to fill out the questionnaire, it is likely they also play a key role in managing these collaborations. Regarding educational background, the majority of respondents hold a Bachelor's degree (87.3%), followed by Postgraduate (8.5%) and High School or equivalent (4.2%). The high level of education indicates that respondents have a deeper understanding of the products and services they manage or use, enabling them to be more critical in evaluating the quality and innovation of the products offered by the company.

In terms of subscription duration, most respondents have been engaged with the company for 4 years (43.7%) or 3 years (35.2%), while 21.1% have been with the company for more than 4 years. This relatively long engagement period suggests that the respondents have considerable experience in managing telecommunications services. Those with longer subscriptions may have higher expectations for service sustainability and product innovation. Thus, the telecommunications company must maintain high satisfaction levels through effective Sustainability Supply Chain Management and continuous innovation to sustain loyalty and competitive advantage.

In addition to the respondent characteristics statistics, the following presents the descriptive statistics and frequency of respondent answers to the questionnaire, covering the variables under study.

Table 4. Frequency Distribution of Research Variables

Variable	Mean	Highest Mean	Lowest Mean
SSCM	3.72	3.89	3.48
Service Innovation	3.79	3.96	3.55
Product Innovation	3.77	3.93	3.54
Competitive Advantage	4.12	4.32	3.96
Customer Satisfaction	3.75	3.89	3.49

Source: Primary Data Processed (2025)

The majority of respondents rated PT X's sustainability efforts, service innovation, product innovation, competitive advantage, and customer satisfaction positively, with some areas for improvement. For Sustainability Supply Chain Management (SSCM), the highest mean (3.89) was related to PT X's service design that reduces carbon footprints through efficient technology, while the lowest (3.48) was about energy efficiency in network services and data centers. The overall mean was 3.72, indicating general approval with room for enhancement.

In Service Innovation, the highest mean (3.96) was for PT X's marketing reflecting its commitment to sustainability. The lowest mean (3.55) was for energy efficiency in services, with the overall mean being 3.79,

reflecting general approval but also areas to improve. For Product Innovation, the highest mean (3.92) was for PT X's technology improving customer service, and the lowest (3.54) was related to customer feedback usage. The overall mean was 3.77, showing general satisfaction with the innovation but room for further improvement.

Competitive Advantage received the highest ratings, with the mean ranging from 3.96 to 4.32, particularly for strategic partnerships that strengthen PT X's market position. The overall mean was 4.12, indicating high satisfaction with PT X's competitive advantage. Finally, Customer Satisfaction had a mean ranging from 3.49 to 3.90, with the highest mean for service quality. The overall mean was 3.75, indicating satisfaction but with areas such as facility comfort and product expectations needing improvement.

Results of Structural Equation Modeling (SEM) Analysis

Measurement Outer Model

The data processing method used in this study is Structural Equation Modeling (SEM) with the Partial Least Squares (PLS) approach, implemented using SmartPLS 4.1.0.3 software, as presented in the following figure:

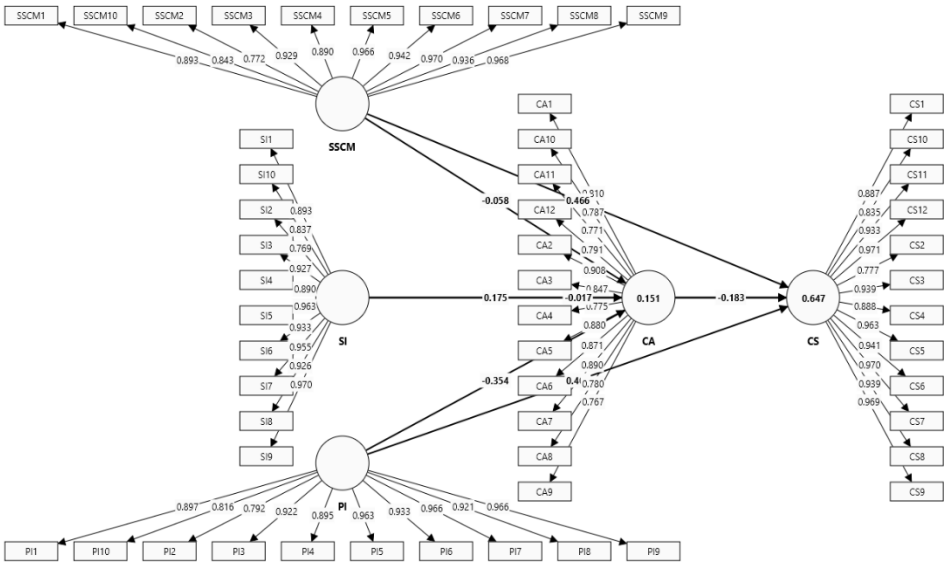

Figure 2. Outer Model

Source: Primary Data Processed (2025)

