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Circular business model in the consumer electronic industry for WEEE management: a desk analysis of Chinese companies

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Author: **Yue Wang**

Student ID:	101644
Advisor:	Jinou Xu
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Abstract

Due to the rapid economic growth, growing demand for high-tech products, and decreasing service life of products, Waste Electrical and Electronic Equipment (WEEE) generation is increasing. Consumer electronics, notably, contribute significantly to the mounting issue of electronic waste (e-waste) due to the factors mentioned earlier, this industry drawing considerable attention to this environmental concern. The Circular Economy has become a crucial driver in promoting sustainable practices by championing circular approaches and closed-loop systems. By advocating for these practices, it not only tackles immediate environmental challenges but also lays the foundation for a circular business model. Circular Business Models play a crucial role in translating the principles of the Circular Economy into practical strategies, particularly for the consumer electronics sector companies, addressing the management of e-waste. China has emerged as a major contributor to global WEEE but has taken noteworthy steps in managing this issue, so this thesis explores China's unique context. Building on the oft-quoted ReSOLVE framework, developed by EMF (2015), Marke et al.(2020) have refined from it 11 Circular Business Models to suit the context of e-waste reduction, called Modified ReSOLVE framework. This thesis mapped these refined models against the evidence of circular business practices identified in the corporate sustainability reports of six out of top 10 consumer electronics companies in China. Then, this thesis uses a cross-case analysis approach to compare the similarities and differences between these companies' Circular Business Model, and by comparing them with the 26 current CEBMs from the literature to get potential Circular Business Models that might be applied in consumer electronic industry. This thesis also discussed the possible factors that contribute to these similarities and differences and the challenges and opportunities to apply the potential Circular Business Models.

Key-words: Circular Economy, Waste Electrical and Electronic Equipment, e-waste, Circular Business Model, China, Consumer Electronics

Abstract in lingua italiana

A causa della rapida crescita economica, della crescente domanda di prodotti high-tech e della diminuzione della durata di vita dei prodotti, la produzione di rifiuti di apparecchiature elettriche ed elettroniche (RAEE) è in aumento. L'elettronica di consumo, in particolare, contribuisce in modo significativo all'aumento del problema dei rifiuti elettronici (e-waste) a causa dei fattori menzionati in precedenza. L'economia circolare è diventata un motore cruciale nella promozione di pratiche sostenibili, sostenendo approcci circolari e sistemi a ciclo chiuso. Sostenendo queste pratiche, non solo si affrontano le sfide ambientali immediate, ma si gettano anche le basi per un modello di business circolare. I modelli di business circolari svolgono un ruolo cruciale nel tradurre i principi dell'economia circolare in strategie pratiche, in particolare per le aziende del settore dell'elettronica di consumo, affrontando la gestione dei rifiuti elettronici. La Cina è emersa come uno dei maggiori contribuenti di RAEE a livello globale, ma ha compiuto passi degni di nota nella gestione di questo problema; questa tesi esplora quindi il contesto unico della Cina. Partendo dal più volte citato quadro ReSOLVE, sviluppato da EMF (2015), Marke et al.(2020) hanno perfezionato 11 modelli di business circolari per adattarli al contesto della riduzione dei rifiuti elettronici, chiamati Modified ReSOLVE framework. Questa tesi ha mappato questi modelli raffinati rispetto alle prove di pratiche commerciali circolari identificate nei rapporti di sostenibilità aziendale di sei delle 10 principali aziende di elettronica di consumo in Cina. In seguito, questa tesi utilizza un approccio di analisi trasversale per confrontare le somiglianze e le differenze tra i modelli di business circolare di queste aziende e per confrontarli con i 26 CEBM attuali della letteratura per ottenere potenziali modelli di business circolare che potrebbero essere applicati nell'industria dell'elettronica di consumo. Questa tesi ha anche discusso i possibili fattori che contribuiscono a queste somiglianze e differenze e le sfide e le opportunità per applicare i potenziali Modelli di Business Circolare.

Parole chiave: Economia circolare, rifiuti di apparecchiature elettriche ed elettroniche, rifiuti elettronici, modelli di business circolare, Cina, elettronica di consumo.

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1. Introduction

In an era marked by rapid technological advancements and a growing emphasis on sustainable business practices, the consumer electronics industry stands at the nexus of innovation and environmental responsibility. The escalating concerns surrounding Waste Electrical and Electronic Equipment (WEEE) and the finite nature of resources underscore the urgency for companies to adopt circular business models. As the Chinese consumer electronics market continues to expand, understanding and implementing circular business models become imperative for both industry leaders and emerging players.

1.1 Circular Economy and Circular Business Model

Amid the escalating concerns surrounding electronic waste (e-waste), the Circular Economy emerges as a pivotal force in championing sustainable practices. By advocating for circular practices and closed-loop systems, Circular Economy not only addresses immediate environmental challenges but also establishes a circular business model (Pollard et al., 2021). Key activities within the Circular Economy framework, including recycling, reuse, remanufacturing, and refurbishment, play a crucial role in extending the life of electronic products and recovering precious materials from discarded items (Pan et al., 2022; Xavier et al., 2023). These actions are integral to sustainable development (Go et al., 2015) and effective e-waste management (Bressanelli et al.,2020), ensuring the utility and value of products throughout their lifecycle(Geissdoerfer et al., 2017b).

As electronic waste generation continues to escalate at a rate of 3–5% per annum(Xavier et al., 2023b), the adoption of circular practices becomes imperative for effective e-waste management. The core objective of circular economy is to promote sustainable practices that not only mitigate the environmental impact of electronic waste but also safeguard the natural domain and ensure the well-being of living beings. In essence, circular economy becomes a cornerstone in the global effort to manage e-waste responsibly, emphasizing the importance of circularity for the health of our environment and the longevity of our communities.

According to the Ellen MacArthur Foundation, circular economy is rooted in three principles. Firstly, it aims to avoid waste and pollution from the front end of the design process, ensuring sustainability by eliminating negative impacts on natural systems and human health. Secondly, circular economy seeks to extend the lifecycle of products and materials through a focus on durability, reuse, remanufacturing, and recyclability. Thirdly, circular economy strives to regenerate natural systems by avoiding non-renewable resources and protecting renewable resources (Ellen MacArthur Foundation).

In our current global context, the linear economy model of "take-make-use-dispose" is unsustainable, leading to resource depletion and environmental degradation. The circular economy, also known as "grow-make-use-restore," presents an alternative model that maximizes benefits to the environment while minimizing associated costs (Chen et al., 2023).

The circular economy challenges traditional business models that promote a linear consumption pattern. Manufacturers, driven by a short-term sales strategy, often design products with limited lifecycles, contributing to the "take-make-waste" paradigm. However, this linear system is unsustainable in the long run, necessitating a shift towards circular economy principles. By managing materials responsibly, economic growth becomes possible without compromising planetary boundaries. Circularity is about minimizing resource waste and maximizing the retention of value in resources and materials (Cécile et al., 2018).

Business models, particularly circular business models, play a significant role in operationalizing the principles of the circular economy. The transition towards a circular economy demands a systemic approach to business models, product design, and supply chains, leveraging digital technologies as system enablers (Roci and Rashid, 2023). Achieving a sustainable business model requires innovation, challenging traditional ways of thinking and doing business. The more radical the innovation, the greater the likelihood of changes required to the traditional business model (Bocken et al., 2016).

The circular economy offers an effective solution to the e-waste problem. By promoting responsible material management and resource efficiency, circular economy not only addresses immediate challenges but also contributes to global environmental sustainability. Circular business models become essential tools in translating the principles of the circular economy into actionable strategies for companies operating in industries, specifically in consumer electronic industry to manage e-waste.

1.2 WEEE and Consumer Electronics

While electrical and electronic devices have transformed the contemporary lifestyle, offering new ways to interact, communicate, entertain, and learn (Nnorom and Osibanjo, 2009), the advent of 'smart' devices and continuous technological development has exponentially increased the production, consumption, and disposal of electrical and electronic equipment (EEE) (Kiddee et al., 2013; Ongondo et al., 2011). The widespread adoption of these devices, coupled with rapid technological advancements and accelerated obsolescence rates, has led to a concerning upswing in waste flows, encapsulated by the term Waste Electrical and Electronic Equipment (WEEE) or e-waste (LeBel, 2016; Richter, 2016). In the contemporary world, the surge in WEEE, commonly referred to as e-waste, has catapulted it into becoming one of the fastest-growing global environmental concerns (UNEP, 2007). With an estimated annual generation ranging from 20 to 50 million metric tons globally, the challenge of managing this electronic waste has become urgent (Lee et al., 2018; Perkins et al., 2014).

The electrical and electronic equipment (EEE) industry, recognized as the leading and fastest-growing manufacturing sector globally, is a pivotal force behind the escalating generation of WEEE (Dias et al., 2022). The continuous advancement of science and technology propels the production of EEE, inevitably resulting in the generation of waste EEE or electronic waste/WEEE. The estimated global generation of WEEE witnessed a remarkable 20% increase between 2016 and 2019, indicating a mean growth of 6.7% per year (De Oliveira Neto et al., 2022) and the shocking statistics from 2019 reveal a global production of 53.6 million metric tons of electronic waste, with projections indicating a surge to 74.7 million metric tons by 2030 (De Oliveira Neto et al., 2022).

WEEE represents not only a potential source of valuable materials, including base and precious metals but also a reservoir of hazardous and toxic substances that pose environmental and human health risks when inadequately managed (Cesaro et al., 2019). Due to the complex and diverse composition of raw materials of electronic products, the pollution caused by them to the environment is also multifaceted. Taking a television as an example, the picture tube contains explosive substances, and the cathode ray tube and the tin drop on the circuit board, plastic shell, etc. are all toxic substances(Geissdoerfer et al., 2017). And for a computer, more than 700 raw materials are needed, more than half of which contain substances harmful to the body and the environment, mainly heavy metals, especially lead. Lead is a persistent pollutant, which cannot be broken down by biological metabolism and will cause damage to the human kidney, nerve, and blood systems; In addition, the computer's battery and switch also contain bundles and complexions, which will not harm human brain nerves, and the complexes will easily penetrate the skin, causing severe skin allergies,

and even cause asthma and damage to DNA structure. Mixing electronic waste with domestic waste directly landfill or incineration, the harmful substances contained in it will dissolve in the leachate, pollute groundwater and soil, and the harmful gases formed after incineration will pollute the atmosphere, and eventually endanger the entire living environment of humans, plants, and microorganisms(Ding et al., 2019). Although electronic waste is very harmful, this new solid waste also contains great wealth, a considerable part of which has high renewable value, and its high grade, can also save exploration, intelligent mining costs, so that processing costs are reduced. For example, the cost of obtaining resources through renewable means such as copper and various rare precious metals, glass and plastics is far lower than the cost of obtaining resources directly from ore, raw materials and other smelting and processing, which can not only effectively avoid environmental pollution, but also save a lot of resources and create considerable economic benefits. According to Danish research results, 130kg of copper, 0.45kg of gold, and 2 g of tin can be separated from 1 ton of electronic plates collected at random, and these gold alone are worth 6,000 US dollars. 1 scrapped computer host, the composition includes 54% steel, 20% copper and lead, 17% plastic W and 8% circuit board, of which the circuit board also contains gold, silver, and other precious metals (Quyang,2015). So, the heterogeneous composition of WEEE, containing both valuable materials and hazardous substances, underscores the complexity of its management. Balancing the economic potential of material recovery with environmental concerns is crucial in designing effective WEEE management systems (Cesaro et al., 2019). In addition, from a socioeconomic perspective, the disposal of WEEE offers economic opportunities through material reuse and commercialization, presenting a spectrum of valuable raw materials (plastics, metals, and others) that can be harnessed for economic benefit (UNEP, 2007).

The discarded e-waste from Electrical and Electronic Equipment (EEE) typically falls into three main categories: large household appliances(refrigerators and washing machines), consumer equipment(TVs, DVD players, mobile phones, mp3 players, and leisure and sporting equipment), and information technology equipment and telecom(personal computers, monitors, and laptops) (UNEP, 2007). At same time, the classification outlined by the WEEE Directive (2012/19/EU) becomes more authoritative. This classification categorizes WEEE into various types, including large household appliances, small household appliances, IT and telecommunications equipment, consumer equipment, and photovoltaic panels, among others and the consumer equipment emerging as among the most generated, given their fast substitution rates and short lifespan (Ongondo et al., 2011).

In the context of this thesis, the focus narrows to the subset of WEEE arising from consumer electronic industry, according to the WEEE Directive (2012/19/EU) classification. Consumer electronics refers to electronic products for daily consumer

life, mainly including parts, modules, and electronic assemblies, etc. They are usually characterized by compactness and lightness, simple operation, and energy-saving design, etc. According to the different functions of use, consumer electronics products can be classified into entertainment products, communication products and home office products(Vanessa et al., 2020). The selection of consumer electronics is driven by the industry's disproportionate contribution to WEEE, as consumer electronic products exhibit higher discard rates and faster growth compared to other categories. It is estimated that 52.7% of WEEE comes from consumer electronics such as cell phones, headphones, or computers (Jenner, 2023).

1.3 WEEE and Consumer Electronic Industry in China

Against the backdrop of China's rapid economic growth, coupled with advancements in the electronic information industry and an elevation in living standards, the nation has witnessed an unprecedented surge in consumer reliance on electronic products (Li and Achal, 2020; Alblooshi et al., 2022). The confluence of soaring consumer demands and lucrative market profits has accelerated the replacement cycle of electronic products, resulting in a startling escalation of e-waste production in China (Xiao and Wang, 2022).China, at same time, being the world's largest producer and consumer of electronic products with a population of approximately 1.44 billion people, stands as a monumental contributor to the global electronic waste landscape. The annual end-of-life rate of electronics in China, ranging between 5% and 10%, projects a future where the nation's e-waste is expected to surpass 27 million tonnes by 2030 and potentially reach a staggering 51 million tonnes by 2050 (Mishima and Nishimura, 2016; Zeng et al., 2020).

The annual growth rate of global e-waste volume has outpaced population growth, with only 17.4% of e-waste appropriately disposed of worldwide. China, a significant contributor to global e-waste, has undertaken notable steps in managing this burgeoning issue. With the continuous enhancement of pilot projects and evolving domestic e-waste legislation, China's legal e-waste recycling industry has demonstrated impressive processing capacity and quality (Song et al., 2015; Zhao et al., 2018). As of 2022, China has already dismantled a staggering 97.05 million units of Waste Electrical and Electronic Equipment, showcasing the China's resolute attitude towards e-waste management (Ministry of Ecology and Environment of China). In the pursuit of effective WEEE management, China has established 109 authorized WEEE recycling and processing enterprises, annually recycling approximately 3.9 million tons and 170 million units of waste electrical and electronic products as of 2020 (Ministry of Commerce of the People’s Republic of China, 2020). Given China's status as a global leader in WEEE production, understanding the intricacies of its WEEE

management becomes paramount for other nations grappling with electronic waste challenges.

China's significance in the WEEE landscape extends beyond its sheer production volume. The nation's population density, economic prowess, and voracious demand for electronic products position it as a trendsetter in shaping global e-waste dynamics. This thesis, therefore, focuses on the unique context of China, its status as a global producer and consumer of electronic products, and its influential role in inspiring and informing the management practices of electronic waste in other nations. Understanding China's multifaceted role in WEEE is not only critical for comprehending the global e-waste scenario but also for formulating effective and context-specific waste management strategies in an era dominated by electronic consumption.

The electronic information Industry in China encompasses a spectrum of activities related to the production, processing, handling, transmission, and reception of information, utilizing electronic and information technologies. This industry involves the collective processes of equipment manufacturing, hardware production, system integration, software development, and application services, all aimed at achieving functions related to information. It can be further categorized into investment-type products, consumer-type products, and component products(Chen and Ke, 2023).

