Development Type Selection of 3D Printing Base: Model Analysis and Empirical Study

Jin Yuran[1, a], Yu Jiangnan[2, b*], Li Xin[3, c] and Liu Qiaoying[4, d]

[1,2,3,4] School of Business Administration, University of Science and Technology Liaoning, Anshan 114051, China

[a]jinyuran@163.com, [b]1158987883@qq.com, [c]lixiaoxin0322@163.com, [d]1163105789@qq.com

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Abstract. In recent years, with the rapid development of 3D printing industry, some 3D printing bases (including parks, centers, etc.) have emerged quickly. In order to assist various subjects to choose reasonable 3D printing base type for construction and development, this paper designed a development selection model of 3D printing base. The model takes the 3D printing industry bases from China as the samples for study, summarizes the types of those bases, analyzes the relevant characteristics, and then combines the SWOT internal and external environment analysis to make the final development type selection decision of 3D printing base. Finally, the paper took Liaoning Province of China as an example to carry out the empirical analysis, which verified the validity of the model.

Introduction

3D printing technology born in the United States in the 1980s has become one of the most popular emerging technologies in the world [1]. "Time" magazine in the United States calls 3D printing industry as 10 of the fastest growing industry in this country, and The Economist magazine calls it "the third industrial revolution in the future" of the digital manufacturing technology [2]. The authoritative report of international rapid manufacturing industry shows that the output value of global 3D printing industry from 1988 to 2010 maintained an average annual growth rate of 26.2%, the industrial output value including equipment manufacturing and service will reach $ 3.1 billion by 2016 and $ 5.2 billion by 2020, and 3D printing will become the next sunrise industry with a broad prospect [3, 4]. Thus, more and more countries and local governments have recognized the important role of 3D printing for stimulating the development of national economy and creating regional characteristic industry. The development of 3D printing industry will be conducive to enhancing the region's overall level of technology research, propelling the manufacturing industry's product research, development and design, promoting the traditional manufacturing industry revitalized, optimizing the mode of economic development, promoting the sustained and healthy development of the social economy. Therefore, various types of 3D printing industry base, park, center, etc. (hereinafter referred to the base) are rising rapidly in the global. In order to avoid the repetitive construction of these bases and the homogenization of competition, and support all kinds of organizations to select a reasonable development type while building 3D printing base in the future, it's clearly necessary to study the type and characteristic of these bases and then construct a development type selection model of 3D printing base.

In recent years, China's 3D printing industry has made remarkable development. More than 40 3D printing bases have sprung up, such as China 3D Printing Technology Industry Headquarters Base; China 3D Printing Innovation Center, China 3D Printing Application Industry Innovation Center, China 3D Printing Technology Industry Innovation Center, Sichuan Shuangliu 3D Printing Technology Industry Innovation Center, Huazhong University Of Science And Technology 3D Printing Industry Park, Zhejiang 3D Printing Industry Park and so on. These bases with wide types and features can provide substantial case data for this study. Hence, this paper regarded China's 3D printing bases as the research object, and took Chinese Liaoning Province as an example to carry out empirical analysis about the construction type of 3D printing base.

Development Type Selection Model of 3D Printing Base

We believe that the type selection of 3D printing base is influenced by the following three major factors: the types of bases, the characteristics of various types of bases (CVTB), and the internal and external environmental conditions of base construction main body (IEEC). Specifically, in the process of selection, we first need to survey and census the types of 3D printing bases and carry on classification analysis; and then study the characteristics of various types of base; after then to analyze the internal and external environment of base construction main body; finally to determine the development type of 3D printing base by the syncretic analysis of CVTB and IEEC. SWOT analysis can be used to analyze the internal and external environment of base construction main body. SWOT analysis is a kind of situation analysis based on the internal and external competitive environment and competitive conditions. It lists out various major internal strengths and weaknesses, and external opportunities and threat closely related to study object through the investigation, and uses the idea of system analysis to analyze the various factors so as to draw a series of corresponding decision-making conclusions [5]. In summary, we have constructed the following development type selection model of 3D printing base, as shown in Fig. 1.
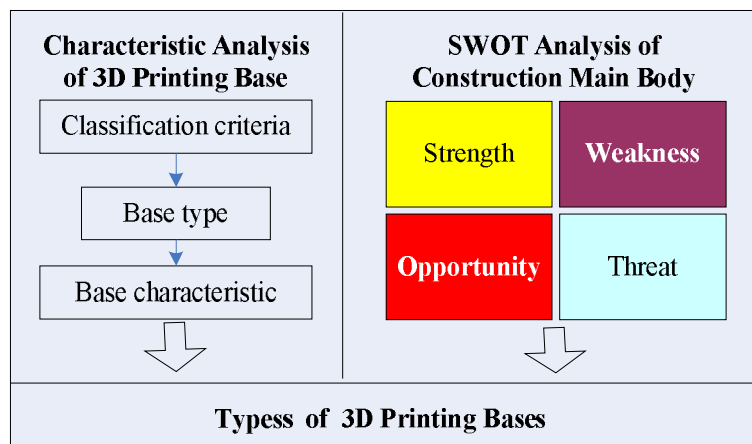

