


THE CRITICAL TRAIT OF DIGITAL ENTREPRENEUR: MIXED METHODS RESEARCH

Li-Min Chuang

The Department of International Business, Chang Jung Christian University, Tainan, Taiwan


liming@mail.cjcu.edu.tw

 <https://orcid.org/0000-0001-6997-8486>

Yu-Po Lee*

The Ph.D. Program in Business and Operations Management, College of Management,

Chang Jung Christian University, Tainan, Taiwan, 109d00107@mail.cjcu.edu.tw

 <https://orcid.org/0000-0002-2365-2373>

Yu-Ju Chang

Kaohsiung Veterans General Hospital Tainan Branch, Tainan, Taiwan,

aau88os107@yahoo.com.tw

Article history: Received 25 July 2022, Received in revised form 25 July 2022, Accepted 12 August 2022, Available online 12 August 2022

Abstract

Pioneers of the digital era have invented a different business model and expanded the existence of the digital economy, and the digital entrepreneurship is the beginning of this digital revolution. To explore the key characteristics of digital entrepreneurs, this study is divided into two stages. The first stage conducted a literature review and case study to construct the characteristic elements of the entrepreneurship into a model of digital entrepreneurs. In the second stage, the relative weights of the key characteristics of digital entrepreneurs are understood through an analysis of the AHP questionnaire results. The results show that autonomy and self-discipline are keys among the main dimensions of the key characteristics of digital entrepreneurs' entrepreneurship; the secondary dimension of "action power" is key in the main dimension of "autonomy and self-discipline"; the secondary dimension of "business networks" is key in the main dimension of "social capital"; the secondary dimension of "insight" is key in the main dimension of "innovation and breakthrough"; the secondary dimension of "communication ability" is key in the main dimension of "leadership communication".

Keywords

digital entrepreneurship; digital economy; entrepreneurship; entrepreneurs; analytic hierarchy process (AHP).

Introduction

The psychological and behavioral characteristics of entrepreneurs are very important for the success of entrepreneurship, as well as undeniable key factors to overcome difficulties in the process of entrepreneurship. To cope with the unpredictable market competition, entrepreneurs must take different plans and decisions at different stages, and exert their personality traits, which is also the focus of many scholars when studying entrepreneurship. While extensive literature has discussed the key characteristics of entrepreneurial success, few have studied the issue from the perspective of entrepreneurs in the digital industry. However, as the environment changes, successful entrepreneurship has become difficult, and there are many entrepreneurs, but few succeed. In addition to the capital injection, how to continue and stabilize entrepreneurship and development in this field is a major issue. Therefore, this study explores the key entrepreneurial characteristics of entrepreneurs in the digital industry. The research motivations of this study are, as follows:

- for an organization to be successful, there must be a successful founder, who always plays an important role in the organization, and the entrepreneurship is an important factor for determining the success of the enterprise. From the performance of the founders of some successful enterprises, it is easy to see that they are the key figures in the success and development of the business.
- many scholars in Taiwan have carried out research on topics related to the characteristics of entrepreneurs, such as analyzing the relationship between entrepreneurs' personal characteristics

and social networks, taking Chinese entrepreneurs as the research object, taking middle-level executives in the high-tech industry as the research object, taking the application of agricultural industrialization in Taiwan as the direction, studying the relationship between five personality traits and the characteristics of social entrepreneurs, and exploring the impacts of the characteristics of entrepreneurs, as well as their previous knowledge and external environments, on entrepreneurial intention, and conducted a comparative analysis of different countries, such as Taiwan and Vietnam, which is the first motivation of this study. Some scholars focused their research on topics related to digital entrepreneurship, such as analysis of the entrepreneurial ecosystem in the digital economy era driven by the entrepreneurship boom, how to stimulate the development of innovation and entrepreneurship through the digital economy, and taking the development of innovation and entrepreneurship in Taiwan under the digital economy as the topic to analyze the innovation and entrepreneurship opportunities in Taiwan under the trend of digital transformation. However, there is currently no relevant literature that studied the key characteristics of successful entrepreneurship by integrating the digital industry and the characteristics of entrepreneurs or has directly taken entrepreneurs operating in the digital industry as the object. Previous studies on entrepreneurs have not discussed the connotation of digital entrepreneurs, which is the second motivation of this study.

Based on the above research background and motivations, there is a lack of literature on digital entrepreneurs, and most focused on industry or technology, thus, this study could not directly obtain the theoretical basis and the weight of key characteristics through literature review. Therefore, case empirical methods must be adopted for further discussion. This study aims to conceptualize the definition of digital entrepreneurs, and it is expected that future research will focus on the model and framework of the digital entrepreneurship and further study the entrepreneurial ability of digital entrepreneurs.

Due to the impact of the digital entrepreneurship - oriented competitive market, traditional industries and emerging entrepreneurs must change their old thinking and actively seek new business models. Inspired by the research background and motivations of this study, the analysis framework of the entrepreneurship of entrepreneurs in the digital industry is constructed to explore and determine the key characteristics. Therefore, the research objectives of this study are, as follows:

- to discuss and analyze the entrepreneurship of successful entrepreneurs in the existing digital industry through literature review.
- to explore the characteristics, significance, dimensions, and indicators of the entrepreneurship of entrepreneurs in the digital industry.
- to construct an analysis framework for the key characteristics of digital entrepreneurs.
- to invite experts in related fields to conduct an empirical analysis on the AHP level according to the above analysis framework of the key characteristics of digital entrepreneurs.
- to propose suggestions as a reference for future research directions according to the construction process and empirical results.