Consumer electronics, a sub-industry within the broader electronic information sector, is pivotal in this landscape. According to the Ministry of Industry and Information Technology, China boasts the world's largest production and sales scale in the consumer electronics sector, holding a global leadership position. The country has emerged as a key manufacturing hub for consumer electronics globally, with a majority of major electronic production and contract manufacturing enterprises establishing their manufacturing bases and research centers in China. Since the 18th National Congress of the Communist Party of China, the consumer electronics industry has undergone rapid development, positioning itself as a leading market for cutting-edge consumer electronic products worldwide. At present, more than 70% of electronic products are manufactured and assembled in China. Although the growth of traditional consumer electronics has slowed down in recent years, the rapid growth of new consumer electronics, represented by mobile phones, tablets and wearables, has provided a steady impetus for China's electronics manufacturing industry. At the same time, it led to large amount of e-waste generation, as mentioned above, in China for the management of e-waste especially in consumer electronic industry is a very valuable research direction.

1.4 Research Objective

The impetus for this research is grounded in the growing significance of circular business models in fostering sustainability and resource efficiency within the consumer electronics sector. With increasing environmental concerns and a shift toward responsible business practices, there exists a pressing need to examine and enhance circularity in the production, usage, and disposal of electronic devices. So, this thesis aims to undertake a comprehensive investigation into the circular business models implemented by key players in the Chinese consumer electronics industry. Specifically, the research focuses on understanding the circular strategies employed by prominent companies(Huawei, Xiaomi, BOE, ZTE, Lenovo, and Transsion.) Through these analysis, this study aspires to not only benefit industry practitioners but also contribute valuable insights to the academic understanding of circularity within the context of the Chinese consumer electronics industry.

The entire research process unfolds through a structured methodology involving a detailed examination of the circular practices adopted by each case company. Through within-case analysis, systematically gather and assess data utilizing the Modified ReSOLVE framework refined by Marke et al.,(2020), thereby presenting the distinctive circular business models employed by each of the companies. Subsequently, a cross-case analysis is conducted to discern commonalities and variations across the spectrum of the Chinese consumer electronics industry. The reason why these similarities and differences occurred in this industry also be analysed and be put as meaningful insights for start-ups or companies seeking to undertake transformative initiatives within their circular business models. This methodological approach enables a comprehensive understanding of both the unique contributions of each case and the emergent patterns characterizing circularity within the industry.

2. Literature review

The literature review is beneficial in providing a general overview of disparate and interconnected research fields.

2.1 Circular Economy

The concept of Circular Economy has gained significant attention in recent years, presenting itself as a potential solution to the challenges posed by waste generation and resource scarcity within the context of industrial and economic activities. The Ellen MacArthur Foundation (EMF) provides a foundational definition, describing circular economy as "an industrial economy that is restorative or regenerative by intention and design" (EMF, 2013, p. 14). This definition aligns with Boulding's (1966) portrayal of Earth as a closed and circular system, emphasizing the need for equilibrium between the economy and the environment (Geissdoerfer et al., 2017a).

In response to the growing population and increasing demands, the concept of circularity has emerged to reshape resource usage not only in production and economic systems but also to address resource scarcity effectively. The core principles of the circular economy involve closing loops in industrial systems, minimizing waste, and reducing raw material and energy inputs (European Environment Agency, 2016; Stahel, 2016). This approach has garnered attention in policy-making globally (EC, 2017; The Standing Committee of the National People's Congress China, 2008) and has been increasingly implemented across various sectors worldwide, including production, consumption, and waste management (Ghisellini et al., 2016).

Key strategies in achieving circularity include eco-design, waste prevention programs, and extending the lifetime of products (European Environment Agency, 2016). The mantra of "Reduce, reuse, and recycle" serves as a guiding principle in waste management, aiming to minimize raw material use, energy input, and waste production. Within the circular economy framework, maintaining the value of products and materials for as long as possible is crucial, emphasizing the creation of value-added products from wastes (European Commission, 2018).

The circular economy concept is intertwined with related notions such as industrial ecology, product-life extension, regenerative design, and the cradle-to-cradle approach. Pearce and Turner (1990) are credited for introducing the concept, emphasizing a circular economic model as opposed to the prevailing linear one, which transforms natural resources directly into waste (Winans et al., 2017). Scholars and practitioners have highlighted the transformative potential of the circular economy in generating innovative business models, including sharing platforms, remanufacturing, modular design, and circular supplies (Esposito et al., 2018).

Transitioning to a circular economy is not only environmentally beneficial but also holds economic advantages. The Ellen MacArthur Foundation (2015a) estimates that a shift to a circular economy could significantly reduce global emissions, contributing to environmental quality and social equity by 2030 and 2050 (Kirchherr et al., 2017). This transition challenges the established linear production and consumption model, aiming to create an economic system that is intentionally restorative of natural and social capital (Blomsma & Brennan, 2017). The circular economy represents a departure from the linear "take, make, and dispose" economic model, offering an alternative that minimizes material and energy losses to preserve the biosphere. This non-linear approach involves creating circular systems, where waste generated by one process becomes the raw material for another, necessitating a shift beyond strictly sectoral concerns to consider the territorial dimension in strategies (Geissdoerfer et al., 2017). It stands as an opportunity to alter the negative spiral between the economy and natural ecosystems, promoting a mutually reinforcing relationship that benefits both environmental protection and innovative business models.

The circular economy is not limited to a focus on products alone but extends to the design of sustainable product-service bundles, integrating approaches to deliver a sustainable economic system through circular business models. However, it is crucial to consider potential rebound effects, where consumer behavior may deviate from the intended sustainable usage (Hertwich, 2005; Zink and Geyer, 2017). Product care, including activities initiated by consumers to prolong product lifetimes, plays a significant role in influencing the sustainability of consumption through circular business models (Agrawal et al., 2012; Bardhi and Eckhardt, 2012; Kjaer et al., 2019).

The essence of the circular economy lies in its systemic approach, engaging multiple stakeholders and emphasizing the redesign of products, processes, and systems. Circular value propositions, facilitating multiple transactions through circular business models, are essential in achieving a resource-centric approach (Bakker et al., 2014; Nußholz, 2017; Urbinati et al., 2017). Factors such as stock improvement, eco-friendly waste minimization, and the 4Rs (reduce, reuse, recycle & recover) contribute

to circular economy principles, emphasizing mechanisms for achieving stock optimization (Ghisellini et al., 2018b; Kalmykova et al., 2018).

Rooted in historical, economic, and ecological fields, the circular economy holds relevance for sustainable business practices. Scholars have defined it as a regenerative system that minimizes resource input and waste, emission, and energy leakage through the slowing, closing, and narrowing of material and energy loops (Geissdoerfer et al., 2017). The circular economy's goals include reducing solid waste, landfill, and emissions through activities like reuse, remanufacturing, and recycling (Murray et al., 2017). Organizations adopting circular economy practices aim to simultaneously address environmental challenges and reap economic benefits (Ghisellini et al., 2016).

The intertwining of the circular economy concept with sustainability-focused business models has led to its recognition as a new approach expected to contribute to more sustainable development. Examples of business models incorporating circularity elements include recycling, upcycling, sharing, repair, and remanufacturing, with applications extending to industries such as fashion (Ghisellini et al., 2015; Murray et al., 2017).

In practice, firms pursuing circular economy principles aim to maximize the value of material resources while minimizing overall resource use, waste, pollution, and emissions associated with their business activities (Geissdoerfer et al., 2017). Material flows within the circular economy can be managed through the 3R principles of reduce, reuse, and recycle, derived from the waste management hierarchy, or through extended versions like the 9Rs, highlighting diverse reusing potentials (Kirchherr et al., 2017). Additionally, business models should aim to narrow, slow, or close resource flows to fully embrace circularity (Bocken et al., 2016).

The challenge at present lies in transforming the current consumption pattern, based on a linear production-consumption-waste model, into a circular economy that is inherently regenerative. Kirchherr et al. (2017) frequently depict the circular economy as a combination of reduce, reuse, and recycle activities. Investing in innovative equipment for environmental protection plays an essential role in facilitating this transition.

2.2 Business model and Circular business model

Business model and Circular business model

Therefore, for the company, the transformation of its business model is crucial, a greater degree of transformation into a circular business model will bring greater benefits to the company, this benefit is not only more to promote sustainable development, but also to transform the entire economic model.

Business models serve as foundational frameworks defining how organizations create, deliver, and capture value, playing a pivotal role in shaping the architecture and expansion paths of companies (Osterwalder and Pigneur, 2010). Business models, integral to organizations' value creation and capture, wield significant influence over their strategic direction and adaptability in dynamic markets (Chesbrough, 2010). However, modifying established business models poses challenges for organizations, limiting their ability to innovate and respond effectively to changing circumstances (Chesbrough, 2010). The emergence of Circular Business Models stands out as a transformative paradigm, defined by Geissdoerfer et al. (2020) as models that cycle, extend, intensify, and/or dematerialize material and energy loops to reduce resource inputs and waste leakage. Within the context of a circular economy, Circular Business Model fundamentally reshape how goods and services are designed, produced, consumed, and disposed of (Geissdoerfer et al., 2020; Nußholz, 2017).

The transition from traditional linear business models to circular ones demands a profound reevaluation of value propositions and requires innovation at various organizational levels: institutional, strategic, and operational (Geissdoerfer et al., 2020; Bocken and Geradts, 2020). Successful implementation of Circular Business Model hinges on overcoming barriers such as policies, customer acceptance, and the structure of circular value networks (Okorie et al., 2021). In addressing these challenges, many literatures provide insights into factors enabling circular business model adoption, including strong leadership, a clear vision, appropriate organizational structures, incentives, and access to necessary resources (Chesbrough, 2010; Foss and Saebi, 2017).

Harmonizing resource and innovation strategies, Circular Business Model balance environmental goals by narrowing, closing, or slowing resource loops. This is illustrated through six archetypes: open-narrowing, open-slowing, open-closing, closed-narrowing, closed-slowing, and closed-closing (Bocken and Ritala, 2022). Geissdoerfer et al. (2020) further refine these archetypes into four generic resource loop strategies: cycling, extending, intensifying, and dematerializing. To facilitate understanding, scholars have developed diverse typologies, such as Nußholz's (2017) mapping against resource efficiency strategies, Lewandowski's (2016) criteria, and

Ludeke-Freund et al.'s (2019) patterns. Additionally, frameworks like the circular business model canvas and tools for integration support Circular Business Model implementation (Rosa et al., 2019a).

The significance of Circular Business Model lies in their alignment with the principles of a circular economy, striving to keep materials at their highest utility and value (Ellen MacArthur Foundation, 2013). They address the shortcomings of conventional models that prioritize product newness over performance and longevity (Rashid et al., 2013). Recognizing this, the academic community's increasing interest in Circular Business Model since 2015 underscores their potential to achieve sustainability goals while maintaining competitive advantage (Geissdoerfer et al., 2020; Rosa et al., 2019a).

Circular business models in WEEE industry

The concept of Circular Economy has gained significant attention as a transformative framework for sustainable resource management, particularly in the context of the WEEE industry. While the theoretical foundations of Circular Economy are still evolving (Velenturf et al., 2019), its importance is widely recognized due to the resource-intensive nature of the current linear business production model.

In the pursuit of economic benefits, environmental quality, and social equity, Circular Economy places emphasis on principles like reuse, recycling, and recovery to mitigate resource depletion and extend product lifecycles (Kirchherr et al., 2017). This is particularly relevant in the EEE sector, where Circular Business Models offer a strategic approach to minimize resource usage, enhance durability, and maximize value retention (Lahi et al., 2018).

The transition from a linear to a circular economy demands the adoption of Circular Business Models by individual organizations (Lewandowski, 2016). The goal of these models is clear: to keep products, components, and materials at their maximum value throughout their entire lifecycle (Korhonen et al., 2018). The EEE sector, which faces significant challenges in end-of-life management, presents a promising domain for the application of Circular Business Models, which prioritize reuse, and repair over recycling, have been proposed for the lifecycle management of electronic products (Macarthur, 2013). Despite the conceptual richness in this area, there is a notable lack of substantial insight and evidence into the technological and business potential for alternative end-of-life options based on reuse, repair, and remanufacturing (Parajuly & Wenzel, 2017). This gap in understanding poses a challenge for stakeholders aiming to implement effective circular strategies.

In the specific context of WEEE, Circular Economy principles are applied through strategies such as reuse, resale, repair, refurbishment, remanufacture, and recycling,

all aimed at extending the useful lifetimes of products and recovering raw materials from their waste (Cordova-Pizarro et al., 2019). The significance of Circular Business Models in the WEEE industry lies in their potential to address the environmental impact of electronic waste, reduce the demand for virgin resources, and create economic value through innovative business practices.

The circular business strategies outlined in Potting et al. (2017) work serve as a foundation for exploring the innovative approaches that contribute to the circular management of WEEE and pave the way for the integration of circular principles in the industry. So as we delve into the current developments in the WEEE industry, it becomes evident that understanding and showcasing existing Circular Business Models is crucial. The current existing Circular Business Models summarized from literatures and discussed in Lüdeke-Freund et al.(2018) are depicted in Table2.2. The value proposition is the most important dimension of a company's business model, in this thesis, the options of products and services forms the core of the circular business model.

Circular Business Models	Value proposition		Definition
	Products	**Services**	
"Circular supplies" (Accenture, 2014)	Recycled inputs/ fully renewable, recyclable, or biodegradable inputs	n.a.	Utilizing waste from third parties as inputs or using own waste as input. It involves the recapturing and reusing of waste materials.
"Classic long-life model" (Bocken et al., 2016)	Long-lasting products	Repair/ maintenance	Designing products with a focus on longevity, creating durable and long-lasting goods.
"Closed-loop production"(Clinton and Whisnant, 2014)	n.a.	Product take back	Involves the continuous cycling of materials, aiming to reduce waste through practices such as recapturing, reusing, and recycling.
"Co-product generation" (Albino and Fraccascia, 2015) / ***"Multiple cash flows / multiple revenues"*** (Pauli, 2010)	Co-products based on recycled waste, process residues or by-products	n.a.	Generating new products using waste from third parties or utilizing own waste. It includes using process residues and by-products as inputs for co-products/ involving generating revenue through various avenues by using waste for new products

Circular Business Models	Value proposition		Definition
	Products	**Services**	
"Cradle-to-cradle" (Braungart et al., 2007)	Cradle-to-cradle certified products; waste less products	n.a.	Separating, reusing, and cycling technical and biological materials to create a closed-loop system
"Create value from waste" (Bocken et al., 2014)	Waste as production input	n.a.	Generating value by using waste from third parties or own waste for creating new products
"Extending product value" (Bocken et al., 2016)	Used products or components in as-new quality/ repaired products/ remanufactured products	Take back of used products/ deposit systems	Recovering and remanufacturing products to extend their overall value and lifespan
"Extending resource value" (Bocken et al., 2016)	Products based on recycled waste	Take back of waste materials	Winning back base materials from waste for new products and using waste from third parties or own waste for new products
"Industrial symbiosis"(Beltramello et al., 2013; Bisgaard et al., 2012; Bocken et al., 2016)	Waste as production input	Cost reductions/ supply risk reduction/ elimination of third-party waste/	Physical exchange of materials, energy, water, and byproducts among industries, aiming to use waste for new products

Circular Business Models	Value proposition		Definition
	Products	**Services**	
		synergistic partnerships	
"Online waste exchange platform" (Albino and Fraccascia, 2015)	n.a.	bringing together producers and users of waste	Establishing online platforms connecting producers and users of waste materials
"Product life extension" (Accenture, 2014)	Long-lasting products	Upgrading	Involves designing long-lasting products and engaging in activities like repairs, upgrades, remanufacturing, or remarketing
"Product recycling/Recycling 2.0" (Planing, 2015) / ***"Recycling and waste management"*** (Kiørboe et al., 2015)	Packaging that can be completely emptied	Education of consumers to reduce product waste/ waste collection/ waste sorting/ waste recycling	Involves recycling practices, educating consumers to reduce product waste, and efficient waste collection and sorting
"Product transformation" (Planing, 2015)	n.a.	n.a.	Involves transforming products by winning back components from used products

