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# Chip-driven innovation and product competitiveness of new energy electronics manufacturing industry in China

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***Abstract***

The study aimed to determine the chip-driven innovation and product competitiveness of New Energy Electronics Manufacturing Industry in China. Specifically, it described the degree of chip-driven innovation benefits in terms of integration, security, and scalability; assessed the level of product competitiveness in terms of product functionality, cost efficiency, and product performance; tested the significant relationship of chip-driven innovation to product competitiveness; and proposed an action plan that New Energy Electronics Manufacturing Industry can implement to showcase chip-driven innovation and product competitiveness. The researcher conducted a survey among research and development personnels and product managers of New Energy Electronics Manufacturing Industry in China. It revealed that a positive perception of chip-driven innovation, highlighted the benefits in terms of integration, security, and scalability, Assessment of product functionality, cost efficiency, and performance also revealed a middle level of product competitiveness for products within China's New Energy Electronics Manufacturing Industry. There was a significant relationship between the integration of chip-driven innovation and product competitiveness. A proposed action plan was formulated to improve the product competitiveness of China's New Energy Electronics Manufacturing Industry.

***Keywords:*** chip-driven innovation, product competitiveness, new energy electronics manufacturing industry

# Chip-driven innovation and product competitiveness of new energy electronics manufacturing industry in China

## 1. Introduction

China's New Energy Electronics Manufacturing Industry is experiencing rapid growth, fueled by the booming domestic electric vehicle market and government initiatives promoting clean energy. This industry encompasses the production of various electronic components crucial for new energy vehicles, including motor controllers, battery management systems, and power semiconductors. With a focus on domestic production and technological advancements, Chinese companies are playing an increasingly prominent role in the global power electronics landscape, aiming to capture a larger share of this lucrative market.

This growth hinges on the development of chip-driven innovation within the industry. Companies are investing heavily in research and development to create next-generation chips that prioritize integration, enabling smaller, more efficient, and multi-functional components (Liu, 2023). Security is another crucial sub-variable, with advancements in chip design and encryption methods aiming to safeguard against cyber threats in increasingly connected vehicles. Finally, scalability is paramount, as manufacturers strive to develop chip production processes and infrastructure that can keep pace with the anticipated surge in demand for new energy electronics (Xu, et. al., 2022). By focusing on these key areas, China's New Energy Electronics Manufacturing Industry can solidify its position as a global leader in chip-driven innovation for the future of clean energy transportation.

Evaluating chip-driven innovation products within the New Energy Electronics Manufacturing Industry requires close attention to several key sub-variables that directly influence product competitiveness. Product functionality stands at the forefront, as innovative chips should empower manufacturers to create new energy electronics with features and capabilities exceeding those offered by competitors (Hu, et. al., 2022). Cost efficiency is crucial, as cost-effective chip solutions enable manufacturers to maintain competitive pricing while maintaining profit margins. Finally, product performance remains essential, with chip innovations expected to deliver tangible improvements in areas like power output, energy consumption, and overall system efficiency (Liu et.al, 2020). By meticulously assessing these sub-variables throughout the development and production process, Chinese companies can ensure their Chip-Driven Innovation products contribute significantly to their competitive edge within the global new energy landscape (Geng, 2019).

The relationship between chip-driven innovation and product competitiveness has been acknowledged, however, the empirical research for proofing such a relationship is still limited. There are some papers proposing action plans for improving the product features and functionality, including the study of Deng (2021) however only a few have included technology adoption of AI in their action plan, such as Wang (2023) and Wang, et. al., (2022). For that reason, this study aims at conducting empirical research to find the relationship between chip-driven innovation and product competitiveness of New Energy Electronics Manufacturing Industry in China.

As the focal point of this study, China's New Energy Electronics Manufacturing Industry offers a fascinating case study in Chip-Driven Innovation. Currently, the industry is making significant strides in integration, with companies like Huawei developing high-density three-in-one electric drive systems (Li et.al, 2019). However, security remains a concern, as some critical chip components are still sourced from foreign suppliers, potentially introducing vulnerabilities. Scalability is being addressed through government initiatives and investments in advanced chip production facilities. In terms of product competitiveness, Chinese manufacturers are displaying innovative functionality, like BYD's leading position in motor controllers (Wang et.al, 2020). However, achieving true cost-efficiency remains a challenge, and product performance is still catching up to established international players in certain areas. Overall, China's New Energy Electronics Manufacturing Industry demonstrates exceptional potential in Chip-Driven Innovation, but ongoing efforts are needed to address security concerns and further enhance cost-efficiency and performance to solidify its global competitiveness (Zhang et.al, 2021).

