

# Technology Innovation in China's Home Electric Appliance manufactory industry-Case study of Haier Smart Home Ltd

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**Abstract.** China is still in the midst of digital transformation revolution. The Internet and advanced mobile communication channels have a profound influence on people's daily life. The e-commerce boosts the economy as the platform innovation and ecosystem establishment. Even though during the COVID-19, the online consumption has a major contribution to stabilizing the whole economy. The post-pandemic era forces the retail industry and other related service industry to transform digitally. Not only the retail industry and traditional financial industry face the digitalization revolution but also the traditional manufactory industry should follow the step of Industry 4.0 and Smart manufactory era. This article will discuss the digital transformation process in home electric appliance manufactory industry by analysing the case of Haier Smart Home Ltd.

## 1 Introduction

The COVID-19 pandemic makes the management team realize the importance of digitalization. As for the e-commerce business, the data analytics help companies learn about consumer behaviours and form the consumer profile even better and more accurate, which is crucial for effective business decision making process. Many industry verticals, such as manufactory or logistic industry, will be transformed through AI integration with enterprise, industrial, and consumer product and service ecosystems (Marketing Weekly news, 2019). Basically, the Industry 4.0 demonstrated that the global manufactory digitalization based on the adaptive automatic control of product lifecycle. The concept of digital twin proposed by Ponomarev, which envisages connection between the physical and digital world over the analytical program and machinery (2018). These new manufacturing digital transformation ideas promote companies' operational performance and production efficiency.

Within an organization, the research and development expenditure could be one indicator of its technological innovation inputs, and the number of proprietary technologies may present its technological level. It is hard to assess one company's digitalization success as huge capital investments but limited immediate payoff. Li and Zhou (2020) [7] developed one guidance for studying the overall status, development trend, key features and future direction of China's digital transformation of sectors. Although the monitoring system of the digital transformation process is comprehensive, it is not suitable for an individual company. The manufactory companies with higher level of digitalization in developed countries already show

good results in financial performance and efficiency improvement. This article is going to analyze the financial figures stated in the annual financial report of Haier and gain insights about Haier's technological innovation process from 2014, which provide some suggestion for decision-maker to pursue the digitalization trend.

## 2 Related research literature review

The digital transformation is one critical part of Smart Manufacturing involving the technologies applied in the Industry 4.0 era. Industry 4.0 is a collective term for technologies and concepts of the value chain. Hermann, Pentek, and Otto (2016) [3] presented the detailed content of Industry 4.0 as follows:

Within the modular structured Smart Factories of Industry 4.0, Cyber-Physical Systems (CPS) monitor physical processes, create a virtual copy of the physical world and make decentralized decisions. Over the Internet of Things (IoT), CPS communicate and cooperate with each other and humans in real-time. Via the Internet of Services (IoS), both internal and cross organizational services are offered and utilized by participants of the value chain.

The leading manufactories in China have started to construct the innovation projects related to production line and platform upgrade. Taken Haier Smart Home Ltd, they made huge investments in programming, software and application management and platform upgrade starting from 2017. In the case of manufacturing, big data methods allow accessing and processing a large amount of information and data generated in the production process [9]. The application of big data is one

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characteristic of digital transformation, which is going to reform the whole business.

The research did by IBM demonstrated that products and services can be reshaped using the new capabilities for mobility, interactivity and information process. Besides, the operating model can be realigned so that customer preferences and requirement inform every activity in the buying and selling chain. However, the companies involved in digital transformation still face some new challenges in the Industry 4.0 era. The first one is how to monetize the customer value and proposition as a huge investment in upgrading the value chain for serving customers even better. Another concern is to determine the business requirement for achieving the company's full benefits [2]. Therefore, the cost-benefit analysis is necessary when devoting heavy capital investments to innovation projects.

The researchers demonstrated some interesting findings in their papers when examining the digital transformation evidence in construction and auto industry. Kline (2019) [5] came up with the concept of Construction 4.0 and talked about the digital transformation in the construction industry. It turns out the conclusion that the challenge is even bigger in construction industry considering the low innovation culture and the demographic of the industry. Similar to the electric appliance manufactory, Llopis-Alber analyzed the digital transformation on Spain's automotive industry this year. Llopis-Alber's comprehensive research demonstrated some factors appropriate to favour the digitalization process and ultimately its effectiveness in the production, sales and connectivity process with the user/ client, but some small or medium companies still lack digital transformation strategies (Llopis-Alber, 2021).