Validity and Reliability Test

The results of the validity tests, conducted using SmartPLS version 4.1.0.3, demonstrate that the measurement model meets the required standards for both convergent and discriminant validity. All indicators exhibit outer loading values greater than 0.70, confirming that each indicator reliably reflects its respective construct. Additionally, the Average Variance Extracted (AVE) values for all constructs exceed the recommended threshold of 0.50, with AVE values ranging from 0.680 (CA) to 0.845 (CS). This indicates that each construct explains more than 50% of the variance in its indicators, supporting good convergent validity. Discriminant validity is also confirmed through the cross loading and Fornell-Larcker criterion tests. Each indicator loads more strongly on its own construct than on any other, and the square roots of the AVE for each construct are greater than the correlations with other constructs, indicating that the constructs are empirically distinct from one another.

The reliability of the constructs is confirmed through the evaluation of Cronbach's alpha and Composite Reliability (CR). All constructs have Cronbach's alpha values ranging from 0.957 (CA) to 0.983 (CS), and CR values ranging from 0.962 (CA) to 0.985 (CS), both of which are well above the acceptable threshold of 0.70. These results demonstrate strong internal consistency and confirm that the measurement instruments used are reliable. In conclusion, the constructs in this study exhibit strong validity and reliability, ensuring that the measurement model is both robust and appropriate for further analysis.

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Evaluation of Structural Model

The results of the coefficient of determination (R^2) test indicate varying levels of explanatory power among the dependent variables. As shown in Table 4.13, the R^2 value for Competitive Advantage (CA) is 0.151, suggesting that only 15.1% of the variance in CA can be explained by the independent variables in the model, which indicates a relatively low level of explanatory strength. On the other hand, the R^2 value for Customer Satisfaction (CS) is 0.647, meaning that 64.7% of the variance in CS can be accounted for by the model. This demonstrates a substantial explanatory power for this construct. In terms of predictive relevance, the Q^2 values presented in Table 4.14 show similar trends. The Q^2 value for CA is 0.095, indicating weak predictive relevance, whereas CS has a Q^2 value of 0.524, reflecting a strong predictive capability of the model for this variable. Furthermore, the Goodness of Fit (GoF) index, calculated using the geometric mean of average AVE and average R^2, results in a value of 0.566. This suggests a moderate to good overall model fit, indicating that the model adequately represents the observed data.

In addition to overall model fit, the effect size (F^2) was analyzed to evaluate the individual contribution of independent variables to the dependent constructs. According to Table 4.15, the path from SSCM to CA has an F^2 value of 0.002, indicating no effect, while the paths from SI and PI to CA show moderate effects with F^2 values of 0.026 and 0.116, respectively. The effect of CA on CS also falls within the moderate range, with an F^2 value of 0.081. More substantial effects are observed in the paths from SSCM and PI to CS, which yield F^2 values of 0.354 and 0.328, respectively—indicating strong effects, particularly in the case of SSCM. In contrast, the path from SI to CS demonstrates a negligible effect with an F^2 of 0.001. These findings highlight that while some variables contribute significantly to explaining customer satisfaction, their influence on competitive advantage is comparatively limited.

Measurement Inner Model

This test is conducted to validate the research hypotheses after the data pass the outer model test. The inner model scheme is analyzed using the PLS-Bootstrapping method, given that the sample size is below 100. In the context of SEM with PLS, where data distributions are not always normal and variations among respondents can be significant, bootstrapping helps address these issues by using a resampling approach that considers every data point in the sample, including potentially extreme or outlier values. Below are the results of the inner model test.:

