Journal of Ecohumanism
2024
Volume: 3, No: 4, pp. 3075 – 3089
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i4.3827

Cognitive Modelling of Service Design Team Based on Genetic Algorithms

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Abstract

Currently, the development of the world economy plays a prominent role in the service industry. Modeling the service industry is an important issue that focuses on the service sector. Therefore, this study created a cognitive model for a service design team and how to build a team based on it. These models and methods aim to promote and realize commercial and social value innovations in service design. However, this study sets two objectives by focusing on the process and analysis as follows: (1) studying the process of cognitive mechanisms for service design and (2) analyzing and designing a model for the establishment of a service design team. This method defines the main focus of the service design team management study using genetic algorithms that search based on the probability of motivation. The process involves designing and creating a cognitive model for services using genetic algorithms. The results show a team management model designed using cognitive mechanisms. These models and methodologies promote the realization of innovative commercial and social value in service design, resulting in satisfactory and reliable results.

Keywords: *Service Design, Cognitive Mechanism, Team Management, Genetic Algorithms, Innovative Commercial.*

Introduction

In recent years, the evolution of the global economy has highlighted the prominent role of the service industry. The economy has shifted from a focus on manufacturing to a focus on the service sector. Changing competition in the market by focusing on products and services. Business models are increasingly emphasizing service-oriented logic. However, economically developed countries such as Europe, the United States, and Canada all contribute to the growth of the service industry and gross domestic product (GDP). Their proportion ranged from 70% to 80% (Fig. 1).

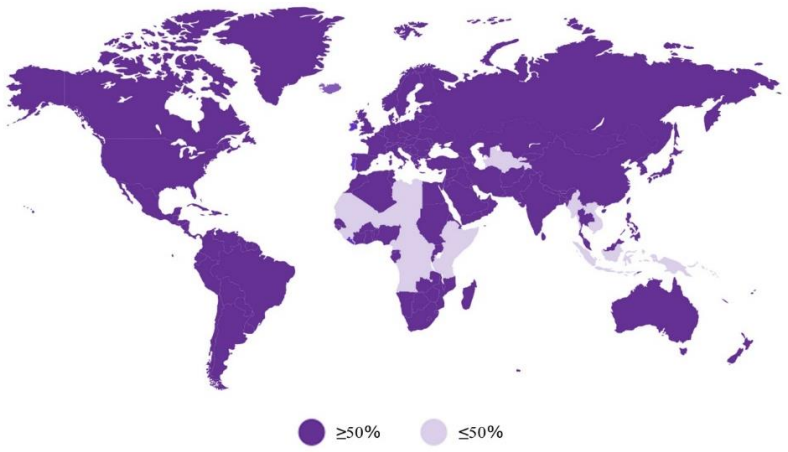

Fig. 1. The Proportion of GDP Contributed by The Global Service Industry

However, the theoretical foundations and principles of design sociology, economics, informatics, and other disciplines (丁满, 程语, 黄晓光, & 赵菱颖., 2020) are also important. Service design can be integrated into many other fields. This shows the trend of being more open and creative. Fig. 2 shows that the quality of service design is closely related to the management of the service design team.

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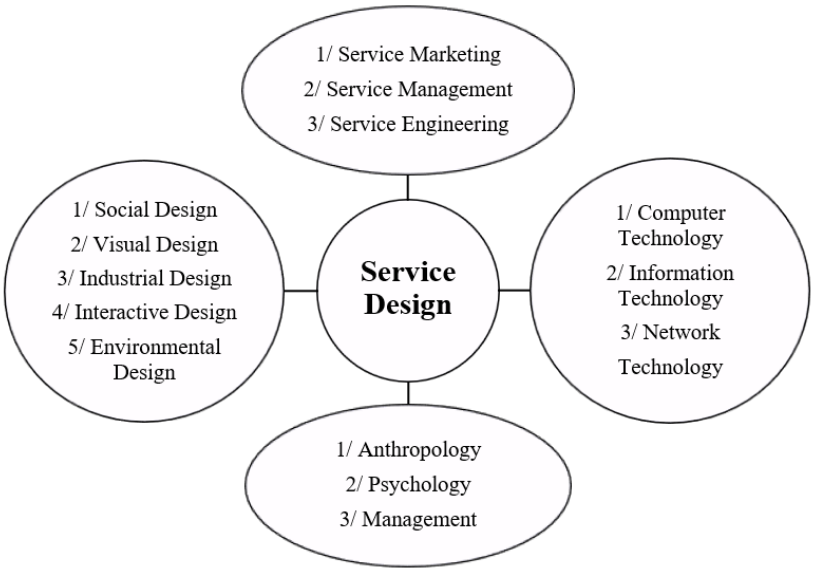

Fig. 2. Subject Areas Integrated with Service Design

Similarly, academic research on design cognition has focused primarily on product design. This reveals a clear gap between cognitive analysis and service design mechanisms. This gap limits the ability to develop and improve the methodologies and tools used to enhance the innovation capabilities of service design teams. Therefore, the representation of cognitive dynamics in a design team is the most important method and channel for academic research in service design.