Circular Business Models	Value proposition		Definition
	Products	Services	
"Remanufacturing/ next-life sales"(Planing, 2015)	Used products or components in as-new quality	n.a.	The process of remanufacturing products or components for resale in their next life
"Rematerialisation" (Clinton and Whisnant, 2014)	n.a.	Elimination of third-party waste	Winning back base materials from waste for creating new products
"Repair" (Kiørboe et al., 2015) / ***"Reuse / refurbish/ maintain / redistribute / next-life sales"*** (Planing, 2015) / ***"Reuse"*** (Kiørboe et al.,2015)	Cheaper products/ repaired equipment/ spare parts	Securing uptime and lifespan of products/ securing uptime and lifespan of equipment/ equipment database/ shipping and installation/ maintenance/ upgrading/ renting out equipment	Involves restoring functionality through repair, reuse, refurbishment, maintenance, redistribution, and next-life sales
"Resource recovery"(Accenture, 2014)	n.a.	n.a.	Recovering products and materials at the end of one product lifecycle, reprocessing materials, and recycling or upcycling

Circular Business Models	Value proposition		Definition
	Products	**Services**	
"Service and function-based models" (Kiørboe et al., 2015) / ***"Functional sale and management services models"*** (Beltramello et al., 2013) / ***"Deliver functionality, rather than ownership"*** (Bocken et al., 2014) / ***"Functional result"*** (Tukker, 2004) / ***"Pay per service unit"*** (Tukker, 2004) / ***"Access and performance model"*** (Bocken et al., 2016)	n.a.	Functionality/ result/ switching from product to service/ user education to shift from owning to using/ product maintenance, repair and control	Delivering services and functionality instead of ownership, with models like pay-per-service unit and access and performance
"Product as a service" (Accenture, 2014) / ***"Product lease"*** (Tukker, 2004) / ***"Product renting or sharing"*** (Tukker, 2004)	n.a.	Unlimited and individual access to a product (lease)/ limited and shared access to a product (renting)/ product maintenance, repair and control	Transitioning from product ownership to providing products as services or leasing/renting/sharing models

Circular Business Models	**Value proposition**		**Definition**
	Products	**Services**	
"Sharing platforms" (Accenture, 2014)	n.a.	Collaboration among product users	Implementing platforms that facilitate the sharing of electronic devices among users
"Take back management" (Bisgaard et al., 2012)	Recyclable and decomposable products (and/or packaging)	Product take back	Involves taking back products at the end of their lifecycle for proper disposal or refurbishment
"Upgrading" (Planing, 2015)	n.a.	n.a.	Improving product components to enhance product functions
"Waste exchange (external)" (Albino and Fraccascia, 2015)	Waste as production input	n.a.	Exchanging waste materials with external parties
"Waste exchange (internal)" (Albino and Fraccascia, 2015)	Waste as production input	n.a.	Exchanging waste materials within the internal processes of a company
"Waste regeneration systems"(Beltramello et al., 2013)	products based on recycled waste	n.a.	Implementation of systems that regenerate or rejuvenate waste materials, potentially transforming them into usable resources or inputs for new products

Circular Business Models	Value proposition		Definition
	Products	**Services**	
"Encourage sufficiency" (Bocken et al., 2016)	long-lasting products	Education of consumers to reduce consumption/warrant ies/upgrading	Involves strategies aimed at promoting sufficiency, encouraging consumers to be content with what they have, and minimizing excessive consumption through various means

Table 2.1 Circular economy business models proposed in the literature(Source: Lüdeke-Freund et al., 2018) (n.a. = information not available)

2.3 The ReSOLVE frameworks

The original ReSOLVE framework

In response to the growing imperative for sustainable business practices and the need for a circular economy, the Ellen MacArthur Foundation introduced the ReSOLVE framework, a strategic approach aimed at integrating sustainability and social responsibility into business decision-making. This framework encapsulates six key actions—Regenerate, Share, Optimise, Loop, Virtualise, and Exchange—providing businesses and governments with a comprehensive tool for developing circular strategies and growth initiatives (Ellen MacArthur Foundation, 2021).

The ReSOLVE framework encompasses a set of actions that collectively contribute to the transition to a circular economy, and they also build a circular economy business model for the company. These actions, as detailed by Lewandowski (2016), are defined as follows and also be summarized in table 2.1.

Re	**Regenerate**	Switch to renewable structures and materials Recover, retain and restore the health of ecosystems Return recovered biological resources to the biosphere
S	**Share**	Share assets (e.g., cars, rooms, appliances); Reuse/use second-hand products; Extend the life of products through maintenance; Design for durability and upgradeability.
O	**Optimise**	Increase product efficiency/performance; Remove waste in production and supply chain; Leverage big data, automation, remote sensing and steering.
L	**Loop**	Remanufacture products or components; Recycle materials; Use anaerobic digestion; Extract biochemical substances from organic waste.
V	**Virtualise**	Incorporation of digital technologies

		Emphasis on dematerialization Integration of various virtual processes Utilization of digital tools for circular practices.
E	**Exchange**	Facilitation of the exchange of goods Promotion of services interchange Sharing of information to enhance circular practices Emphasis on resource-efficient trade initiatives

Table 2.2 ReSOLVE structure (Ellen MacArthur Foundation, 2015)

Jabbour et al. (2019) emphasize that ReSOLVE represents more than just a theoretical construct; it is a practical and specific tool that combines financial, environmental, and social metrics within business decision-making. The framework acknowledges the pivotal role that companies play in addressing global challenges, asserting that incorporating ethical and sustainable considerations into business strategies can generate competitive advantages.

The innovative nature of ReSOLVE is underscored by its capacity to address contemporary challenges faced by businesses and society at large (Sehnem et al., 2019). Companies adopting circular practices aligned with the ReSOLVE framework contribute to environmental preservation, operational efficiency, positive corporate reputation, and pave the way for innovation, new business models, and more resilient economies (de Sousa Jabbour et al., 2019; Marcon et al., 2023).

Lewandowski (2016) notes that although various types of circular business models exist in the literature, most can be reflected in the ReSOLVE framework. The framework provides a structured approach to guide processes related to raw material extraction, conversion, manufacturing, distribution, product use, and end-of-life management. By emphasizing reuse, recovery, and reintegration of components in new products, the circular business models developed through the ReSOLVE framework align with circular economy principles (Ellen MacArthur Foundation, 2015).

The ReSOLVE framework's utility for circular business model research is evident in its ability to offer a structured lens through which to evaluate and compare the circular practices of businesses. Bocken and Short (2020) highlight that the framework allows for the examination of processes throughout the entire product life cycle, promoting resource efficiency, waste reduction, and the circulation of products and materials at the highest possible level. As a result, the ReSOLVE framework becomes an invaluable

tool for researchers seeking to understand, evaluate, and enhance circular business models across diverse industries.

The ReSOLVE framework, with its practical orientation and emphasis on sustainability, emerges as a key enabler for businesses aiming to transition towards circular practices. Its comprehensive approach provides a robust foundation for circular business model research, fostering innovation and sustainability in the face of contemporary economic and environmental challenges.

The Modified ReSOLVE framework

In principle, capitalizing on the opportunities presented by the Circular Economy, consumer electronics manufacturers should strategically maximize the recovery of value from electronic devices while concurrently minimizing their environmental impact. It is crucial that delve into the transformation of the Modified ReSOLVE framework, a crucial precursor to our exploration of circular business models. Table 2.3 illuminates the evolution and final configuration of the Modified ReSOLVE framework which is refined by Marke et al.,(2020), building upon the foundation laid by the ReSOLVE framework outlined by the Ellen MacArthur Foundation (EMF). This transformation is pivotal, as it establishes the framework's adaptability and applicability to the nuanced landscape of the consumer electronics industry. By charting this course of transformation, we gain a comprehensive understanding of the framework's structure and its tailored alignment with the industry's circular goals. This sets the stage for a more nuanced exploration of circular business models within the context of the Modified ReSOLVE framework. The Table 2.3 also illustrates the Circular Business Models summarized from literature under the Modified ReSOLVE framework tailored specifically for e-waste reduction. The adoption of Circular Business Models promises comparable outcomes under these refined models. Within Marke et al.,(2020) these models are categorized and further elucidated with modified descriptions to align seamlessly with the nuanced context of e-waste. The ensuing customized framework will serve as the benchmark for evaluating the circular business model performance of China's consumer electronics manufacturers.

The rationale for the modified ReSOLVE framework's application in the realm of electronic waste is grounded in its alignment with the unique challenges and intricacies of managing e-waste. Unlike generic circular business models, the modified ReSOLVE framework, takes into account the specific circular business practices identified in Corporate Social Responsibility (CSR) reports, Environmental, Social and Corporate Governance(ESG) Report or Sustainability Report, categorizing them as authentic Circular Business Models. This adaptation ensures a tailored and

contextually relevant evaluation of circular practices within the consumer electronics sector.

The suitability of the modified ReSOLVE framework for electronic waste lies in its capacity to provide a nuanced and industry-specific lens through which to assess circular business models. By leveraging CSR, ESG and sustainability reports and aligning with e-waste management principles, this model offers a more tailored approach for evaluating and enhancing the circularity of consumer electronics manufacturers in China. As a result, it becomes an indispensable tool for this thesis.

ReSOLVE framework category	Modified description(relevance to e-waste management)	Modified ReSOLVE framework category	Circular Business Model from literature review according to modifed ReSOLVE framework
Regenerate	A significant shift to renewable or biodegradable materials aiming to reclaim, retain and regenerate the health of ecosystems through, e.g. locating production units in eco- industrial parks	Regenerate	Sustainable product locations
Share	Extending product lifecycle through improved maintenance and repair services Replacing components with better quality ones, extending its functions and performance upgradable firmware and applications Creating mobile electronics that will be treasured or trusted longer through more robust design features	Life cycle extension	Maintenance and repair; Upgrading; Product attachment and trust/lock-in
	Incentivising customers to return used mobile electronics for an agreed value while collected products are resold, or refurbished and sold	Take-back services	Incentivised return and reuse
	Enabling shared use, access or ownership of electronic devices among members of the public or businesses – exclusive use of a device for a period	Product sharing system	Collaborative consumption, sharing platform, product–

ReSOLVE framework category	Modified description(relevance to e-waste management)	Modified ReSOLVE framework category	Circular Business Model from literature review according to modifed ReSOLVE framework
	without being the owner (e.g. renting service plan and replacement of new models)		service system (PSS) PSS: Product lease
Optimise	Optimising resource value through internal collection, reuse, refurbishment and resale of used products; waste reduction along the production chain and/or reduction of material usage with improved eco- design of mobile electronic products and technological innovations in the manufacturing process for enhancing their reusability, ease of disassembly, recyclability and remanufacturability into other products	Optimise resource value	Asset management Narrowing resource loops Waste reduction/ good housekeeping/ lean thinking/ fit thinking Modularity
	Creating data management facilities which enable product personalisation (produce only on demand) by introducing made-to-order mobile electronics with personalised functions but less material needed to suit the needs of particular clienteles	Produce on demand	Produce on demand Personalisation
Loop	Using supplies from material loops and recyclable materials from the mobile electronics where possible	Circular supplies	Circular supplies

ReSOLVE framework category	Modified description(relevance to e-waste management)	Modified ReSOLVE framework category	Circular Business Model from literature review according to modifed ReSOLVE framework
	Recovering e-waste out of disposed products or by-products from manufacturing, consumer take-back programmes or new sources and remanufacturing their components into new products of higher or lower quality	Resource recovery	Upcycling Downcycling Recycling/ recycling 2.0/ resource/ recovery Remanufacture, product transformation
	Recycling (including reprocessing and recovering) waste from upstream and downstream of the supply chains as feedstock for other chains	Industrial symbiosis	Intra- and inter-firm industrial symbiosis
Virtualise	Shifting mobile device parts/ accessories to joint virtual services (e.g. availing cloud-based storage service instead of producing memory cards)	Product-as-a-service	Dematerialised services
Exchange	Introducing transformative design of mobile devices, which features more durable components (e.g. self-healing foldable screen, graphene glass) and/ or eliminate accessories (e.g. wireless or kinetic charging that discards traditional chargers)	Transformative innovation	New technology

Table 2.3 Modified ReSOLVE framework categories & circular business models (source: Marke et al.,(2020)

2.4 Research gap

Upon meticulous review and analysis of an extensive body of literature, this study identifies a research gap in the understanding of circular business models within the context of the Chinese consumer electronics industry. In the dynamic landscape of the consumer electronics industry, characterized by rapid technological advancements and evolving consumer preferences, there exists a conspicuous void in the current body of literature. While numerous studies have explored sustainable practices and circular economy principles in various industries, a specific and in-depth analysis of the circular business models adopted by major players in the Chinese consumer electronics market remains notably scarce.

Existing literature has certainly provided valuable insights into the general principles of circular business models and their potential benefits for environmental sustainability. However, a focused examination of the unique strategies employed by these key industry players within the Chinese context is conspicuously absent. The complex interplay between technological innovation, consumer behavior, and corporate strategies in the realm of circular practices within this specific industry has not been thoroughly explored.

Furthermore, with a limited number of studies offering an in-depth analysis of circular business models applied by companies in the Chinese consumer electronics sector, there is a clear research gap in understanding the intricacies, challenges, and opportunities that shape these organizations' sustainability initiatives. Addressing this gap is imperative for academia and industry stakeholders alike, as it not only contributes to the academic discourse on circular business practices but also provides actionable insights for companies striving to enhance their circularity in this rapidly evolving market.

3. Research design and Methodology

This thesis aims to address this research gap by embarking on a comprehensive exploration of circular business models applied by major consumer electronics companies in China. The primary aim of this thesis is to explore and promote the adoption of circular business models within the consumer electronics industry in China. And this thesis hopes to bring about circular business models under the consumer electronics industry in China through desk research. This thesis attempts that serve as a valuable resource for comparative models of circular business practices within established companies and provide insightful lessons for startups aiming to transition towards circular business models. At same time can be utilized as a benchmark for researching circular business models across diverse industries and countries. The research questions are as follow:

1. **“What kind of circular business models are implemented in China’s consumer electronic industry?”**
2. **“What other circular business models might be used in China's consumer electronic industry?**

This thesis relies on the analysis of secondary materials to conduct an in-depth analysis of the circular business models within the China’s consumer electronic industry and answer the questions. The analysis involves the examination of the Environmental, Social, and Governance (ESG) reports, Corporate Social Responsibility (CSR) reports, and sustainability reports over a three-year span from 2020 to 2022 on companies in the consumer electronics industry in China, which considers that the report for a given year is mainly limited to the development of the current year and that it is not possible to do it in one year for the transformation of the circular business model, this thesis analyzes and summarizes the reports for the three years starting from 2020 and ending in 2022. This thesis focuses on the top 10 consumer electronics companies(Huawei, Xiaomi, BOE, ZTE, Lenovo, THTF, Transsion, Goertek, UNIS and Sugon) in China, as identified by the "2023 China Consumer Goods Industry Brand Value" report by Consumer Daily and CCID Consulting, which is defined based on their brand value,

ensuring a representation of industry leaders. The higher brand value means it's a large and loyal consumer base, more e-waste will be generated, and established leaders are better able to sustain the risks and costs of transitioning to circular business model, with more research value than startups.

This selection criterion aims to capture a diverse range of mature circular business models within the consumer electronics sector in China. But after gathering information of THTF, Goertek, UNIS and Sugon, shows that there is no evidence of transformation to a circular business model, only for green awareness and some practices to reduce resource consumption, so it can be concluded that the circular business model is not mature, and this thesis excludes these four companies from the desk analysis. So, the companies analyzed in this thesis are Huawei, Xiaomi, BOE, ZTE, Lenovo and Transsion. And all the basic information of case companies that might impact the circular business model transformation are summarized in Table 3.1, other basic introduction sees appendix A.

