Current Status and Perspectives on 'Computational Service Design' in China from a Bibliometric Perspective

Yimin Wang and Honglin Zhu(✉)

Guangdong University of Finance and Economics, Guangzhou, China
zhuhonglin@gdufe.edu.cn

Abstract. Purpose: The 'Computational' service design widens the boundary of service design, and few researchers conduct researches in this field. The author is committed to combing its knowledge context, building its knowledge framework and tapping its future development potential. Method: With the help of the methodology of knowledge measurement, the author used Python language and atlas analysis software Gephi to gather, compare and analyze literature available on China National Knowledge Infrastructure. Result: The author has completed the exploration, deconstruction and induction of the knowledge system of 'Formulas' service design, proposed the process framework of 'computational' service design based on the double-diamond model and put forward the outlook for future design direction. Conclusion: 'computational' service design is a brand new study with high attention, inclusive themes, and diverse approaches. The new mechanism could be explored combining with natural science technology and design method, innovation process and implementation path at different stages in service design, embodying the core elements of people-oriented design principle of humanized design process. It provides new innovative ideas for researchers in educational circle and industrial circle.

Keywords: computational service design · design process · data mining and knowledge discovery · social network analysis · bio metrics · knowledge engineering

1 Introduction

Service design is a new expansion of the traditional design field in the post-industrial era, focusing on the relationship between people, objects, behaviors and the environment, dedicated to the delivery of experience and value [1]. As the design paradigm shifts, specialist terms such as 'design artificial intelligence', 'affect measurement' and 'computational design' begin to appear frequently in the design field. However, the knowledge structure of service design is gradually being created and an unfamiliar field that has not yet been precisely defined - 'computational service design' - is emerging. Defined in 2010 by 15 scholars including Lazer, D. [2] in Science, 'computational' has been extended to a wide range of disciplines, including service design, data science, statistics,

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etc., with the ultimate aim of the ultimate goal to be able to better predict the future after learning natural data through machines. According to Liu Guanzhong, the essence of design is to 'predict the future' and then 'fix it'. The complex relationship between design needs has shifted design from the traditional 'cause and effect' to 'correlation' [3]. Argues that designers in the information age are better able to explore the 'gear-like' logic of narratives with the help of data. At the same time, service design research relies on massive, multi-dimensional data, connectivity between innovation tools, logic between innovation content, and most importantly, a formulaic nature of the innovation concept that relies on design tools. Thus, there is significant scope for research in computational service design. In fact, some literature and research results have already emerged, but scholars have not done much to organize and explain this phenomenon. The author will define its knowledge system in more depth, build its knowledge framework and explore the future development potential.

2 Reasons and Current Situation of 'Computational' Service Design

2.1 Questioning and New Thinking About Design Tools

The movement moving toward 'computational' service design stems from the rigidity of traditional service design methods. In the process of implementing traditional service design, many design tools from home and abroad are used, such as questionnaire research, user portraits, user experience maps, etc. These tools are highly repetitive, slow in the process of information migration and inefficient in design implementation. In addition, the content of design innovation is highly subjective. Designers involve users in the process evaluation when conducting user testing, but various factors such as inconsistent user backgrounds and inconsistent understanding of design criteria result in the researcher's inability to objectively access user ideas. As a result, this lack of objectivity criteria for measurement is insufficient to fully support the design of the system. Zhang Caizhong analyses from the design science solution landing layer, contemporary designers dare to propose ideas has been a good tendency, but sometimes lost the objective criteria to support the feasibility of the design, so it is difficult to win the trust and voice of the team, and even the product followed with being put into use is full of mistakes, also can only rely on traditional tools again to find mistakes caused by a vicious circle [4].

2.2 Epiphany and New Perception of Design Content

The 'computational' movement stems from researchers' epiphanies and new perceptions of the complex processes and uncertainty criteria of emerging service delivery content. As Internet products and innovative organizational forms change rapidly, service models and user experiences become more complex, and traditional methodologies limit the thinking of top designers. Fang Yuling [5] and others suggest that user experience in the new contemporary Internet environment is undergoing a shift from the pursuit of practicality alone to both enjoyment and enjoyment, and that the enjoyment attribute,

which emphasizes diverse outcomes, is more valuable than the practical attribute, which is solely for solving problems. This has led to a shift in the service design paradigm from the traditional 'two-point-one' solution setting to a multi-dimensional, fluid innovation model. Some service designers can only create a small number of personalized experiences if they use a small number of interviews, ethnographies and questionnaire samples to generate user profiles as design content. However, AI technology has an impact on the entire service design process, enabling users to assess their complex mental models and algorithmically find the 'optimal solution' to build the most user-friendly design logic and segmented deployment.