Based on the problems described above, this paper proposes a systematic study of the theory and management methods of creative city service design teams within the scope of design cognition. This approach explored the innate style of design cognition within a service design team. It creates a theoretical framework and principles for managing a service design team, with the aim of developing a theoretical research system refinement in service design. This study provides necessary theoretical support and methodological foundations for related studies. The result is to realize the innovation of business value and social value in the field of service design.

Similarly, it also raises the practical requirements for the management of creative city service design teams. This research was conducted on the service design team from the perspective of design cognition. To create a team management method, design services must be based on cognitive mechanisms. This service design process encompasses various steps, including the design of the service concept, implementation, implementation of the operation, and feedback on the service. This article focuses on investigating the management of service design teams using genetic algorithms, which focus on the service concept design process. However, this stage results in effective communication and thorough discussions with the service design team to create a value system that is accepted by stakeholders. This ensures that the design of the developed service concept aligns with the values of various stakeholders. In the next section, the literature review, research methods, research results, and conclusions are explained.

Literature Review

This topic presents a review of the literature related to the cognitive modelling of a service design team based on genetic algorithms, with the following details:

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Service Design

The concept of service design has a history of more than 33 years. The term service design first appeared in the book Design Management by Bill Holins and his wife in 1999. In the same year, Dr. Michael Erlhoff, a German design expert and professor at the Cologne International School of Design, first proposed the concept of service design and introduced it to the university's curriculum. Since then, service design has become a multidisciplinary research course in which many fields have applied this concept, such as service economics, service marketing, service management, service engineering, and service science. However, the definition of services used in different disciplines remains unclear, and no conclusions have been reached.

Emphasis on the systematic nature of service design. In 2007, Staffer defined the concept of service design as a form of system theory similar to system design. It focuses on the holistic systems used in processes or workflows (Saffer, 2010). In 2008, Bedford and Lee viewed service design as the design of a system or process that represents the concept of service for users (Bedford et al., 2008). The interaction research laboratory has integrated tangible and intangible media to plan system and process designs, which will provide customers with a complete and meticulous service experience (Stickdorn, M., & Schneider, J, (2012). The distinctive logic of the service serves as a pillar of the service design. It presents a framework for understanding service system (Wetter-Edman K, Sangiorgi D, et al., 2014). The service system configures actors and resources that interact with other service systems to create shared value (Costa N, Patrico L, et al., 2018). Service design is a system that includes various influencing factors. Therefore, a holistic perspective is required to consider the needs of different actors within the system. Kim (2018) suggested that designers could use service blueprints to organize roles, amenities, and props to support customer actions and create memorable experiences through instant service (Kim, 2018).

Discussion of the Content Object of Service Design. In 2000, Clark et al. strengthened the overall service design process, including service delivery, experience, outcomes, and value (Baun Schulz W al., 1990). The specific content of the service design includes not only server facilities and other products but also service systems, service rules, service processes, and service policies (Chen Jia-jia., 2016). Service design aims to innovate or improve the overall service experience by exploring customer activities in order to identify, coordinate, and provide opportunities for new service processes and interfaces. It seeks to connect organizations and customers in new ways (Secomandi et al., 2011). This has led to efforts to connect organizations and customers in a new way (Moriz, 2005). Service design focuses on designing various touchpoints that can drive the experience throughout the adoption process, helping businesses improve their work environment, workflows, and tools to convey brand value to consumers through services (Clatworthy, 2011). In 2015, Wang Guosheng designed a coordination service using three factors: the area where the service occurred, scope related to motivation, human behavior, and scene (Wang Guo-Shen, 2013). In 2016, Dai Fuping and Xin Xiangyang explained that phenomenological theory defines service design as the design of business processes that affect service providers, customers, customer assets, or data. The goal is to achieve customer interest according to the service provider's work objectives (Dai Fuping and Xin Xiang-yang, 2016). In 2011, Secomandi F and Snelders D published The Object of Service Design in Design Issues. It analyzes research on the relationship between service organizations and customers in various disciplines such as touchpoints (Secomandi F, Snelders al., 2011). Similarly, it can be concluded that the purpose of the service design is to state that the service interface creates an exchange relationship between the service provider and customer. Service design considers service quality as a prerequisite, especially focusing on the service interface and user experience, pursuit of service quality, and core values (Mager, 2009)(Yu E, Sangiorgi D., 2014).