Literature Review

Digital entrepreneurs: Digital entrepreneurship is a mechanism of the innovation system, which often occurs in the formation of new enterprises or the transformation of current enterprises [1]. The characteristics of digital technology, such as editable, re-combinable, re-programmable, and generative nature, affect entrepreneurship in many aspects [2–5]. Digital entrepreneurship is to use the characteristics of digital technology to create new values for enterprises and become the driving force for innovation [6–10]. Digital entrepreneurs are usually defined as those who pursue business or economy based on opportunities to use digital technology. Entrepreneurs who participate in digital entrepreneurship are described as digital entrepreneurs, and the resulting economic and social values of venture enterprises, companies, or communities are known as digital enterprises [11]. Despite the widespread use of the term "the digital entrepreneurship" by many experts, scholars, and government policy makers, and despite growing interest in understanding the digital entrepreneurship, its concept and definition remain elusive, and there is little related literature to provide empirical evidence. With the rapid developments of digital technology, the resulting digital economy has created unprecedented economic benefits for many countries, and it is believed that this is due to the development of the entrepreneurship, and people begin to pay attention to the empirical research of entrepreneurship and experience. Table 1 sorts the definitions of digital entrepreneurship from other literature. In short, digital entrepreneurship includes "selling digital products or services across electronic networks" [12].

In addition to the different definitions of the digital entrepreneurship phenomenon in Table 1, the term “digital entrepreneurship” is used differently in all articles, including digital entrepreneurship, digital innovation, digital industry, and digital commerce. Therefore, the proper nouns used in the corresponding articles are used in Table 1.

Table 1. Summary of Definitions of Digital Entrepreneurship in Previous Studies. *Source: [13].*

Literature	Definition of digital entrepreneurship
[11]	Digital entrepreneurship: pursue new venture opportunities presented by new media and internet technologies
[12]	[Digital entrepreneurship is] the creation of a venture to produce and generate revenue from digital goods across electronic networks
[14]	Digital entrepreneurship may be defined as entrepreneurship in which some or all of the entrepreneurial venture takes place digitally instead of in more traditional formats
[15]	Digital entrepreneurship is a subcategory of entrepreneurship in which some or all of what would be physical in a traditional organization has been digitized
[16]	Digital entrepreneurship is defined as the reconciliation of traditional entrepreneurship with the new way of creating and doing business in the digital era
[17]	Entrepreneurship [...] is [...] defined as occupying niches, monetizing business opportunities, as well as being innovative, radical and risk-taking
[18]	Digital entrepreneurship [...] includes any agent that is engaged in any sort of venture be it commercial, social, government, or corporate that uses digital technologies. [...] In other words, they are performing activities that need digital engagement but may not in themselves be digital, for example, an Uber taxi driver

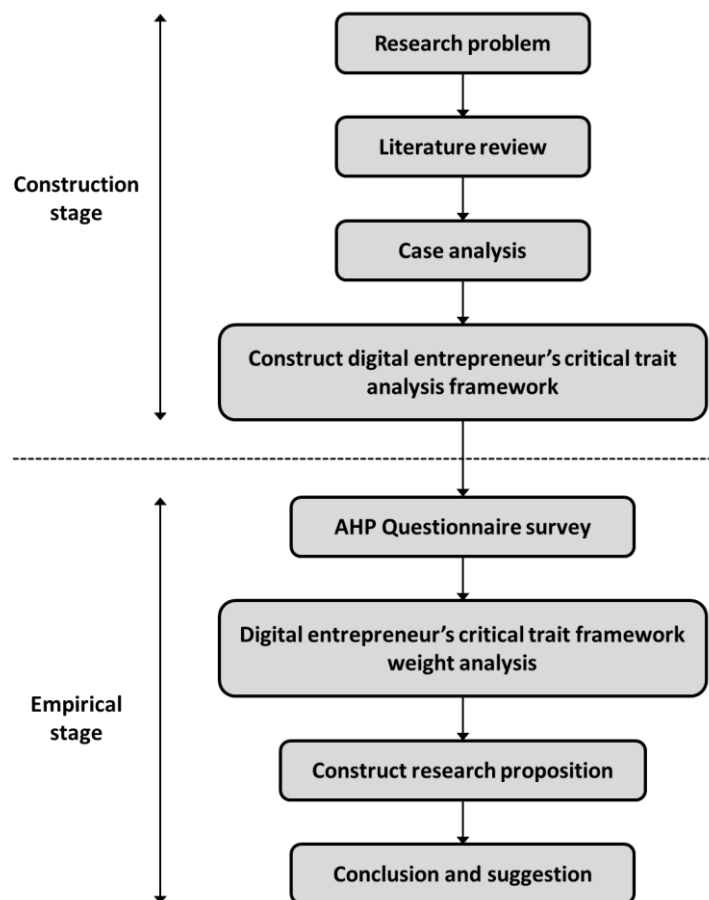


Figure 1. The research flow chart.

Exploration of the digital entrepreneurship: The digital entrepreneurship is an important driving force in innovation systems, as it changes the structure, objectives, and network mechanism of the entire relevant business system, which affects the various levels and scales of innovation systems and brings unprecedented changes to innovation systems. While digital technology provides new business opportunities, it is also quite destructive to the original business model [3]. In order to study the mixed concept of the digital entrepreneurship, Satalkina and Steiner conducted a systematic literature review of innovation transformation systems, and confirmed the key categories of digital entrepreneurship, as well as the differences from other fields, by studying 52 core papers [9]. A total of three key core elements of entrepreneurship were developed from the analysis results, including:

- entrepreneurs: including behavior, competence, and mindset patterns, as well as the results and consequences of individual entrepreneurial activities.
- entrepreneurial process: including digital-related activity strategies and operational activities in the organizational management process, as well as digital entrepreneurial companies.
- related ecosystem: including the impacts of external infrastructure and institutions on the development of digital entrepreneurs .

Methods

Construction of the Model of Key Characteristics of Digital Entrepreneurs

Construct an analysis framework for key characteristics of digital entrepreneurs: In order to construct the research model of the key characteristics of digital entrepreneurs' entrepreneurship, this study developed 4 main dimensions and 12 secondary dimensions as the theoretical basis and took internationally well-known digital entrepreneurs as the research objects to explore the key characteristics of their entrepreneurship and revise the structural model of this study.

- case analysis of digital entrepreneurs
This study referred to the following 37 materials (6 papers, 4 journal articles, 23 books, and 4 websites), and conducted content analysis according to Table 1.

