



Design Management Capability in Entrepreneurship: A Case Study of Xiaomi

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In recent years, entrepreneurship has become a popular topic and attracted many young people to start their own companies. In entrepreneurship, design is generally viewed as essential to innovation, replacing the conventional role of the engineer. Unlike traditional businesses, which generally take a longer time to become established in the more stable economic context of mass production, current start-ups have to face fierce competition and have a tendency to expand rapidly and accommodate the dynamic business environment. Consequently, design management is considered to be crucial to business growth, since it contributes to both competitive advantage and strategic flexibility. However, start-up companies are well-known for their high failure rate. This triggered our initial research question: what is the role of design in a start-up to support it in achieving success? A case study of Xiaomi, a well-known successful enterprise in China, is used to report on the new capabilities of entrepreneurial design management. These are further classified into three key topics in line with the three stages of entrepreneurial business development. Unlike the design management capabilities reported in previous studies, the new capabilities show the dynamic nature of entrepreneurial design management.

Keywords – Entrepreneurship, Design Capability, Design Management, Entrepreneurial Design Management.

Relevance to Design Practice – How to facilitate entrepreneurial business with design management capability is critical for a start-up. Founders of a start-up team may be able to clarify their direction in building design management capability throughout the three stages of entrepreneurial business by using the new capabilities of entrepreneurial design management reported in this article.

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Introduction

In recent years, entrepreneurship has become a popular topic, and it has attracted many young people to start their own companies. Start-up projects and teams generally view design as being essential to their innovation activities to replace the conventional role of the engineer and take a leading role in firms (Shih, 2012; Field, 2017). However, technology start-up companies are well-known for their high failure rate: 67% of them die or become merely self-sustaining, as reported by *CB Insights* (“Venture Capital Funnel,” 2019). This triggered our initial research question: what is the role of design in successful start-up companies? If the path of building design capability in a successful start-up could be explored, it might guide entrepreneurs in how to control their risks and increase their chances of success by applying and managing design efficiently.

This is a topic reflecting the overlap between design management and entrepreneurship. Unlike traditional businesses, which generally take a longer time to become established in the more stable economic context of mass production, current start-ups have to face fierce competition in the marketplace and have a tendency to expand rapidly and accommodate the dynamic business environment. Consequently, design management is considered to be crucial to business growth, since it contributes to both competitive advantage and strategic flexibility (Kotler & Rath, 1984; Bruce, Cooper & Vasquez, 1999; Chiva & Alegre, 2007, 2009; Acklin, 2010). *Design management capability*

(DMC) refers to the capacity to deploy design resources in an adequate and dynamic way (Fernández-Mesa et al., 2013; Acklin, 2010, 2013), along with contributing to the dynamic capability of an organization (Teece, Pisano, & Shuen, 1997; Acklin, 2013). With DMC, a company can both sense and respond to emerging opportunities in a timely manner, and create new value (Teece, 1998; Jevnaker, 2000). These advantages are of importance with regard to the main challenges faced by start-ups, which need to develop their knowledge through fast learning, competing in markets, launching new products efficiently and adapting to a dynamic business environment. In the past decade, an overlap of design management and entrepreneurship has emerged from both sides. From a design management perspective, this overlap has been defined as *entrepreneurial design management*, seen as an updated mode within an evolutionary view of design management (Acklin & Fust, 2014). From an entrepreneurship perspective, it has been viewed as an innovative process dealing with the *fuzzy*

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front end (Curran & Burroughs, 1986), which was similar to a design process (Stevenson & Jarillo, 1990). Furthermore, in a review of the “winning performance” of entrepreneurship, it was considered that most aspects could be contributed to or supported by design activities (Okpara, 2007). Accordingly, we use the concept of entrepreneurial design management to describe this overlap, which is the main content of this research.

For the previous modes of design management, there is abundant literature on their framework and the factors of DMC. The results contribute to an evolutionary way of viewing DMC. Two frameworks were the most popular. The first was a proposed index of DMC based on a quantitative study from a management perspective (Dickson, Schneier, Lawrence, & Hytry, 1995), which was later applied in studies of DMCs’ relationships with product innovation (Veryzer, 1998; Gemser & Leenders, 2001; Beverland, 2005; Fernández-Mesa, Alegre-Vidal, Chiva-Gómez, & Gutiérrez-Gracia, 2013), design investment (Moultrie & Livesey, 2014), organizational learning capability (Chiva-Gómez, Camisón-Zornoza, & Lapiedra-Alcami, 2003) and business performance (Howell & Shea, 2001). Another consisted of six capabilities of design management that were explored through case studies from the perspective of design management (Jevnaker, 2000). However, all of these design management capabilities were rooted in the industrial economy and were confined, within their simple or integrated modes, to product or project. As a consequence of the changing business environment in the knowledge economy, a dynamic mode of design management for incumbents to sustain competitive advantage, and an entrepreneurial mode of design management to launch a product on the market and scale up successfully, were the core content (Zahra & George, 2002; Acklin & Fust, 2014). Moreover, the content, framework and factors of entrepreneurial design management were rarely studied.

From the above, it may be seen that there is an urgent demand for a new framework of DMC in the knowledge economy, specifically one that could contribute to successful entrepreneurship. To achieve this, the new roles of design in the framework of DMC should be studied and this was the aim

of the research under discussion. Accordingly, the following research questions were posed: what is the role of design in a start-up business, and what are the associated implications for entrepreneurial design management? Through a case study of Xiaomi, a leading innovative company supplying smart products in China, the heterogeneous role of design in its development stages was analysed in terms of key factors to illustrate the path of building DMC. Four objectives of this research were as follows: 1) to explore the role of design in entrepreneurship by identifying the factors of entrepreneurial design management capability; 2) to establish a pathway for building and developing those new DMCs according to the stages of entrepreneurial business development; 3) to formulate a basic framework of entrepreneurial design management for further studies on this topic; and 4) to guide the practice of entrepreneurship with the new DMCs to enhance the chance of success.