Service design emphasizes participation, collaboration, and collaboration among stakeholders (Holmlid et al. 2007)(Holmlid 2009). The development of new services through a people-centric engagement approach has expanded from a focus on service interfaces to service systems at the enterprise level (Yu et al., 2014). The process of repetition can be used to analyze and coordinate interactions between different types of social elements (Holmlid et al., 2008) (Kimbell, 2011).

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In 2018, Carvalho L and Goodyear P proposed an activity-centric analytical and design approach for participatory service innovation derived from research in education. Baek JS, Ezio Manzini, et al. propose a collaborative community framework for social and technical systems to support collaborative service innovation (Grenha T J, et al., 2017) In the context of community-driven social innovation. The goal of service design is to think and implement valuable propositions from new people-centric services. This is based on an understanding of the user experience (Costa et al., 2018) (Meroni et al., 2011).

Service design focuses on an interdisciplinary nature, which is a multidisciplinary field of practice and research (Carvalho et al., 2018). It integrates skills and methodologies, ranging from design, management, and process engineering to application. The practical outcome of service design is to provide comprehensive services to customers through system and process design. Design practices have expanded to include social administration and innovation, which are interdisciplinary research directions (Stikdorn M et al., 2011)(; Fisk R P., 2013). This interdisciplinary research will cover portfolio design, interaction design, service marketing, etc.. Service design is often based on the various strengths that users collectively know to create a strategic approach, system, and process. These processes are multidisciplinary and can be designed and are continuous and repeatable.

Cognitive Mechanism

This section describes the cognitive mechanisms involved in this process. The function of this cognitive mechanism is the cognitive component related to cognitive processes and outcomes, which are caused by the use of various cognitive elements (Chen et al., 2016). Similarly, cognitive mechanisms also use the estimation of one or more cognitive processes operated by an operator to achieve understanding and prediction.

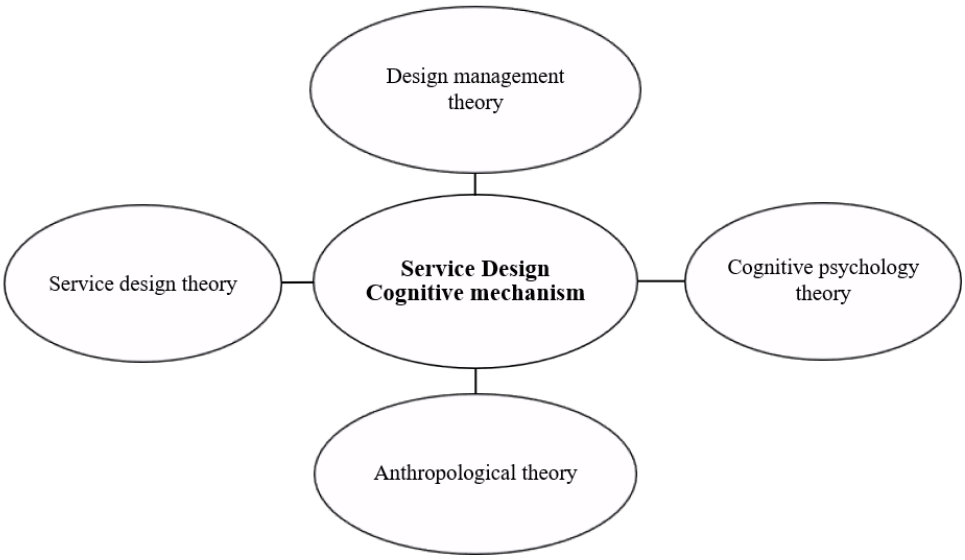

Fig. 3. Main Theories Related to Cognitive Mechanisms of Service Design

However, there are many types of recognition mechanisms, such as box and arrow diagrams, a set of equations, and software programs that interact with tools from the user to complete the task. When considered in terms of information processing, cognitive mechanisms can simulate human perception, reasoning, memory, and behavior. The perception mechanism in this service design process consists of two parts: the individual and team perception mechanisms. The cognitive mechanism of this service design is characterized by comprehensive innovation and needs to consider the interdisciplinary nature of service design. The main supporting theories are Service Design Theory, Design Management Theory, Cognitive Psychology Theory, and Anthropological Theory, as shown in Fig. 3.