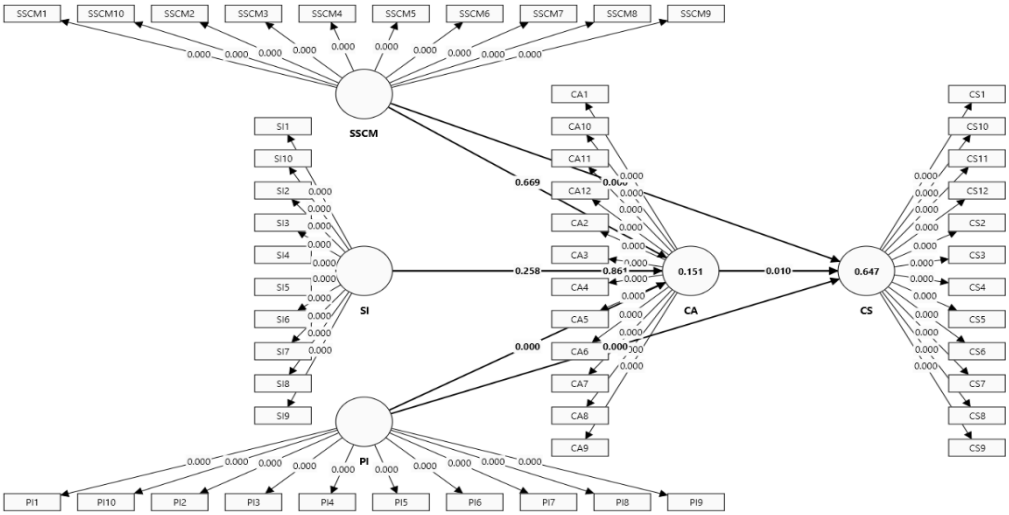

Figure 3. Inner Model
Source: Primary Data Processed (2025)

Hypothesis Testing Summary

Table 5. Total Effect and Specific Indirect Effect

Correlation	Original sample	Sample mean	Standard deviation	T statistics	P

	(O)	(M)	(STDEV)	(|O/STDEV|)	values
SSCM -> CA	-0.058	-0.051	0.136	0.427	0.669
SI -> CA	0.175	0.174	0.154	1.132	0.258
PI -> CA	-0.354	-0.361	0.099	3.569	0.000
CA -> CS	-0.183	-0.186	0.072	2.561	0.010
SSCM -> CS	0.476	0.472	0.118	4.039	0.000
SI -> CS	-0.049	-0.040	0.095	0.517	0.605
PI -> CS	0.470	0.467	0.103	4.555	0.000
SSCM -> CA -> CS	0.011	0.008	0.027	0.399	0.690
SI -> CA -> CS	0.032	0.032	0.034	0.946	0.344
PI -> CA -> CS	0.065	0.067	0.032	2.054	0.040

Source: Primary Data Processed (2025)

The results of the hypothesis testing, based on the t-statistic (threshold > 1.96) and p-value (< 0.05), indicate varied relationships among the variables. Among the direct effects, the relationships between Product Innovation (PI) and Competitive Advantage (CA) (t = 3.569, p = 0.000), CA and Customer Satisfaction (CS) (t = 2.561, p = 0.010), SSCM and CS (t = 4.039, p = 0.000), and PI and CS (t = 4.555, p = 0.000) are statistically significant. Interestingly, the effect of PI on CA is negative, suggesting that although significant, product innovation may not be aligning with competitive expectations. Similarly, the relationship between CA and CS is negative, indicating that competitive advantages may not directly translate to customer satisfaction. On the other hand, SSCM and PI positively influence CS, showing their relevance in enhancing customer experience. Meanwhile, the effects of SSCM and Service Innovation (SI) on CA, and SI on CS, are not statistically significant, leading to the rejection of H1, H2, and H6.

Regarding indirect effects, only one mediating relationship is found to be significant. Competitive Advantage significantly mediates the relationship between Product Innovation and Customer Satisfaction (H10), with a t-statistic of 2.054 and a p-value of 0.040. However, Competitive Advantage does not mediate the effects of SSCM or Service Innovation on Customer Satisfaction, as indicated by non-significant t-values (H8 and H9). These findings imply that while product innovation indirectly contributes to customer satisfaction via competitive advantage, other constructs do not rely on this mediating mechanism. Overall, the results emphasize the strategic importance of product innovation in influencing both competitive advantage and customer satisfaction, either directly or through mediation.

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B. Discussion

Discussion of Direct Effects

The direct effects analysis revealed nuanced insights into how PT X's strategic initiatives namely Sustainability Supply Chain Management (SSCM), Service Innovation (SI), and Product Innovation (PI) impact both Competitive Advantage (CA) and Customer Satisfaction (CS). The strongest positive direct relationship was observed between SSCM and CS (O = 0.476; t = 4.039; p < 0.001), confirming the growing relevance of sustainability in value creation. This result is firmly rooted in Stakeholder Theory (Freeman, 1984) and the Triple Bottom Line framework (Elkington, 1997), which posit that environmental and ethical practices serve as essential elements in fulfilling stakeholder expectations. In alignment, Chavez et al. (2020) found that firms demonstrating transparency in sustainable operations experience improved customer perception, leading to higher satisfaction. For PT X, it suggests that customers value the company's visible commitment to sustainable supply chain practices.