The developed countries technology innovation achievement has demonstrated that the digitalization of the value chain is one indicator of the capacity of a company with respect to the fourth industrial revolution and the future success of the company. Eva et al. (2016) have examined the positive relationship between the degree of automation and the resulting contribution to the corporate success. Additionally, Bughin et al. (2017) also found that a higher score of digital intelligence would have a good impact on companies' financial performance, such as revenue, EBIT and growth rate. The digitalization and intelligentization of manufacturing industry will empower them with the ability to react market demand quickly, which will be helpful to achieve more market share and follow the step of industrial revolution.

### 3 Research design and findings

Haier Group is a world-leading provider of better life and digital transformation solutions. Through technology innovation, Haier aims to help corporate clients with digital transformation. Also, Haier has been recognized National Science & Technology Award, which is the highest honor in China's science and technology field.

The research will examine the Haier's digital transformation process by analyzing three critical variables: Technology acquisition, R&D expenditure and PVP. All the data origins from Haier's annual financial report from 2014 to 2019 and processed by Excel.

#### 3.1 Investment in technology acquisition from 2015 to 2019

Wu and Zhou (2020) [10] did comprehensive research about the dynamic characteristics of technological innovation investment, particularly in Chinese power equipment manufactories. The variables applied in their research, such as Technology Purchase, Equipment purchase investment, will be used in this paper to examine the Haier's investment in technology acquisition from 2015 to 2019.

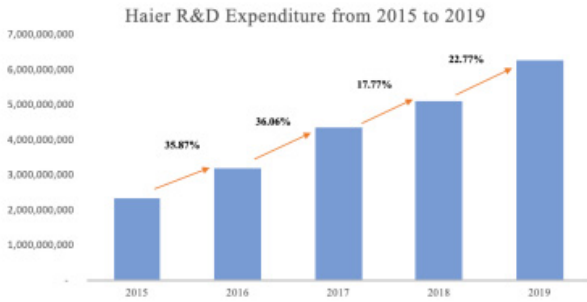
The technology acquisition mainly comes external parties and internal R&D. The total investment for technology acquisition has four main components from Wu and Zhou's previous paper when examining the Openness of one company's technology innovation, which include Cooperative R&D(External), Technology Purchase (External), Equipment Purchase (External) and in-house R&D (2020). Sourcing external knowledge broadly has a significant effect on a firm's innovation performance as external knowledge is used to create innovation (Kang, 2015). If technology acquisition is effectively applied, companies could learn more from technological solutions and hence take advantage of new business opportunities.

The following stack bar illustrates the annual change of each component in total investment for technology acquisition from 2015 to 2019.



**Fig. 1.** Four components in technology acquisition.

Haier has a global R&D network, which not only relies on the 10 R&D centers around the world but also enhances the proprietary technology and platform development by business combination and purchase. Firms have different levels of R&D activities and knowledge (Caloghirou et al.2004), and these differences may cause varying innovation performances across firms.As Haier plays a leading role in the development of products and technologies, they had a huge amount of investment in production equipment annually. The internal research and development of proprietary technology amount (in-house R&D) have been recognized as intangible assets in the annual report.



**Fig. 2.** Haier R&D expenditure from 2015 to 2019.

The investments spent on research and development have increased at a fluctuated rate from 2015 to 2019. Most manufactories realized the importance of technology innovation and digitalization in 2015. Haier started the digital transformation journey from the platform innovation in 2016: U+ SmartLife platform (U+ home OS) + smart manufacturing platform. Then, the rapid development of e-commerce business impels Haier to strengthen the logistic supply chain and enhance delivery efficiency. The huge investment in the logistic supply chain from 2016 to 2017 is one reasonable evidence to support the argument.