Company	Brand Value	Company size	Main business	Business model
Huawei	RMB 425.13 billion	207,000 employees and operate in over 170 countries and regions, serving more than three billion people around the world(Huawei official website).	Focuses on R&D and manufacturing of communication equipment and consumer electronics products(Phone, PC, Computer…), in addition to software development, design and production of integrated circuits, photovoltaic and electric vehicles, and other cross-border products(Wikipedia, 2024).	Huawei is a B2B supplier of networking hardware and systems and a B2C major player in the consumer electronics products market, e.g. smartphone market(Sekulich, 2020).
Xiaomi Corporation (Xiaomi)	RMB 268.17 billion	Xiaomi has 32,543 employees as of the end of 2022, of which 29,967 are located in mainland China, mainly at its headquarters in Beijing, with the rest mainly in India and Indonesia, and serves more than 100	Xiaomi is a smartphone, smart hardware and consumer lifestyle products, Internet services, e-commerce and new retail, Internet of Things (IoT) platform, and industrial investment as the main business of a diversified high-tech company(Cui et al., 2018).	Xiaomi's business model is summarized as B2C, relying on e-commerce platforms and online and offline channels such as Xiaomi Home to sell smartphones and other hardware products to users(Cui et al., 2018)

Company	Brand Value	Company size	Main business	Business model
		international and regional markets(Xiaomi 2022 Annual Report).		
BOE Technology Group Co., Ltd. (BOE)	RMB 255.46 billion	BOE subsidiaries in 20 countries worldwide with 68,175 employees(BOE official website)	a leading IoT company providing intelligent interface products and professional services for information interaction and human health(BOE official website).	B2B
ZTE	RMB 76.41 billion	Covering more than 160 countries and regions, ZTE serves over 1/4 people worldwide with 74,811 employees(ZTE official website) .	A global Leading Integrated Communication Information Solution and products Provider, including consumer electronics products, network services and other solutions(ZTE official website).	B2B for services and B2C for consumer electronic products
Lenovo	RMB 169.51 billion	more than 63,000 employees to serve customers in 180 markets((Lenovo official website).	Lenovo mainly develops, produces, and sells notebooks, all-in-one computers, desktop computers, servers, cell phones, tablet PCs, game consoles, and other mobile Internet, digital	B2C for consumer electronic products and B2B for solution services

Company	Brand Value	Company size	Main business	Business model
			and computer peripheral products (Lenovo official website).	
Shenzhen Transsion Holdings Co., Ltd. (Transsion)	RMB 64.83 billion	a global sales network covering more than 70 countries and regions and 16,232 employees in 2022(Transsion official website)	Mobile phones are its core products, while it also offers mobile Internet services based on a self-developed operating system.	B2C- centered

Table 3.1 Basic information of case companies in desk analysis

The Corporate social responsibility reports, ESG reports, and sustainability reports in three years serve as primary sources of information. These reports provide insights into the companies' environmental initiatives, social responsibility commitments, and governance practices. All three types of reports have a common focus on environmental concerns and disclosures related to environmental protection practices and the steps of gradual transition to circular business model, which are the main parts that this thesis focus on. It was determined that all companies have published their CSR or ESG reports or sustainability reports in 2022, 2021 and 2020, except Transsion, in April 2022, it released its first ESG report, which covers the whole year of 2021, so the data collection for Transsion in this thesis comes from the ESG reports of the two years of 2021 and 2022. This thesis will also use some of the company's supplemental reports as a source of data for a deeper and better study of its circular business model. The table 3.2 demonstrates all the data source. In addition, the Modified ReSOLVE Framework will be employed as a guiding framework for the analysis. Marke et al.(2020) summarized and analyzed the literature to come up with Modified ReSOLVE framework for e-waste management, which is specifically applicable in the context of e-waste and is the perfect model source for this thesis. This framework enables a detailed examination of how each company approaches circularity in its business model. The Modified ReSOLVE framework is based on ReSOLVE structure which stands for Recover, Shared Use, Optimize, Loop, Virtualize, and Exchange, representing key principles of circular business models (Lüdeke-Freund et al., 2019). This framework allows for a systematic breakdown of the circular practices of each company, facilitating the within- case analysis and cross-case analysis. The within-case analysis plays a pivotal role in this research by providing an in-depth examination of each individual case company's circular business model, which involves summarizing circular business models of Huawei, Xiaomi, BOE, ZTE, Lenovo, and Transsion based on the Modified ReSOLVE framework. This thesis uses deductive analysis to summarize the circular business models of 10 companies, listed 11 circular categories of Modified ReSOLVE framework and based on this framework, start reading from Huawei's reports to Sugon’s reports, the circular business models that map the Modified ReSOLVE framework will be extracted and summarized in an Excel table to complete the data extraction and summarization of the companies to answer the first research question. By comparing and contrasting the circular business models of Huawei, Xiaomi, BOE, ZTE, Lenovo, and Transsion, this analysis seeks to unveil industry-wide trends and best practices. The examination of shared strategies and distinct approaches enables the identification of emergent patterns and the formulation of a collective narrative for circularity in the Chinese consumer electronics landscape. And after comparing the results with existing literature on circular business models, any gaps or areas of improvement will be identified. This thesis will explore

circular business models that has not yet been applied by such companies and discuss if it could be applied in China's consumer electronic industry to answer the second question.

Rank	Company	Data Source
1	Huawei	• Huawei Consumer Business Sustainability Progress Report(2020- 2021) • Huawei Consumer Business Sustainability Progress Report(2021- 2022) • Huawei Investment & Holding Co., Ltd. 2020 Sustainability Report • Huawei Investment & Holding Co., Ltd. 2021 Sustainability Report • Huawei Investment & Holding Co., Ltd. 2022 Sustainability Report
2	Xiaomi Corporation (Xiaomi)	• 2020 Environmental, Social and Governance Report • 2021 Environmental, Social And Governance Report • 2022 Environmental, Social And Governance Report • Xiaomi Corporation 2020 Sustainability Report • Xiaomi Corporation White Paper on Climate Action
3	BOE Technology Group Co., Ltd. (BOE)	• 2020 Corporate Social Responsibility Report • 2021 Corporate Social Responsibility Report • 2022 (BOE) Sustainability Report
4	ZTE	• 2020 Sustainability Report • 2021 Sustainability Report • 2022 Sustainability Report
5	Lenovo	• 2020/21 Environmental, Social and Corporate Governance Report • 2021/22 Environmental, Social and Corporate Governance Report

Rank	Company	Data Source
		• 2022/23 Environmental, Social and Corporate Governance Report
7	Shenzhen Transsion Holdings Co., Ltd. (Transsion)	• 2021 Environmental, Social and Governance Report • 2022 Environmental, Social and Governance Report

Table 3.2 The data source of case companies in desk analysis

4. Finding

Following the comprehensive data collection process, this thesis meticulously examines the circular business models of the 6 companies mapping the Modified ReSOLVE framework using within case analysis. It is noteworthy that not all of these companies have implemented all 11 circular categories. Therefore, this thesis provides a detailed exploration of the specific circular business models that each company has adopted in practice. And also a cross case analysis be applied in this section to explore the similarities and differences between the circular business models of these 6 companies and the potential circular business models in electronic consumer industry.

4.1 Within case analysis

The following section delves into an intricate exploration of circular business models applied by each of the selected case companies: Huawei, Xiaomi, BOE, ZTE, Lenovo, and Transsion, which aims to unearth the nuanced approaches and distinctive practices that characterize each company's commitment to circularity within the Chinese consumer electronics industry.

4.1.1 Huawei

Immediately after the release of the Sustainability Report, Huawei also released the Consumer Business Sustainability Progress Report as a complementary explanation of the sustainability of its consumer business segment. In this thesis, we also incorporate the Consumer Business Sustainability Progress Reports for the years 2020-2021 and 2021-2022 into the data source to analyze and summarize Huawei's circular business model according to Marke et al.(2020)'s modified RESOLVE framework. Over the years, Huawei has continuously adhered to the environmental protection concept of "letting technology coexist with nature" and actively responded to climate and environmental challenges. Based on ICT technologies, Huawei has focused its actions on "continuously promoting energy conservation and emission reduction, increasing the use of renewable energy, and promoting the recycling economy", so as to safeguard the common homeland of mankind with scientific and technological innovations.

According to Huawei's sustainability reports and Consumer Business Sustainability Progress Reports, its circular business model is summarized as follows:

4.1.1.1 Regeneration

Huawei demonstrates a commitment to sustainability by incorporating renewable materials like thesis, gold, aluminum, cobalt, tin, and more in its product lineup. The company actively explores the use of high-quality recycled materials in collaboration with suppliers, aiming to enhance the ecological health of ecosystems (Huawei Consumer Business Sustainability Progress Report, 2020- 2021; Huawei Sustainability Report 2020). In addition, Huawei is actively transitioning from fossil to renewable energy sources. The company utilizes 100% renewable energy in its Chengdu research institute, and it has established solar parks in various locations(Huawei sustainability Report, 2020; Huawei Sustainability, 2021). Notably, a 300MW solar plant in Dalad Qi employs a "forest-light complementarity" model for sand control, ecological restoration, and supply of renewable electricity(Huawei Sustainability Report, 2022).Widely known that plastics are the most difficult part of electronics materials to reuse, so the direct selection of plastics with the lowest environmental impact is an important consideration in the material selection process. To address the difficulty in recycling plastics in electronic products, Huawei opts for bioplastics, significantly reduce the environmental pollution and damage in the production of traditional petrochemical plastics. Since 2013, the company has extensively used bioplastics in the production of Huawei smartphones (Huawei Consumer Business Sustainability Progress Report, 2020- 2021; Huawei Sustainability Report, 2020).Huawei's Smart Campus 3.0 solution focuses on visualizing and managing energy-consuming devices through an AI-controlled platform, contributing to the creation of efficient, energy-saving, and safe smart buildings(Huawei Sustainability Report, 2021).To minimize energy consumption, Huawei sets strict requirements for equipment selection in its campuses. By choosing more efficient devices, the company effectively reduces overall energy and materials consumption (Huawei Sustainability Report, 2021).

4.1.1.2 Life Cycle Extension

Huawei conducts rigorous reliability testing for its products before reaching consumers. For smartphones, this includes drop tests, temperature environment tests, and wear resistance tests. And for PC products, Huawei conducts tests on screen opening and closing scenarios, button tapping scenarios, touch control scenarios, friction and rubbing scenarios, high and low temperature scenarios, dust scenarios, etc. to ensure product quality. Additionally, Huawei provides on-site maintenance services for laptops and comprehensive reliability tests for wearable products (Huawei Consumer Business Sustainability Progress Report, 2020- 2021).To extend product lifecycles, Huawei offers continuous system updates and affordable repair services,

including the establishment of customer service centers globally to provide on-site repair services, door-to-door services, and mail-in repair services; and dedicated advanced repair centers that can provide more refined repair services. At same time, Huawei offers more competitively priced repair services and events, such as the "Bite Price Battery Replacement" event, which provides economical and convenient battery replacements without hassle. In 2021, Huawei launched the "Special Offer Board" campaign for models sold in mainland China, which allows consumers to purchase Huawei's original motherboards at up to 30 percent off when the motherboard fails out of warranty(Huawei Consumer Business Sustainability Progress Report, 2020-2021; Huawei Consumer Business Sustainability Progress Report, 2021- 2022; Huawei Sustainability Report 2021). Last, the company provides a convenient and economical repair network, full product maintenance strategy development, global maintenance network layout, full-scenario maintenance solutions, professional maintenance engineer team and automated dismantling platform, encouraging consumers to repair devices rather than replace them frequently(Huawei Consumer Business Sustainability Progress Report, 2020- 2021; Huawei Sustainability Report 2021).

Huawei addresses the fragmentation of smart devices by launching the HarmonyOS 3 operating system, providing a unified language for diverse devices. With over 3.3 billion HarmonyOS-enabled Huawei devices by the end of 2022, the company ensures that even older devices can maximize their functionality. (Huawei Consumer Business Sustainability Progress Report, 2022; Huawei Sustainability Report 2022). In addition, Huawei continues to provide consumers with feature experiences and security patch updates to their cell phone systems during the product lifecycle, greatly extending the life of their phones(Huawei Consumer Business Sustainability Progress Report, 2021). In 2021, Huawei initiated memory upgrade services for smartphones, allowing users to enhance storage capacity(Huawei Sustainability Report, 2021), breathe new life into their older devices, and reduce the need for frequent replacements.

4.1.1.3 Take-back Services

Huawei implements a trade-in program, encouraging users to exchange old devices for new ones. Consumers not only contribute to environmental sustainability but also receive additional vouchers for purchasing new Huawei products. This initiative has been active since 2015, resulting in the redistribution of nearly 600,000 devices. Meanwhile, in 2021, Huawei launched a one-stop replacement program in China, which allows consumers to get a newly purchased device at the same time as they recycle their old one, improving the efficiency of recycling while helping consumers migrate their old phone data. (Huawei Consumer Business Sustainability Progress Report, 2020- 2021; Huawei Consumer Business Sustainability Progress Report, 2021-2022; Huawei Sustainability Report 2020). Recent updates to Huawei's service centers

include redesigned recycling bins for a more professional and standardized collection of electronic waste(Huawei Consumer Business Sustainability Progress Report, 2020-2021), which is a more convenient process for consumers to take back their products and encourage them.

4.1.1.4 Optimize Resource Value

Huawei has been actively managing hazardous substances in its product designs since 2016, as evidenced by the company's commitment to minimizing environmental impact (Huawei Consumer Business Sustainability Progress Report, 2020-2021). The utilization of high-quality recycled materials and eco-friendly plastics underscores Huawei's dedication to reducing direct extraction from mineral sources. The company strategically designs products with easy disassembly, avoiding permanent connections and prioritizing non-destructive disassembly to preserve high-value modules (Huawei Consumer Business Sustainability Progress Report, 2021-2022). Concurrently, Huawei focuses on material reduction while ensuring optimal product performance, a key aspect highlighted in their sustainability progress reports. Moreover, Huawei makes environmentally conscious choices in packaging, opting for recyclable and compostable materials, including recyclable thesis and sustainable thesis certified by relevant authorities, thereby contributing to forest conservation (Huawei Sustainability Report, 2021).

4.1.1.5 Resource Recovery

Huawei collaborates with professional suppliers to responsibly extract and reuse raw materials from devices that cannot be refurbished. Through a meticulous 23-step process, the company achieves environmentally friendly and harm-free disposal of old smartphones. Reuse metal resources such as aluminum, copper, steel, and plastics to reduce the e-waste landfills (Huawei Sustainability Report, 2022; Huawei Consumer Business Sustainability Progress Report, 2021-2022).

Huawei places a significant emphasis on resource recovery by actively engaging in the refurbishment and recycling of valuable materials, particularly screens, from old devices (Huawei Consumer Business Sustainability Progress Report, 2022). Through a series of refurbishment processes and stringent testing standards, Huawei reintroduces screens into the special offer screen market, providing users with fully functional refurbished screens at nearly half the original price. In 2021, the company implemented technological innovations to dismantle screens meeting quality standards from returned cell phones, transforming them into service spares. This initiative not only facilitates material recycling but also enables consumers to update their screens at a more affordable cost through the special offer screen replacement service. Building on this success, Huawei extended its preferential screen program

from cell phones to smartwatches in 2022, fostering the reuse of smartwatch screens and further reducing electronic waste (Huawei Sustainability Report, 2022).

In a broader effort towards circular economy, Huawei collaborated with industry-leading recyclers and service providers in 2021 to establish a complete closed-loop system for the recycling, refurbishment, and resale of used cell phones. The company ensures that every Huawei-certified used phone undergoes rigorous quality inspections, guaranteeing 100% original Huawei devices equipped with the HarmonyOS 2 system, an original brand-new battery, and an official one-year warranty. This commitment extends beyond cell phones, as Huawei expanded its used phone business to include tablets and PCs, providing consumers with access to more high-quality used terminal products (Huawei Consumer Business Sustainability Progress Report, 2022; Huawei Sustainability Report, 2021). By selling these high-quality used devices, Huawei effectively extends the life cycles of its products, contributing to resource conservation and reduced environmental impact.

