The Structural Strategies of the International Branding in Traditional Chinese Medicine (TCM) in the Era of Technology Upgrading

Leman Wu [1], Jiahao Fan [2], Guangbin Ren[3], Xueying Zhang[4], Yingmiao Jiao [5], Song Yang [6], Xingai Qiu[7], Zihuan Yue[8], Xiuli Chen[9]

[1,4,5,7,8,9]College of Global Talents, Beijing Institute of Technology Zhuhai, China

[2,3]Committee for International Specialists,
Shenzhen International Finance Research Association, Shenzhen, China

[6]Liberal & Arts college university of Illinois at Urbana- Champaign, USA

Abstract

With a growing desire for holistic and affordable healthcare and treatments, it is possible for Traditional Chinese Medicine (TCM) to offer new perspectives that can benefit modern medicine beyond East Asia. In order to make more people aware of the merits of TCM, this research encourages TCM knowledge and concentrates on branding. The significant focuses of prospect, prescription, product, patent, price, professionalism, partnership, place, people, and philosophy (indicated as the 10 Ps) were selected as the structural strategies of the international branding in TCM to develop the brand equity in the era of digitalization. This study collected data from fiscal reports, government websites and product advertisements related to around 70 TCM production companies in East Asia mainly from China. Several variables are chosen to embody different aspects in 10P, and cluster analysis is employed to figure out the branding strategy pattern among TCM industries under 10P. Because there are both nominal variables and continuous variables, K-Prototype was applied. It is a clustering method based on partitioning, which improve the K-Means and K-Mode clustering algorithm to cluster the mixed data types. New technologies such as virtual reality and novel automotive electronics will continue to emerge and accelerate cross-integration with artificial intelligence (AI) to promote intelligent alternation in production and lifestyle. Combining AI techniques with 10P models, the popularity efficiency of TCM will be improved obviously.

Keywords: Health for One, herbal medicine, international branding, brand equity, machine learning

1. Purpose

Regionally, China's traditional Chinese medicine (TCM) export value from exceeded four billion U.S. dollars in 2019 including Vietnam, the most potential market registered over 69 percent year-on-year growth, followed by India with 34 percent, Malaysia with 24 percent and South Korea with almost 11.4 percent year-on-year expansion (Statista, 2020). This is especially true when constructing solid brands with optimistic equity in an exceedingly competitive traditional herbal medicine market is critical for an advantage over the competition (Chen, 2021). Therefore, it was recommended that traditional medicine companies should develop brand awareness, association, loyalty, and perceived quality to enhance brand equity to advance competitive uniqueness in the market (Oppong & Phiri, 2018).

Research and development for TCM as well as western medicine is based on completely different metrics. Choosing a safer and healthier approach to cure would be a reasonable tendency. TCM focuses not only on a cure but also sustaining a healthy mind (i.e., keeping mental health when curing) and on seeking harmony between body and mind, human and society, and human and nature (Lu & Fan, 2011). These play an essential role to accomplish the aim of "Health for One" proposed by WHO all around the world. In order to make more people aware of the merits of TCM, this research encourage TCM knowledge and concentrate on branding. Furthermore, keeping well-informed with breakthrough digitalization, like machine learning while branding TCM, is also essential to make the branding more effective and achievable in thorough system and processes of TCM international branding (Cong et al.,2019).

Technology-upgrading is creating quite a lot of opportunities. For example, the Electronic Health Records (EHR) market is poised to observe the wildest development in Asia Pacific, with a predicted multiple annual growth rate of 5.7% until 2023, on the support of encouraging funds by governments, non-profit institutes and the private segments (Reportbuyer, 2018). As well, investigational data in China tells us that maintainable smart agriculture based on blockchain technology - which is encouraged by the governments - creates excessive opportuneness to farmers' sales, growing by 25% on average compared with traditional electronic agriculture for dynamic strength to the supportable advance of agricultural products (Li et al., 2020). As part of agricultural products, such as traditional Chinese herbs, the TCM industry will get benefits from the blockchain and other technology upgrading such as biotechnology (Gatlin, 2018).

Companies such as Jilin Aodong Pharmaceutical Group, Beijing Tongrentang, and Heilongjiangzbd Pharmaceutical have provided advice on branding strategy to help companies increase their revenues and brand equity in the international branding ecosystem for medical products in East Asia. In reference to TCM industries in the era of technology upgrading, this

research explores answers to what might be an effective international branding model for TCM industries in East Asia and what role does "technology upgrading" play in TCM industries. The significant focuses of prospect, prescription, product, patent, price, professionalism, partnership, place, people, and philosophy (indicated as the 10 Ps) were selected as the structural strategies of the international branding in TCM to develop the brand equity in the era of digitalization. The TCM companies selected in this research and their brand equities will be investigated based on the key elements in the following three models.