Understanding China's evolving landscape in Chip-Driven Innovation within the New Energy Electronics Manufacturing Industry offers valuable insights for various stakeholders. The researcher provided a compelling study on the intersection of technological advancement, business strategy, and global competition. For the Product managers, they have to glean valuable information on emerging trends, competitive analysis frameworks, and potential challenges to navigate in this rapidly evolving market. For company owners, insights into potential opportunities and strategic approaches to participate in this lucrative sector, fostering informed decision-making are now available. Finally, for the China's business community, this study shed light on the country's strengths and weaknesses in this critical industry, informing future investments, policy decisions, and collaborative efforts to solidify China's position as a global leader in clean energy technology and chip development.

***Objectives of the Study -*** The study aimed to determine the chip-driven innovation and product competitiveness of New Energy Electronics Manufacturing Industry in China. Specifically, it described the degree of chip-driven innovation benefits in terms of integration, security, and scalability; assessed the level of product competitiveness in terms of product functionality, cost efficiency, and product performance; tested the significant relationship of chip-driven innovation to product competitiveness; and proposed an action plan that New Energy Electronics Manufacturing Industry can implement to promote chip-driven innovation and product competitiveness.

## 2. Method

***Research Design -*** This study mainly adopted descriptive research methods such as literature review, questionnaire, and content analysis to systematically describe the relationship between chip-driven innovation and product competitiveness in China's new energy electronic manufacturing industry, to explain the research results fully and accurately. According to Liang (2020) research, descriptive research is a fundamental and important research tool, providing rich foundational materials and detailed factual basis for related research. By using this method, one can comprehensively and deeply understand the actual situation and problems of the research topic, laying a solid foundation for subsequent theoretical exploration and practical application. Peng, et. al., (2023) also unanimously believed that descriptive research methods are a systematic, objective, and comprehensive research method used to reveal the relevant expression viewpoints of the research topic, providing a foundation and basis for subsequent research.

***Participants of the Study -*** The researcher conducted a survey among research and development personnels and product managers of New Energy Electronics Manufacturing Industry in China. The total number of research and development personnel and product managers of New Energy Electronics Manufacturing Industry in China is 23,500. The study used the purposive sampling technique to determine the required sample of e respondents. For the minimum target sample of the study, the researcher used Raosoft Calculator to determine the sample size with a 5% error and confidence level of 95%, and a sample size of 378.

***Instruments of the Study -*** The study used three sets of questionnaires as the major mechanism for collecting the necessary data. The items per instrument have been presented as descriptive statements, and respondents indicate the frequency with which each statement applies on a four-point Likert scale as a 3.50 – 4.0 scale means strongly agree, 2.50 – 3.49 rate means agree, 1.50 – 2.49 scale means disagree and, 1.00 – 1.49 rating means strongly disagree. A self- made questionnaire was used by the researcher in data gathering. The questionnaire was composed of two parts. Part I contained the assessment of Chip-driven Technology which consists of Integration (5 items), Security (5 items), and Scalability (5 items). In part II, the questionnaire measured the product competitiveness consisting of product functionality (5 items), cost efficiency (5 items), and product performance (5 items). A pilot test was undertaken to determine the survey questionnaire's efficacy. 30 samples were subjected to a reliability test using Cronbach's alpha via SPSS 28.

***Data Gathering Procedure -*** To obtain necessary data, the researcher used a survey questionnaire and wrote a letter of request to the company to conduct the study. The questionnaires were distributed by the researcher to the participants of the study through sending them hard copy to their company in any available time and used Google forms that were sent thru emails and other communication platforms that the respondents had. The responses to the survey items were tallied and sent to the university statisticians for statistical analysis.

***Ethical Considerations -*** Ethical considerations was practiced in the conduct of the research work to warrant that every information that was gathered was used for research purposes only to maintain the quality and integrity of the research. The researcher sought ethical clearance and the consent of the companies through letters and communication to make sure that the target respondents were prepared to answer necessary questions involved in the research. It also ensured the confidentiality and anonymity of the respondents by not seeking their names as they were answering the questionnaires. The researcher ensured that the respondents voluntarily answered the questionnaires according to their will. Lastly, it was guaranteed that none of the respondents of the study will be hurt or harmed, and their safety and security was the top priority.

***Data Analysis -*** Weighted mean and rank were used to describe the chip-driven innovation benefits in terms of integration, security, and scalability; assessed the product competitiveness in terms of product functionality, cost efficiency, and product performance. The result of Shapiro-Wilk Test showed that p-values of all variables were less than 0.05 which translated that the data set was not normally distributed. Therefore, Spearman rho was used as part of the non-parametric tests to determine the significant relationship. All analyses were performed using SPSS version 28.