**3.2 Correlation analysis: internal and external R&D investments**

Haier’s technology innovation origins from internal research and development, global R&D centers cooperation and business combination or purchase. The number of R&D personnel has increased from 10,293 to 16,679 between 2016 and 2019. The professional enterprise contributed to the technology and product innovation, and the total R&D expenditure increased constantly. Therefore, the strong relationship between R&D expenditure and in-house R&D is reasonable.

Instead of closed innovation, the recent model suggests an open innovation paradigm, where the R&D structure should be seen as an open system (Chesbrough, 2003; Chesbrough et al., 2006). Firms should use external ideas as well as internal ideas as firms to advance their technology. Hair obviously has an opened innovation model with in-house research center as well as external technology acquisition.

**Table 1.** The correlation analysis.

	R&D Expenditure	In-house R&D	Technology Purchase	Cooperative R&D
R&D Expenditure	1			
In-house R&D	0.9244	1		
Technology Purchase	0.9661	0.9595	1	
Cooperative R&D	0.7253	0.4589	0.6803	1

The proprietary technology and application software incurred from purchase or business combination has been recognized as intangible assets. Since the research focuses on the technology innovation, the license and

franchises achieved by purchase transaction will not be taken into account although it has a large amount. When the internal research and development ability has steadily enhanced, the role of cooperative R&D is going to get less significant. Hair will be able to mostly rely on their own technology. Thus, there is a low to moderate correlation between in-house R&D and Cooperative R&D.

Expect for the production proprietary technology, some of the proprietary technology, such as algorithms operation and artificial intelligence, are invisible, but it continuously upgrades the capacity of business operation interconnectivity by integrating the technology in the production line with necessary R&D inputs and turns into better operational performance. For example, Hair has applied cutting-edge technologies such as 5G and edge computing in more than 200 projects for in-depth integration of advanced manufacturing technologies and new-generation artificial intelligence technologies. Those technology inputs have driven efficiency improvement throughout the whole manufacturing process as well as achieved the production goals and created the opportunities for cost optimization.

**3.3 The ratio of the platform against the product (PvP)**



**Fig. 3.** The change of PvP ratio.

Sebastian Olma (2014) argues that the platform has emerged as a “generic ‘ecosystem’ able to link potential customers to anything and anyone, from private individuals to multinational corporations. For firms, the ecosystem establishment may cost more research and development expenditure. The management team or the decision-maker in the organization would do the cost-benefit analysis and consider whether the huge investment is worthwhile.

In 2015, Haier still focused on product innovation and new manufactories for home appliances production have been constructed in different areas in China. There was a rapid growth in platform innovation projects from 2016 to 2018 due to the popularity of e-commerce and data-driven trend. Krishnan and Gupta (2001) have examined that a firm’s product positioning and introduction sequence decisions made during the product-planning phase are significantly impacted by the presence of platforms. Haier deepened the AI+5G technology and investment in smart appliances and applied digital insight to optimize the entire ecosystem with factories as the core task. Also, the Smart Home

Platform is one of the main platform innovation projects, which uses the Smart Home APP as the core entry and the Smart Home cloud brain as the brain for data analysis. This platform also enables the '5+7+N' smart home scenario and provides a customized home experience. Haier opened up its global resources, built HOPE (Haier open innovation platform) to incorporate users, enterprise and resources into the same interactive ecosystem. However, the product innovation project outweighs the investment in platform innovation.

## 4 Conclusion

Digital transformation is one prospecting trend, and it accelerates the business. We found out that Haier made huge capital investments in research and development, as well as the product and platform innovation projects. Haier focused on platform upgrade at the early stage due to the growth of e-commerce and developed more intelligent electric appliances recently. The actions taken in a different stage of digital transformation are able to fit with the short-term and long-term business development goals.

On the one hand, for the large size company in home electric appliance industry, they could learn some experience from Haier's digital transformation strategies. On the other hand, the enterprises could explore the digitalization path in marketing and after-sale service. The small or medium size enterprises may consider the delay between the current investment in the required technologies and expected benefit as the limited budget and digital transformation strategies. There is still a long road for traditional manufactories toward digitalization. Also, the assessment and monitoring system of individual's company digitalization process should be developed by future's research.

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