1.1 Prospect-prescription Model

The main significance of this small model is to argue for the reliability and scientific validity of TCM and Chinese medicine (Yuan et al., 2016) and single-targeted treatment in Western medicine (Sams-Dodd, 2005). With the support of big data (Mainenti, 2019) and artificial intelligence (Alice et al., 2021), the technical content and standardization of Chinese medicine can be improved, and a global brand can be formed.

1.2 Product – Patent – Price

The system of Product-Patent-Price follow the logic of production and sales. The quality and trait of product are the most elemental factors in this section of the "10P" of TCM international branding method (Summers, 2016). After creating a TCM product, the medical enterprise should search for the access to protect its product as intellect output because international branding without protection would bring a disaster to a brand or a company, such as plagiarism and fake (WHO, 2021). The third component, price, would depend on product and patent, as the quality of the product determines the original value that would be reflected in price (Mankiw, 2014) and the patent would create additional value to the rudimental product, both would be revealed in the final pricing (Griliches et al., 1987). The low cost of product forms the advantage of price competition, and the patent increases the value of a brand or a company, which eventually impacts the price (Hall et al., 2005).

1.3 Professionalism-Partnership-Place

The model of professionalism-partnership-place highly focuses on branding places, either cities or countries, as professional TCM areas through building global partnerships and industry professionalism (Boisen et al., 2018; Roberts & Cayla, 2009). International brand strategy and brand partnership policy to pursue international marketing in the destinations of TCM in a digital scenario will also be argued for the expertise of professionalism-partnership-place (Dyer & Singh, 1998).

1.4   People – Philosophy

In People-Philosophy of the TCM international branding model, people are the fundamental factor that should be considered at first as the degree of customer satisfaction is the core of certain product on sales (Summers, 2016). In the stage of producing, the enterprise demand professional TCM master. The TCM enterprises are able to brand with the unique philosophy of TCM according to the rudimental basis of employees as well as consumer. For example, in Chinese medicine theory, TCM aim at "prevention of disease", supporting forestalling before the disease happens and prevention of change after disease to robust people's self-healing power and to keep or improve body sustainability (Wang et al., 2020), which conforms with the people-oriented and people-sustainable ideas. Self-healing power encourages them remedying by themselves, and advocates that human subjective consciousness conquers their body's fitness. However, the impact of cultural diversity apparently acts on international market that is the huge challenge of TCM international branding. There are plenty of ancient Chinese base terms in Chinese medicine theory that is difficult to be explicated in modern and objective scientific language and phenomenon, like yin-yang and the five elements, which are the fundamental concepts guiding other traditional theories and terms and being recorded in ancient Chinese medical literatures. Therefore, when branding TCM all over the world, the philosophy of Chinese medicine theory needs to be popularized to make the notion of people's self-healing and sustainable development that would be the TCM branding ecosystem, for human as well as nature (He, 2019).

2.   Methodology

The use of qualitative methods is a well-established approach in the field of combination of TCM industry and international branding, since they offer an effective way of identifying and characterizing status quo of TCM industry, features of successful branding models and outlook of the TCM industry development and popularity. However, in this research, quantitative method is adopted to acquire further in-depth understanding on the 10P performance among the listed TCM enterprises in China. However, the quantitative method in this did not analyze the factors of price, prescription and prospect due to the difficulties of data collection. For example, it is problematic to collect precise and standard information on as the TCM pricing in different platforms (eg.Jingdong or Taobao) and channels (physical stores and online stores) is changeable. In addition, most companies allocate their medicines to proxy stores, proprietary stores and hospital, it is impossible to grasp patients' prescription due to privacy issues.

2.1   Data Source

This study obtained data by literature review process and crawler. 72 listed TCM

corporations are selected as investigation targeted sample for figuring out valuable patterns. This study collected data including Chinese TCM production companies like Jilin Aodong Pharmaceutical Group, Beijing Tongrentang, Heilongjiangzbd Pharmaceutical corporation and other 31 firms' fiscal reports, government websites and product advertisement in 2020. Another 38 companies that are developing both Chinese and Western medicines were added at the second stage for comparation.

2.2 Method

Several variables are chosen to embody different aspects in 10P, and cluster analysis is employed to figure out the branding strategy pattern among TCM industry under 10P. Because there are both nominal variables and continuous variables, K-Prototype was applied. It is a clustering method based on partitioning, which improve the K-Means and K-Mode clustering algorithm to cluster the mixed data types.