Literature Review

In the literature review, three themes—DMC in a dynamic environment, existing models of design’s role, and related ecosystem theory for dynamic issues—were used as the basis for establishing a framework for the case study.

A Dynamic Environment

According to Schumpeter (1942), society is destroyed every 50 years, with disruptive innovation resulting in industrial revolution. In the Western timeline, the industrial economy was initiated at the end of the 17th century. In the 20th century, companies based on technologies and manufacturing methods arising from the second and third industrial revolutions emerged in various product categories, in what has been referred to as the experience economy (Duguay, Landry, & Pasin, 1997; Heskett, 2001). The current stage of development is described as the fourth industrial revolution and is characterized by both significantly improved abilities of problem-solving and the capacity for changing the world through introducing digital technology across society (Schwaab, 2015). It is supported by relatively new and very popular technologies, such as the Internet, computing, cloud data and 3D printing, all of which have rapidly improved and pushed the economic transformation from industry and the experience economy to a knowledge economy (Brand & Rocchi, 2011; Schwaab, 2015). This transformed economic paradigm (Gardien, Djajadiningrat, Hummels, & Brombacher, 2014) created a dynamic environment (Stalk, Evans, & Shulman, 1992; Hilton & Platt, 2013).

This has had consequences for various product categories, ways of manufacturing, “life-styling,” people’s mindset and business mindset, in addition to transforming ways of creating value (Normann & Ramirez, 1993; Heskett, 2008; den Ouden, 2012), design methods (Gardien et al., 2014), and the role of the designer (Perks, Cooper, & Jones, 2005). The role of design has been transformed from that of assigning the styling of a finished product to a power of business innovation, industrial strategy and even national competitiveness since the early stage of the

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1900s (Freeman, 1995; Perks et al.), accompanying the second and third industrial revolutions. This implied a changed business environment of design practice. The lifecycle of new start-ups became shorter and the pace of development of business types and the role of design accelerated.

Design Management Capability (DMC)

DMC supplied the means for the deployment of design resources in an adequate and dynamic way (Fernández-Mesa et al., 2013; Acklin, 2010, 2013), in addition to contributing to the dynamic capability of an organization (Teece et al., 1997; Acklin, 2013). Although DMC was viewed as an effective way of building both the dynamic capability of firms and strategic flexibility, its specifics were seldom studied. Two aspects that were popularly cited were reported in the quantitative study of *design management skills* by Dickson et al. (1995) and a qualitative study conducted by Jevnaker (2000). Analysing high growth business, Dickson et al. referred to five dimensions of design management skills: basic skills, specialized skills, involving others, organizational change, and innovation skills. The first two referred to the design capabilities of a team, while the last three were the capabilities of managing design. With case studies, Jevnaker explored six

dimensions of *organizing design capability* aligned with the leadership activity of a corporation. These were resourcing capability, combinative capability, organizational learning capability, innovation capability, design-strategic capability, and capability of protecting design-based advantage.

By combining the specifics reported in the two previous studies, a new list of DMC was generated based on the three levels of design management: strategic, tactical and operational (Borja de Mozota, 2003). This was utilized in our study to review the role of design in the business development of entrepreneurship (Table 1).

Entrepreneurial Mode of Design Management

The overlap between entrepreneurship and design management is shown from two perspectives: design management and business management. In the research field of design management, the concept of entrepreneurial design management was proposed by Acklin and Fust (2014), with an evolutionary path of the changing role of design in business development. According to their findings, previous studies and practice were focused on simple or integrated modes, which referred to design management of products or projects. Facing the dynamically changing business environment in the knowledge economy, incumbent companies

Table 1. A combined list of DMC factors from two previous studies.

Jevnaker (2000) Organizing design capability	Dickson (1995) Design management skills
Strategic DMC	
Design-strategic capability - Providing a strategic focus while allowing out-of-the box discovery - Anchoring design developments in business strategy and strategists - Implementing strategy stretch	Replacing sequential with concurrent design
Capability of protecting design-based advantages - Protecting new designs by patents, licencing, and pattern protection - Capturing design-based value and sharing risks through legal agreements, royalties and relational contracting - Sustaining design capabilities through design alliancing and R&D partnering	Quickly becoming aware of competitors' innovations and imitations
Organizational learning capability - Communicating design with ethos repeatedly to multiple stakeholders. - Exposing and testing design within a reciprocal and acknowledged design relationship - Inaugurating design experiences to key stakeholders - Debriefing design, building memory	Changing traditional ways of doing things
Tactical DMC	
Combinative capability - Configuring design resources - Tapping and connecting to firm-specific resources, strategic assets, or otherwise distinctive resources - Creating interaction of design resources and the firm's core competent people	Involving customers in the design process Involving suppliers in the design process Obtaining new product ideas from customers Enabling different functions in the firm to work together
Resourcing capability - Starting up design or development initiatives (design resourcing capability) - Accessing best suitable design and business expertise - Resourcing money, time, projects, and facilities without detrimental overload of capacity.	Finding people with excellent design skills
Operational DMC	
Design innovation capability - Adopting new knowledge and ideas - Fostering creative design developments - Nurturing open exchange and taking advantage of creative abrasion	Designing quality into products Designing manufacturability into products Designing low cost into products Designing and launching new products faster Using the latest computer-aided design tools effectively Estimating the true cost of new products during the design process Testing manufacturability of new products during the design process Finding new design ideas—not just me-too imitations

faced the challenges of deploying knowledge, design competence and capabilities, which was named as the dynamic mode of design management (Zahra & George, 2002). As the fourth and the most up-to-date mode, the entrepreneurial mode of design management goes further with an overlap between design management and entrepreneurship, especially the core element of business opportunity.