In terms of qualitative research, this study mainly conducted an analysis of actual content, in order to identify the psychological and behavioral characteristics of entrepreneurs when they faced people, events, and objects during their childhood, growth background, study process, and work experience, as well as the characteristics of each behavioral motivation in their entrepreneurial process. The key characteristics of digital entrepreneurs were identified from the literature, relevant materials, and quotations and speeches of entrepreneurs, which were summarized into 15 key characteristics, as shown in Table 2. Each entrepreneur has their own key characteristics for success, and while they also have differences, they all have willpower full action power and strong intention, and innovation ability.

Regarding the key characteristics, Item 1 is "taking the initiative to challenge, taking responsibility, and having strong willpower to persist". Entrepreneurs with such characteristics have full action power; for example, Zhengfei Ren has the spirit of a wolf pack, perseverance, fearlessness, and group struggle. He said that, in addition to hard work, what we learned over the past 20 years is that we should be struggle-based and customer-centered, and we need to be able to persist for a long time. Jeff Bezos believes that someone who wants to succeed in entrepreneurship must persist to the point that others find it unconscionable. Jack Ma believes in his own judgment and sticks to it.

In terms of Item 2, "having the spirit of adventure without fear of failure", entrepreneurs take the initiative to accept challenges, have the courage to take risks without fear of failure, and possess the willpower to persist. An enterprise that has grown to global renown was not always stable, instead, it passed countless difficulties through its perseverance and persistence. Zhengfei Ren stated that we learn through failure. Jeff Bezos believes that, in order to have no regret in the future, we should try even if we fail, and failure is a necessary element for innovation. Jack Ma said that failure is the greatest wealth of life. About 18 months into its start-up, the Alibaba Group was on the verge of bankruptcy, then an order from an American customer allowed the company to turn a profit, thus, the spirit of unrelenting effort resulted in the active expansion of the business.

In terms of Item 3, "be enthusiastic about charity", with the success of entrepreneurship, entrepreneurs must also do their best to fulfill their social responsibilities in charity and public welfare. In 2016, Huateng Ma ranked first in the Hurun China Philanthropy List, with a total donation of RMB 13.9 billion. The Jack Ma Foundation and the Alibaba Public Welfare Foundation donated medical supplies and large amounts of cash to support the research and development of COVID-2019 vaccines during the COVID-2019 epidemic. The "Bezos Earth Fund"

was established, which will donate USD 10 billion to fight climate change, charitable funds were established to assist homeless families, and pre-schools for young children were established in low-income communities.

In terms of Item 4, "attaching importance to the responsibility and obligation of individuals and enterprises to society"; for example, Mark Elliot Zuckerberg, a vegetarian, is grateful for everything. Sergey Brin invests in the development of alternative energy technologies, in order to make the environment sustainable and to seek a wider range of renewable energy sources. Regarding employees, Brin is willing to give, meaning "free" has become part of the corporate culture, and he even allows employees to bring their children and pets to work. Jack Ma says that public welfare is about managing one's own humanity. Robin Li shared the truth of helping others to achieve oneself.

In terms of Item 5, "family network", some entrepreneurs had access to relevant environments since childhood, and some parents had relevant knowledge to share or arranged for them to learn relevant skills. For example, when Steve Jobs was a teenager, his adoptive father gave him the opportunity to learn about devices and machinery, including disassembly, as he was a dealer of second-hand goods, and specialized in installing, refitting, and selling second-hand cars. Later, Steve Jobs believed that he liked sophisticated devices because he was deeply influenced by his family when he was young. Mark Elliot Zuckerberg started writing programs from middle school age, and his father hired software developers as his tutors.

In terms of Item 6, "relevant expertise or academic background"; for example, Zhengfei Ren joined the People's Liberation Army after graduation to develop communication technology and started his own business in his middle age after retiring from military service. Steve Chen was very fond of mathematics and science in high school, and later majored in computer science at the University of Illinois, and he joined the PayPal Team in his senior year. As the research objects of this study, except for Jack Ma, who did not have family network support, expertise, or educational background, all other entrepreneurs examined in this study had relevant technical or educational backgrounds.

In terms of Item 7, "social network relationship", some entrepreneurs need to raise money to start a company for the first time or seek financial assistance in time of crisis. Several of the digital entrepreneurs examined in this study did not have bountiful funds at the beginning and even started their businesses in humble garages. For a company to succeed, it is difficult to achieve its ambitious goals completely on its own, and sometimes, it needs to rely on business network relationships, such as external investment and the involvement of partners. In 1999, Huateng Ma launched real-time communication software "OICQ", and obtained investment capital of USD 2.2 million from International Data Group and Richard Li's Yingke Digital Technology to establish Tencent. In 1998, Larry Page and Sergey Brin obtained investment funds from Andy Bechtolsheim, the co-founder of Sun Microsystems, and founded Google without sufficient funds in a friend's garage in Menlo Park, California. Faced with an initial funding shortfall, Jack Ma persuaded the SoftBank fund to invest in the Alibaba Group in only six minutes, which was its first venture capital.

In terms of Item 8, "ability to foresee the future and high sensitivity to environmental changes", successful entrepreneurs have a better ability to foresee the future, have a head start in an unpredictable market, and are highly sensitive to changing circumstances. For example, Zhengfei Ren has always been able to anticipate forward-looking opportunities ahead of competitors, thus, no matter how the environment changes, it can grow in each wave of change and turn into a world-shaking technology kingdom. Through foresight, Jeff Bezos saw Apple's music store sweeping the world in 2003 and concluded that in the future, only companies would need to be like Apple dominating the music market to survive in the new digital age. Consequently, he launched the Kindle e-book reader in 2007. People who see the future before others do can seize opportunities faster than others.

In terms of Item 9, "ability to innovate and create", except for Huateng Ma, who later attracted a lot of criticism, the ability of all entrepreneurs in this area is evident around the world, and they have this ability from the very beginning. The performance of innovation and creativity is an important part of a company's sustainable operation and one of the important factors for leading competitors to create differentiation. Positive innovative products can bring profitability for an existing enterprise, obtain new customers to create new markets, and create a good overall image of the enterprise. For example, when Steve Jobs presented a new Apple product at the company's new product presentation, the audience would always burst into cheers, and when he explained new features, the audience applauded constantly, which shows the importance of innovation

to a company. Jeff Bezos said innovation or death, and Jack Ma also thinks that innovation should be considered as the cause of entrepreneurs.