4.1.1.6 Industrial Symbiosis

Huawei underscores the importance of recycling through its commitment to recovering substantial amounts of gold and copper from decommissioned smartphones, as outlined in the Huawei Consumer Business Sustainability Progress Report for 2021-2022. The retrieved metals play a pivotal role in recycling industrial raw materials, exemplifying Huawei's dedication to true circular utilization.

In addition to its direct recycling efforts, Huawei actively promotes circular practices within its supply chain. The company encourages its suppliers to establish waste-free landfill management systems, taking a proactive approach to reduce environmental impact. Through a collaborative effort with TÜV Rheinland, Huawei certifies a supplier's waste management system, contributing significantly to sustainable development. This certification process not only ensures responsible waste disposal but also encourages the recycling of e-waste, transforming it into raw materials for use in other industries. A notable achievement in 2020 was the certification of a supplier factory with a TÜV Rheinland waste-free landfill management system two-star certification, marking a global first and showcasing Huawei's commitment to pioneering sustainable practices (Huawei Sustainability Report, 2020).

4.1.1.7 Transformative Innovation

Huawei's NetEngine high-end router production line demonstrates transformative innovation, ensuring a defect rate far below industry benchmarks. The meticulous manufacturing process extends product lifecycles, upholding circular standards. (Huawei Sustainability Report, 2021)

4.1.2 Xiaomi

Xiaomi released its 2020 Sustainability Report alongside its 2020 ESG Report, which is only available in English and aims to expand Xiaomi's international presence and build a positive brand image. Similarly, following the release of its 2022 ESG report, Xiaomi also released the Xiaomi Group Climate Action White Thesis during the 28th Conference of the Parties (COP28) to the United Nations Framework Convention on Climate Change (UNFCCC), which will take place from November 30 to December 12, 2023, this white thesis is more specific and profoundly written Xiaomi circular business model transformation behavior, so this thesis for the Xiaomi case study in addition to the ESG reports data sources have 2020 Sustainability Report and Xiaomi Group Climate Action White Thesis. This thesis summarizes Xiaomi's circular business model as follows:

4.1.2.1 Regenerate

Xiaomi demonstrates a strong commitment to circular product design, emphasizing the optimization of structures to reduce material usage. This commitment is evident through the incorporation of recycled and energy-efficient materials, including bio-based high-polymer materials and biogenic carbon content highlighted in both the Xiaomi ESG reports for 2021 and 2022. Moreover, Xiaomi extends its environmentally conscious approach to the construction of technology parks, maintaining green standards with 10% recycled materials and 20% green space design(Xiaomi ESG Report, 2020).

In line with its circular economy vision, Xiaomi actively embraces clean and renewable energy sources for its facilities, encompassing technology parks and manufacturing units. The company ensures that these spaces are powered by renewable energy, further solidifying its commitment to circular practices, as detailed in the Xiaomi ESG Report for 2020.

4.1.2.2 Life Cycle Extension

Xiaomi demonstrates a commitment to extending product lifespan through various initiatives. The company offers maintenance services and promotes repairability by ensuring a stable supply of parts at reasonable prices (Xiaomi ESG Report, 2020; Xiaomi ESG Report, 2022). In addition to in-store and at-home services focusing on maintenance, repairs, and recycling, Xiaomi provides consumers with convenient repair options, encouraging them to choose repair over replacement and contributing to prolonged product use (Xiaomi ESG Report, 2022). Furthermore, Xiaomi prioritizes software updates and hardware compatibility across its product models to prevent premature obsolescence and support prolonged product lifecycles, as outlined in the Xiaomi Corporation White Thesis on Climate Action for 2023. The company also

ensures product quality through rigorous testing, surpassing international standards for dust, waterproofing, and drop resistance (Xiaomi ESG Report, 2022). This commitment not only enhances product quality but also significantly extends the service life of Xiaomi products.

Xiaomi is dedicated to integrating energy-efficient hardware and software designs into its products, consistently striving for improvements in product energy efficiency. Notably, the MIUI 12 operating system introduces a "balanced" usage mode, extending the phone's usage time by 47 minutes on a single charge. This feature identifies different application scenarios and adjusts the screen refresh frequency to optimize usage time while reducing energy consumption. These efforts are outlined in both the Xiaomi ESG reports for 2020 and 2021. Continuing its commitment to energy efficiency and longer product lifespan, Xiaomi implements continuous enhancements, such as upgrading the flagship phone System-on-Chip (SoC) to 5nm specifications, as highlighted in the Xiaomi ESG Report for 2021. The Redmi 9A handset, featuring a 5000mAh battery with a 1000 charge cycle—double the smartphone's expected lifespan—exemplifies Xiaomi's dedication to sustainable design. Furthermore, the Mi 11/11 Pro/11 Ultra models incorporate super-tough Corning Victus glass and Gorilla glass corners, making them 1.5 times more resistant if dropped and two times more resistant to scratches (Xiaomi Sustainability Report, 2020).

In the production of TV backplanes, Xiaomi places a strong focus on craftsmanship and internal structure quality improvements. By enhancing the quality of critical components and reducing the risk of product contact damage, Xiaomi extends the service life of its products, as detailed in the Xiaomi ESG Report for 2020.

Xiaomi actively collaborates with experts to meticulously identify allergy-causing substances in its products, demonstrating a commitment to user safety and trust. The company goes a step further by fully disassembling products to gain comprehensive insights into the parts and structures containing allergy-causing substances. Building on this knowledge, Xiaomi implements targeted reductions through material substitution and structural adjustments, prioritizing the well-being of its users. These efforts are highlighted in the Xiaomi ESG Report for 2022.

Additionally, Xiaomi focuses on delivering products with enduring features, showcasing a dedication to waste reduction. The company continually invests in advanced technologies to ensure that its products stand the test of time in terms of both performance and relevance. By reducing the need for frequent upgrades, Xiaomi contributes to circular goals, as outlined in the Xiaomi Corporation White Thesis on Climate Action for 2023.

4.1.2.3 Take-back Services

Xiaomi operates global product recycling programs, including a trade-in program for smartphones, promoting responsible disposal, and reducing electronic waste(Xiaomi ESG Report, 2021). Especially in China, Xiaomi provides comprehensive take-back services, covering various device types(Xiaomi sustainability Report, 2020), and encourages users to participate in recycling through convenient methods that Xiaomi provides clear and accurate quality inspection reports as the final pricing basis, and after a successful transaction, the equivalent amount will be sent to the user in the form of cash or cash coupons. At the same time Xiaomi provides online and offline recycling methods such as store recycling and mailing and provide free door-to-door and other convenient services to encourage consumer recycling (Xiaomi ESG Report, 2020; Xiaomi ESG Report, 2022).

4.1.2.4 Optimize Resource Value

Xiaomi demonstrates a strong commitment to green design principles by optimizing structures to reduce material usage and maximizing the adoption of renewable or recycled materials, as highlighted in both the Xiaomi ESG reports for 2021 and 2022. For instance, the flagship series of Xiaomi's cell phones incorporates plant-derived bio-based nylon resins for internal mounts, while Metal Device Antenna (MDA) models utilize recyclable metals for one-third of the total weight of the phone's metal parts and the back covers of Xiaomi 12 series mobile phones are made of BASF Haptex® low carbon solvent-free polyurethane (PU) material. (Xiaomi ESG Report, 2021). Xiaomi's superior industrial design concepts integrate aesthetics and practicality in consumer electronics, simplifying product structures to enhance practicality and quality, thereby reducing material consumption, and improving product coordination in different scenarios(Xiaomi ESG Report, 2022; Xiaomi Corporation White Thesis on Climate Action, 2023). This design approach minimizes the possibility of disposal, contributing to circular economy goals.

In a strategic move towards circular practices, Xiaomi released two versions of the phone at the same price point with and without the charger, providing options for consumers with a circular economy philosophy and encouraging multiple purchases while reducing material waste (Xiaomi ESG Report, 2020).

Moreover, Xiaomi actively reduces energy and material consumption by optimizing the structural and material design of its products. Collaborating with production suppliers, the company focuses on streamlining the production process to further minimize environmental impact, as detailed in the Xiaomi ESG Report for 2020.

In 2021, Xiaomi implemented three in-purchase projects, selling products with packaging damage at discounted prices to employees while ensuring the product's

performance remained intact. To address e-waste concerns, Xiaomi facilitates product reuse through donations and internal employee welfare initiatives, thereby contributing to a reduction in electronic waste (Xiaomi ESG Report, 2022). In a significant effort to enhance the recycling rate of product materials and contribute to the development of a circular economy, Xiaomi has independently constructed refurbishment factories, as highlighted in the Xiaomi ESG Report for 2022. In 2021 alone, the refurbishment factory successfully completed the refurbishment of approximately 94,000 smartphone products, 5,600 electric scooter products, and 6,200 smart TV products. All these refurbished products were sold as qualified and certified products, showcasing Xiaomi's commitment to sustainable practices and the promotion of a circular economy (Xiaomi Corporation White Thesis on Climate Action, 2023).

4.1.2.5 Circular Supplies

Xiaomi commits to incorporating recycled materials from waste, such as plastics derived from discarded fishing nets, into components of all smartphones(Xiaomi Corporation White Thesis on Climate Action, 2023; Xiaomi ESG Report, 2022).

4.1.2.6 Industrial Symbiosis

Xiaomi takes a proactive approach to responsible recycling by entrusting third-party experts with the task of recycling devices. This involves monitoring the material flow to ensure compliance with sales regulations and extracting valuable materials for secondary use in other industries (Xiaomi ESG Report, 2020).

4.1.2.7 Transformative Innovation

Xiaomi leads the way in battery management systems, achieving technological self-reliance and implementing triple-charging architectures (including wired fast charging, wireless fast charging, and wireless reverse charging) to reduce energy consumption and extend product lifespan. A standout feature is the introduction of infinite reverse charging, which eliminates the need for additional charging devices (Xiaomi ESG Report, 2022). In addressing electronic waste concerns, Xiaomi introduces long-lasting batteries equipped with health-monitoring technology, contributing to a 25% extension in lifespan and a significant reduction in electronic waste generation (Xiaomi ESG Report, 2022). Demonstrating a commitment to renewable energy, Xiaomi's portable solar panel utilizes Metal Wrap Through (MWT) technology, minimizing reliance on conventional power sources and eliminating the need for extra charging accessories, as detailed in Xiaomi Corporation White Thesis on Climate Action for 2023.

Additionally, Xiaomi's efforts in material innovation include the development of durable ceramic materials and organic silicone skin with wear-resistant, stain-resistant,

mold-resistant, acid, and alkali-resistant properties, aiming to reduce the environmental impact of material consumption (Xiaomi Corporation White Thesis on Climate Action, 2023; Xiaomi ESG Report, 2022).

4.1.3 BOE

From the perspective of sustainable development and circular economy, BOE continuously utilizes its own advantages to explore solutions for the symbiotic development of the enterprise and the environment, protects the green homeland with science and technology, and integrates the enterprise's mission and commitment to the environment into all aspects of its management, production, operation, products, etc., and contributes to the building of a clean and beautiful world(BOE Sustainability Report, 2022). Since 2022, BOE has renamed its CSR report to a sustainability report, but the areas of focus for its disclosures remain the same, except that for the sustainability report, it is less investor-centric. The stakeholder focus is much broader, including employees, customers, and shareholders (Szweda, 2023). And while the CSR report focuses more on the company's past contributions to society, the environmental aspects of the disclosure remain the focus, so in BOE's case, both the 2020-2021 CSR report and the 2022 sustainability report are the sources of data for this thesis. According to modified ReSOLVE framework, BOE’s circular business model summarized as follows:

4.1.3.1 Regenerate

BOE exemplifies a steadfast commitment to regenerative circular practices by prioritizing the use of renewable energy sources and actively reducing atmospheric emissions. The Chongqing 8.5th generation TFT-LCD production line stands out as a prime example, incorporating distributed photovoltaic power stations on facility roofs to emphasize the utilization of clean energy sources (BOE Sustainability Report, 2020). Furthermore, BOE's Suzhou hospital underscores circular practices by integrating solar thermal panels, harnessing solar energy for water heating, and thereby minimizing environmental impact (BOE Sustainability Report, 2020; BOE Sustainability Report, 2022).

In a significant move towards circular business model which lead to highly reduce the waste, BOE introduces zero VOC (Volatile Organic Compound) materials in its product production processes, as outlined in the BOE Sustainability Report for 2022. This initiative demonstrates a commitment to reducing harmful emissions and promoting a healthier manufacturing environment.

Moreover, BOE places a strong emphasis on raw material selection, prioritizing non-polluting, less-polluting, and recyclable materials and fuels. The company conducts

thorough toxic and hazardous substance tests on raw materials(BOE Sustainability Report, 2022), ensuring the selection of qualified materials that align with circular and environmentally friendly practices.

4.1.3.2 Life Cycle Extension

BOE prioritizes extending the lifecycle of its products by providing comprehensive technical support and issue resolution services. This includes telephone support, remote system debugging, on-site assistance, and product warranties, effectively prolonging the usability of their products (BOE sustainability report, 2021; BOE sustainability report, 2022).

BOE's TV products adopt high-transparency designs and material productization, achieving a 30% increase in light transmittance. This design strategy enhances product efficiency, extends product lifespan, and reduces waste generation, aligning with circular economy principles (BOE sustainability report, 2022).

4.1.3.3 Optimize Resource Value

BOE demonstrates a commitment to optimizing resource value through various initiatives. For instance, the company has implemented a waste organic solvent recovery system in the 5.5th generation LTPS-LCD/AMOLED production line, reducing chemical waste and minimizing resource wastage (BOE sustainability report, 2021). Additionally, the company continuously reviews and optimizes production lines including optimization of process parameters and equipment status, which achieves reductions in waste generation and resource consumption across multiple facilities (BOE sustainability report, 2021; BOE sustainability report, 2022). For example, as outlined in BOE Sustainability Report for 2022, BOE Wuhan 10.5-generation TFT-LCD production factory, waste ITO (indium tin oxide) etching solution as a wastewater treatment chemicals to achieve 100% utilization of general solid waste recycling rate of 100%, mainly used in building materials, cement and other industries raw materials.

BOE integrates ecological assessments into the product development phase, ensuring adherence to green and recyclable product requirements(BOE Sustainability Report, 2021). Simultaneously, the company prioritizes recyclable, universal, and minimalist design principles, promoting energy efficiency, minimal environmental impact, and maximum renewability throughout the product life cycle (BOE sustainability report, 2021; BOE sustainability report, 2022). Also the BOE's snap design facilitates the dismantling and sorting of products for recycling after their end-of-life, increasing the recyclable ratio of the entire machine from 65% to more than 80%, and realizing the development of a circular economy(BOE Sustainability Report, 2020).

4.1.3.4 Circular Supplies

BOE actively engages in circular supplies management by considering the reuse of large-volume chemical waste as raw materials in production. Notably, all BOE factories have achieved electronic-grade purification and reuse of stripping solution, contributing to a closed-loop system (BOE sustainability report, 2020; BOE sustainability report, 2021).

4.1.3.5 Industrial Symbiosis

For chemicals that cannot be recycled internally, BOE collaborates with waste recovery companies to purify and reintroduce them into the market as industrial-grade raw materials. This industrial symbiosis approach ensures the responsible management of chemical waste, contributing to circular economy (BOE sustainability report, 2020; BOE sustainability report, 2021; BOE sustainability report, 2022)

4.1.4 ZTE

ZTE is committed to sustainable development and circular economy around the globe. It adheres to "Innovation, Convergence, and Green Development" throughout the product lifecycle and the process of R&D, production, logistics, and customer services, making constant contributions to the reduction of global energy consumption and carbon emissions. As a member of the UN Global Compact and Global Enabling Sustainability Initiative (GeSI), ZTE has been releasing the sustainability report to the public for 15 consecutive years(ZTE Sustainability Report, 2022). In August 2022, ZTE was named to Fortune China ESG Influential Listing 2022, becoming one of the leading enterprises with remarkable performance in ESG.