2.3 Measurement and variables

The gathered data serve for Product, Patent, People, Professionalism, Partnership, Place, and Philosophy in 10P. To be specific, regarding Product, the style of package patterns and logo and production are used to describe features of product. And the style is divided into traditional patterns and nontraditional patterns. In terms of Patent, the amount of patent right in intangible asset is utilized to evaluate the innovation of a TCM company. With regard to People and professionalism, the sales volume is obtained to estimate the popularity of a company, as well as the ratio of research and development personnel to employees and ratio of investment to operating income are grasped to assess what extent a company focuses on product and staff professionalism. In the case of partnership, as the earnings per share and return on net asstes are important indexes for investors to judge whether establish cooperative relationship, those two amounts are used to measure the possibility of being invested. With respect to Place, since all of these companies have proxy sales channels and academic promotion, the variable called whether manage self-operated stores is added to indicate the mode of selling. As regards Philosophy, because cultural consideration has considerable impact on consumer behaviors, whether a company publicize TCM culture and medicine history become the last two variables.

Firstly, 34 companies dedicated to Chinese medicine have been selected and then added another 38 companies that are developing both Chinese and Western medicines, and their results will be analyzed and compared separately.

Moreover, regarding the model of people and philosophy, in the process of TCM international branding and TCM's value judging, the relationship between humanity, science, and nature must be considered. The characteristic of holist, the core value of TCM contributing

to modern society, emphasizing the harmony and balance between human and nature regulation, and then reach the final healthy life. The fundamental principle of TCM is quite squared with the notion of sustainable development in modern society, so the international branding of TCM is the inevitable trend of social improvement (He, 2019), which will also be an important future research topic.

3.   Results

For companies dedicated to the research and production of Chinese medicines or proprietary Chinese medicines, as be illustrated from the table 1 above: the final clusters yielded three groups, and the percentages of these three groups are 50.00%, 38.24% and 11.76% respectively. On the whole, the distribution of the 3 groups is relatively even and the similarity between clusters is low, which instructs that this process is meaningful.

Table 1

Summary of Cluster Results		
Clusters	Frequency	Percentage (%)
cluster_1	17	50.00%
cluster_2	13	38.24%
cluster_3	4	11.76%
total	34	100%

Once the clustering categories have been obtained, in order to explore the particular characteristics of each category, an analysis of variance (ANOVA) is used to investigate the differences between groups of clusters (for quantitative variables) and these three categories are named in relation to their characteristics. After using ANOVA to figure out the variation in the characteristics of each cluster, the table 2 shows that: among sales volume (million boxes), production (million boxes), patents (million), ratio of R&D personnel to employees, ratio of R&D investment to operating income, earnings per share (yuan) and return on net assets, there is only one item named return on assets does not show significance (p=0.265>0.05) in characteristics across cluster categories and can be removal. From table2, it indicates that low-production cluster like Xiangxue pharmaceutical corporation, Zhejiang Jolly Pharmaceutical corporation, Shandong Wohua Pharmaceutical corporation and other fourteen companies owns low earnings per share, TCM production, sales volume as well as low patent value although their the ratio of R&D investment to operating income is the highest one among three clusters. On the contrary, the professionalism of Beijing Tongrentang, ZhangZhou PienTzeHuang Pharmaceutical limited company, Chongqing Taiji Industry (Group) and other 10 enterprises

tend to be weaker than other corporations and their amount of patent is slightly higher than the low-production companies, but the branding strategies of People and Product are mostly better than the first cluster. Finally, Jilin Aodong, Buchang, Yabao, Lingrui pharmaceutical limited corporations can be concluded as the high-production enterprises with excellent performance in People, Product, Patent and Professionalism and they are more likely to receive more investment than the other two.

Table2

	Analysis of variance comparison results for clustered categories (mean ± standard deviation)			F	p
	cluster_1 low production(n=17)	cluster_2 medium production(n=13)	cluster_3 high production(n=4)		
sales volume（million boxes）	79.50±158.28	210.58±253.08	1288.32±1272.92	12.365	0.000**
production（million boxes）	79.49±159.44	188.97±208.43	1121.30±1100.40	12.161	0.000**
patent（million）	14.50±28.67	15.31±26.16	69.31±64.12	4.817	0.015*
ratio of r&d personnel to employees	0.13±0.04	0.06±0.04	0.07±0.05	11.576	0.000**
ratio of r&d investment to operating income	0.03±0.01	0.02±0.01	0.05±0.01	8.354	0.001**
earnings per share(yuan)	0.05±0.41	0.82±0.70	0.97±0.73	8.518	0.001**
net asset	-0.07±0.44	0.11±0.06	0.10±0.05	1.388	0.265
* p<0.05 ** p<0.01					

However, according to chi-square analysis, product-package patterns (traditional or not), product-package logo (traditional or not), self-operated stores, marked as TCM (yes or no), culture description (yes or no), medicine history description (yes or no) do not show significance ($p>0.05$), implying that after cluster analysis, these six items do not show significant differences in the clustering categories.