2.3 Rethinking Design Contexts and New Decisions

The 'computational' movement is also the result of reflection and new decisions by researchers about the inefficiency, confusion and laxity of research contexts. Participatory, collaborative and co-creative approaches to innovation as a service to design practitioners have improved the fit between innovators and stakeholders and reduced the gaps in traditional design processes, but the acceptance of co-creative approaches such as 'innovation theatre', which require high levels of interpretative and empathic skills, has yet to be considered. Low-order service design methods such as brainstorming, role-playing, markers and sticky notes in business strategy do not allow for a deeper understanding of innovative ideas, and many solutions are not evaluated against criteria, which can lead to conflicting decisions. Many scholars have attempted to break this rigid research context, with Liu Jian [6] and others combining the TRIZ group wisdom model with heterogeneous neural networks to provide innovators with an insight that a group wisdom hybrid computing approach is more suitable for use by large companies. At the same time, numerous new value assessment methods from management operations research are being studied by traditional design researchers. As a result, in a business environment where major business decisions require more accurate design, design contexts are being adapted to incorporate knowledge from other disciplines.

3 Research Design

As a new direction in service design research, no scholar has yet provided a clear answer to the questions of what kind of research fervour, topics, implementation paths and trends there will be in the future, which can be interpreted by webometrics. To a large extent, cybernetics can assist scholars in their work of uncovering changes in knowledge structures, domains and properties. In recent years, Xu Jiang and other prominent scholars have used our science foundation-funded literature as a data source to understand the clustering and genealogical characteristics of the new field of design, the 'conceptual design' subdivision, to improve the efficiency of cross-disciplinary identification and classification, value and evaluation [7].

Therefore, the research data in this paper was mainly obtained from all the literature related to 'computational service design' on CNKI China, by setting the search criteria as: search content = (service design, intelligent service design, big data service design, service design engineering), search criteria = (keywords), literature type = (Chinese),

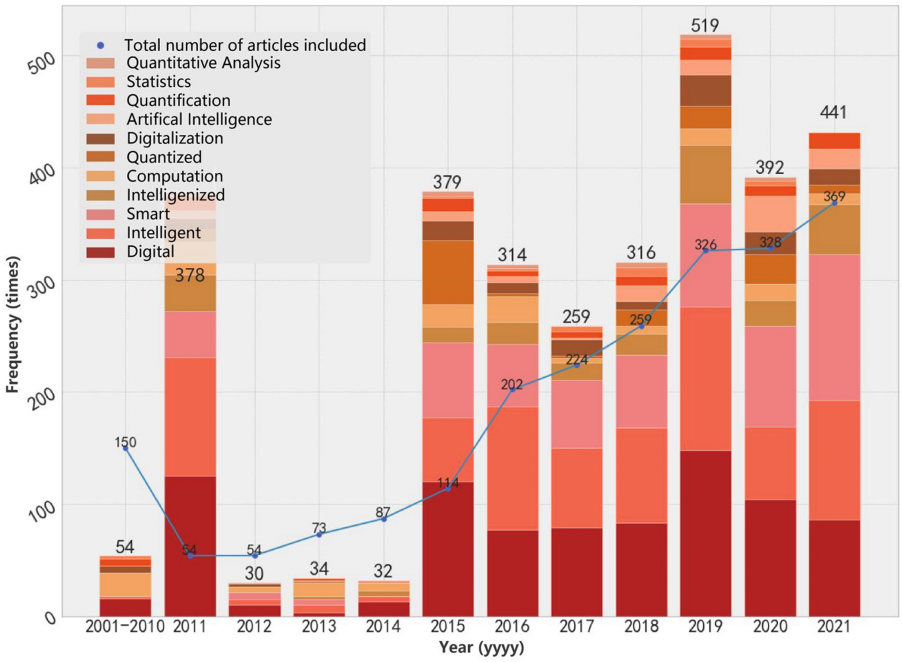

Fig. 1. Analysis of research attention of computational service design

time = (2001–2021), and time = (2001–2021). (2001 - 30 June 2021), 2019 literature abstracts were crawled using Python to clean, extract keywords, abstracts and get rid of single abstract repeat word frequencies, resulting in basic research data for time series analysis. Secondly, 500 highly relevant literature were extracted and keywords were recorded, re-meaning words were pruned and word pairs were manually tagged with service design hot topic words, and Gephi software was used to construct an undirected weighted network for exploratory analysis of the knowledge structure of computational service design.