In the sustainability reports for the period 2020-2023 , ZTE Corporation clearly states that it realizes the green development of various industries through technological empowerment, rationally controls resource and energy consumption, reduces carbon emissions, optimizes waste management, contributes to the circular economy, and continuously reduces the environmental impact of its operations. Its circular business model is summarized below:

4.1.4.1 Regenerate

ZTE actively embraces sustainable and circular development, exemplified by the extensive use of renewable energy and the rooftop photovoltaic project at its Shenzhen headquarters (ZTE sustainability report, 2021).

4.1.4.2 Life Cycle Extension:

ZTE enhances customer satisfaction and prolongs product lifecycles by implementing upgraded protocols for handling significant market quality issues, ensuring prompt

and efficient problem resolution (ZTE sustainability report, 2021). During the pandemic, ZTE adheres to providing off-site services to overseas clients, extending product lifecycles, and reducing electronic waste generation. Moreover, the adoption of a service delivery cloud model in 2020 further facilitates efficient business support, better protection for maintenance and repair services, ensuring product longevity (ZTE sustainability report, 2020).

ZTE focuses on the multiple maintenance of product materials and upgrades to component attributes, improving product quality to extend its lifespan and reduce waste (ZTE sustainability report, 2020source:).

4.1.4.3 Take-back Services

ZTE encourages consumers to recycle through product labeling, recycling manuals(ZTE sustainability report, 2020), and the establishment of a global recycling network covering 140 collection points. In addition, the company collaborates with environmental organizations to optimize four centralized waste collection platforms and through its own official website, the ZTE Mall App and third-party recycling companies to cooperate in a variety of recycling channels, fostering convenient consumer participation in recycling (ZTE sustainability report, 2021).

4.1.4.4 Optimise Resource Value

ZTE actively pursues sustainability goals by implementing green packaging pilot projects to reduce packaging material consumption. These initiatives involve strategies such as lowering thesis box weight, changing packaging materials, and adopting collective packaging approaches, as outlined in both the ZTE Sustainability Reports for 2020 and 2021. Furthermore, ZTE emphasizes optimizing packaging design, utilizing more efficient cushioning materials, and employing design strategies aimed at reducing package size and weight(ZTE Sustainability Report, 2022).

In alignment with circular resource management, ZTE ensures the recycling of all kinds of materials in its production process. The waste materials are meticulously processed and reused, contributing to both safety and maximized recycling efforts(ZTE Sustainability Report, 2020).

In a commitment to continuous improvement, ZTE focuses on upgrading its smart manufacturing capabilities to enhance production efficiency and reduce material consumption. This includes the deployment of innovative applications such as 5G private networks, cloud-based AGV (Automated Guided Vehicle), and machine vision quality inspection, showcasing ZTE's dedication to embracing advanced technologies for sustainable and efficient manufacturing practices(ZTE Sustainability Report, 2022).

4.1.4.5 *Industrial Symbiosis*

ZTE takes proactive measures in sustainable material management, employing centralized collection and sheltered storage methods for recyclable materials like metal and wood. These materials are subsequently handed over to professional recyclers for processing, disposal, and reintegration into the market, effectively contributing to a reduction in material consumption (ZTE Sustainability Report, 2020).

In a significant stride towards circular e-waste management, ZTE collaborates closely with over 150 leading environmental protection service providers and has established a global recycling material processing network. This network facilitates one-stop dismantling and recycling of telecom equipment on a global scale, ensuring that e-waste is treated in an environmentally friendly manner(ZTE Sustainability Report, 2021). This initiative results in the annual recycling of substantial amounts of metal and plastic, specifically 1,418 tons of metal and 61 tons of plastic(ZTE Sustainability Report, 2022). The recovered resources are then recycled and reused, ZTE reintroducing these materials into the market as raw materials for various industries, which contributes to the circular economy.

4.1.4.6 *Transformative Innovation*

ZTE showcases commitment to transformative innovation with over 500 green 5G innovation patents(ZTE Sustainability Report, 2020). The company's second-generation 5G chip, introduced in 2021, achieves a doubling of performance and integration, coupled with a halving of power consumption and reduction in upgrades due to substandard energy consumption through architecture optimization, process upgrades, and enhanced computing power(ZTE Sustainability Report, 2021).

4.1.5 Lenovo

From Lenovo's packaging and products to their global manufacturing footprint, the circular economy is integrated into all of Lenovo's practices. As a provider of world-class technology solutions, Lenovo wants to ensure that their solutions have a positive impact on the environment and society(Lenovo Sustainability Report,2021). Lenovo's sustainability report covers a different timeframe, from April of the previous year to March of the following year, and given the timeliness of the data, this thesis collected data is from 2021 sustainable report to 2023 sustainable report, covering April 2020 to March 2023 and summarizes its circular business model as follows:

4.1.5.1 *Regenerate*

Lenovo demonstrates a strong commitment to sustainability through the installation of solar energy facilities, encompassing solar hot water systems and solar power stations in Beijing and Hefei (Lenovo Sustainability Report, 2021). Notably, a

significant stride towards renewable energy is highlighted in the Lenovo Sustainability Report for 2022, where ninety percent of the energy purchased is converted to renewable sources, underlining the company's dedication to a more sustainable energy profile.

In a proactive approach to environmental responsibility, Lenovo prioritizes the use of Trend Sea plastic (OBP) and recycled metals, including recycled aluminum and recycled magnesium. This strategic choice not only helps mitigate marine pollution but also significantly reduces the demand for new resource extraction, showcasing Lenovo's commitment to circular economy principles (Lenovo Sustainability Report, 2022; Lenovo Sustainability Report, 2023).

4.1.5.2 Life Cycle Extension

Lenovo emphasizes product longevity through a robust warranty and maintenance strategy, offering three-year standard maintenance and five-year parts replacement services for several best-selling business computers (Lenovo Sustainability Report, 2021; Lenovo Sustainability Report, 2022). To further support extended product life, customers have the option to purchase upgraded maintenance and repair services, prolonging the basic maintenance and repair period by one to two years (Lenovo Sustainability Report, 2023).

In a pioneering move towards circular economy, Lenovo introduced its first circular supply chain infrastructure, Lenovo Value Recovery (LVR). This initiative focuses on providing certified refurbished data center equipment, highlighting the reutilization of surplus, redundant, and recalled products as part of Lenovo's commitment to sustainable practices (Lenovo Sustainability Report, 2021).

Lenovo actively promotes user repairability by providing service and repair manuals for many of its products, along with instructional videos on parts removal and replacement. This empowers customers to purchase parts from Lenovo or its authorized partners for their own repairs. Additionally, Lenovo offers on-site repair services, enhancing the convenience of repairs and encouraging consumers to choose repair over replacement (Lenovo Sustainability Report, 2023).

Lenovo prioritizes product longevity by incorporating embedded batteries, a strategic choice that increases durability two to three times. To further support extended use, the company provides three-year maintenance, repair, and upgrade services for most embedded batteries, as outlined in the Lenovo Sustainability Reports for 2021, 2022, and 2023.

In a proactive move towards reducing waste, Lenovo introduces firmware updates for in-use batteries. This initiative eliminates the need for premature battery replacements

due to firmware issues and contributes to extending the overall battery life of Lenovo devices(Lenovo Sustainability Report, 2021).

4.1.5.3 Take-back Services

Lenovo actively promotes responsible disposal through its take-back initiatives, encompassing end-of-life or obsolete products and components, extending its efforts to cover both Lenovo and non-Lenovo brands (Lenovo Sustainability Report, 2021; Lenovo Sustainability Report, 2022; Lenovo Sustainability Report, 2023).For business customers, Lenovo provides Asset Recovery Services (ARS) to ensure the proper disposal of IT assets and data center infrastructure as highlighted in the Lenovo Sustainability Reports for 2021, 2022, and 2023.

4.1.5.4 Optimize Resource Value

Lenovo actively engages in the reuse and recycling of packaging and production waste, and additionally harnesses energy through the incineration of non-recyclable waste as outlined in the Lenovo Sustainability Report for 2021.

A core aspect of Lenovo's commitment to circular business model is reflected in the prioritization of environmentally friendly and recyclable materials in product design. This includes the incorporation of industrial recycled plastics (PIC), post-consumer recycled plastics (PCC), and closed-loop recycled plastics (CL PCR) (Lenovo Sustainability Report, 2021; Lenovo Sustainability Report, 2022). These initiatives align with Lenovo's product development strategy and contribute to the company's transition to a circular economy, playing a crucial role in conserving natural resources, minimizing energy requirements for manufacturing new plastics, and reducing the disposal of waste plastics in landfills and incinerators.

Furthermore, Lenovo has implemented a new Low Temperature Solder Paste (LTS) process in the production of its computer products, showcasing a commitment to reducing energy consumption and minimizing material usage (Lenovo Sustainability Report, 2022).

4.1.5.5 Circular Supplies

Lenovo incorporates post-consumer recycled materials in 298 different products including laptops, desktops, workstations, monitors and accessories, etc. (Lenovo Sustainability Report, 2023), demonstrating a commitment to integrating recycled materials across its product lines.

4.1.5.6 Resource Recovery

Across the entire company, Lenovo reintegrates surplus, returned, or outdated products and components after refurbishment or in their original state, fostering a

circular approach (Lenovo Sustainability Report, 2021; Lenovo Sustainability Report, 2022).

4.1.5.7 Industrial Symbiosis

Lenovo's recycling initiatives contribute to an impressive 88.2% of waste being reintroduced into various markets for recycling(Lenovo Sustainability Report, 2022), establishing a model for industrial symbiosis.

4.1.5.8 Transformative Innovation

Lenovo pioneers the development of certified closed-loop recycled plastics, addressing the challenges associated with the unique structure, performance, and appearance requirements in incorporating recycled plastics into IT products (Lenovo Sustainability Report, 2021). This initiative significantly increases the recyclability of Lenovo products and reflects the company's dedication to advancing circular practices.

The introduction of dual-mode charging algorithm technology, applied to most laptop batteries, is another notable innovation outlined in the Lenovo Sustainability Report for 2021. This technology adjusts the charging voltage and current over time, extending the battery life and underlining Lenovo's commitment to technological advancements that contribute to circularity.

Furthermore, Lenovo's collaboration with battery manufacturers has resulted in mobile batteries with an extended lifespan of up to 1200 cycles, surpassing the industry standard of 800 cycles (Lenovo Sustainability Report, 2022; Lenovo Sustainability Report, 2023). This achievement not only increases battery life but also contributes to the reduction of product repairs and replacements due to batteries, aligning with Lenovo's commitment to circular economy and environmental responsibility.

4.1.6 Transsion

Transsion is concerned about climate change and ecological harmony, advocates green operations, practices energy conservation and emission reduction, pays attention to the application of clean technologies, continuously improves its management practices, transforms itself into a circular business model, and strives to become a resource-friendly provider of intelligent terminal products and mobile Internet services(Transsion ESG report, 2022) .

Although Transsion has only released the ESG report for two years, it has been more mature for the reuse of resources and the transformation to a circular economy. As the fifth largest consumer electronics brand in the global cell phone market(TechInsights, 2023), it is necessary to study its circular business model, and this thesis summarizes its circular business model through the modified ReSOLVE framework as follows:

4.1.6.1 Regenerate

Transsion integrates renewable energy sources into its manufacturing processes, exemplifying a commitment to sustainable energy practices (Transsion ESG Report, 2021). The company ensures that over 50% of the materials in each product's casing are recyclable, utilizing materials like recyclable grey board (Transsion ESG Report, 2022).

4.1.6.2 Life Cycle Extension

Transsion prioritizes the extension of its product life cycle by offering repair services for both mobile devices and digital accessories, as highlighted in the Transsion ESG Report for 2021. Additionally, the company enhances its repair service network by providing broken screen insurance and extended insurance services, aiming to continually improve the coverage of the repair service network and enhance the convenience of repairs for consumers, ultimately reducing the need for product replacement (Transsion ESG Report, 2022).

To ensure the high quality and longevity of its products, Transsion operates a CNAS level reliability and safety testing laboratory. All products undergo rigorous experiments and tests before leaving the factory, guaranteeing their durability and service life. The absence of surface attachment processes further enhances product durability, making them resistant to drops and weathering (Transsion ESG Report, 2022).

Transsion opts for long-lasting materials in battery production, meeting safety, environmental, and flame-retardant requirements to extend battery lifespan (Transsion ESG Report, 2022). And continuous improvement in the durability of phone casing materials ensures prolonged product lifespan. Apart from these, Transsion ensures regular system and software updates further contribute to increased product longevity (Transsion ESG Report, 2022).

4.1.6.3 Take-back Services

Transsion actively retrieves both its own-brand and non-Transsion brand mobile electronic waste from consumers through various convenient methods. These include direct in-store drop-offs, doorstep pickups, and recycling bins, all provided at no cost to consumers(Transsion ESG Reports, 2021; Transsion ESG Reports, 2022). To further facilitate environmentally responsible disposal, Transsion offers both in-store and online trade-in services. The company has also launched an online platform, allowing consumers to easily evaluate and receive quotes for their devices, promoting consumer engagement and simplifying the disposal process (Transsion ESG Report, 2022).

In addition to these initiatives, Transsion conducts regular environmental awareness campaigns aimed at educating consumers on the importance of electronic waste

recycling. These campaigns contribute to raising awareness and understanding among consumers, with the ultimate goal of boosting e-waste recovery rates(Transsion ESG Report for 2022).

4.1.6.4 Optimize Resource Value

In the design of lightweight materials for its products, Transsion places a priority on material reduction without compromising quality, resulting in a thin product profile. This approach, highlighted in both the Transsion ESG Reports for 2021 and 2022, not only achieves a sleek product design but also contributes to the simultaneous reduction of material consumption and waste generation.

Transsion consistently strives to improve its manufacturing processes, incorporating the use of spray-free materials. This not only reduces material consumption but also enhances product aesthetics, ensuring sustained color quality and increasing the overall lifespan of the product (Transsion ESG Report, 2021).

4.1.6.5 Circular Supplies

Transsion pioneers the extraction and reaggregation of fibers from ocean-recovered materials, creating recycled fiber skin for mobile battery covers (Transsion ESG Report, 2022).Additionally, recycled glass serves as a raw material in Transsion's production line for processing into glass fiber materials used in the production of mobile devices (Transsion ESG Report, 2022). And significant utilization of secondary materials in the manufacturing process serves as an innovative approach to circular supplies (Transsion ESG Report, 2021).

4.2 Cross case analysis

After looking closely at how each company handles circular business model, the exploration now extends to a panoramic view, interweaving the narratives of Huawei, Xiaomi, BOE, ZTE, Lenovo, and Transsion. This section, endeavors to distill the common threads and distinctive nuances that define circularity across the spectrum of the Chinese consumer electronics industry.

As we compare these companies, we'll focus on finding what they do similarly, where they take different paths. The goal here is not just to talk about what each company does but also to uncover the bigger trends that show how the whole industry in China is working towards sustainability and circularity.

By digging into both the shared and unique aspects of their circular efforts, we aim to paint a clearer picture of how these companies contribute individually and collectively to making the consumer electronics scene in China more sustainable and circular. In order to visualize the circular business models of the six companies, Table 4.1 created

by summarizing companies circular business models and mapping Modified ReSOLVE framework, which is used to demonstrate the comparison result of these companies and let readers easier to summarize the direction that the companies' efforts towards a circular business model, this table is also an important basis for cross-case analyses.

The cross-case analysis will also be juxtaposed against the current existing circular business models summarized by Lüdeke-Freund et al. (2018) to identify prevailing trends and areas of divergence in the China's consumer electronics industry and the circular business models which are not applicated according to Modified ReSOLVE framework to answer the second question. This thesis will also explore the possibilities and challenges of these potential circular business models applications.