Table 3

chi-square analysis		Cluster_Kprototype_715714			total	χ^2	p
		cluster_1	cluster_2	cluster_3			
product-package patterns(Traditional or not)	0	10(58.82)	8(61.54)	1(25.00)	19(55.88)	1.776	0.412
	1	7(41.18)	5(38.46)	3(75.00)	15(44.12)		
	total	17	13	4	34		
product-package logo （traditional or not）	0	12(70.59)	10(76.92)	4(100.00)	26(76.47)	1.559	0.459
	1	5(29.41)	3(23.08)	0(0.00)	8(23.53)		
	total	17	13	4	34		
self-operated stores	0	10(58.82)	7(53.85)	2(50.00)	19(55.88)	0.138	0.933
	1	7(41.18)	6(46.15)	2(50.00)	15(44.12)		
	total	17	13	4	34		
marked as TCM (yes or no)	0	3(17.65)	2(15.38)	0(0.00)	5(14.71)	0.812	0.666
	1	14(82.35)	11(84.62)	4(100.00)	29(85.29)		
	total	17	13	4	34		
culture description(yes or no)	0	16(94.12)	10(76.92)	4(100.00)	30(88.24)	2.703	0.259
	1	1(5.88)	3(23.08)	0(0.00)	4(11.76)		
	total	17	13	4	34		
medicine history description(yes or no)	0	10(58.82)	10(76.92)	4(100.00)	24(70.59)	3.051	0.217
	1	7(41.18)	3(23.08)	0(0.00)	10(29.41)		
	total	17	13	4	34		
* p<0.05 ** p<0.01							

For companies that produce both Chinese and Western medicines, the final clustering produced three groups, the percentages of these three groups were 86.11%, 12.5% and 1.39%

respectively. As a whole, the distribution of these three groups was not as homogeneous as the one focusing only on Chinese medicine, with a larger number of parts having the same characteristics, and the classification was not as good as the previous one.

Table4

Summary of Cluster Results		
Clusters	Frequency	Percentage (%)
cluster_1	9	12.50%
cluster_2	62	86.11%
cluster_3	1	1.39%
total	72	100%

Table 5 shows that among sales volume (million boxes), production volume (million boxes), patents (million), R&D staff to employee ratio, R&D investment to operating income ratio, earnings per share(yuan) and return on net assets, sales volume (million boxes), production volume (million boxes), patents (million), and R&D investment to operating income ratio show significance (p<0.05). The other variables did not differ much under different groups. As can be seen from Table 5, nine high production enterprises, such as Yabao Pharmaceutical Group Co Ltd, Henan Lingrui Pharmaceutical Co Ltd and Yunnan Baiyao Group Co Ltd, have higher production, sales and R&D investment in Chinese medicine as a proportion of operating income than the other two groups, but have low patent values. On the contrary, 62 enterprises such as Neptunus Bioengineering Co Ltd , Hansen Pharmaceutical Co., Ltd and Wanbangde pharmaceutical Holding Group Co.,Ltd were weaker in professionalism than the first cluster and had much lower production and sales volume than the first cluster, but their patent volume was slightly higher than that of the high production enterprises. Finally, Kangchen Pharmaceuticals has the highest patent value of all companies and the largest share of research and development, but the sales and production volumes are not as high.

Table 5

	Analysis of variance comparison results for clustered categories (mean±standard deviation)			F	p
	cluster_1(n=9)	cluster_2(n=62)	cluster_3(n=1)		
sales volume（million boxes）	2.49±0.68	-0.35±0.24	-0.52±null	306.666	0.000**
production （million boxes）	2.49±0.67	-0.35±0.24	-0.52±null	310.756	0.000**
patent （million）	-0.21±0.13	-0.10±0.33	7.96±null	334.123	0.000**
ratio of r&d personnel to employees	0.13±1.04	-0.05±0.97	2.09±null	2.441	0.095
ratio of r&d investment to operating income	0.22±0.92	-0.08±0.95	2.87±null	5.017	0.009**
earnings per share(yuan)	0.46±1.19	-0.08±0.97	0.53±null	1.269	0.288
net asset	0.29±0.25	-0.04±1.07	0.10±null	0.433	0.65
* p<0.05 ** p<0.01					

Similarly, according to chi-square analysis, product-package patterns (traditional or not),

product-package logo (traditional or not), self-operated stores, marked as TCM (yes or no), culture description (yes or no), medicine history description (yes or no) do not show significance (p>0.05), implying that after cluster analysis, these six items do not show significant differences in the clustering categories.