From the perspective of management, entrepreneurship was viewed as design mainly for two reasons. First, both had a fuzzy front end process (Stevenson & Jarillo, 1990). Entrepreneurship was an innovative process of creating value (Curran & Burroughs, 1986). This consisted of three core elements, which were recognizing, evaluating and exploiting business opportunity, attracting and combining necessary resources, and building and managing organizations. Among these elements, business opportunity was the front end, with an exploration process that was similar to the front end of the design process (Okpara, 2007). Second, there were five aspects of the “winning performance” of the entrepreneur and successful entrepreneurship, namely 1) competing on quality not prices, 2) domination of a market niche, 3) competing in an area of strength, 4) having tight financial and operating controls, and 5) frequent product or service innovation (particularly important in manufacturing) (Okpara, 2007). These were the aspects that design could contribute to more or less directly.

Here, the main content of entrepreneurial design management as the overlap of design management and entrepreneurship existed in business opportunity, in which design could contribute to exploiting new business opportunities, marshalling necessary resources and building organizational DMC appropriately to achieve the business goals of new business segments or new business ventures (Acklin & Fust, 2014).

The Overlap between Design Management and Entrepreneurship

Combining the factors of DMC from the two representative previous studies, as shown in Table 1, a basic framework of DMC was established for all the design management modes. This was applied in this study as the framework for further exploring the factors of entrepreneurial design management. Linking it with the three core elements of entrepreneurship and the main stages of entrepreneurship, a pathway of building its DMC could be defined. Thus, we further defined our research questions as follows:

- What are the factors of entrepreneurial design management capability, especially the new factors compared to the general DMC in previous studies?
- What are the key capabilities of entrepreneurial design management?
- How do the new DMCs contribute to entrepreneurial business development?

Therefore, the frame of this research consisted of two dimensions: 1) The process of entrepreneurship, including formation, validation and growth. 2) The process of problem solving, which includes problem, solution and effect. Within

the research frame, the case of Xiaomi, a well-known successful entrepreneurial business, is studied with rich description and analysed to explore the factors of entrepreneurial design management capability.

Methodology

Case Selection

Xiaomi was selected as a case study because of its successful and high-growth start-up, along with its being in the knowledge economy. Xiaomi was established in 2010 with a strategy of expansion through building a supportive ecosystem. Initially founded by CEO Jun Lei, together with seven co-founders, it has grown into a firm with 8,000 employees and had an estimated value of 100 billion USD in 2018. Its original products were a smartphone operating system and a smartphone. By 2014, it had become the market leader for smartphones in China and third in the global market, although it subsequently lost market share, apparently as a consequence of perceived poor product quality. Xiaomi is now recovering market share with a redefined strategy and was floated on the stock market in July 2018.

The Xiaomi case is significant in that it increases an understanding of constructing design capability from a base of almost zero to diverse product categories through the building and co-opting of ecosystems. A process-based methodology was applied to investigate Xiaomi’s path to domination—or attempted domination—in a number of digital technology sectors in China.

Data Collection Protocol

Data collection was primarily based on interviews carried out from 2013 onwards, on a longitudinal basis, with senior managers from the company. The selection of interviewees followed a purposive protocol, in that potential respondents were chosen and approached based on their ability to provide relevant information. Because of the personal relationships involved, access was rarely refused. Given that this may have biased the data and that the provision of “insider” corporate data may incur some expectation of beneficial publicity, it was taken that the subject matter of this paper, and the openness of respondents’ accounts, suggested that the validity of the data was acceptable for purposes of academic research.

Altogether, we conducted 20 semi-structured interviews, accompanied in 15 cases by direct observation of the interviewees’ working environment and the company’s Mi Home stores (Table 2). These were supplemented by numerous follow-up conversations via WeChat or phone call. Of the 20 interviews, 16 were recorded while others were not recorded owing to confidentiality concerns during the “silence phase” when the company was preparing for listing on the Hong Kong stock market. In these cases, detailed notes were taken. The interviews normally lasted between one and two hours. Since Dr. Jun Su and Hua Hong are university classmates and friends of more than 15 years of one of the authors of this paper, no additional permission was needed to initiate

the conversations with their colleagues. Complementary data came from internal documents, site observations of corporate operations such as Xiaomi's experience store Mi Home, and real-time observation of units, and from secondary data such as news reports, online videos and open talks. With the first author's links to the company, we had privileged access to internal company information.

All the interviews were transcribed. A database was established to compile and help to analyse the data. In keeping with thematic qualitative analysis (Boyatzis, 1998), data were organized according to themes, using extant theory from inter alia the fields of strategic DMC, tactical DMC and operational DMC. These were used to assess developments over time with a focus on the core elements, business opportunity, necessary resources, and organization. A total of three time periods were used as the basis of the process methodology. Any emerging themes that did not appear to be consistent with existing theories were noted and form part of the discussion below.

Process Theory

A process-based methodology was chosen to understand the role of design over time. In the study of the Xiaomi case, the entrepreneurship was divided into three phases: formation, validation and growth. It was applied in the stages of both data collection and data analysis with a structure of cause–solution–effect. In data collection, to arrive at explanations as to what problems were met, why certain decisions were taken, what was the role of design in the process, and how these decisions shaped what the company could or could not do, the process theory was applied to develop interview questions. These questions included: what problems did they meet in their entrepreneurship? How did they solve the problems? What resources did they bring in and what organization did they develop accordingly? In the data analysis stage, the interviewees' responses to interview questions were analysed with the structure of cause–solution–effect. The representative factor of DMC from each solution was summarized. They were further compared with factors in general design management capability to explore the new ones and those particular to entrepreneurial design management. Furthermore, these factors were classified according to the three core elements of entrepreneurship to define the contribution of design to entrepreneurship.

Xiaomi Case

In keeping with the process-based methodology, the findings are presented in three different time periods to demonstrate the development of Xiaomi's design capability and business over time. The relationship between problem, solution, effect and its DMC in each event is listed in the Appendix with details. The number of the event is shown in the related case description. In the case description below, only those events related to or solved by injecting DMC are included. Other events that are related only to issues and solutions of financial, investment or business management are not included. First, some background information on the company's socioeconomic context is supplied.