4 Data Analysis

4.1 Analysis of Research Attention

Computational service design has a steady trend of growing research. The author first used word frequency statistics to examine the popularity of this field. The results of the research show that 'computational' thinking has gradually become prevalent in the field of service design today. In 2011, in only 54 abstracts, the relevant words have appeared 378 times, nearly eight times the total number of the previous decade. It can therefore be judged that 2011 was the first year that computational thinking infiltrated the field of service design in China, while the system has gradually maintained a steady growth after 2015, as shown in Fig. 1.

Fig. 2. The structural mining of the knowledge distribution of computational service design

4.2 Analysis of Research Topics

The research topics of computational service design are mainly reflected in the design content and process. The author based on the label data set using Degree as a single node with other nodes connected to the number of times can intuitively refine the popular topics, mining results as shown in the visualization of clustering mapping in Fig. 2.

4.2.1 Analysis of Content-Centric Topics

The content-centred topics were seen by academics as being mainly on the theme of new scenarios and new lives created by the combination of service design and new technologies. The 'medical, elderly and health management' category stood out due to the easy combination of technology and social concerns, with themes such as intelligent systems, fall monitoring and care assistants appearing several times in the keywords. In a study on the design and management of chronic disease services, Yu Lingjie [8] points out that new technologies such as the Internet of Things, cloud computing and smart wearable have built the core problem-solving approach to smart healthcare. The involvement of computing technologies in service industries such as 'everyday life and smart products', 'transport and travel' and 'hospitality and tourism' is beginning to be widely studied by academics. Among the key words for example the involvement of products such as smart stereos, tea making machines, access control systems and home security systems all reflect the combination of service design and new technologies in the theme of life.

4.2.2 Analysis of Process-Centred Topics

Process-centred topics reflect the integration of new technologies in the execution of service design. Computational methodological terms such as 'affective computing', 'methodological intelligence' and 'uncertainty computing' metaphorically reflect the initial integration of service design in cross-disciplines such as engineering management

and artificial intelligence in the combination of service design with interdisciplinary disciplines such as engineering management and artificial intelligence has gradually developed a sense of automated work based on research data and case studies. Liu Key's [5] research is the most informative in this topic. Based on the traditional service design operation model, the scholar constructs a low-threshold multi-stakeholder participatory and highly automated solution decision-making and generation system design by integrating various methods such as machine learning, knowledge management and prototype testing, covering three core systems: user requirement mining, solution matching and solution management. It also empirically demonstrates the specific application of the model through shared vehicle service optimization, and explains how technologies such as text mining, heterogeneous information networks and SOA are used in combination with service blueprints and user journey maps to achieve an intelligent process of service design.

4.3 Analysis of Research Tools

Computational service design has a rich set of research tools around the rational and the emotional. Whereas the previous section provided an in-depth account of 'content' and 'process' using the Degree algorithm, this section will explore more out-of-the-box methodological changes and explore different patterns of tool use. Closeness Centrality (Cc) of the network nodes will be used as a basis for evaluating the popularity of the mining tool, by calculating the geodesic distance d(i,j) which assesses the proximity of the path of a participant (i) to other participants (j) in the network to define its importance, the higher the value the higher the importance of the node in the network.

4.3.1 Analysis of Traditional Tools

Traditional means remain the basis of research in computational service design. Contact points (Cc = 0.367) and service blueprints (Cc = 0.308) can qualitatively assist designers in front-to-back planning and commercial placement of services, while user profiling (Cc = 0.308) has a well-established system of integrated applications within the discipline of artificial intelligence and is therefore widely respected. In the 2013 Tsinghua International Design Management Conference, Zhang Chongqi [9] and other scholars proposed research in the field of recommendation systems based on social network models, arguing that user profiles can effectively provide engineers with a rational basis for construction in an era of information overload, becoming the core of data summarisation and summation on top of massive social interaction information, and that users' personalized needs are precisely met, and are therefore more likely to be the user's personalized needs are precisely met and therefore more likely to be used in the context of digital design needs. Other traditional service design tools such as shadow-following, interviews and the card method do not appear in the keyword network, reflecting a degree of obsolescence of these tools.