Fig. 1 Development type selection model of 3D printing base

Types and Characteristics of 3D Printing Bases

Under the guidance and support of the government and the great attention of the enterprises, 3D printing industry in China has been emerging rapidly in recent years. We found by survey that China has poured out 46 3D printing-related bases under construction and planning since 2013, which is over 25 provinces and municipalities. In addition, more than 12 regions and organizations will attach great importance to the development of 3D printing industry in the future. We have sorted out and classified these bases from 5 layers, including development target, subject character, industrial characteristics and professional field, as shown in Table 1.

Empirical Analysis: Development Type Selection of 3D Printing Bases in Liaoning Province

Liaoning Province is one of Chinese old industrial bases, and has the industrial base to develop 3D printing industry. However, its economic development has stagnated in recent years, and it need seek new economic growth point urgently. Exploring strategic emerging industry is bound to become the focal point of economic development in Liaoning Province.3D printing just burst out of the market energy of a new technology. It can help Liaoning Province to get a new powerful engine of growth, and its quality and staying power of economic development is expected to greatly improve. Therefore, taking Liaoning Province for an example to analyze the types building 3D printing base will have practical significance.

The Development Situation of 3D Printing Industry in Liaoning Province. Currently, there are two 3D printing parks in Liaoning Province, which is Wafangdian 3D Printing Industry Park and

Anshan Laser Industry Park. Wafangdian 3D Printing Industry Park collaborates with Dalian University of Technology, Wuhan Binhu Mechanical and Electrical Technology Co.,Ltd, Hunan Farsoon High-Technology Co.,Ltd. and other universities and enterprises. It introduces 3D printing technology and equipment actively to promote deep cooperation of Industry-Academy-Research. It is expected to break through the key technology restricting the development of 3D printing industry, and has a head start of the development of 3D printing industry. Anshan Laser Industrial Park is one of the ten key industrial parks in Liaoning Province. It rely on the broad market of the old northeast industrial base, focuses on Laser technology application, makes laser technology independent innovation as the main line, and makes Laser systems integration as the main direction. It is promoting the optimizing and upgrading of industrial structure and the shrift of economic growth mode. In comprehensive view, Liaoning Province has not formed the pattern of 3D printing manufacturing base with research collaboration, resource sharing, and system configuration.

Table 1: Overall classification of 3D printing bases

Division standard	Type	Characteristic
Development target	International union type	Have the ability or potential to integrate the global 3D printing industry resources.
	Domestic regional type	Create the strength of the 3D printing industry which surrounds the radiation combined with the characteristics and requirements of regional economic development.
Subject character	Government dominated type	Promote the development of 3D printing industry from the government level with the policy and other supports.
	Enterprise dominant type	Dominated by enterprises, weak, and difficult construction.
Industrial characteristic	Innovative research and development type	The main goal is technology innovation. It has the outstanding competitiveness.
	Technology industrialization type	Promote the existing 3D printing technology, to achieve the production and sales of industrial, facing the homogenized competition.
	R&D and industrialization and heavy	Own excellent research and development strength, perfect facilities, superior policy environment and strong financial support, It can make the whole industry chain running smoothly.
Professional field	National defense industry type	For different areas of specialization, combined with their own advantages, to create a professional, characteristic 3D printing industry base. Have strong core competitiveness.
	Electronic information	
	Automobile making	
	Biological medical apparatus	
	Creative class	

Type Selection Analysis of 3D Printing Bases in Liaoning Province. Based on the above analysis of 3D printing base types and characteristics, combined with the current development in Liaoning 3D printing industry, we make the SWOT analysis of building 3D printing industry foundation in Liaoning Province and the results are as follows:

Strength: Developing 3D printing industry in Liaoning Province has industrial advantages and location advantages. As China's northeast old industrial base, the steel metallurgy and equipment

manufacturing industry in Liaoning Province is well developed with a solid industrial design and manufacturing capabilities, which is conducive to combine processing and application technology such as the laser cutting, welding, marking and surface modification and so on to equipment manufacturing industry together, to promote the rapid development and upgrading of 3D industry. 3D printing technology has vast industrial space here. Wafangdian 3D Printing Industry Park and Anshan Laser Industry Park have laid the foundation to Liaoning Province for the development of professional 3D printing base.