The Chinese Context: From Manufacturing to Creativity

China's economy has been evolving since 1978, beginning with the Reform and Opening Policy, which aimed to promote China's modernization and development by reforming its economic and political systems and opening its doors to foreign investment. At the initial stage of the reforms, to increase productivity and bridge the gap between supply and demand, "Introduction–Absorption–Innovation" was defined as the national innovation policy. It was promoted during the first 30 years of the Reform and Opening Policy, and led to the perception that products "Made in China" were copycat by nature (Akdeniz Ar & Kara, 2014).

In 2010, China established its "Innovation-Driven Development Strategy" as part of its national development strategy. Two years later, China entered another new stage in its development, defined as the "New Normal," which is characterized by four changes: a change from high-speed economic growth to medium-to-high-speed growth; a change from extensive growth fuelled by industrial scale to intensive growth focusing on quality; a change from enhancing the capability of economic structures to optimizing their capacity; and a transition to new growth drivers. Since then, the Chinese government has attempted to rebalance its slower economy with more sustainable development (Rein, 2014). Challenged by the economic slowdown, the Chinese government shifted the focus of its innovation strategy to indigenous innovation, as evidenced by a series of policy enactments.¹ In response, Chinese entrepreneurs and senior managers, especially those from private enterprises, have shown unprecedented interest

Table 2. Brief background of interviewees.

Interviewee	Year of joining Xiaomi	Area of business	Business activities	Times interviewed	Site observation
Co-founder of Xiaomi	2010	Xiaomi Group	Eco-chain division	Twice	Yes
CEO and founder	2016	Granary College	Knowledge sharing	Twice	Yes
CEO and founder	2013	Smart Mi	Air purifiers & air conditioners	12 times	Yes
CEO and founder	2014	Roborock	Robot vacuum cleaners	Once	Yes
Co-founder, vice president	2015	Cleargrass	Thermometers	Once	/
CEO	2017	Ciga	Mechanical watches	Twice	Yes

in innovation and risk-taking (Tan, 2001; Li & Tang, 2010). China is reportedly becoming “a New Innovation Powerhouse,” turning into an R&D machine, and rapidly catching up with the US (Wertime, 2014; Osawa & Mozur, 2014).

At the same time as traditional manufacturing industry initially became confronted with the challenges for transformation and upgrading to “Created in China,” the Internet industry emerged and subsequently boomed. The year 2010 was viewed as the initial year of the Internet of Things (IoT) in China (Ning & Xu, 2010; Chen, Xu, Liu, Hu, & Wang, 2014). Today, China has the largest Internet consumer markets in the world² and is embracing the era of the Internet of Things. Against this background, Xiaomi was established in 2010, to capture the business opportunities of the mobile Internet. According to the stages of entrepreneurial business, their business development can be divided into three phases: the formation stage as Xiaomi 1.0 from 2010 to 2013, the validation stage from 2013 to 2015, which was also the turning point from Xiaomi 1.0 to 2.0, and the growth stage as Xiaomi 2.0 from 2015 to 2018, before the company was floated on the stock market.

Formation Stage: *Xiaomi 1.0 (2010–2013)*

Xiaomi was founded on April 6, 2010. When Jun Lei began the company, he stated that ecosystem building was their business strategy. Their tentative ecosystem structure consisted of three business sectors, these being hardware, software and retail. All of the founders had a level of expertise and knowledge of relevance to the three business sectors (Event 1). The founding team included two from the design profession. One was Wanqiang Li, an expert in the field of human–computer interface design. In the new team, he was responsible for the MIUI system, a smartphone operating system developed by Xiaomi and customized for Chinese users, and for user experience related business. Another design expert was De Liu, a professor of product design at a university. He was responsible for the industrial design of hardware.

Six months after its establishment, Xiaomi launched their first product, the MIUI system, through a co-design process with members in Xiaomi’s online chatroom. Having participated in the design process, members in the chat community viewed the system as their own product, became the first generation of Xiaomi’s customers, and introduced it to their friends (Event 2). Without any advertising, the community reached a size of 600,000 users in the first year. Subsequently, Xiaomi launched the Mi Talk app in its software business, as well as low-cost and high-performance smartphones in its hardware business; Mi.com was its online retail channel and the Mi Home stores were its offline experience centres in the first year (Event 3).

In addition to the two co-founders with a design background, Xiaomi gradually established and developed its internal design team for smartphone products by recruiting designers and collaborating with external design teams (Events 6 & 7). Correspondingly, an initial design process was built up through the product development projects. Later on, a standard and efficient working pattern was established based on their

accumulated experience and resources. At this stage, their designers focused on developing products, launching them on markets according to a targeted schedule and establishing a process (Events 8 & 9).

Xiaomi reached its first peak of development after the initial three years. 18.7 million Mi smartphones were sold in 2013, achieving a 15% market share and entering the top three brands in the Chinese market. Xiaomi’s online community grew significantly, reaching 0.15 billion active members by 2013, mainly 18–35 years old, male, and diehard IT fans.

Validation Stage (2013–2015)

After the first-generation hardware and software were launched on the market, some problems emerged immediately. The two main problems were both related to design. Good design was the basic principle that Xiaomi pursued since the development of the first product. However, Mi1 was criticized for poor performance, such as screen, microphone, touch keys and memory crashes, because they lacked experience in product development and quality control. This led to a poor reputation for Xiaomi and loss of consumer confidence. Fortunately, their consumers and fans in the online community, who viewed the Xiaomi smartphone as their “baby,” helped them to test and improve product performance. Through collecting feedback from them directly, Xiaomi designers improved the design of Mi1 immediately. This resulted in upgraded versions of the smartphone: the Mi1S and Mi2 (Event 11).