Circular business models	Companies / Circular business practices	Huawei	Xiaomi	BOE	ZTE	Lenovo	Transsion
Regeneration	Materials & design	x	x	x	x	x	x
	Green energy	x	x	x	x	x	x
Life cycle extension	Reliability testing	x	x				x
	Comprehensive warranty					x	
	Maintenance & repair	x	x	x	x	x	x
	Software upgrade	x			x	x	x
	Hardware upgrade	x	x		x	x	x
	Product attachment and trust/lock-in		x				
Take-back services	Trade-in Program	x					
	Recycling program	x	x		x	x	x

Circular business models	Companies / Circular business practices	Huawei	Xiaomi	BOE	ZTE	Lenovo	Transsion
Take-back services	Customer education				x		x
Product sharing system							
Optimise resource value	Green and minimalist design	x	x	x		x	x
	Material optimization in production	x	x	x	x	x	x
	Energy optimization in production			x	x	x	
	Eco-friendly packaging	x			x		
	Materials inside recovery		x	x	x	x	
Product sharing system							
Circular supplies	Using post-consumer recycled materials		x	x		x	x

Circular business models	Companies / Circular business practices	Huawei	Xiaomi	BOE	ZTE	Lenovo	Transsion
Resource recovery	Refurbished recycled products or components for re-sale	x				x	
Industrial symbiosis	Materials & components recovery for other industries	x	x		x	x	
	Collaboration for waste management	x		x	x		
Product-as-a service							
Transformative innovation	Technology innovation for production line	x					
	Technology innovation for battery		x			x	
	Innovative renewable energy solutions		x				
	Innovative materials					x	
Transformative innovation	Green Innovation for 5G				x		

Table 4.1 Six case companies' circular business models

4.2.1 Similarities in circular business models

In pursuing circular business models, Huawei, Xiaomi, BOE, ZTE, Lenovo, and Transsion collectively demonstrate noteworthy commonalities, reflecting a shared commitment to sustainable and environmentally responsible practices.

The first central to their strategies is a resolute dedication to the integration of renewable energy sources into manufacturing processes, signaling a collective emphasis on reducing carbon footprints and fostering a shift towards cleaner, more sustainable energy utilization. This commitment is evident in the installation of solar energy facilities and rooftop photovoltaic projects, showcasing a unified effort to embrace and prioritize renewable energy in electronic consumer industry.

Furthermore, all six companies prioritize the selection of materials with a focus on environmental friendliness and actively engage in recycling initiatives. From recycled plastics, WEEE to the reuse of chemical waste as raw materials in production, these companies manifest a collective consciousness towards reducing the environmental impact of their operations and promoting the circularity of resources. The shared commitment to incorporating post-consumer recycled materials and recycled plastics in product designs underscores a concerted effort to mitigate resource depletion, minimize waste generation, and contribute to the evolution of a circular economy.

Extending the lifecycle of products stands out as another commonality, with all companies offering repair services, warranty extensions, and technical support. This emphasis on product longevity aligns with the broader circular business model objective of reducing overall resource consumption and waste. Moreover, initiatives such as Lenovo's circular supply chain infrastructure, Lenovo Value Recovery (LVR), and Transsion's focus on the extraction and reaggregation of fibers from ocean-recovered materials exemplify a collective commitment to innovative and responsible product lifecycle management.

In the realm of innovation, all six companies actively pursue innovative product components or the technologies upgrading, though the focus of the innovation may be different, but the overall goal is the same, enhancements to boost efficiency, reduce waste, and improve resource utilization. The incorporation of embedded batteries, firmware updates, and a continuous commitment to durability improvements highlight a shared belief in the power of technological innovation to drive sustainability and circularity.

In essence, the commonalities observed among Huawei, Xiaomi, BOE, ZTE, Lenovo, and Transsion in adopting circular business models underscore a collective industry-wide commitment to environmental stewardship, resource efficiency, and the promotion of a circular economy. Through their shared endeavors, these companies

contribute to a growing China momentum towards sustainable and circular practices, transcending industry boundaries and emphasizing the transformative potential of circular business models on a broader scale.

4.2.2 Differences in Circular Business Models

In examining the circular business models of Huawei, Xiaomi, BOE, ZTE, Lenovo, and Transsion, distinctive differences emerge that reflect the diverse approaches these companies undertake in embedding circularity into their operations, build different circular business model.

While commonalities exist in their commitment to waste reduction, resource optimization, and industrial symbiosis, these differences highlight the nuanced and context-specific strategies employed by each company. Huawei and Xiaomi concentrate on product design and modularity, BOE emphasizes material selection and emission reduction, ZTE prioritizes global collaboration and sustainability initiatives, Lenovo pioneers a circular supply chain, and Transsion focuses on product longevity and environmentally responsible disposal. These distinct approaches collectively contribute to a comprehensive understanding of the diverse pathways companies navigate to embrace circular business models.

Huawei's circular business model, as evidenced by its focus on eco-design, product life cycle management, and recycling programs, places a significant emphasis on product longevity and energy efficiency. In contrast, Xiaomi emphasizes its role as an enabler for circular consumption by developing products with modular components that allow for easy repair and upgrades, fostering a more sustainable approach to consumer electronics.

BOE's commitment to circularity is characterized by a rigorous selection of raw materials and the introduction of zero Volatile Organic Compound (VOC) materials in its production processes. This environmental focus distinguishes BOE's circular business model, highlighting its dedication to minimizing harmful emissions and selecting materials aligned with circular and environmentally friendly practices.

ZTE's approach stands out through its active participation in global sustainability initiatives, such as the UN Global Compact and the Global Enabling Sustainability Initiative (GeSI). This commitment to global collaboration and adherence to international standards underscores ZTE's orientation towards a circular business model that extends beyond individual company boundaries.

Lenovo's circular business model is notable for its comprehensive circular supply chain infrastructure, Lenovo Value Recovery (LVR), which focuses on providing certified refurbished data center equipment. This distinctive initiative emphasizes the

reutilization of surplus, redundant, and recalled products, showcasing Lenovo's dedication to sustainable practices in the IT sector.

Transsion, as a prominent player in the mobile phone market, places a strong emphasis on product life cycle extension through repair services, extended warranties, and a CNAS level reliability and safety testing laboratory. The company's proactive retrieval of electronic waste and incorporation of recycled materials into product casing further distinguish its circular business model

Based on a detailed analysis of the table 4.1, it becomes evident that, concerning life cycle extension, Lenovo stands out as the sole provider of a Comprehensive warranty, extending warranty services beyond the basic period for numerous products. This underscores Lenovo's strategic emphasis on delivering high-quality services to prolong product life. Additionally, in terms of the initiative for Product attachment and trust/lock-in, Xiaomi distinguishes itself by prioritizing the safer and more responsible production of products, aligning with Xiaomi's unique focus in this aspect. Furthermore, within the take-back services category, only Xiaomi and Transsion have launched customer education initiatives. Xiaomi implements various circular economy campaigns, while Transsion concentrates on advocating consumers to recycle their waste products back to the company. Lastly, an analysis reveals that efforts on Eco-friendly packaging are notably undertaken by only two companies, namely Huawei and ZTE.

4.2.3 Potential circular business models

The next phase of this section involves addressing the second research question. This will be accomplished by comparing the circular business models implemented by Huawei, Xiaomi, BOE, ZTE, Lenovo, and Transsion with the established circular business models outlined by Lüdeke-Freund et al. (2018). The circular business models not employed by the aforementioned companies, as per the Modified ReSOLVE framework, will be highlighted separately for in-depth analysis. The overarching goal is to identify and delineate novel circular business models that have yet to be applied in the current business landscape of China's consumer electronics industry and analyse the reason why absent in this industry and the challenges and opportunities to implement these potential circular business models.

The first analysis of this part focuses on the circular business models that companies in the Modified ReSOLVE framework are not applying. Among the examined companies – Huawei, Xiaomi, BOE, ZTE, Lenovo, and Transsion – certain circular business models from the Modified ReSOLVE framework, namely “Product sharing system”, “Produce on demand”, and “Product-as-a-service”, are notably absent.

The absence of these models can be attributed to various factors deeply embedded in the companies' strategic orientations and operational contexts. After reviewing the companies' reports and literature, this thesis finds that the reasons for the lack of application of the three circular business models in the China's consumer electronics market may be a combination of industry dynamics, consumer preferences, and technological constraints. The companies prioritize strategies that align with their core values, such as durability, sustainability, and consumer trust, which may not be fully compatible with the characteristics of the aforementioned circular business models.

Product sharing system, which involves enabling shared use, access, or ownership of electronic devices, is not explicitly evident in the circular business models of the companies. This absence can be rationalized by the nature of the consumer electronics industry, where personal ownership and customization are often integral to consumer preferences. Additionally, the absence of this model aligns with the emphasis on durable and long-lasting products, fostering consumer trust and attachment, which may conflict with the temporary and shared nature of a product-sharing system(Alves et al., 2023).

Produce on demand, a model centered around creating data management facilities for product personalization and introducing made-to-order electronics, is also not explicitly embraced by the case companies(Anyaoha et al., 2024). The companies, instead, focus on optimizing resource value, waste reduction, and sustainable materials, aligning with a more standardized mass production approach. This might stem from considerations related to efficiency, economies of scale, and the challenges associated with individualized manufacturing processes in the fast-paced consumer electronics industry.

Product-as-a-service, involving a shift toward virtual services for mobile device parts and accessories, is another circular business model not fully adopted by the companies. The emphasis on physical product quality, reliability, and attachment may overshadow the potential benefits of dematerialized services. Moreover, the technology landscape might not have matured to a point where such services can entirely replace the traditional model of physical products.

Then, this thesis delivers a comprehensive exploration of potential circular business models relevant to China's consumer electronics industry. The analysis incorporates established circular business models outlined by Lüdeke-Freund et al. (2018), the specific circular business models implemented by case companies (Huawei, Xiaomi, BOE, ZTE, Lenovo, and Transsion). Through this comparative analysis, a nuanced comprehension of circular business models in the China's consumer electronics industry emerges, shedding light on both embraced and untapped circular business

models. These circular business models include “Online waste exchange platform”, “Waste exchange (internal)”, “Waste exchange (external)”, “Product as a service”, “Sharing platforms”, “Functional sales and management services models” /“Deliver functionality, rather than ownership”/“Access and performance model”/“Functional result”, “Pay per service unit” and “Product lease”/ “Product renting or sharing”.

Implementing circular business models in the China’s consumer electronics industry involves both opportunities and challenges. So in this section, a comprehensive overview of the potential application and associated difficulties for each model be discussed.

The prospect of establishing an Online Waste Exchange Platform presents an avenue for companies to efficiently manage and exchange waste resources. However, challenges may arise in ensuring a secure and transparent platform, adhering to regulatory frameworks, and establishing trust among participants (Ingemarsdotter et al., 2020). For instance, the platform could facilitate the exchange of electronic components or materials, optimizing resource utilization within the industry but it could also result in the leakage of confidential material from the company's product components.

Waste Exchange (External/Internal) further extends the collaborative approach to resource management. External waste exchange involves interactions between companies, while internal exchange occurs within an organization. The potential lies in creating synergies and reducing waste generation. Challenges may include logistical complexities, legal considerations, and the need for standardized protocols. Companies could explore partnerships or alliances to enhance external waste exchange and streamline internal processes.

The concept of Product as a Service (PaaS) offers an alternative revenue model centered on delivering functionality rather than products. While this model aligns with sustainability goals, challenges include shifting consumer mindsets accustomed to ownership. For instance, offering smartphones as a service could involve a subscription-based approach, providing continuous updates and maintenance. Convincing consumers of the value proposition may be crucial in overcoming adoption hurdles (Ingemarsdotter et al., 2020).

Sharing Platforms provide an opportunity for collaborative consumption, enabling users to share access to products, reducing overall consumption. Challenges include establishing trust, addressing legal complexities, and managing the wear and tear of shared items(Kalar et al., 2021). In the context of consumer electronics, a sharing platform could involve shared access to high-end electronic devices or collaborative usage of specialized equipment.

The adoption of Functional Sales and Management Services Models, also known as delivering functionality rather than ownership, introduces a paradigm shift. Companies can sell outcomes and ongoing management services rather than products. Challenges encompass defining measurable outcomes, educating consumers on this model, and risk allocation. For instance, a company could sell the functionality of energy-efficient electronic devices and offer continuous optimization services.

Access and Performance Models focus on providing users with access to a product's performance rather than owning the physical product. Establishing clear performance metrics, ensuring data security, and determining competitive pricing are challenges. For instance, companies could offer access to advanced software functionalities instead of selling the software itself, charging based on performance metrics.

The Functional Result Model centers on delivering specific functional outcomes to customers. Challenges include defining and measuring outcomes, collaborating closely with customers, and gaining market acceptance(Kalar et al., 2021). A practical example could be a company offering data storage services with guaranteed outcomes related to data accessibility and security.

Pay Per Service Unit introduces a flexible pricing model based on consumption. Fair pricing, service quality assurance, and operational efficiency are challenges. In the context of consumer electronics, companies could implement this model by charging users based on actual usage of software features or specific device functionalities(Aloini et al., 2020).

Product Lease and Product Renting or Sharing involve providing alternatives to ownership, presenting opportunities for revenue diversification. Challenges include effective asset management, addressing the desire for ownership, and establishing consumer trust. For example, companies could lease high-end electronic devices or enable short-term rentals of specialized equipment.

5. Discussion

This section will combine the literature review with an in-depth analysis of why the case companies have similarities and differences as analysed in the previous section.

5.1 Possible factors contributing to similarties in circular business models

The observed similarities in the circular business models of the six companies, namely Huawei, Xiaomi, BOE, ZTE, Lenovo, and Transsion, can be attributed to several key factors rooted in both industry trends and the evolving paradigm of sustainability, a multifaceted interplay of environmental imperatives, industry trends, and innovation pursuits.

First and foremost, the commitment to integrating renewable energy sources into manufacturing processes reflects a strategic response to the escalating environmental challenges facing the electronics industry. As the global community grapples with the urgent need to mitigate climate change and reduce carbon emissions, companies operating in energy-intensive sectors, such as electronics manufacturing, face increasing pressure to transition towards sustainable practices. The imperative to curb carbon footprints and embrace cleaner, renewable energy sources is not only a reflection of corporate environmental responsibility but also a proactive stance to align with evolving international sustainability standards.

Within the broader context of global environmental responsibility, the electronics industry stands out as a significant contributor to carbon emissions and resource depletion due to its intricate supply chains and energy-intensive production processes. Against this backdrop, the adoption of renewable energy becomes a crucial lever for companies to not only meet regulatory expectations but also to future-proof their operations. Geissdoerfer et al. (2018) argue that integrating renewable energy into manufacturing aligns with circular economy principles, contributing to the decoupling of economic growth from resource consumption. This transformative approach not only addresses immediate environmental concerns but also positions companies for

long-term resilience and competitiveness in an increasingly sustainability-conscious marketplace.

The literature in sustainability and circular economy corroborates the strategic importance of embracing renewable energy sources in manufacturing. Studies emphasize that companies adopting renewable energy solutions demonstrate a commitment to reducing their ecological footprint, which, in turn, enhances their corporate image and brand reputation (Seidel et al., 2019). Furthermore, integrating renewable energy into manufacturing processes aligns with the broader goals of achieving a circular economy, emphasizing the interdependence of economic, environmental, and social factors in sustainable business practices (Ellen MacArthur Foundation, 2013).

Moreover, the prioritization of environmentally friendly materials and active engagement in recycling initiatives can be understood as a multifaceted response to dynamic external pressures, including the escalating influence of consumer awareness and evolving regulatory frameworks that underscore sustainable sourcing and waste management. This strategic alignment with circular practices not only addresses immediate environmental concerns but also reflects a nuanced understanding of the shifting landscape of consumer preferences and regulatory expectations.