## 3. Results and Discussion

**Table 1**

*Summary Table on Chip-driven Innovation Benefits*

| Key Result Areas | Composite Mean | VI | Rank |
|---|---|---|---|
| Integration | 2.70 | Agree | 1 |
| Security | 2.51 | Agree | 3 |
| Scalability | 2.53 | Agree | 2 |
| Grand Composite Mean | 2.58 | Agree | |

Legend:3.50-4.00=Strongly Agree;2.50-3.49=Agree;1.50-2.49=Disagree;1.00-1.49=Strongly Disagree

Table 1 presents summary assessment on Chip-driven Innovation benefits. The composite mean of 2.58 indicates that the respondents Agree in general. This implies that the respondents agree on the benefits of integration, security, and scalability across all key areas, the results suggest room for improvement. This indicates a solid foundation for the technology, but there's potential to strengthen user confidence. In the study of Geng (2019), it was found out that Developers can focus on optimizing the integration process, clearly communicating security features, and addressing concerns about upgrade paths for scalability. By taking these steps, they can move user perception from cautiously optimistic to a more confident endorsement of the chip-driven technology.

Among the items cited, Integration ranked first with a mean score of 2.70 and verbal interpretation of agree. This implies that chip-driven innovation was seamlessly connected with existing systems and is easy to incorporate. This is a positive sign for adoption as smooth integration reduces complexity. According to the study of Bao (2021), it's important to consider if concerns exist in other areas (security, scalability) that might impact the overall user perception of the chip-driven technology. Scalability, ranked second with a mean of 2.53, followed by item Security with a mean score of 2.51. All the items have a verbal interpretation of agree.

**Table 2**

*Summary Table on Product Competitiveness*

| Key Result Areas | Composite Mean | VI | Rank |
|---|---|---|---|
| Product Functionality | 2.70 | Agree | 1 |
| Cost Efficiency | 2.53 | Agree | 3 |
| Product Performance | 2.54 | Agree | 2 |
| Grand Composite Mean | 2.59 | Agree | |

Legend:3.50-4.00=Strongly Agree;2.50-3.49=Agree;1.50-2.49=Disagree;1.00-1.49=Strongly Disagree

Table 2 presents the summary of the assessment of the respondents on product competitiveness. The composite mean of 2.59 indicates that the respondents agree in general. This implies that the respondents generally agreed the technology is competitive, the result reveals areas for improvement. In the study of Liu (2023), the respondents also perceived value aligns with cost, but optimization might be beneficial. Overall, the chip has potential but could be strengthened by focusing on both performance and cost efficiency to solidify its competitive edge in the market. Among the items cited, product functionality, ranked first with a mean score of 2.70 and verbal interpretation of agree. This implies that the data point emphasizes a strength of the chip-driven technology. With a high mean score and "Agree" interpretation, the respondents ranked functionality as the most positive aspect. The result suggests strong user satisfaction with the chip's features and capabilities. In the study of Zhang (2022), Functionality is crucial in a competitive market where products need to effectively address user needs. While in the study of Xu, et. al., (2022), when functionality excels, are there weaknesses in other areas like performance or cost efficiency that might impact the overall perception of competitiveness? A well-rounded analysis of all categories is necessary to understand the chip's true market position and identify potential areas for improvement.

*Product performance* ranked second with a mean of 2.54 and verbal interpretation of agree. Meanwhile cost efficiency, ranked third with a mean score of 2.53 and verbal interpretation of agree. This implies mixed signals regarding the chip's competitiveness. The respondents generally agreed (all "Agree" interpretations) that both performance and cost efficiency are positive aspects. However, these scores are lower than functionality. This suggests features are the strongest selling point, followed by acceptable performance and cost efficiency. In the study of Chen, et. al., (2022), it was found that there's room for improvement, as users might expect performance to match functionality's high satisfaction level. Optimizing cost efficiency could also make the chip more attractive. By focusing on both performance enhancement and cost optimization, developers can create a well-rounded product that excels across all categories, solidifying its competitive edge in the market.

**Table 3**

*Relationship Between Chip-driven Innovation Benefits and Product Competitiveness*

| Variables | rho | p-value | Interpretation |
|---|---|---|---|
| Integration | | | |
| Product Functionality | -0.042 | 0.410 | Not Significant |
| Cost Efficiency | -0.002 | 0.972 | Not Significant |
| Product Performance | -0.096 | 0.062 | Not Significant |
| Security | | | |
| Product Functionality | 0.286** | <.001 | Highly Significant |
| Cost Efficiency | 0.387** | <.001 | Highly Significant |
| Product Performance | 0.331** | <.001 | Highly Significant |
| Scalability | | | |
| Product Functionality | -0.268** | <.001 | Highly Significant |
| Cost Efficiency | -0.251** | <.001 | Highly Significant |
| Product Performance | -0.249** | <.001 | Highly Significant |