In terms of Item 10, "a strong desire to create something that will change the world", entrepreneurs have a strong intention to change the world according to their own predictions. For example, Zhengfei Ren's sayings show that he is ambitious, and he looks at the layout of the world, rather than just the gains and losses of one city or another. For Mark Elliot Zuckerberg, making the world more open is his primary goal now and in the future, he considers innovation and layout, and makes Facebook indispensable to the world. Sergey Brin wants to make the entire world's information universally searchable. Larry Page wants to collect the world's information and make it available to the public so that everyone can benefit from it.

In terms of Items 11 and 12, "ability to communicate with customers and employees", Steve Jobs attached great importance to human capital, maintained communication with employees, clearly conveyed the company's implementation goals, put customers first, and maintained good communication with customers. Sergey Brin maintains a good communication channel with employees and allows them to express their opinions, especially when they come up with innovative ideas, which they can express at any time. Zhengfei Ren maintains communication with customers, is highly sensitive to business issues, and learns the needs of customers in the fastest way.

In terms of Items 13 and 14, "having planning ability and decision making ability", every entrepreneur's success depends on their decision-making and planning abilities. Steve Jobs had his own methods for company planning and decision-making, and he put customers first, attached importance to customer capital, and planned the company's innovation goals based on customers' needs. Although Ren-fei Wang has a commanding style, he is goal-oriented in planning and decision-making, with high ambitions and full execution abilities. Jeff Bezos emphasizes patience in business, and most of Amazon's investment plans are over seven years and focus on long-term growth rather than short-term profits.

In terms of Item 15, "taking customer needs as guidance to plan company innovation goals", the leadership style of Steve Jobs presented charisma to convince himself and others that his ideas were right, meaning he had unique charm during presentations and extraordinary influence on the whole team; he made the impossible possible and motivated the team to achieve their goals. Jack Ma has an optimistic attitude, saying that we should know how to warm our right hand with our left hand.

Summary of the psychological and spiritual characteristics of digital entrepreneurs

This study summarizes the previous case analysis of internationally well-known digital entrepreneurs, as shown in Table 2:

Identifying and defining the dimensions of the key characteristics in this study.

According to the aspects and dimensions in Table 2, the psychological and behavioral characteristics of entrepreneurs were summarized again to determine the homogeneity among the items in the four dimensions, and the 12 secondary dimensions were sorted according to the homogeneity. This study adjusted the theoretical basis framework according to the 12 simplified dimensions, and the AHP questionnaire was designed based on this framework to conduct empirical research on the psychological and behavioral characteristics of digital entrepreneurs in Taiwan. The 12 dimensions of the psychological and behavioral characteristics of digital entrepreneurs are respectively defined and explained, as shown in Table 3,

Research Framework: The four dimensions of the key characteristics of entrepreneurs' entrepreneurship, as developed by relevant literature, were used as the main dimensions of this study, while the secondary dimensions of the entrepreneurship of entrepreneurs in the digital industry were sorted according to the above-mentioned literature, which were used as the theoretical basis, to design the components of the hierarchical framework of this study, as shown in Figure 2.

Research object and AHP questionnaire design: This study adopted a qualitative research method and extended the theory developed through literature review to identify the key characteristics of entrepreneurship from the data. The AHP questionnaire was designed to further understand the key characteristics of digital entrepreneurs' entrepreneurship, and then, the characteristic elements were analyzed according to the results of the questionnaire, to construct the measurement model of the key characteristics of digital entrepreneurs. This study was carried out in stages. In the first stage, the hierarchical structure of the primary and second criteria was preliminarily established. To determine the hierarchical structure again, the preliminary hierarchical

structure produced in the first stage was revised. Then, to determine the main dimensions and the secondary dimensions in the hierarchical structure, the decision support software, Expert Choice 2000, was used to calculate weights.

Table 2. Summary of psychological and spiritual characteristics of entrepreneurs.

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Taking the initiative to challenge, taking responsibility, and having strong willpower to persist	Having the spirit of adventure without fear of failure	Enthusiastic about charity	Attaching importance to the responsibility and obligation of individuals and enterprises to society	Family network	Relevant expertise or academic background	social network relationship	Ability to foresee the future and high sensitivity to environmental changes	Ability to innovate and create	A strong desire to create something that will change the world	Communicate with customers and maintain business operation sensitivity	Communicate well with employees to make them clearly understand leaders' goal orientation	Taking customer needs as the guidance, planning company innovation goals	Having planning ability and decision making ability	Leading and motivating others with a unique personal style
Jack Ma	✓	✓	✓	✓			✓	✓	✓	✓				✓	✓
Jeff Bezos	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	✓	✓
Mark Zuckerberg	✓			✓	✓	✓		✓	✓	✓					
Larry Page	✓				✓	✓	✓	✓	✓	✓					
Sergey Brin	✓		✓	✓		✓	✓	✓	✓	✓		✓		✓	✓
Steve Chen	✓					✓	✓		✓	✓					
Huateng Ma	✓		✓			✓	✓	✓	✓	✓					
Steve Jobs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Robin Li	✓	✓	✓			✓	✓	✓	✓	✓					
Zhengfei Ren	✓	✓				✓		✓	✓	✓	✓		✓	✓	✓

Taking internationally renowned digital entrepreneurs as the research object.

During data collection in the process of research and exploration, it was found that the digital industry has not been a new industry in recent years. World-renowned digital entrepreneurs, such as Jeff Bezos, Mark Elliot Zuckerberg, Jack Ma, and Bill Gates, have successfully created enterprise kingdoms. Many scholars have further studied how these enterprises succeed, and some scholars have also studied how CEOs in this industry lead enterprises to success. However, no scholars have directly taken the key characteristics of CEOs in the digital industry as the research direction, thus, this study could not obtain relevant information through literature review. Therefore, this study extracted relevant information from many books and network information as objectively as possible and identified the key characteristics of digital entrepreneurs' entrepreneurship, which were used as the secondary dimensions of the theoretical basis for constructing the dimension model of the key characteristics of entrepreneurs in the digital industry.