Likewise, Product Innovation (PI) had a statistically significant positive effect on Customer Satisfaction (O = 0.470; t = 4.555; p < 0.001), affirming the assertion of Marei et al. (2022) that tailored innovation addressing specific customer problems enhances perceived service value. From a Resource-Based View (RBV) perspective (Barney, 1991), innovation is a vital intangible asset that, when properly aligned with customer needs, fosters not only uniqueness but also satisfaction. The fact that PT X's product innovations, such

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as its SD-WAN and IoT platforms, positively influence satisfaction indicates their relevance and usability. These findings resonate with Digdowiseiso & Lestari (2021), who emphasized that innovation creates customer trust when it is practically valuable and strategically executed.

Conversely, the negative direct relationship between PI and CA (O = -0.354; t = 3.569; p < 0.001) was unexpected, suggesting potential misalignment between innovation activities and competitive positioning. While innovation is traditionally associated with differentiation and sustained advantage (Barney, 1991), Puspaningrum (2021), Daragahi (2020), and Chukwunwem & Ndubueze (2021) cautioned that innovation efforts that are either miscommunicated, overly technical, or unaligned with market demand can erode rather than bolster a firm's strategic edge. In PT X's case, this could reflect a gap between technological capability and perceived value especially if innovations do not address core customer concerns or fail to integrate with existing workflows.

The analysis also revealed a significant negative effect from Competitive Advantage (CA) to Customer Satisfaction (O = -0.183; t = 2.561; p = 0.010), which challenges the assumption that strategic superiority automatically translates to customer benefit. Asha et al. (2023) and Syahrial & Nofriza (2022) observed that when competitive edge stems from internal efficiency or technological dominance, it may not always be perceptible or appreciated by end-users particularly if it lacks direct usability, emotional resonance, or cost savings. In PT X's case, a strong market position might be perceived by customers as complexity, exclusivity, or lack of accessibility, which inadvertently lowers satisfaction.

Other direct relationships were found to be statistically non-significant. The path from SSCM to CA (t = 0.427; p = 0.669) failed to confirm the anticipated link between sustainable practices and competitive edge. This suggests that while PT X may be engaging in sustainability, its practices might not yet be perceived as unique or value-generating in competitive terms. Nguyen et al. (2024) argue, sustainability strategies must be externally validated (e.g., through certifications) and strategically positioned to confer competitive legitimacy. Similarly, Service Innovation (SI) to CA (t = 1.132; p = 0.258) and SI to CS (t = 0.517; p = 0.605) were both insignificant. These findings confirm the cautionary stance of Chen & Chen (2023) and Kanwal & Yousaf (2019), who found that service innovations often fail to produce results unless they deliver emotional, functional, and experiential value that customers can clearly distinguish and appreciate.

In sum, the direct effect results suggest that while PT X's product innovation and sustainable supply chain initiatives are achieving partial success especially in influencing customer satisfaction significant gaps exist in how these efforts translate into competitive advantage. Notably, service innovation, though essential in service-dominant industries, is underutilized or misaligned in PT X's current strategy. The findings urge PT X to not only innovate but also communicate and package those innovations in ways that highlight their distinctiveness and relevance to both strategic and customer outcomes.

Discussion of Indirect Effects

The analysis of indirect effects focused on whether Competitive Advantage (CA) mediates the relationships between SSCM, SI, and PI with Customer Satisfaction (CS). Among the three hypothesized indirect paths, only one exhibited statistical significance PI → CA → CS (O = 0.065; t = 2.054; p = 0.040). This result supports the mediating role of CA in the link between Product Innovation and Satisfaction, aligning with Marei et al. (2022) and Winarti et al. (2021), who emphasized that innovation becomes most impactful when it simultaneously strengthens organizational competitiveness. Moreover, Digdowiseiso & Lestari (2021) argue that product innovations reinforce satisfaction not only through novelty but by enhancing the firm's reputation, perceived leadership, and service performance factors that collectively form a competitive edge.

For PT X, this finding may reflect how advanced technologies such as AI-integrated SD-WAN solutions or cloud-based IoT monitoring enhance market credibility. Though the direct effect of PI on CA was negative, the indirect positive effect through CA to CS implies a nuanced mediation. It suggests that while some innovations may not directly improve competitiveness, they may still empower aspects of it (e.g., brand equity, service agility), which in turn positively influence customer satisfaction. This complex relationship aligns with the broader perspective offered by Barney (1991), where resources must be valuable, rare, and organizationally embedded to generate sustained advantage.