Table 6

chi-square analysis							
	type	Cluster_Kprototype			total	χ^2	p
		cluster_1	cluster_2	cluster_3			
product-package patterns(Traditional or not）	0	3(33.33)	34(54.84)	1(100.00)	38(52.78)	2.366	0.306
	1	6(66.67)	28(45.16)	0(0.00)	34(47.22)		
total		9	62	1	72		
product-package logo （traditional or not）	0	6(66.67)	46(74.19)	1(100.00)	53(73.61)	0.593	0.744
	1	3(33.33)	16(25.81)	0(0.00)	19(26.39)		
total		9	62	1	72		
self-operated stores	0	3(33.33)	44(70.97)	1(100.00)	48(66.67)	5.516	0.063
	1	6(66.67)	18(29.03)	0(0.00)	24(33.33)		
total		9	62	1	72		
marked as TCM (yes or no)	0	0(0.00)	12(19.35)	0(0.00)	12(16.67)	2.323	0.313
	1	9(100.00)	50(80.65)	1(100.00)	60(83.33)		
total		9	62	1	72		
culture description(yes or no)	0	7(77.78)	54(87.10)	1(100.00)	62(86.11)	0.734	0.693
	1	2(22.22)	8(12.90)	0(0.00)	10(13.89)		
total		9	62	1	72		
medicine history description(yes or no)	0	7(77.78)	44(70.97)	0(0.00)	51(70.83)	2.639	0.267
	1	2(22.22)	18(29.03)	1(100.00)	21(29.17)		
total		9	62	1	72		
* p<0.05 ** p<0.01							

The diversity of the products produced by the companies, the inconsistencies and missing information in the financial statements, and the small size of the data set are all factors that contribute to the inaccuracy of the results, so further data collection is needed to find ways to better complement the missing values in order to accurately show the propensity of the brand strategy. And it would be desirable to collect uniform prices, real reviews from consumers and users, and places related to tourism development to enrich the study.

4.   Discussion

It is expected that new technologies such as virtual reality and novel automotive electronics will continue to emerge and accelerate cross-integration with artificial intelligence (AI) to promote intelligent alternation in production and lifestyle. Simultaneously, AI and big data, 5G, internet of things, cloud computing, quantum computing, blockchain, mixed reality (MR) and Edge computing and other new generation information technologies are mutually supportive and dependent (CCID Intelligence Inc., 2021). With the industrialization of smart technologies and the intellectualization of TCM industries, AI will provide the underlying and powerful support for the development of the smart economy and the digital transformation of TCM

industry, such as the establishment of Intelligent Decoction System, Intelligent Factory for Chinese Medicine Production and Chinese Medicine Assisted Treatment System, which can promote this industry becoming more standardized, precise and efficient and improve the worldwide acceptance of TCM to some extent (Zhang et al., 2021).

Gathering patients' information as well as syndrome differentiation are two essential steps in TCM clinical diagnosis (Arji, 2019). There are four common diagnostic methods used by TCM specialists to figure out the specific location, nature, and pathogenesis of disease, including palpation, inspection, auscultation, and interrogation (Jiang et al., 2012). After that, detailed treatment schemes are designed based on syndrome differentiation, a classifier of patients, which distinguishes a class from other classes by analyzing their symptoms (Zhang et al., 2008). However, due to lack of experience and knowledge of patients and other external factors that cannot be ignored, it is difficult for TCM doctors to identify accurate syndrome which specifically refers to the dynamic, impermanent, and spatial morbid condition of patients (Feng et al., 2006).

To be specific, the pulse diagnosis usually depends on the experience and intuition of TCM physicians so that the descriptions of pulse are mostly obscure and imprecise (Wang et al., 2021). With the combination of detector and transducer techniques, the ambiguous descriptions can be taken place by digital palpation data (Luo et al., 2019). Various traditional machine-learning methods are applied to identify the five pulse patterns (moderate, smooth, unsmooth, taut, and hollow) and to improve the accuracy of pulse diagnosis, such as Random Forest (RF), k-nearest neighbor (KNN), decision tree (DT), principal component analysis (PCA), Logistic regression (LR) and a naïve Bayes algorithm(NB) (Lee et al., 2015), and support vector machine (SVM) usually outperforms the other algorithms in precision (Zhao et al., 2015).

Furthermore, employing deep learning networks can automatically detect furtive and helpful features. For example, 12 types of human pulse signals, including short pulse, feeble pulse, stringy pulse and so on can all be recognized by convolutional neutral network (CNN) which achieved an accuracy of 93.49% (Zhang & Sun, 2016). In addition, a large amount of machine learning algorithms is used to displace visual inspection by TCM physicians in tongue diagnosis and this integration of AI-assisted techniques and tongue diagnosis can distinguish gastritis, bronchitis, appendicitis, pulmonary heart disease patients from healthy people productively (Zhang et al., 2005).