AHP questionnaire distribution

This study selected entrepreneurs in related digital industries in Taiwan as the respondents, such as e-commerce,

blockchains, and the Internet of Things. While these industries are spread across different areas of northern, central, and southern Taiwan with different environmental backgrounds, it does not affect their success or failure, which proves that digital business opportunities are endless. This study distributed a total of 10 AHP questionnaires, which were delivered to the respondents at the appointed time and explained in person to remove any doubts about completing the questionnaire, to demonstrate the key characteristics of the entrepreneurship of entrepreneurs in the digital industry.

Table 3. Definition and Description of Key Characteristics of Digital Entrepreneurs.

Dimension	Characteristic	Definition
Autonomy and self-discipline	Action power	The ability to continuously learn, think, and develop habits and motivations that lead to successful outcomes. The practical ability to adhere to the implementation of strategic intentions and achieve predetermined goals.
	Frustration tolerance	A person's ability to avoid misconduct in the face of setbacks, the ability to withstand a blow.
	Social responsibility	Paying attention to the obligations and responsibilities of individuals and enterprises to society.
Social capital	Family network	A strong family connection, with the same values, so that knowledge and information transmission will be more efficient. Encourage entrepreneurship through linkages.
	Expertise background	Having relevant skills, education, and work experience.
	Business networks	Access to information and financial sources or other resources through business networks.
Innovation and breakthrough	Insight	One's ability to observe things from many perspectives and grasp the core of a variety of issues.
	Creativity	The ability of divergent thinking, generating new ideas, discovering, and creating new things.
	Ambition	Being aggressive and motivated to succeed. Knowing one's unique purpose in the world and believing they can make the world different.
Leadership communication	Communication ability	The process by which information, thoughts, and emotions are transmitted between specific individuals or groups of people to reach a common agreement for a set goal.
	Planning ability	Forecasting future events that are likely to affect the achievement of a goal.
	Personal charm	Having a unique personal style that attracts, inspires, or enlightens others.

Empirical Analysis

To confirm the rationality of the AHP questionnaire, this study initially verified the consistency index and ratio of the recovered questionnaires. If the verification value was within the reasonable range, the relative weights of the main evaluation criteria and the evaluation index would be calculated to obtain the empirical analysis results.

Consistency verification: The rate of consistency verification is acceptable when $C.R. \leq 0.1$, and the hierarchy consistency has rationality; on the contrary, there is a problem in the connection of the hierarchy, and the hierarchy for the evaluation must be reformulated; another scholar, Saaty, put forward the same argument in 1980, arguing that the acceptable range of C.I. values must be judged within $C.I. \leq 0.1$. This study distributed a total of 10 AHP questionnaires, and 10 were recovered. According to the calculation results of this verification, the 10 AHP questionnaires are all valid.

Calculation of relative weights: For each "main evaluation criteria" and "evaluation index", the relative weights were calculated after consistency verification in this study (Table 4, Figure 3). After integrating the relative importance of each hierarchy, the weight ratio of each evaluation index at the second hierarchy was further summarized. The implications of each weight index were discussed according to the calculation results of relative weights.

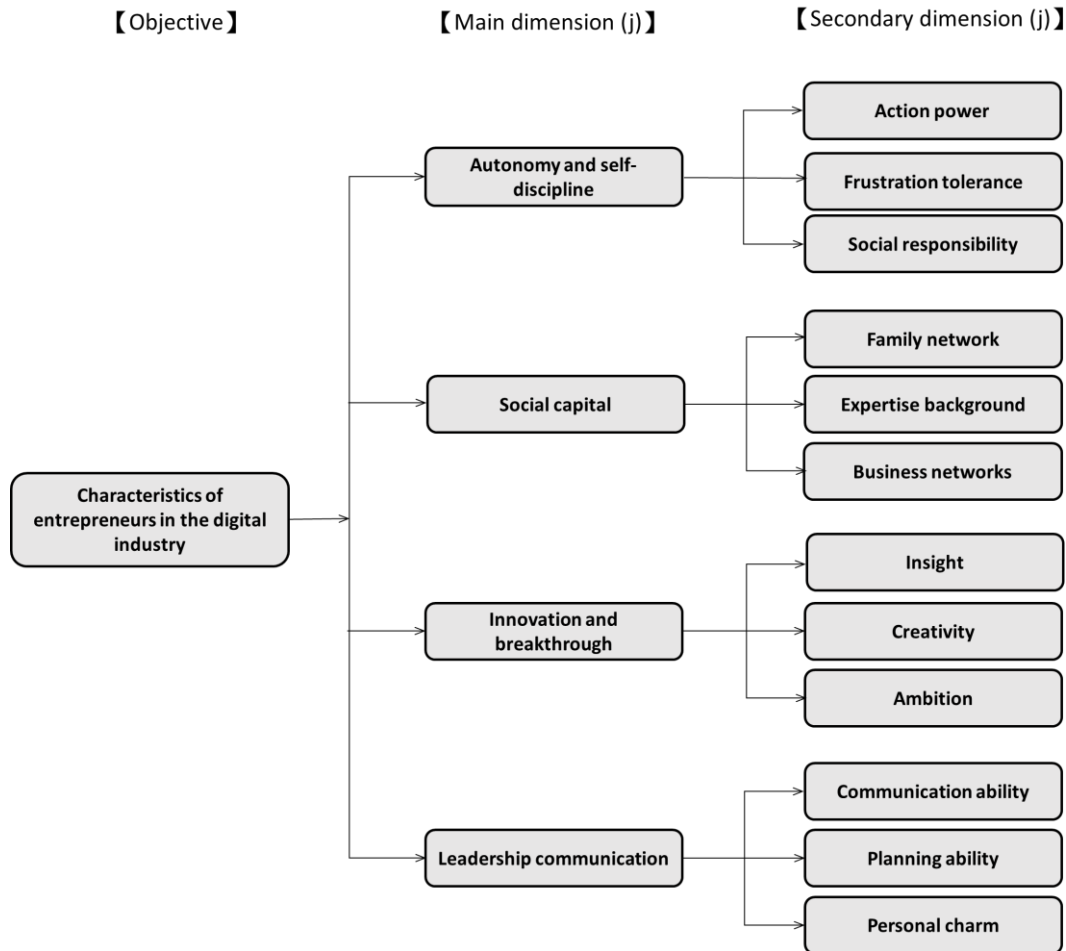


Figure 2. Research Framework.