Another problem was their product image, with the company becoming known as “China’s Apple” due to the smartphone’s white colour and its rectangular shape with round corners. This was too similar to Apple products. The similarities even extended to Mi Home, which featured large tables to show the products, open spaces without shelves, and a simple colour interior of white and wood. This problem could not be solved immediately, although design has always been viewed as the most effective way of building brand at Xiaomi (Event 10). Later on, it was solved by collaborating with world-top designers for branding in the growth stage, such as the Mi MIX smartphone designed by Philippe Starck in 2016, and 8 Inc., the same design consultancy as used by Apple for its retail stores, for Mi Home in 2017 (Event 18).

The same low cost and high performance strategy was to be repeated when Xiaomi began to develop smartphone peripherals, such as earphones in 2013, power banks in 2013 and fitness bracelets in 2014, as well as other products. The mobile phone would open gates to the personal mobile Internet, and the TV to the smart home. With the experience, resources and capability accumulated in the first three years, Xiaomi decided to expand with an “eco-chain” strategy. Its objectives were to maintain Xiaomi as a popular brand, improve total sales revenue through synergies between key products and eco-chain products and expand the imaginative space of Xiaomi. In 2014, an eco-chain department was formally set up to develop more smart products by enabling interactions between Xiaomi’s internal and external resources,

and potential resources (Event 12). De Liu, the design co-founder, was assigned as the head of this new business sector. Its role was growth through searching out, incubating and investing in external start-up teams or projects, instead of relying on internal investment to have every new product developed by Xiaomi itself. The initial principles of the eco-chain business were: all eco-chain products were to be based on MIUI, controlled by the Mijia App, sold through Xiaomi's retail channel and supplied by Xiaomi's own network. The strategy indicated the intention of bringing maximum value to current core consumers by making full use of existing resources (Event 13). In 2014, it achieved sales of 78 million USD from 55 projects.

2015 was a turning point for Xiaomi. Its sales revenue from smartphones dropped from first to third place in the China market. The sales performance of the new smartphone, Mi Note, was disappointing. There was a crisis in the supply chain, which led to the delayed release of the Mi5, the sales of which were approximately 7 million units, far below their targeted 0.1 billion units. However, the eco-chain businesses' smart products showed a high growth rate, from 2 billion RMB sales revenue in 2014, to 5 billion in 2015 and 10 billion in 2016.

Growth Stage: Xiaomi 2.0 (2015–2018)

Xiaomi adopted a reactive strategy for its mobile phone business and redefined the eco-chain of smart products to focus more on retail channels, resulting in a new wave of development after late 2016. With the newly launched high-end smartphone and self-developed chip, in the third quarter of 2017 Xiaomi mobile phones returned to fifth place by market share and shipment volumes for smartphones worldwide. Its 2016–2017 growth was 102.6%, and its market share in China recovered to 13.7% in Q3 2017. In the first half of 2018, there were over 100 firms in Xiaomi's eco-chain. A Granary College and an Exploration Lab were established to further link the three business sectors (Event 17). Meanwhile, the three business sectors were developed into a booming stage, especially the hardware sector.

From Software to Internet Service

Xiaomi's previous concentration on software was now transformed into a focus on Internet services, with the content and deliverables being redefined to achieve a holistic understanding of the various services developed. MIUI was still the core software business, with 0.3 billion users and 55 language versions, covering 142 countries and regions as of December 2017. The extended Internet services included Xiaomi's App Store (which was built into their smartphones), Internet browser, security centre, video, music and reading platforms, and live broadcasts. The Mijia App was the platform used to control all of Xiaomi's smart products (Event 16).

From Hardware to Eco-chain Businesses

By August 2018, there were 130 firms in the eco-chain, whose products ranged from smartphone peripherals, smart mobility, wearable devices, smart home, IoT, consumer products, VR/AR

and drones to notebooks. They formed the three layers of the eco-chain, with the smartphone and its peripherals as the core layer; the second layer comprising IoT products, the wholly owned notebook business, and 130 eco-chain firms invested in by Xiaomi; the third layer is consumer products for mass consumption, selected from external markets, that were deemed to reach Xiaomi's quality standards (Events 21 & 26).

Xiaomi insisted that products should conform to the low-cost and high-performance strategy with a focus on good design, so that all eco-chain products could establish a standard and reliable impression among Xiaomi's targeted consumers. The 0.3 billion MIUI users were to have access to any new eco-chain product. Xiaomi also supported the eco-chain businesses by providing seven open resources: design advice, financial capital, exclusive sales channels, supply chain management, product managers, brand marketing and user research. In terms of design, Xiaomi shared their knowledge of users, supported eco-chain firms with design standards and resources, and evaluated eco-chain products according to Xiaomi's design standards (Events 23 & 24). To facilitate innovation and nurture the sustainable competitive advantages of the eco-chain firms, Xiaomi only invested in them as a shareholder, and was not involved in decision-making (Event 25). The eco-chain products enriched the lives of the core consumer group and gave them reasons to frequent Xiaomi's online or offline channels, allowing for the cross-selling of the different products.

The eco-chain business was a closed system. External firms had to go through a rigorous selection process to join it (Event 27). Although the eco-chain companies were diverse in terms of age, performance and size, from OEM or ODM partners to fast growing unicorns valued at more than 1 billion USD, 99% of them survived. Compared to a 10% success rate of start-ups in the market at large, the value of the eco-chain was significant. This implies that if one start-up joined Xiaomi, the survival chances of the remaining start-up teams within the same product category would be even lower. This large group of successful start-up businesses in diverse product categories also influenced and changed the traditional supply chains, which had maintained stable relationships and the same level of quality over a long period. As a group, Xiaomi had the bargaining power to obtain lower cost of components or service from suppliers. Moreover, as a leading brand in the market they improved the average standard of products in the category and could require suppliers to improve their quality to match the requirements of Xiaomi, which described this strategy with the metaphor of a "catfish" effect (Events 19 & 20).