Moreover, auscultation, classical machine-learning methods like KNN, SVM, Neural network and so on are utilized in auscultation gradually to extract features from speech samples and judge the functions of internal organs and the deficiency or sufficiency of the qi, blood, and body fluids (Yan, 2011). However, AI-assisted interrogation still concentrates on the connection between symptoms and syndromes, which is in the initial stage and more

exploration in needed in the future (Wang et al., 2021).

In terms of TCM treatment strategies, AI can not only help TCM physicians design the combination of herbal medicine, but also provide aid in applications of acupuncture, Tui Na and Qigong of TCM. AI can imitate the dialectical thinking processes of human and collect data from previous diagnosis and experience while considering detailed information like geographical location and ethnicity to figure out abundant and functional solutions (Feng et al., 2021). The knowledge mapping technology plays a pivotal role in this process as it is the essential condition of establishing a clinical diagnosis database and is conducive to visualizing and analyzing the treatment effects before adopting treatment strategy in order to offer better potential schemes for TCM specialists (Feng et al., 2021). With respect to acupuncture, to reach the international standardization and reduce the contradiction about security of acupuncture, the robot-controlled acupuncture (RCA) has been developed and tested effects from three aspects: the precision of points' localization, whether activate robot's arm to stimulate points and investigate the simulation efficacy automatically (Lan & Litscher, 2019).

Most people have realized the importance of preventive treatment which require three steps in preventative treatment: first, gathering macro-, meso- and micro health data; next, employing AI techniques like Ada Boost and fuzzy mathematics to establish the state identification model; third, intervene, estimate, and conclude model to optimize intervention (Feng et al., 2021). Additionally, blending Tui Na with AI, anthropomorphic robots' arm with complete elastic joints programmed (Huang et al., 2015) and portable back massage robot (Wang et al., 2018) are developed to expand the coverage of the massage area and maximize effect. In the treatment of Qigong that requires patients to coordinate their breathing, gestures, motion and consciousness, AI can supervise patients by monitoring daily vitality scores and summarizing the specific breathing features (Liu et al., 2020).

5.   Conclusion

The absence of scientific development processes and controlled clinical trials has held back the integration of TCM for centuries. Combining AI techniques with 10P models, the popularity efficiency of TCM will be improved obviously. In regard to product, the smart technologies are helpful in solving the difficulty of quality tracing which consists of TCM internal detection and identification by employing schematic of spectral imaging and machine learning respectively (Tao et al., 2020), as well as nonstandard manufacturing to realize the self-perception, self-learning, self-decision-making, self-execution, and self-adaptive production methods (Feng et al., 2018). As mentioned above, professionalism can be promoted by machine learning algorithms and deep learning in clinical diagnosis and treatment. For instance, CNN models, ordered to perform a particular task and extract features automatically (Wang et al., 2020), can

be applied in tongue diagnosis including observing tongues' color, shape, humidity and so on to indicate whether the mental and physical conditions of patients are healthy (Fu et al., 2017). For prescription, it is imperative for TCM doctors to prescribe treatments with productive and novel effects by comprehending the combination rules of TCM formulae (Liu et al., 2012). This can be achieved by a strategy called AI-powered knowledge discovery which requires constructing text documents and relational database by storing knowledge of TCM ancient literature and books allowing us to discover more valuable and potential formulas by coalescing data mining methods (Feng et al., 2008). Big data techniques enable analysts in the TCM industry to generate predictive, descriptive, and prescriptive data, gain deep insights into consumers' behavior and thinking, establish personalized strategy and determine demanding price (Sheehy, 2020), making the considerable contribution to people, philosophy and prospect, place, and partnership, as well as price.

References

Alice, L. Y. L., Binghe, G. U. A. N., Shuang, C. H. E. N., Hoyin, C. H. A. N., Kawai, K. O. N. G., Wenjung, L. I., and Jiangang, S. H. E. N. (2021). Artificial intelligence meets traditional Chinese medicine: a bridge to opening the magic box of sphygmopalpation for pulse pattern recognition. *Digital Chinese Medicine,* vol. 3, no. 1, pp. 1-8.

Arji, G., Safdari, R., Rezaeizadeh, H., Abbassian, A., Mokhtaran, M., and Ayati, M. H. (2019). A systematic literature review and classification of knowledge discovery in traditional medicine, *Computer methods and programs in biomedicine,* vol. 168, no. 1, pp. 39-57.

Boisen, M., Terlouw, K., Groote, P. and Couwenberg, O. (2018). Reframing place promotion, place marketing, and place branding-moving beyond conceptual confusion. *Cities,* vol. 80, pp. 4-11.

CCID Intelligence Inc. (February 2021) Learn more about "China's AI industry trends in 2021" in one article, CCID Outlook, Available: https://www.ccidgroup.com/info/1105/32595.htm

Chen, C. C. (2021). Consumers' purchase intention on consumptive medical products-a comparative study of Taiwai and China, *International Journal of Organizational Innovation,* vol.13, no.3, pp. 350-364.