Results and discussion

After systematic analysis, the relative weights of the "main evaluation criteria" and "evaluation index" are shown in Table 4, and the relative weights of the main and secondary dimensions of the key characteristics of digital entrepreneurs in Table 4 are sorted, as shown in Figure 3.

This study used Expert Choice as the application software for analysis. After hierarchical analysis, the relative weights of the main dimensions and the secondary dimensions were obtained, as shown in Figure 3. The obtained values are analyzed and discussed, as follows:

"The dimension of autonomy and self-discipline" and its secondary dimensions.

According to Table 4, the questionnaire respondents in this study consider "the dimension of autonomy and self-discipline" (relative weight=0.353) to be the most important among the main evaluation criteria of the first hierarchy, which accounts for the highest proportion among all the main criteria. Correspondingly, it indicates that digital entrepreneurs in Taiwan agree that it is very important to constantly think and learn, adhere to the implementation and completion of the predetermined goals, and withstand the challenges of setbacks and failures to achieve success in the process of entrepreneurship. Entrepreneurs themselves attach great importance to the social obligations and responsibilities of the individuals and enterprises they operate.

According to the secondary dimensions in Table 4, "action power" (relative weight=0.167) is the most important, followed by "frustration tolerance" (relative weight=0.119) and "social responsibility" (relative weight=0.067), which indicates that the respondents consider action power to be the most important factor among the key characteristics of entrepreneurs; any lofty goals and ideals need to be put into action to be achieved. For digital entrepreneurs in Taiwan, taking practical action, making all plans according to the goals set by themselves, and

consistently putting them into practice, are the foundation of the entrepreneurship and an important indicator to lead organizations to success.

Table 4. Relative Weights of "Main Evaluation Criteria"

Relative weight of "main evaluation criteria"			
First hierarchy (Main evaluation dimension)	Relative weight	C.R. value	Ranking
Autonomy and self-discipline	0.353	0.01	1
Social capital	0.093		4
Innovation and breakthrough	0.253		3
Leadership communication	0.300		2
Relative weight of "evaluation index"			
Second hierarchy (Evaluation index)	Relative weight	C.R. value	Ranking
Action power	0.167	0.01	1
Frustration tolerance	0.119		3
Social responsibility	0.067		7
Family network	0.017		12
Expertise background	0.036		11
Business networks	0.040		10
Insight	0.112		4
Creativity	0.057		9
Ambition	0.085		6
Communication ability	0.143		2
Planning ability	0.97		5
Personal charm	0.061		8

"The dimension of leadership communication" and its secondary dimensions

According to Table 4, the questionnaire respondents consider "the dimension of leadership communication" (relative weight=0.300) to be the second most important item among the main evaluation criteria of the first hierarchy, which indicates that entrepreneurs can always effectively convey information related to their goals and plans and can make good use of communication skills when facing problems with customers, employees, partners, and shareholders. In terms of planning and execution, they can play an effective role in implementing strategies and achieving predetermined goals. Entrepreneurs who think this dimension is important may also have extraordinary leadership characteristics; for example, Steve Jobs was forced to leave Apple due to his eccentric personality. However, whenever a new product launch meeting was held, his persistence and unique personal charm always won applause from the audience.

According to the secondary dimensions in Table 4, "communication ability" (relative weight=0.143) is the most important, followed by "planning ability" (relative weight=0.097) and "personal charm" (relative weight=0.061), which indicates that the respondents consider communication ability as the most important key characteristic factor of entrepreneurs in the dimension of leadership communication.

"The dimension of innovation and breakthrough" and its secondary dimensions.

According to Table 4, the secondary dimensions of "the dimension of innovation and breakthrough" (relative weight=0.253) rank third among the main evaluation criteria of the first hierarchy, meaning is less important than the dimensions of autonomy, self-discipline, and leadership communication ability for digital entrepreneurs in Taiwan. The performance of innovation and creativity is an important part of a company's sustainable operations and one of the important factors for leading competitors to create differentiation. However, for Taiwan's entrepreneurs with a relatively conservative national style, in addition to the spirit of autonomy and self-discipline, they attach more importance to corporate ethics and social responsibilities and obligations, giving play to their leadership communication characteristics in the enterprise, and adhering to the belief of achieving goals, which are more important than innovation and breakthrough. It can be seen that digital entrepreneurs in Taiwan generally have higher self-requirements than other main evaluation criteria indices.

According to the secondary dimensions in Table 4, "insight" (relative weight=0.112) is the most important, followed by "creativity" (relative weight=0.057) and "ambition" (relative weight=0.085), which indicates that the respondents consider insight to be the most important key characteristic of entrepreneurs in the dimension of innovation and breakthrough. It can be seen that a successful digital entrepreneur must be able to foresee the future and understand the changing environment in order to gain an advantage in an unpredictable market.

"The dimension of social capital" and its evaluation indices.

According to Table 4, "the dimension of social capital" (relative weight=0.093) ranks last among the main evaluation criteria of the first hierarchy, which does not mean that the relevant secondary dimensions of the dimension of social capital are not important to digital entrepreneurs, but that the respondents of this questionnaire are domestic digital entrepreneurs, most of whom live in the family network without relevant learning or access environment, meaning only a few entrepreneurs had relevant skills, expertise, or education before starting a business. This study defines social networks as being able to make good use of connections and access funds to enhance success opportunities. The enterprises run by the questionnaire respondents of this study are not as large-scale as those run by world-renowned digital entrepreneurs, such as Larry Page, Sergey Brin, and Mark Zuckerberg, which required massive capital injections as they grew. In addition, some domestic entrepreneurs themselves have richer family resources to provide financial assistance; therefore, the relative weight of this dimension is relatively low.

According to the secondary dimensions in Table 4, "business networks" (relative weight=0.040) is the most important, followed by "expertise background" (relative weight=0.036) and "family network" (relative weight=0.017), which indicates that the respondents consider business networks as the most important key characteristic of entrepreneurs in the dimension of social capital. With limited resources, enterprises have to rely on business network relationships to seek capital investment or partners due to rising costs or investment failures in the development process and pressure from the competitive environment.