Retail

In 2015, Xiaomi extended sales of its products to multiple sales channels and transformed Mi Home from an experience store to a retail store selling only the company's own products. By January 2018, they had established 300 Mi Home stores in China. Sales per square foot reached 260,000 RMB, ranking second in the world, just behind Apple's stores (Event 22). Sales were aided by

the inclusion of eco-chain products that offered diverse items, all of which targeted satisfying the lifestyle needs of Xiaomi's core consumer group. Xiaomi also established a new online sales channel, Youpin Mall, which sold products from Xiaomi and the eco-chain and products from external sources that were deemed to reach Xiaomi's quality standards according to three selection principles: good quality, good price–performance ratio, and the product's technological elements.

Results and Discussion

Within the cause–solution–effect framework of the Xiaomi case, a total of 27 events in three stages of Xiaomi's entrepreneurial business were collected and analysed. They include nine events in the formation stage, four events in the validation stage, and 14 events in the growth stage. Among them, four events in the formation stage and six events in the growth stage were not related to or solved by DMC. The remaining 17 events were further analysed with the factors of DMC contributing to the solution. The DMC factors explored for each event were listed and further divided into three categories: new DMC explored, DMC in design management skills (Dickson et al., 1995) and organizing design capability (Jevnaker, 2000). Detailed information on all the events and the factors of DMC in the analysis results are shown with the cause–solution–effect framework in the Appendix. As the result, a total of 20 new factors of DMC are defined. They can be further clustered into seven new DMCs with three key topics in line with the three stages of entrepreneurial business development. The content of the new DMCs and their distinctive features based on comparison with the previous studies are reported in the following section.

New Design Management Capabilities

The 20 new DMC factors obtained are listed in Table 3 in line with the three stages of entrepreneurial business development. According to content and topic, they can be further classified into seven capabilities of entrepreneurial design management within three key topics, which are *working patterns*, *reconfiguring resources* and *building knowledge* in the three stages. Among the seven new DMCs, two are particularly focused on the first two stages, while four contribute only to the growth stage. One, the capability of reconfiguring resources, covers all three stages. This implies the distinctive focus of DMC at the three stages.

Establishing Working Patterns in the Formation Stage

Involving consumers and *formulating working patterns* are the two new DMCs in this stage. As a method of improving product quality, involving consumers could be achieved by involving leading consumers in a co-creation process in the formation stage and through interaction between designers and consumers in the validation stage. Formulating working patterns started from the first stage with a focus on controlling design quality. It is extended to the working patterns of the whole design process in the second stage and applied to various aspects of product development to

speed up the process. The aim of cross-functional collaboration is a flexible process of product development. Among the two DMCs, *working patterns* is the core, since involving consumers is one element of working patterns.

Reconfiguring Resources in the Validation Stage

Among the new DMCs that we explored, *reconfiguring resources* is the only DMC that could be utilized in all the three stages with the same aim of creating new value. In the first stage, it was simply utilized for accessing design expertise via reliable social networks. In the second stage, the firm built up its resources network to support product development effectively. In the third stage, when the resources network was formulated as a competitive advantage, it could be shared broadly with stakeholders in the business ecosystem and to attract potential partners. The DMC of reconfiguring resources was changed from establishing resources in the formation stage, to utilizing the resource network for product development in the validation stage, and finally to sharing resources to expand collaborative networks in the growth stage. Although the same capability, its objectives and content changed across the different business development stages.

Building Knowledge in the Growth Stage

Building knowledge is the topic of all the new DMCs in the growth stage, because design standards, brand definition, and knowledge of product development are all components of internal knowledge. At this stage, with the support of working patterns and formulated resource networks, design standards could be set up to control the quality of products and product development, as well as to guide quality improvement of suppliers. With regard to branding, design management could upgrade the brand by defining the brand identity, initiating collaboration with top designers and communicating the brand philosophy to the public. To develop products with a systematic view of the product family or product brand, knowledge of product development should be built up so as to sustain competitive advantage. All these DMCs are related to knowledge building, which could continually nurture innovation.

Contribution of the New DMCs

The seven newly reported DMCs contributed to our understanding of DMC, especially with regard to the topic of entrepreneurial business and dynamic capability, in three ways: Firstly, the relationships between the new DMCs and the three stages of entrepreneurial business development are revealed. *Working patterns*, *reconfiguring resources* and *knowledge building* are the main topics of DMC in the stages of formation, validation and growth. Working patterns should be formulated at the initial stage to develop products and launch them on markets according to the business strategy and plan. In the stage of validation, the firm needs to think of sustaining its original competitive advantages, and facilitating innovation continually. Accordingly, establishing resource networks and reconfiguring resources among stakeholders are the topics at this stage. In the growth stage, based

Table 3. The newly reported DMCs in this research.

New DMC		1 st stage: Formation (2010–2013)	2 nd stage: Validation (2013–2015)	3 rd stage: Growth (2015–2018)
1. Involving consumers	Involving consumers to improve product quality	Involving leading consumers in co-creation process.	Improving product quality through interaction between designers and consumers.	
2. Working patterns	Formulating working patterns for efficient product development	Formulating working patterns to control design quality; Cross-functional collaboration within a flexible process.	Establishing working patterns for the design process; Applying the working patterns to the design process for faster product development.	
3. Reconfiguring resources	Sharing resources to create value	Accessing design expertise via reliable social networks.	Maximizing the value created by using existing resources to the full; Developing products through combining internal and external resources; Sharing resources for a faster product design process.	Attracting potential partners for innovation; User research and design experience as resources shared by stakeholders for business development.
4. Design standards	Establishing design standards to control quality			Establishing design standards for components and services to guide quality improvement of suppliers; Establishing design standards to control the quality of products; Establishing design standards to control the quality of product development.
5. Knowledge building	Building knowledge to nurture innovation			Accumulating experience and building knowledge of design and innovation.
6. Brand	Upgrading brand via design			Systematically introducing the brand story and innovation strategy to the public; Collaborating with top designers to upgrade the brand; Defining brand identity through design.
7. Product development	Design products to sustain core competitiveness			Designing low cost and high performance into products through a systematic view of the product family.

on accumulated experience, the firm can build the knowledge system to control the quality of products in a systematic way and define the brand identity. This establishes a solid basis for further development of the business, especially for scaling up the business with the same quality standards.