Cong, C., Zhang, X. and Li, L. (2019). "Prediction of potential targets of traditional Chinese medicine based on machine learning," *In AIP Conference Proceedings*, vol. 2110, no. 1, p. 020022.

Dyer, J. H., & Singh, H. (1998). The relational view: Cooperative strategy and sources of

interorganizational competitive advantage, *Academy of management review*, vol. 23, no. 4, pp. 660-679.

Feng, Y., Wu, Z., Zhou, X., Zhou, Z., and Fan, W. (2006). Knowledge discovery in traditional Chinese medicine: state of the art and perspectives, *Artificial Intelligence in Medicine*, vol. 38, no. 3, pp. 219-236.

Feng, C., Zhou, S., Qu, Y., Wang, Q., Bao, S., Li, Y. and Yang, T. (2021). Overview of Artificial Intelligence Applications in Chinese Medicine Therapy. *Evidence-Based Complementary and Alternative Medicine*, vol. 2021.

Fu, H., Zheng, Z., Yang, B., Yan, H. S. and Liu, L. (2017) Computerized tongue coating nature diagnosis using convolutional neural network. *IEEE 2nd International Conference on Big Data Analysis (ICBDA).* Beijing, China, pp. 730-734.

Gatlin, A. (2018, September 7). Is China's Next Great Leap Forward Coming Through Biotechnology? *Investor's Business Daily.* https://www.investors.com/news/technol ogy/chinese-biotech-companies-hong-kong/

Griliches, Z., Pakes, A., and Hall, B.H. (1987). *The Value of Patents as Indicators of Inventive Activity*, In P. Dasgupta and P. Stoneman, eds. Cambridge, U.K.: Cambridge University Press.

Growth rate of traditional Chinese medicine exports from China in 2019, by markets. (2020, May). Statista. Retrieved June 3, 2022, from https://www.statista.com/statisti cs/1231909/china-emerging-export-markets-of-traditional-chinese-medicine/

Hall, B. H., Jaffe, A. and Trajtenberg, M. (2005). Market value and patent citations, *RAND Journal of economics*, pp. 16-38.

He, K. (2019). Modern holistic medicine from the perspective of traditional Chinese medicine. *International Journal of Complementary & Alternative Medicine* 12.

Huang, Y., Li, J., Huang, Q. and Soueres, P. (2015). Anthropomorphic robotic arm with integrated elastic joints for TCM remedial massage, *Robotica*, vol. 33, no. 2, pp. 348-365.

Jiang, M., Lu, C., Zhang, C., Yang, J., Tan, Y., Lu, A., and Chan, K. (2012). Syndrome differentiation in modern research of traditional Chinese medicine, *Journal of ethnopharmacology,* vol. 140, no. 3, pp. 634-642.

Lan, K. C. and Litscher, G. (2019). Robot-Controlled Acupuncture-An Innovative Step towards Modernization of the Ancient Traditional Medical Treatment Method. *Medicines (Basel, Switzerland)*, vol. 6, no. 3, p. 87.

Lee, B.J, Jeon, Y., Ku, B., Kim, J.U., Bae, J.H. and Kim, J.Y. (2015). Association of

hypertension with physical factors of wrist pulse waves using a computational approach: a pilot study, *BMC Complement Altern Med*, p. 222

Li, X., Wang, D. and Li, M. (2020). Convenience analysis of sustainable E-agriculture based on blockchain technology, *Journal of Cleaner Production*, vol. 271, p. 122503.

Liu, L., Xu, X., Sun, Q., Yu, Y., Xia, F., Xie, J. and Qiu, H. (2020). Neurally adjusted ventilatory assist versus pressure support ventilation in difficult weaning: a randomized trial, *Anesthesiology*, vol. 132, no. 6, pp. 1482-1493.

Liu, B., Zhou, X., Wang, Y., Hu, J., He, L., Zhang, R., Chen, S. and Guo, Y. (2012) Data processing and analysis in real-world traditional Chinese medicine clinical data: challenges and approaches, *Statistics in medicine,* vol. 31, no. 7, pp. 653-660.

Lu, L. and Fan, M. S. (2011). Cultural analysis of Chinese medical professionalism [in Chinese], *Chin Med Ethics*, no.2, pp. 195-196.

Luo, Z. Y., Cui, J., Hu, X. J., Tu, L. P., Liu, H. D., Jiao, W. and Xu, J. T. (2018). A study of machine-learning classifiers for hypertension based on radial pulse wave. BioMed research international, 2018.