Weakness: First, in the related planning about the upgrade of traditional industries and the development of intelligent manufacturing, the overall planning on 3D printing industry is still not perfect in Liaoning Province. The overall plan about 3D printing industry Planning has not been issued, the technical standards and development platforms has not been established, and the level of industrialization is lower; second, the related 3D printing enterprises in Liaoning Province have generally smaller scale, who are lack of R&D, research collaboration, and joint research mechanisms; Furthermore, universities in Liaoning Province lack of 3D printing-related required courses, which results in the lack of front-line skilled personnel; finally, Liaoning Province is lack of 3D printing leaders such as Yan Yongnian from Tsinghua university, Shi Yusheng from Huazhong University of Science and Technology , Lu Bingheng from Xi'an Jiaotong University , and Wang Huaming from Beijing University of Aeronautics and Astronautics. Anshan has disadvantages in Scientific research strength, which directly affects the development of 3D printing.

Opportunity: At present, the domestic has raised a hot wave of the development of laser industry. The size of the Chinese 3D printing market is about $300 million in 2013 and nearly 100 companies engaged in the 3D printing production, service, technology and other business [6]. In 2013, Xi Jinping, the general secretary of China, explicitly put forward the requirement of accelerating the development of 3D printing technology industrialization. The Ministry of Industry and Information Technology, The Ministry of Science and Technology, and The National Development and Reform will also introduce policies to support the development of 3D printing industry [7]. The association of Chinese 3D printing industry forecast that Chinese 3D printing market scale will expand to 10 billion Yuan by 2016[8]. The consolidation degree of 3D printing industry is low, the related development platform and the leading technical standards have not been established, and technology research and application is still in the disorderly state in our country. In addition, Liaoning provincial party committee and the provincial government has made the important strategic decision that they want to unite the power of the whole Province to develop 3D printing industry, and to encourage the government to cooperate with colleges and universities, to promote the construction of 3D printing bases together.

Threat: Recently, the quick actions from some areas of the country have put pressure on Liaoning Province. Fro example, Nanjing municipal government said that it will attempt to Built Nanjing into the commanding heights of the 3D printing industry in China, and accelerate agglomerating 3D printing industry to the economic and technological development zone [9]. Wuhan established Chinese first 3D printing factory, and wrote 3D printing in the 2013 Government Work Report regarded as a strategic emerging industries [2]. Chi Zhou high-tech industrial development zone set up a research center about 3D printing and advanced laser remanufacturing technology, which is specialized in researching high-end 3D printing manufacturing equipment and developing the laser sintering 3D printing devices with independent intellectual property rights of. This base will have a competitive threat on Liaoning provincial laser industrial park undoubtedly.

Comprehensive SWOT analysis results show that Liaoning Province has good opportunities for the construction of 3D printing bases. However, it is because some 3D printing related enterprises in the province are so weak that the industrial development should be promoted by Liaoning Province government in the early period. In addition, Liaoning Province has owned good advantages in building 3D printing bases. In particular, Anshan Laser Industrial Park has very strong and professional core technology competitiveness, which already has the characteristics of specialized 3D printing industry base. From the view of development localization, Liaoning Province does not have power or potential to integrating global industrialization resources of 3D printing in the short time, which is more in line

with the characteristic of the domestic regional industry base. From the view of industry characteristics, Whether Wafangdian 3D Printing Industry Park or Anshan Laser Industry Park does not have the first-class research and development strength. Therefore, Liaoning Province is more in line with the characteristic of technology industrialization base. At this point, combining with the above analysis of 3D printing base types and characteristics, we think that Liaoning Province should build "government-led, regional, focusing on laser equipment industrialization, and specialized 3D printing industry base".

Summary

With the proposed development type selection model of 3D printing base, the government and enterprises can understand the types and characteristics of 3D printing base scientifically. They can choose a more reasonable base type to invest in construction and development after analyzing the internal and external environment conditions, so as to reduce the risk of project construction and improve the competitiveness of the base development.

The feasibility of the model is verified by the empirical analysis of Liaoning Province in China. The research sample of this thesis is from China. Although the development of 3D printing base in China has a good sample representative, there are still possible omissions and deficiencies in the research of 3D printing base. In the next phase, we will further collect global and more comprehensive data to carry on in-depth study.

Acknowledgements

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