Secondly, the dynamic characteristics of DMC are indicated. Not only are the seven DMCs linked to the stages of business development with different topics, but the changed content and function of each DMC in the business development process are also indicated. For example, in the first stage, working patterns are formulated as part of the product development process to control design quality. Entering the second stage, a working pattern for the whole design process is established and is applied in all product development projects to speed up the process. With this example, the dynamic character of the new DMC is shown. It indicates that one DMC can be applied in different stages of business development with different content and subjects.

Thirdly, one DMC may contribute to different aspects of the entrepreneurial business. Rather than contributing to business development in different stages with different content, some new DMCs contribute to various aspects in a particular stage. For example, establishing design standards to control quality is a

DMC in the growth stage. It could be utilized to control the quality of products that may not be developed by the firm, or to control the quality of products developed by the firm, or as a requirement to suppliers to improve their products' quality. With the different objectives and subjects, the content of the design standards may be varied. This diverse application and contribution of DMC factors also demonstrates the dynamic characteristic.

Distinctive Characteristics of the New DMCs

Through comparing the DMC explored here with the two previous studies, the distinctive characteristics of the 20 new factors of DMC are clarified. They are distributed equally among the three stages of entrepreneurial business, they simplify the previous statements of DMC, and they integrate solutions, resulting in a practical guideline.

Comparison with Dickson's Design Management Skills

The DMCs reported in Dickson et al.'s (1995) research contributed only to the stage of formation, with an emphasis on basic skills, product development and the organization of projects. In that model, there are no DMCs that contribute to the remaining two stages.

Moreover, three of the DMC factors of Dickson et al.'s model were never utilized in the Xiaomi case. These three DMCs are "using the latest computer aided design tools effectively" as specialized skills, "quickly becoming aware of competitors' innovations and imitations" as innovation skills, and "replacing sequential with concurrent design" as organizational change. The reasons were that computer aided design tools were viewed as by now being basic design skills, which could no longer contribute to competitive advantage; that "quick awareness of competitors' innovation or imitation" didn't fit Xiaomi's situation, since as a new entrant and later a leader in the field, Xiaomi had to launch new products quickly and continually, while all its competitors were followers; and that for concurrent design, Xiaomi had developed further with a flexible design process, which cannot be simply described as concurrent design. In summary, in the context of entrepreneurial business, the capabilities reported in Dickson et al.'s model contributed to basic design skills, the product design process and the design team in the formation stage only. The model cannot describe the function of design management in the following two stages, nor indicate how it contributed to business survival or success.

Comparison with Jevnaker's Organizing Design Capability

The DMCs reported in the organizing design capability (Jevnaker, 2000) are distributed equally between the three stages. Moreover, all the capabilities were used in the Xiaomi case. However, compared to the newly reported DMCs in our research, Jevnaker's DMCs mainly describe the results of DMC in general terms, rather than behaviours or actions by which to obtain them. For example, in Event 8, the new DMC is "formulating working patterns to control design quality," which is related to the capability of protecting design-based advantages as "protecting new designs by patents, licencing, pattern protection."

Distinctive Characteristics of the New DMCs

By comparing the newly reported DMCs in this research with the DMCs in the two previous models, two distinctive characteristics of the new DMCs are identified.

Firstly, the descriptions of the DMCs in the previous studies are simplified in the new DMCs. Compared with the previous DMCs, the new DMCs are more precise and focused. For example, in Event 2, the new DMC of "involving leading consumers in the co-creation process" could include the six capabilities in Dickson's and Jevnaker's models.

Secondly, unlike the previous DMCs, which describe the capabilities only as outcomes, the new DMC combines the solution or action with the results or objective. For example, in Event 7, the new DMC is defined as "Accessing design expertise via reliable social networks," while similar capabilities in the other two studies are only described as "finding" or "accessing" as the way of obtaining resources. In summary, compared with the DMCs in the previous studies, the new DMCs cover the three stages of entrepreneurship, rather than being limited to one to

two particular stages. Moreover, the new DMCs are focused on entrepreneurial design management with explicit descriptions that combine solution with result and can easily be applied in practice.

Conclusions

In the context of entrepreneurship, design is viewed as a crucial factor of the founder team because of its contribution to innovation. There are sufficient studies of frameworks and factors of design management. However, these were viewed as a traditional mode of simple or integrated design management, rather than a new mode in the knowledge economy. From the perspectives of design management and business management, an overlap between design management and entrepreneurship emerged, defined as entrepreneurial design management. To understand the role of design and the contribution of DMC to successful entrepreneurship, the factors of entrepreneurial design management should be studied to fill the research gap. In this study, the case of Xiaomi was studied through a triangulation strategy with semi-structured interviews, documents and site observation throughout the initial stages of entrepreneurial business. Process theory was applied to collect and analyse the data. All the problem-solution-effect combinations were sorted according to the three stages of entrepreneurial business: formation, validation and growth. Consequently, a total of 20 new DMC factors were finalized. They can be further classified into seven new capabilities of entrepreneurial design management under three key topics in line with the three stages of entrepreneurial business development.

Compared to the DMCs reported in the previous studies, the contribution of this study is shown in newly defined capabilities of entrepreneurial design management. This not only enriches our understanding of the overlap between design management and entrepreneurship but also indicates the pathway of building DMCs in the development of entrepreneurial business. Moreover, the key topics of DMC in each stage, how they are utilized in the different stages, and how to deploy them in different areas in one particular stage are indicated as the findings of this study. This also contributes to our understanding of DMCs as dynamic capabilities. This research finding formulates a basic framework of entrepreneurial design management with a holistic view and detailed factors that are simplified and integrate solutions with results. These new DMCs could guide the application of design management in entrepreneurship to increase the chance of solving problems and developing business successfully. As an initial piece of research into entrepreneurial design management, this study was limited to a single case. The reported factors of entrepreneurial design management should be further explored with more case studies in the near future.