***. Correlation is significant at the 0.01 level*

As seen in the table, the computed rho-values ranging from -0.002 to -0.096 indicate a very weak indirect relationship between integration and the sub variables of product competitiveness. It shows that there was no statistically significant relationship between integration and the sub variables of product competitiveness since the obtained p-values were greater than 0.01. The computed rho-values ranging from 0.286 to 0.387 indicate a weak direct relationship between security and the sub variables of product competitiveness. It shows that there was a statistically significant relationship between security and the sub variables of product competitiveness since the obtained p-values were less than 0.01. The computed rho-values ranging from -0.249 to -0.268 indicate a weak indirect relationship between scalability and the sub variables of product competitiveness. It shows that there was a statistically significant relationship between scalability and the sub variables of product competitiveness since the obtained p-values were less than 0.01.

The results explore how chip features influence product competitiveness. Integration with other systems shows no significant impact (weak, indirect relationship). Security features, however, have a weak but positive impact (weak, direct relationship) on competitiveness, suggesting stronger security is linked to a more competitive product. Interestingly, scalability shows a weak negative impact (weak, indirect relationship). This means highly scalable solutions might come at the cost of functionality, performance, or affordability (Taylor, et. al., 2021). Security should be prioritized during development. Further investigation is needed to understand why scalability seems to have a negative correlation with competitiveness Deng (2021).

**Proposed Action Plan to improve product competitiveness**

A proposed action plan aims to address four key areas: security, patching, scalability architecture, and communication of scalability. The plan focuses on reducing vulnerabilities, implementing robust security measures, and ensuring competitiveness in the market through actions like threat modeling, hardware-based security features, and independent security audits. The goal of the action plan is to ensure timely identification, communication, and deployment of security patches. Streamlining development and implementing automated testing are key strategies. Also, this plan proposes designing a chip architecture that facilitates efficient scaling for growing data processing demands. Research into scalable architectures, hardware accelerators, and software tools for resource allocation are included. Also in this plan, a clear communication about scalability capabilities and limitations is crucial. Rigorous testing to validate these claims involves detailed documentation, benchmark tests, and open communication with users about future enhancements.

**Table 4**

*Proposed Action Plan to improve Chip-driven Innovation and Product Competitiveness*

| KEY RESULTS AREA | STRATEGIES/ ACTIVITIES | OBJECTIVES | EXPECTED OUTCOME | RESPONSIBLE PERSONS OR PERSONS INVOLVED |
|---|---|---|---|---|
| Enhance Security Features | Conduct thorough threat modeling and vulnerability assessments. | Reduce potential vulnerabilities in chip design. | Reduced potential vulnerabilities in chip design, leading to a more secure product. | Security Engineering Team, Research & Development Team |
| Maintain Prompt Patching Process | Establish a dedicated team for vulnerability response and patch development. | Ensure timely identification, communication, and deployment of security patches. | Timely identification, communication, and deployment of security patches, minimizing the window of exploitation for vulnerabilities. | Security Engineering Team, IT Operations Team |
| Enhance Scalability Architecture | Conduct research into scalable chip architectures like | Design a chip architecture that facilitates efficient | Chip architecture designed to facilitate efficient scaling to meet growing data processing | Chip Design Team, Software Development Team |

| | | | | |
|---|---|---|---|---|
| | multi-core processors or network-on-chip designs. | scaling to meet growing data processing demands. | demands, ensuring long-term product viability. | |
| Improve Scalability Communication & Testing | Develop detailed documentation outlining the chip's scaling potential and resource limitations. | Clearly communicate the chip's scalability capabilities and limitations to users. | Users are clearly informed about the chip's scalability capabilities and limitations, enabling them to make informed decisions about product usage. | Product Marketing Team, Quality Assurance Team |

## 4. Conclusions and Recommendations

A positive perception of chip-driven innovation, highlighting the benefits in terms of integration, security, and scalability, is observed in the New Energy Electronics Manufacturing Industry in China. Assessment of product functionality, cost efficiency, and performance reveals a middle level of product competitiveness for products within China's New Energy Electronics Manufacturing Industry. There is a significant relationship between the integration of chip-driven innovation and product competitiveness. A proposed action plan was formulated to improve the product competitiveness of China's New Energy Electronics Manufacturing Industry.

The research and development personnel may prioritize robust security and scalability in chip-driven technology design. The product managers may promote security and scalability as key differentiators in chip-driven technology for product competitiveness. The company may evaluate and assess the applicability of the proposed action plan to improve the product features and functionality of China's New Energy Electronics Manufacturing Industry. The future researchers in the field of Chip-driven technology may explore the long-term impact of prioritizing security and scalability in chip-driven technology on the product competitiveness and growth trajectory of China's New Energy Electronics Manufacturing Industry.

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