4.3.2 Analysis of Emerging Tools

Emerging service design tools are also beginning to make their mark. Emerging tools occupy a high frequency and a central position in the computational field as a research

Table 1. The emerging convergence of "computational service design tools" in the literature network

No.	Emerging service design tools	Closeness Centrality	Key words	The starting point of the discipline
1	KANO Model	0.308/0.262	KANO/KANO Model	Management Science and Engineering
Adaptation of theories and tools	The KANO model algorithm classifies and prioritises user requirements and builds a quality model to identify user requirement elements			
Related studies	1. Service design of wearable smart products for the elderly based on Kano model 2. Design of service facilities attached to Wuhan BRT platform based on KANO model			
2	ECT/Technology Acceptance Model	0.299/0.286	User stickiness/expectations/continued use	Information systems
Adaptation of theories and tools	Both models are used to assess user loyalty to the product and to build sustainable marketing through improved service			
Related studies	1. Hot Topics Analysis of Technology Acceptance Theory Research from a Service Design Perspective 2. Research on the impact of user perceptions and emotions on the continued use of self-health management services			
3	PCN Process Chain Network	0.278/0.276	PCN/PCN Analysis	Management Science and Engineering
Adaptation of theories and tools	By reorganising service elements iterative service models achieve maximum value optimisation of design outputs			
Related studies	1. PCN analysis to build a model of high speed rail internet ordering service 2. Using PCN analysis to build a model of the demand for medical care for the elderly in their homes			
4	FAHP/AHP Hierarchical Analysis	0.246/0.277	Fuzzy Hierarchical Analysis/Hierarchical Analysis	Operations Research
Adaptation of theories and tools	1. Facilitates the solution of multi-objective decision making problems by ranking the order of merit of decisions based on weights			

(*continued*)

driver, as in As shown in Table 1, the KANO model (Cc = 0.308) has the highest proximity centrality in the network, as is a professional user personalized demand acquisition

Table 1. (*continued*)

No.	Emerging service design tools	Closeness Centrality	Key words	The starting point of the discipline
Related studies	1. Research on the design of smart kitchen catering service based on hierarchical analysis for elderly users 2. Research on the evaluation model of chauffeur service experience based on hierarchical analysis			
5	Quality House	0.276/0.232	HOQ/QFD	Management Science and Engineering
Adaptation of theories and tools	A graphical approach that makes it easy to explore the relevance of product features to user needs			
Related studies	1. Customer demand-driven product service system solution design techniques 2. Service design process optimization based on multi-method integration			

method, is widely used in the field of large scale engineering service construction, laying the foundation for demand transformation for later internet products and building a scientific service model. Yang Ling [10] used the KANO model based on the combination of questionnaire method to collect information, and came up with the natural interaction needs to be satisfied by additional user habits, equipment active perception, and multi-interface interaction experience. Lu Weihua [11] created a 'multimodal user experience assessment model' based on experimental eye movement, heart rate variability and behavioural data combined with hierarchical analysis (Max Cc = 0.277) to locate design contact priorities in the civil aviation engineering check-in experience, addressing the uncertainty and ambiguity of traditional subjective design. Therefore, 'computational service design' can provide more objective content for traditional service design by breaking the boundaries of industries and organizations and incorporating new tools as time and technology allow.

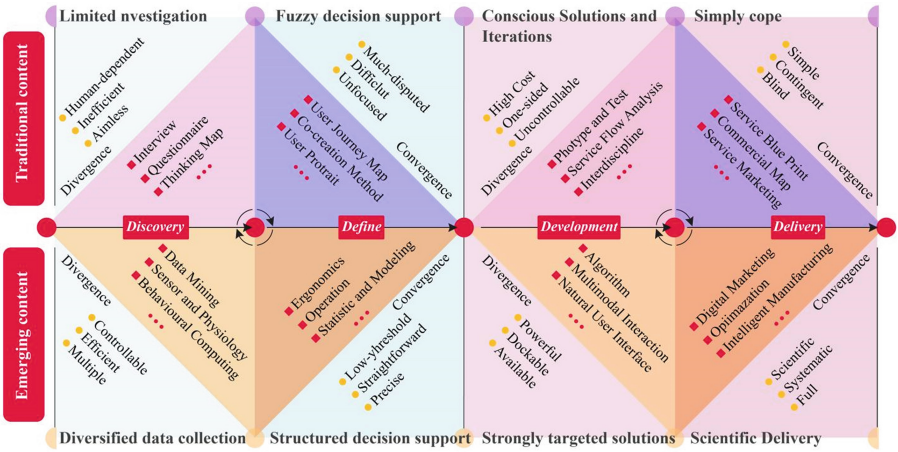

Fig. 3. The contribution of computational service design from the perspective of double diamond