Mainenti, D. C. (December 2019). Big data and traditional Chinese medicine (TCM): What's state of the art?. In 2019 IEEE International Conference on Big Data (Big Data). IEEE. [Online]. pp. 1417-1422. Available: https://ieeexplore.ieee.org/abstract/document/9006479

Mankiw, N. (2014). *Principles of Economics,* 7th Edition. Cambridge, U.K.: Harvard University.

Oppong, P. K. and Phiri, M. A. (2018). Measuring customer-based brand equity in traditional herbal medicine market in Kumasi, Ghana, *African Journal of Business and Economic Research*, vol.13, no.3, pp. 115-133.

Reportbuyer. (2018). *Electronic Health Record Market by Delivery Mode, by Component, by End User, by Geography - Global Market Size, Share, Development, Growth and Demand Forecast, 2013-2023.* https://www.reportbuyer.com/product/5586801/electronic-health-record-market-by-delivery-mode-by-component-by-end-user-by-geography-global-market-size-share-development-growth-and-demand-forecast-2013-2023.html

Roberts, J. and Cayla, J. (2009). Global branding, *The SAGE Handbook of International Marketing*, pp. 346-360.

Sams-Dodd, F. (2005). Target-based drug discovery: is something wrong? *Drug discovery today*, vol.10, no.2, pp. 139-147.

Sheehy, M. (2020, February 4). Using Big Data to Predict Consumer Behavior and Improve ROI. Brandpoint. https://www.brandpoint.com/blog/using-big-data-to-predict-consumer-behavior-and-improve-roi/

Summers, D. C. (2016). *Quality*, Sixth edition. New York: Pearson Education.

Tao Y et al. (2020). Application and prospect of artificial intelligence and industrial 4.0 high-spectral imaging technology fusion deep learning method in the field of traditional Chinese medicine, *World Chinese Medicine*, vol. 45, no. 22, pp. 5438-5442.

Wang, S., Wang, Y., Lu, Y., Li, J., Song, Y., Nyamgerely, M., Wang, X. (2020). Diagnosis and treatment of novel coronavirus pneumonia based on the theory of traditional Chinese medicine. *Journal of Integrative Medicine* 18.

Wang, W., Zhang, P., Liang, C. and Shi, Y. (2018) A portable back massage robot based on Traditional Chinese Medicine, Technology and health care: official journal of the European Society for Engineering and Medicine vol. 26, no. 4, pp. 709-713.

Wang, X., Liu, J., Wu, C., Liu, J., Li, Q., Chen, Y. and Chen, J. (2020). Artificial intelligence in tongue diagnosis: Using deep convolutional neural network for recognizing unhealthy tongue with tooth-mark. *Computational and structural biotechnology journal*, vol. 18, pp. 973-980.

Wang, Y., Shi, X., Li, L., Efferth, T., and Shang, D. (2021). The impact of artificial intelligence on traditional Chinese medicine, *The American journal of Chinese medicine*, vol. 49, no. 6, pp. 1297-1314.

Yan, J., Shen, Q., Ren, J., Wang, Y., Chen, C., Guo, R. and Yan, H. (2011). A multi-instance multi-label learning approach to objective auscultation analysis of traditional Chinese medicine. In 2011 4th International Conference on Biomedical Engineering and Informatics (BMEI), Shanghai, China, vol. 3, pp. 1626-1630.

Yuan, H., Ma, Q., Ye, L., and Piao, G. (2016). The traditional medicine and modern medicine from natural products, *Molecules*, vol. 21, no. 5, p. 559.

Zhang, H. Z., Wang, K. Q., Zhang, D., Pang, B. and Huang, B. (2006). Computer aided tongue diagnosis system. In 2005 IEEE Engineering in Medicine and Biology 27th Annual Conference. Shanghai, China, pp. 6754-6757.

Zhang, L.L., Cao, T. T. and Li, M. (2021) The development and outlook of the Chinese medicine smart industry, World Chinese Medicine, vol. 2, p. 346.

Zhang, N. L., Yuan, S., Chen, T., and Wang, Y. (2008). Latent tree models and diagnosis in traditional Chinese medicine, *Artificial intelligence in medicine,* vol. 42, no. 3, pp. 229-245.

Zhang, S. R. and Sun, Q. F. (2016). Human pulse recognition based on convolutional neural networks, *In 2016 International Symposium on Computer, Consumer and Control (IS3C)* IEEE. Xi'an, China, pp. 366-369.

Zhao, C., Li, G. Z., Wang, C. and Niu, J. (2015). Advances in patient classification for traditional Chinese medicine: a machine learning perspective, Evidence-based complementary and alternative medicine: eCAM, vol. 2015, p.18.

Zhipei, F., Ran,Z., and Daiyin, P. (2018). Internet + Collaborative Fusion Research on Upgrading with the Chinese Medicine Industry, *Chinese Herbal Medicine*, vol. 49, no.24, pp. 5980-5984.