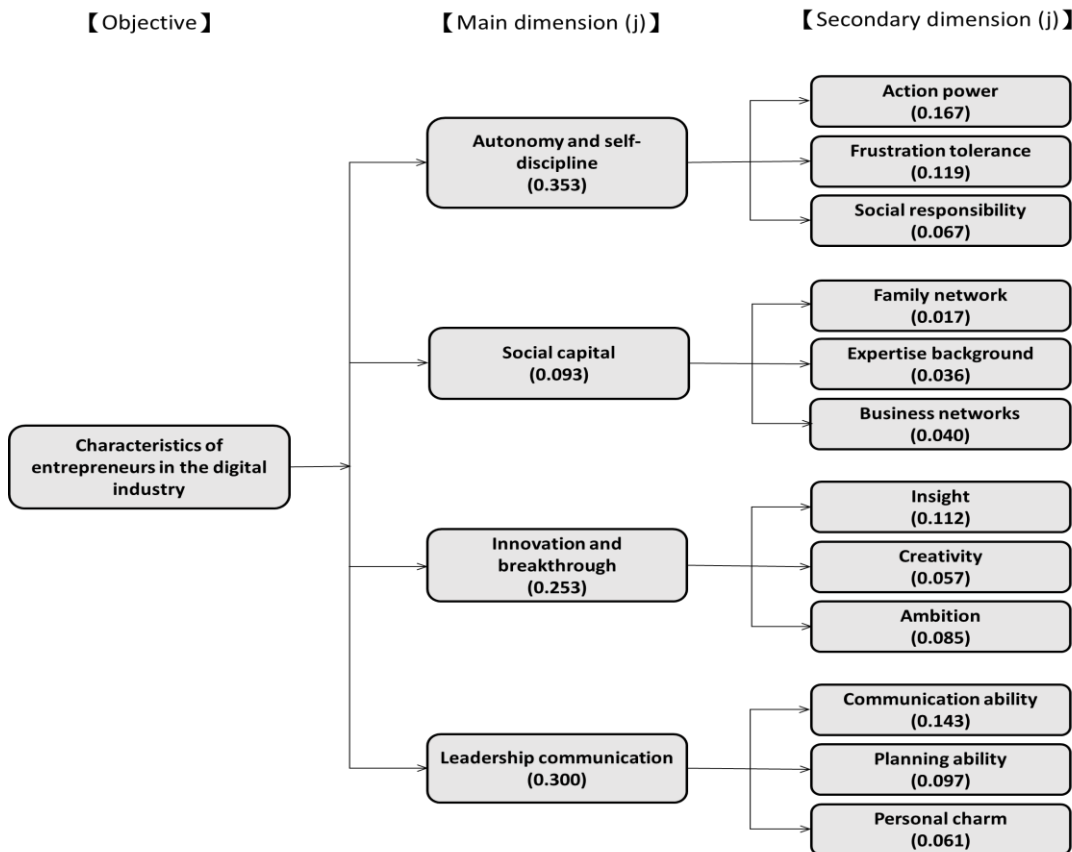


Figure 3. Relative Weights of Research on Key Characteristics of Digital Entrepreneurs.

Impact

More and more people are interested in the term digital entrepreneurs, which has also aroused the attention of countries and government units to initiate relevant support measures, such as policy promotion. Many experts and scholars have also begun to explore how international digital entrepreneurship giants created such a prosperous era, as such changes have created incredible wealth and brought great growth to countries. Most importantly, it has changed the pattern of people relying on brick-and-mortar stores. From the discussion of domestic literature, it can be seen that entrepreneurs in different industries have different psychological and behavioral characteristics.

In order to construct the evaluation framework, this study applied the analytic hierarchy process, which is flexible and easily understood hierarchical analysis method, to collect the opinions of experts and scholars through literature review of the digital industry, the characteristics of entrepreneurs, and in-depth interviews.

Conclusions

This study took "entrepreneurs in the digital industry" as the research object to explore their "key characteristics of successful entrepreneurship". This study integrated the relevant literature of the digital industry and the key personality traits of entrepreneurs as the theoretical basis and used the analytic hierarchy process to analyze and study the AHP questionnaire results of contemporary digital entrepreneurs. According to the research results, conclusions and suggestions are put forward as references for subsequent researchers.

Research conclusions and propositions

Based on the analysis results, this study developed the following propositions:

- Proposition 1: among the dimensions of the key characteristics of digital entrepreneurs, the dimension of "autonomy and self-discipline" is more important than the dimensions of "leadership communication", "innovation and breakthrough", and "social capital".
- Proposition 2: among the dimensions of the key characteristics of digital entrepreneurs, the characteristic of "action power" is key in the dimension of "autonomy and self-discipline".
- Proposition 3: among the dimensions of the key characteristics of digital entrepreneurs, the characteristic of "business networks" in the dimension of "social capital" is the key.
- Proposition 4: among the dimensions of the key characteristics of digital entrepreneurs, the characteristic of "insight" in the dimension of "innovation and breakthrough" is the key.
- Proposition 5: among the dimensions of the key characteristics of digital entrepreneurs, the characteristic of "communication ability" in the dimension of "leadership communication" is the key.