On the other hand, SSCM → CA → CS (t = 0.399; p = 0.690) and SI → CA → CS (t = 0.946; p = 0.344) were statistically insignificant, indicating that CA does not serve as a valid mediator in these relationships. In the case of SSCM, while customers appreciate ethical sourcing and environmental practices (Chavez et al., 2020), these may not be seen as direct contributors to strategic superiority unless backed by certification, scale, or competitive pricing. Yousefi et al. (2020) and Sharifabadi et al. (2022) similarly note that sustainability must be deeply woven into core strategy rather than treated as a peripheral activity to yield

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competitive returns. If stakeholders are unaware or unconvinced of SSCM's strategic intent, its ability to elevate satisfaction via CA diminishes.

The absence of mediation in the SI → CA → CS pathway further emphasizes the need for value-driven service innovation. As Chen & Chen (2023) argue, service innovations must enable clear operational or emotional advantages. Similarly, Kanwal & Yousaf (2019) found that in sectors such as ICT, customers evaluate service enhancements based on usability, intuitiveness, and personalization. If such criteria are unmet as may be the case with PT X service innovations, no matter how technologically advanced, fail to register as competitive strengths or satisfaction drivers.

Collectively, the indirect effect results show that Product Innovation holds strategic significance in PT X's ecosystem, not only delivering value directly but also enabling satisfaction through competitive positioning. Conversely, SSCM and SI appear to contribute more toward internal operational goals rather than external perception of superiority or satisfaction. These insights suggest that PT X should further integrate and communicate its sustainability and service innovations as part of a larger narrative of competitive excellence. Strategic storytelling, transparent performance metrics, and user-centric innovation design can bridge the gap between internal improvement and external value recognition.

V. CONCLUSSION

Based on the results of the research conducted, the following conclusions can be drawn:

1. The findings indicate that Sustainable Supply Chain Management (SSCM) does not have a significant effect on Competitive Advantage. This result does not align with the initial research objective, which anticipated a positive relationship. The lack of impact is attributed to the normative implementation of SSCM at PT X, which has not been strategically utilized as a differentiation tool to create added value for customers. Limited communication about sustainability practices and customers' preference for technical service aspects have prevented SSCM from becoming a driver of competitive advantage.
2. Service Innovation was also found to have no significant effect on Competitive Advantage. This result does not support the initial research assumption. At PT X, service innovation efforts are primarily focused on improving internal system efficiency, without directly enhancing the customer experience. As a result, these innovations have not yet created a meaningful differentiation value.
3. The results reveal that Product Innovation has a negative effect on Competitive Advantage, contrary to the expected outcome. This finding suggests that PT X's innovative products are not aligned with market needs, which prioritize stability and user-friendliness. Overly technical products are perceived by customers as offering limited practical benefit, thereby diminishing their contribution to competitiveness.
4. Competitive Advantage was found to have no significant effect on Customer Satisfaction, which does not support the research objective. This result is explained by the fact that PT X's competitive strengths largely stem from internal efficiencies, rather than from improvements in service quality that are directly perceived by customers.
5. The study shows that SSCM has a positive effect on Customer Satisfaction, supporting the research objective. However, the effectiveness of SSCM depends heavily on communication and transparency regarding the benefits of sustainability to customers. When customers are aware of these benefits, it enhances the company's image and strengthens customer loyalty.
6. Service Innovation was found to have no significant effect on Customer Satisfaction, which does not support the research objective. This is due to the focus of innovation being primarily on internal efficiency, which does not directly impact the customer experience. A more customer-centric innovation approach emphasizing comfort and engagement is required.
7. Product Innovation has a positive effect on Customer Satisfaction, aligning with the research objective. The products offered by PT X are relevant to customer needs and provide tangible added value. It is essential for PT X to continuously maintain this relevance to meet the evolving expectations of its customers.
8. Competitive Advantage does not mediate the relationship between SSCM and Customer Satisfaction. This finding does not support the research objective. SSCM practices at PT X have not yet sufficiently distinguished the company from its competitors. Therefore, SSCM must be developed into a more customer-relevant differentiation strategy.
9. Competitive Advantage also does not mediate the relationship between Service Innovation and Customer Satisfaction. This result contradicts the initial expectation. PT X's service innovation efforts have not yet generated sufficient value to create a perception of competitive superiority in the eyes of customers.

10. Competitive Advantage is proven to mediate the relationship between Product Innovation and Customer Satisfaction, thereby supporting the research objective. PT X's innovative products contribute meaningfully to the company's image and service quality, which enhances customers' positive perception of the company's value.

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