The pivotal role of consumer awareness in driving companies toward sustainable practices (Toppinen et al., 2015). In the context of the electronics consumer industry, consumers are becoming increasingly environmentally conscious, seeking products that align with their values of sustainability and ethical sourcing. Companies recognize the business imperative of adapting to this changing consumer landscape, where eco-friendly products and transparent supply chain practices are becoming key drivers of competitive advantage. By prioritizing environmentally friendly materials, the six companies are not merely responding to immediate regulatory demands but strategically positioning themselves to capture a growing market segment that values sustainability.

Simultaneously, the evolving regulatory landscape plays a pivotal role in shaping companies' approaches to circularity. Governments and international bodies are progressively introducing stringent regulations to curb environmental degradation, promote sustainable sourcing, and mandate responsible waste management practices. Companies that proactively adopt circular practices align themselves with these regulatory expectations, ensuring compliance and demonstrating a commitment to responsible corporate citizenship.

By manifesting a collective consciousness toward reducing environmental impact and promoting resource circularity, the six companies navigate a delicate balance between

meeting consumer expectations and complying with evolving regulatory demands. This strategic alignment positions them not only as environmentally responsible entities, but also as forward-thinking organizations attuned to the interconnected dynamics of consumer preferences and regulatory shifts in the pursuit of sustainable business practices.

Furthermore, the emphasis on extending the lifecycle of products, offering repair services, and integrating innovative product components resonates with the core principles of circular economy, aligning with the notion of "closing the loop" and strategically addressing the imperative to reduce overall resource consumption. This commitment to product longevity, repairability, and responsible end-of-life management reflects a comprehensive understanding of circular economy principles, emphasizing not only the initial creation of products but their entire lifecycle.

Extending product lifecycles, a key tenet of circular strategies, is recognized in the literature as a fundamental approach to minimizing the environmental impact of consumer goods (Bocken et al., 2016). By offering repair services and promoting the durability of their products, the six companies are strategically positioned to reduce the demand for new resources, alleviate the environmental burden associated with frequent replacements, and contribute to a more sustainable consumption pattern. This aligns with the broader discourse in sustainability literature, which highlights that fostering a circular economy requires a shift from the traditional linear model of production and consumption to one that prioritizes resource efficiency and longevity (Kirchherr et al., 2017).

The potential economic and environmental benefits associated with extending product lifecycles and engaging in responsible product lifecycle management. Businesses adopting circular strategies often find that these practices not only contribute to environmental conservation but also open up new revenue streams and enhance brand reputation (Bocken et al., 2016). As such, the six companies' focus on product longevity and responsible lifecycle management can be seen as a strategic move, not only in response to environmental concerns but also as a means of securing long-term economic viability and cultivating a positive brand image.

Finally, in terms of innovation pursuits, the shared commitment to continuous improvements in product components and technologies resonates with the broader understanding that innovation serves as a pivotal driver in the transition towards a circular economy. Building upon the established practices of renewable energy integration, sustainable materials sourcing, and product lifecycle extension, the emphasis on innovation becomes paramount in addressing the multifaceted challenges of sustainability and circularity.

As established earlier, a resolute dedication to renewable energy sources, environmentally friendly materials, and extended product lifecycles collectively forms the foundation of the six companies' circular business models. However, to navigate the evolving landscape of sustainability and meet the dynamic expectations of consumers and regulators, an ongoing commitment to innovation is crucial. The technological advancements not only contribute to enhanced resource efficiency but also play a transformative role in shaping circular business models (Kirchherr et al., 2017).

The incorporation of embedded batteries, firmware updates, and a commitment to durability improvements exemplifies a collective belief in the transformative power of innovation to address sustainability challenges. These innovations are strategically integrated into their products, showcasing a forward-looking approach that goes beyond conventional practices. The continuous pursuit of technological advancements allows companies to stay ahead in the dynamic market, aligning their circular strategies with the ever-evolving landscape of environmental consciousness, regulatory requirements, and consumer expectations.

Moreover, innovation serves as a catalyst for the development of new business models that are inherently circular in their approach. The companies embracing innovation are better positioned to explore novel revenue streams, optimize resource utilization, and create products that align with circular principles (Kirchherr et al., 2017). In this context, the collective innovation initiatives of the six companies not only respond to current sustainability challenges but also future-proof their operations, ensuring adaptability to emerging trends and fostering resilience in a rapidly changing market.

5.2 Possible factors contributing to differences in circular business models

The observed differences in the circular business models of Huawei, Xiaomi, BOE, ZTE, Lenovo, and Transsion can be attributed to various factors, encompassing company values, size, main business focus, and underlying business models.

Huawei's substantial brand value and extensive global reach position it as a prominent player in both B2B and B2C markets within the technology and communication industry. The company's commitment to circular business practices is notably reflected in its strategic emphasis on eco-design, product life cycle management, and recycling programs. Huawei's large-scale operations and diversified product portfolio play a pivotal role in facilitating a comprehensive integration of circular practices. The company's global presence allows it to implement circular strategies across various markets and regions, leveraging its influence to promote sustainable practices within

the broader technology ecosystem. The diversified product range provides opportunities to apply circular principles to a spectrum of electronic devices, contributing to a more circular and resilient business model.

In contrast to other players, Xiaomi adopts a distinct approach in prioritizing circular consumption as a core element of its business strategy. Xiaomi's emphasis on circularity is evident in its commitment to developing products with modular components, thereby facilitating easy repair and upgrades. This focus aligns seamlessly with the company's B2C-focused business model, which relies on e-commerce platforms and a comprehensive network of online and offline channels.

The B2C-focused business model adopted by Xiaomi plays a pivotal role in shaping its circular practices. Xiaomi's direct engagement with end consumers through e-commerce platforms and various channels enables the company to respond swiftly to evolving consumer preferences. The accessibility of Xiaomi's products through online channels enhances consumer awareness regarding the repairability and upgradeability of the devices they purchase, contributing to a more informed and environmentally conscious consumer base.

BOE, as a B2B IoT company, recognizes the critical role it plays in the global supply chain and its responsibility to minimize its environmental impact. The emphasis on material selection and emission reduction reflects BOE's commitment to being an environmental steward and aligns with the company's core values of sustainability.

As a supplier in the B2B domain, BOE is attuned to the evolving expectations of its business customers. Many enterprises are now prioritizing sustainability and seeking partners that share their commitment to environmental responsibility. BOE's focus on emission reduction and environmentally friendly materials addresses these expectations, potentially enhancing its market competitiveness.

ZTE's distinctive approach in actively participating in global sustainability initiatives is a testament to its commitment to responsible business practices that transcend geographical boundaries. As a company operating in both B2B and B2C spheres, ZTE recognizes the interconnectedness of global markets and the importance of collaborative efforts in addressing environmental challenges.

ZTE's active engagement in global sustainability initiatives aligns with its ambitions for international market expansion. By positioning itself as a responsible and sustainability-focused player, ZTE enhances its reputation on the global stage.

Lenovo's circular business model stands out for its comprehensive circular supply chain infrastructure, Lenovo Value Recovery (LVR). This unique initiative is based on Lenovo's strategic approach to sustainability, particularly within the IT sector.

Lenovo, as a prominent player in the technology industry, leverages its technological expertise to establish a circular supply chain infrastructure. This approach aligns with the company's core capabilities and allows it to integrate sustainable practices seamlessly into its operations.

As businesses seek to minimize their environmental impact, Lenovo positions itself as a supplier that not only meets but exceeds such expectations, contributing to its competitiveness in the IT sector. The focus on providing certified refurbished data center equipment through LVR indicates how Lenovo positions itself.

Transsion operates as a B2C-centered company in the competitive mobile phone market. The nature of the mobile phone industry, characterized by rapid technological advancements and frequent product upgrades, necessitates a strategic approach to address environmental concerns associated with electronic waste. Transsion's focus on product life cycle extension incorporating repair services, extended warranties, and reliability testing aligns with the need to counteract the disposable culture prevalent in the electronics sector.

6. Conclusion

In conclusion, this thesis has endeavored to provide a comprehensive examination of the circular business models adopted by prominent companies in the China's consumer electronics industry, including Huawei, Xiaomi, BOE, ZTE, Lenovo, Transsion. The analysis was conducted in alignment with the Modified ReSOLVE framework and compared against established circular business models summarized by Lüdeke-Freund et al. (2018). The research aimed to identify both applied and unapplied circular business models, shedding light on the evolving landscape of sustainable practices in the industry.

The findings underscore the industry's commendable efforts in incorporating various circular principles, such as material regeneration, life cycle extension, and resource optimization. These companies exhibit a commitment to sustainability through renewable energy adoption, recyclable materials usage, and comprehensive take-back programs etc. The incorporation of circular practices is particularly evident in product design, material selection, and end-of-life strategies etc.

However, despite these advancements, certain circular business models outlined by Lüdeke-Freund et al. (2018) remain largely unapplied in the examined companies. The unapplied models present untapped opportunities for further innovation and integration of circularity within the industry. Challenges persist in terms of consumer perceptions, regulatory frameworks, and operational complexities, hindering the seamless adoption of some models.

Future research in this domain could delve into a more extensive array of companies, encompassing not only the industry leaders but also the emerging players. A more in-depth exploration of the unapplied circular business models, coupled with direct engagement with companies, could provide richer insights into the challenges and opportunities associated with their implementation. Moreover, an examination of the evolving regulatory landscape and its impact on circular practices within the Chinese consumer electronics industry would contribute to a more holistic understanding.

The limitations of this study primarily lie in the available information and the dynamic nature of the consumer electronics industry. The selection of only 6 case companies imposes constraints on the depth and comprehensiveness of the results. And the analysis is based on publicly accessible data, and detailed proprietary practices may not be fully disclosed. Moreover, the rapidly evolving landscape of technology and sustainability practices requires continuous monitoring and adaptation.

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A. Appendix A

The other basic information of case companies

1. Huawei

Founded in 1987, Huawei is a leading global provider of information and communications technology (ICT) infrastructure and smart devices. Huawei's 207,000 employees and operate in over 170 countries and regions, serving more than three billion people around the world. Huawei is committed to bringing digital to every person, home, and organization for a fully connected, intelligent world.

Scientific exploration and technological innovation drive civilization and society forward. Huawei understands the importance of research and innovation and how openness is critical for both. We are ready and willing to work with academia and industry to explore the frontiers of science and technology, push innovation forward, create value for industry and society as a whole, and build a better intelligent world.

2. Xiaomi

Xiaomi Corporation was founded in April 2010 and listed on the Main Board of the Hong Kong Stock Exchange on July 9, 2018 (1810.HK). Xiaomi is a consumer electronics and smart manufacturing company with smartphones and smart hardware connected by an IoT platform at its core.

Embracing our vision of "Make friends with users and be the coolest company in the users' hearts", Xiaomi continuously pursues innovations, high-quality user experience and operational efficiency. The company relentlessly builds amazing products with honest prices to let everyone in the world enjoy a better life through innovative technology.

Xiaomi is one of the world's leading smartphone companies. In June 2023, MAU of MIUI reached approximately 606 million globally. The company has also established the world's leading consumer AIoT (AI+IoT) platform, with 654.5 million smart devices connected to its platform (excluding smartphones, laptops and tablets) as of

June 30, 2023. Xiaomi products are present in more than 100 countries and regions around the world. In August 2023, Xiaomi was included in the Fortune Global 500 list for the fifth year in a row, ranking 360th.

Xiaomi is a constituent of the Hang Seng Index, Hang Seng China Enterprises Index, Hang Seng TECH Index and Hang Seng China 50 Index.

3. BOE

Founded in April 1993, BOE Technology Group Co., Ltd. (BOE) is a leading IoT company providing intelligent interface products and professional services for information interaction and human health. It has formed a "1+4+N+Eco-chain" business structure with the semiconductor display business as the core and featuring the integrated development of IoT innovation, sensor and solutions, MLED and smart engineering medicine.

As of 2022, BOE had independently filed more than 80,000 patent applications to patent offices around the world. Out of the new patent applications, over 90% were patents for inventions and above 33% were filed overseas, such as the United States, Europe, Japan and South Korea. According to the 2022 U.S. Patent Grant Statistics Report released by IFI CLAIMS Patent Services, BOE ranked 11th in the world, making it into the top 20 for the fifth consecutive year and becoming one of the few Chinese enterprises on the list. According to the 2022 ranking of international patent applications published by the World Intellectual Property Organization (WIPO), BOE ranked seventh in the world with 1,884 PCT patent applications, staying among the top 10 for seven years in a row.

BOE owns a number of manufacturing sites in Beijing, Hefei, Chengdu, Chongqing, Fuzhou, Mianyang, Wuhan, Kunming, Suzhou, Ordos, Gu'an, etc. Its subsidiaries span 20 countries and regions, including the United States, Germany, Britain, France, Switzerland, Japan, South Korea, Singapore, India, Russia, Brazil and the United Arab Emirates. Its service network covers major regions in Europe, the Americas, Asia, Africa and beyond.

4. ZTE

ZTE Corporation is a global leader in information and communications technology. Founded in 1985 and listed on both the Hong Kong and Shenzhen Stock Exchanges, the company has been committed to providing innovative technologies and integrated solutions for global operators, enterprise customers, and consumers from over 160

countries. Serving over a quarter of the global population, the company is dedicated to enabling connectivity and trust everywhere

5. Lenovo

Lenovo is a global technology company founded in China with operations in 180 markets. Focusing on globalization and developing innovative technologies, Lenovo is committed to building a more inclusive, trustworthy and sustainable digital society, leading and empowering the transformation of the new era of intelligence, and creating better experiences and opportunities for hundreds of millions of consumers around the world.

Lenovo, as a leading global ICT company, adheres to the philosophy of "Intelligence for Every Possibility" and continues to research, design and manufacture the world's most complete portfolio of end-to-end smart devices and smart infrastructure, providing users and industries with smart devices that integrate applications, services and the best experience, as well as powerful cloud infrastructure and industry smart solutions. and industry intelligence solutions.

As a global leader in smart devices, Lenovo provides hundreds of millions of smart devices, including computers, tablets, smartphones, etc., to users around the world every year. 2022 Lenovo PC sales ranked No. 1 in the world. As a top global provider of enterprise digitalization and intelligent solutions, Lenovo actively promotes the development of "device+cloud" and "infrastructure+cloud" across the industry, as well as the implementation of intelligent solutions.

Facing the industrial upgrading opportunity of the new round of intelligent change, Lenovo puts forward the strategy of intelligent change, focusing on the three directions of Smart IoT, Smart Infrastructure, and Smart Verticals & Services to become the leader and enabler of the industry's intelligent change. Lenovo will continue to invest in technological innovation and social value, deepen service-oriented transformation, strengthen the same Lenovo and digitalization, and continue to make services and solutions Lenovo's new core competencies in the future.

Currently, Lenovo's core business consists of three business groups, namely IDG Intelligent Devices Business Group focusing on intelligent IoT, ISG Infrastructure Solutions Business Group focusing on intelligent infrastructure, and SSG Solution Services Business Group focusing on industry intelligence and services, with approximately 77,000 employees worldwide. In FY2022/23, Lenovo's overall turnover has reached RMB424 billion.

6. Transsion

Transsion Holdings is a Chinese manufacturer of mobile phones based in Shenzhen which was founded in Hong Kong in 2006. It was the largest smartphone manufacturer by sales in Africa in 2017, and also sells mobile phones in the Middle East, Southeast Asia, South Asia, and Latin America. Its brands include phone brands such as Itel, Tecno, Infinix; after-sales service brand Carlcare; and accessories brand Oraimo. It manufactures phones in China, Indonesia, Pakistan, Ethiopia, Bangladesh and recently in India. Transsion is a company dedicated to becoming the favorite smart terminal product and mobile internet service provider for consumers in emerging markets. Transsion has been focusing on providing users with high-quality multi-brand smart terminals centered on cell phones and providing mobile Internet services based on its self-developed smart terminal operating system and traffic portal.

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