Suggestions for future studies

This study also briefly summarized some suggestions for entrepreneurs who intend to start up digital industries, and a reference for related studies in the future:

- a. Select the research object to make the research and analysis more accurate
In the first stage of this study, the key psychological and behavioral characteristics of current internationally renowned digital entrepreneurs were analyzed and summarized to establish a measurement model of the key characteristics of digital entrepreneurs. Then, by applying the analytic hierarchy process questionnaire, current digital entrepreneurs in Taiwan were taken as the object of analysis. According to the data, while it is not difficult to find that the characteristics of both domestic and foreign digital entrepreneurs are inseparable from the research dimension of this study, there are still differences in the important and key characteristics; for example, among the globally famous digital entrepreneurs, with the exception of Jack Ma, who had no relevant background in technology or education, other entrepreneurs all had relevant technical backgrounds or had studied related disciplines. Compared with foreign entrepreneurs, there are few domestic entrepreneurs who had relevant technical backgrounds or education before starting their own business. Obviously, many domestic entrepreneurs are connected to family networks or have parents who were entrepreneurs themselves. The research results show that, due to the different entrepreneurial scales and cultural backgrounds, although entrepreneurs meet the four main criteria, there are some differences in the secondary criteria. Therefore, in order to make the research value more accurate, it is suggested that follow-up research on related topics can select research objects according to their own research direction.
- b. Pursue the root of the problem by exploring a single dimension
According to the questionnaire results, entrepreneurs had different results in filling out the questionnaire due to different personal characteristics. Whether in the digital industry or other

industries, we know from previous literature that the beginning is the hardest for some entrepreneurs; some entrepreneurs will be tested repeatedly and suffer setbacks frequently in the entrepreneurial process, while it goes smoothly for other entrepreneurs. Moreover, the market and scale developed by enterprises will vary according to the different ideas and ambitions of entrepreneurs. As leaders with different temperaments show different personal leadership characteristics, the values created by their enterprises will also be different. As each of the different dimensions has a different reference value, it is suggested to choose a single dimension according to different cultural backgrounds to determine the root of a problem, which will give each research value a practical reference value.

Conflict of interest

There are no conflicts to declare.

Acknowledgments

This research has not been supported by any external funding.

References

- [1] European Commission, Digital Transformation of European Industry and Enterprises - A report of the Strategic Policy Forum on Digital Entrepreneurship, (2015). <https://digital-europe-website-v1.s3.fr-par.scw.cloud/uploads/2019/01/Final report Strategic Policy Forum.pdf>.
- [2] K. Lyytinen, Y. Yoo, R.J. Boland, Digital product innovation within four classes of innovation networks, *Inf. Syst. J.* 26 (2016) 47–75. <https://doi.org/10.1111/isj.12093>.
- [3] S. Nambisan, Digital Entrepreneurship: Toward a Digital Technology Perspective of Entrepreneurship, *Entrep. Theory Pract.* 41 (2017) 1029–1055. <https://doi.org/10.1111/etap.12254>.
- [4] S. Nambisan, K. Lyytinen, A. Majchrzak, M. Song, Digital Innovation Management: Reinventing Innovation Management Research in a Digital World, *MIS Q.* 41 (2017) 223–238. <https://doi.org/10.25300/misq/2017/41:1.03>.
- [5] H. Zaheer, Y. Breyer, J. Dumay, Digital entrepreneurship: An interdisciplinary structured literature review and research agenda, *Technol. Forecast. Soc. Change.* 148 (2019) 119735. <https://doi.org/10.1016/j.techfore.2019.119735>.
- [6] M. Ardolino, M. Rapaccini, N. Sacconi, P. Gaiardelli, G. Crespi, C. Ruggeri, The role of digital technologies for the service transformation of industrial companies, *Int. J. Prod. Res.* 56 (2018) 2116–2132. <https://doi.org/10.1080/00207543.2017.1324224>.
- [7] B. Hinings, T. Gegenhuber, R. Greenwood, Digital innovation and transformation: An institutional perspective, *Inf. Organ.* 28 (2018) 52–61. <https://doi.org/10.1016/j.infoandorg.2018.02.004>.
- [8] M. Luz Martín-Peña, E. Díaz-Garrido, J.M. Sánchez-López, The digitalization and servitization of manufacturing: A review on digital business models, *Strateg. Chang.* 27 (2018) 91–99. <https://doi.org/10.1002/jsc.2184>.
- [9] L. Satalkina, G. Steiner, Digital entrepreneurship and its role in innovation systems: A systematic literature review as a basis for future research avenues for sustainable transitions, *Sustain.* 12 (2020) 2764. <https://doi.org/10.3390/su12072764>.
- [10] F. Vendrell-Herrero, O.F. Bustinza, G. Parry, N. Georgantzis, Servitization, digitization and supply chain interdependency, *Ind. Mark. Manag.* 60 (2017) 69–81. <https://doi.org/10.1016/j.indmarman.2016.06.013>.
- [11] E. Davidson, E. Vaast, Digital Entrepreneurship and Its Sociomaterial Enactment, in: 2010 43rd Hawaii Int. Conf. Syst. Sci., IEEE, 2010: pp. 1–10. <https://doi.org/10.1109/HICSS.2010.150>.
- [12] Guthrie, The digital factory: a hands-on learning project digital entrepreneurship, *J. Entrep. Educ.* 17 (2014) 115–133.
- [13] S. Kraus, C. Palmer, N. Kailer, F.L. Kallinger, J. Spitzer, Digital entrepreneurship, *Int. J. Entrep. Behav. Res. ahead-of-p* (2018) 353–375. <https://doi.org/10.1108/IJEBR-06-2018-0425>.
- [14] N. Hair, L.R. Wetsch, C.E. Hull, V. Perotti, Y.T.C. Hung, Market orientation in digital entrepreneurship: Advantages and challenges in a web 2.0 networked world, *Int. J. Innov. Technol. Manag.* 9 (2012) 1250045. <https://doi.org/10.1142/S0219877012500459>.
- [15] C.E. Hull, Y.T.C. Hung, N. Hair, V. Perotti, R. Demartino, Taking advantage of digital opportunities: A typology of digital entrepreneurship, *Int. J. Netw. Virtual Organ.* 4 (2007) 290–303. <https://doi.org/10.1504/IJNVO.2007.015166>.
- [16] T. Le Dinh, M.C. Vu, A. Ayayi, Towards a living lab for promoting the digital entrepreneurship process, *Int. J. Entrep.* 22 (2018) 1–17.

- [17] C. Richter, S. Kraus, A. Brem, S. Durst, C. Giselsbrecht, Digital entrepreneurship: Innovative business models for the sharing economy, *Creat. Innov. Manag.* 26 (2017) 300–310. <https://doi.org/10.1111/caim.12227>.
- [18] F. Sussan, Z.J. Acs, The digital entrepreneurial ecosystem, *Small Bus. Econ.* 49 (2017) 55–73. <https://doi.org/10.1007/s11187-017-9867-5>.