5 Summary and Outlook

5.1 The Fit Between Technology and Method

Based on the traditional service design double diamond diagram framework, the author has sorted out and summarized the framework of computational service design after literature analysis, as shown in Fig. 3. In the Define stage, it can also combine knowledge of human factors engineering, psychology and sociology to achieve accurate evaluation of solution decisions, and in the Develop and Deliver stages, it can guide designers to use AI and data science techniques, physical interaction and devices, intelligent manufacturing and production technologies to complete the solution. For example, excellent service design research abroad: Balderas, A. [12] et al. crawled through a large amount of review data left by users on the use of social media for Michelin-starred cuisine, containing: representative customer consumption evaluations, using natural language processing technology as a means of feature engineering, frequency, and statistical text of multiple sentiment analysis, and unearthed the factors that generate service pain points. So that subsequent restaurants can use these quantitatively generated Hajj opinions to make objective design innovations, build more accurate human interaction solutions and improve service satisfaction. Computational Service Design is therefore a way to integrate multiple new technologies into traditional methods to provide design researchers with objective innovation methods, decision criteria and solutions.

5.2 A Change in Education and Research

The 'computational' approach will become a new momentum for the continued construction of service design theory. Teaching and research workers can take each aspect of service design as an entry point, adhere to the global concept and continue to build innovative models of 'computational' service design, while focusing on the various subdisciplines of service design. In terms of teaching, many universities have introduced the

'new engineering' education concept into their design education programmes in recent years. Many universities with strong design disciplines have introduced a large number of talents from engineering backgrounds and focused on developing interdisciplinary thinking in their curricula. For example, the School of Creativity and Design at Tongji University has introduced a specialization in artificial intelligence and data design. The School of System Design and Intelligent Manufacturing of the South University of Science and Technology has introduced a large number of courses on interdisciplinary knowledge integration in its industrial design programme, such as machine learning system design, system design and optimization processes, and computational design. In terms of research, many outstanding researchers continue to focus on cutting-edge technological breakthroughs. For example, Hu, Y. [13] explored the relationship between the design process and neural data based on non-invasive EEG monitoring techniques and concluded that designers are most likely to produce highly original solutions when the overall EEG state remains low frequency. Data from the evaluation of theta and alpha wave oscillations allows the designer's expected work outcomes to be evaluated. It also includes a range of new areas of research around intentional productivity tools, brain-computer interaction and cognitive computing. Thus, as universities continue to practice, the integration of service design theory and emerging technologies will become more rigorous and feed into a new design education system.

5.3 The Integration of Practice and Business

For the business community, 'computational' will become the new dynamic for service design solutions to be implemented. Service design differs from the 'linear' concept of lean innovation, and is more akin to the 'net' collaborative approach of agile development, involving the business of various stakeholders, with new technologies replacing manual involvement in repetitive tasks. The team of Tzeentch's founder, Fan Ling [14], has pushed the issue of machine creation from the theoretical to the applied level. In the DAM marketing project, the team used AI technology to build a 'digital intelligence' content production system, which was a major breakthrough in replacing single jobs with teamwork. At the same time, Wang Wenyi [15] also initiated a real-time digital marketing visualization system, arguing that a diverse range of data modelling and analysis methods can simplify and efficiently analyse processes and improve efficiency for corporate marketing departments. This achieves a seamless integration of new technologies with various aspects of product innovation, team collaboration and operational models, expanding the possibilities of business innovation.

6 Conclusion

The definition and refinement of 'computational' service design has been a gap in the design field, and the authors use knowledge engineering approaches to measurement, computation and visualisation to explain the research gaps in computational service design. In doing so, an analysis of research hotspots, topics and tools is achieved and a process framework for 'computational' service design is defined. The authors complete an analysis of research highlights and trends in the field and provide an outlook on future developments in academia and industry.

This study is not perfect because the author only take the domestic literature as the perspective, and authors hope to contribute to the field of 'computational service design' with more perfect analysis methods and tools in the next research.

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Honglin Zhu, the corresponding author, Female, Faculty in Guangdong University of Finance and Economics, Mobile: +86 13829711308, QQ: 331334377, E-mail: zhuhonglin@gdufe.edu.cn.

Authors' Contributions. In this study, the first author and corresponding author selected topics and discussed topics together. However, the first author is responsible for writing the full text, including literature review, data collection, data analysis, speculation and discussion. The next two are responsible for revising and submitting the article together.

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