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Endnotes

1. “Mass Entrepreneurship and Innovation” in 2014, “Made in China 2025” in 2015, and “Developing Service-Oriented Manufacturing” in 2016.
2. According to statistics from the China Internet Network Information Center, China had a total of 751 million netizens by June 2017, which is approximately equivalent to the total population of Europe.

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Appendix. Cause–Effect Relationships in the Three Stages of Entrepreneurial Business

No.	Problem	Solution	Effect	DMC
Formation (2010–2013)				
1	How to enter the competitive smartphone market	Focus on business ecosystem instead of smartphones Establish a founder team with experience in three business sectors: design, IT and management	Xiaomi ecosystem with three business sectors Seven founders with mixed backgrounds from friend network. Two of them are designers.	N.A. Involving designers in decision making and strategic planning.
2	How to understand the needs of users	Co-design process with users in Xiaomi's online chatroom	MIUI launched. Xiaomi developers collect comments and participators view MIUI as their product.	Involving users in the design process Getting new product ideas from users Developing products to satisfy consumers' needs
3	How to attract first-generation consumers with limited resources	Geeks become the first generation of Xiaomi's customers, and introduce it to their friends	Geeks from online chatroom become core fans of Xiaomi	Involving leading consumers in co-creation process
4	No supplier is willing to work with a small-size startup	Seek out resources from personal network	Finding friends who are willing to produce for Xiaomi	N.A.
5	Risk control of financial investment	Pre-order system and sales online	Hungry market effect	N.A.
6	How to develop and design smartphone	Establish design team; design founder is responsible for quality of design	Well-designed smartphone with good manufacturability, new design ideas and rational low cost	Designing quality into products Designing manufacturability into products Designing low cost into products Estimating the true cost of new products during the design process Testing manufacturability of new products during the design process Finding new design ideas—not just me-too imitations
7	How to establish design team	Seek designers through friends' recommendations	Establishing internal design team and external design partnerships	Finding people with excellent design skills
8	How to manage design quality of design team	Formulate the workflow, including design process, communication with other functional departments, working pattern with suppliers	Launching well-designed products onto markets faster	Managing design team with working pattern
9	How to develop new products efficiently, faster	Different functional departments work tightly together and with suppliers	Design working with other functions with flexible processes Designing and launching new products faster	Getting different functions in the firm to work together Replacing sequential with concurrent design Designing and launching new products faster with efficient working processes
Validation (2013–2015)				
10	Criticized as China's Apple	No specific solution	Explaining the design philosophy	Design for branding
11	Performance of M1 smartphone criticized	Use online chatroom to collect feedback and search for solutions with geeks	Launching M2 with problems solved	Improving design quality through new methods Instant feedback from design to improve product
12	How to expand business for the core consumer group	Eco-chain pilot projects. Apply existing resources and knowledge, develop surrounding products first.	Launching more products—TV, power bank, etc.—faster than before	Design as strategic planner Maximizing value creation by using existing resources Developing more products through partnership with external resources Sharing common resources for a faster product design process
13	How to manage eco-chain businesses	Use the same internal methods and processes as for new product development	Launching new products with same strategy as for smartphones	Duplicating existing working patterns to develop new products

No.	Problem	Solution	Effect	DMC
Growth (2015–2018)				
14	Core components suspended by supplier	Invest in developing core technologies	Developing own chips and establishing Exploration Lab	N.A.
15	Limited online sales channels	Extend offline channels	Combining online and offline channels	N.A.
16	How to enhance interaction between the three business sectors	Mijia as built-in app for all products	Mijia as built-in app for all products	N.A.
17	How to define the core competitiveness of Xiaomi	Establish Granary College to analyze lessons learned and disseminate experience through incubation program Establish Exploration Lab for core technology R&D	High-end smartphones with core technologies Incubation program supported by Xiaomi story	Summing up experience of design and innovation Telling the innovation story to the public
18	How to enhance Xiaomi's design reputation	Work with prestige designers from around the world	MIX smartphone designed by Philip Stack (2016), and Mi Home by 8 Inc. (2017)	Collaborating with top designers to upgrade brand
19	How to reduce costs for low-price, high-performance products	With successful products and large market share, Xiaomi has bargaining power	Cost reductions for low-price, high-performance products	Designing low cost and high performance into products
20	How to improve the quality of products	With successful products and large market share, Xiaomi can require suppliers to improve their quality	Pushing quality improvement from supplier	Design leads quality improvement of suppliers
21	How to supply current consumers with more related products to satisfy their lifestyle	Select products from external sources with Xiaomi's quality standards according to three selection principles: good quality, good price–performance ratio, and the product's technological elements	Youpin Mall	Establishing design standards to manage product quality
22	How to approach consumers effectively	Transform Mi Home from an experience store to a retail store	Mi Home as highly effective retail store	Finding and collaborating with top designers Defining brand identity through design
23	How to control the quality of eco-chain products	Insist that products conform to the low price and high performance strategy with a focus on good design	Consistent product quality	Setting up standards of product design in product development
24	How to support eco-chain firms	Provide seven open resources: design advice, financial capital, exclusive sales channels, supply chain management, product managers, brand marketing, and user research	Flexible resources	User research and design experience as resources for business development
25	How to manage the relationship between Xiaomi and eco-chain firms	Shareholder, not decision maker	Eco-chain firms make decisions independently	N.A.
26	How to manage the relationship among eco-chain products	Three layers of eco-chain products	Well design the eco-chain product structure	N.A.
27	How to select eco-chain firms	A closed system. External firms have to go through a rigorous selection process to join it.	Well-defined selection criteria	N.A.