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Team Management

Team management is essential in all the processes of any type of work. Describing a team usually understands the meaning of a team as a particular type of organization, or it may also explain that a team is a different type of group. To understand the organizational characteristics of a team, it is necessary to examine the concept of a group before creating a tummy. The groups are generally divided into two types: formal and informal. Informal groups often occur naturally among employees. To meet the needs of social interaction. Similarly, in organizations that lack a formal organizational structure, the specific goal of the organization will not be stable in the management of the organization. By contrast, formal groups, also known as task groups, are usually defined by organizational structures and have clear assignments. The behavior of individuals in a workgroup is guided and limited by the objectives of the organization. If an organization has members and working groups coming together, it will often help them achieve their goals. Likewise, these organizations often interact and share information to help each member fulfill their responsibilities better [30]. However, Stephen Robbins conducted in-depth research on the differences between teams and groups of work and believes in the differences between teams and groups in terms of pursuit of goals and the nature of collaboration. The patterns of taking responsibility for and using skills are clear, as shown in Fig. 4.

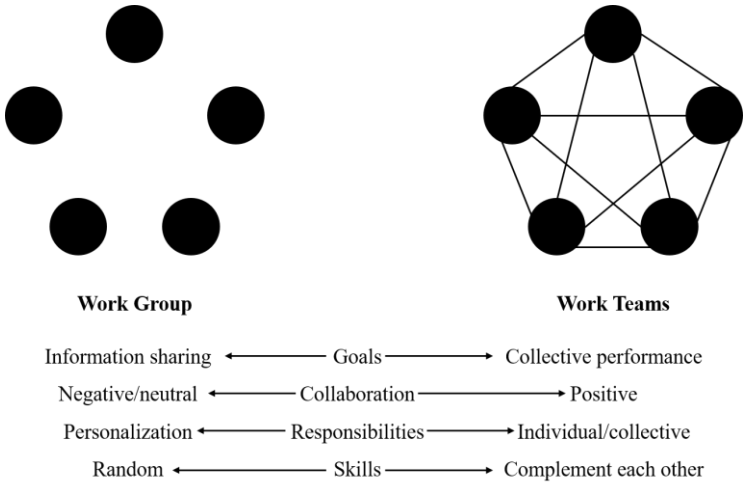

Fig. 4. Work Groups Vs Work Teams

Fig. 4 shows that the joint efforts of team members can create positive synergy, making team performance higher than the sum of each member's performance. Similarly, Katzenbach et al. emphasized that teamwork represents a set of values that encourages members to listen to each other. They actively respond to the opinions of others, support each other, and respect each other's interests and achievements. The team has a common goal: members work together for a common goal and are accountable to each other. The fundamental difference between a team and a working group lies in whether members have the goals and principles to work together. It is also based on creating a culture of shared responsibility, shared risk, and shared problem solving, which will continuously promote and improve effectiveness

Therefore, performance management is essential to improve team performance. Performance management is achieved using performance evaluation as the primary basis. Performance appraisals often involve evaluating goal achievement. The performance evaluation results are also associated with meaningful activities using these goals as benchmarks. On the other hand, performance management relies on this evaluation to receive feedback and adjustments. However, at present, performance management covers a wide scope, including the supervision and follow-up of organizational activities. Team performance

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management is a collaborative process between team managers and team members. It was founded on consensus about the team's goals and how to achieve them. This process involves constant communication and adjustments to improve individual performance. In this process, leaders must not only accurately evaluate the performance of their team members but also align the overall objectives of the team with their individual goals through an effective performance management approach. It is important to realize that evaluating both the overall performance of the team and the involvement of individuals is inevitable in team management. These evaluation results are often closely linked to the development of a team and its members. Performance appraisals provide external support for team growth and serve as the basis for rewarding or punishing individual work efforts.

Although necessary, managing team performance and evaluation remains challenging. This can significantly impact a team's operations and development. However, performance management and scientific evaluation often increase performance. Performance management is also a tool for improving motivation and coaching functions to promote team productivity and organizational performance. However, poor management can have a negative impact, severely affecting the growth of the team and its members.

Research Methods

Cognitive modeling of a service design team based on this genetic algorithm focuses on the process of creating a service design solution. The service design process is divided into four stages: exploration, formulation, concept generation, and evaluation. As shown in Fig. 5.

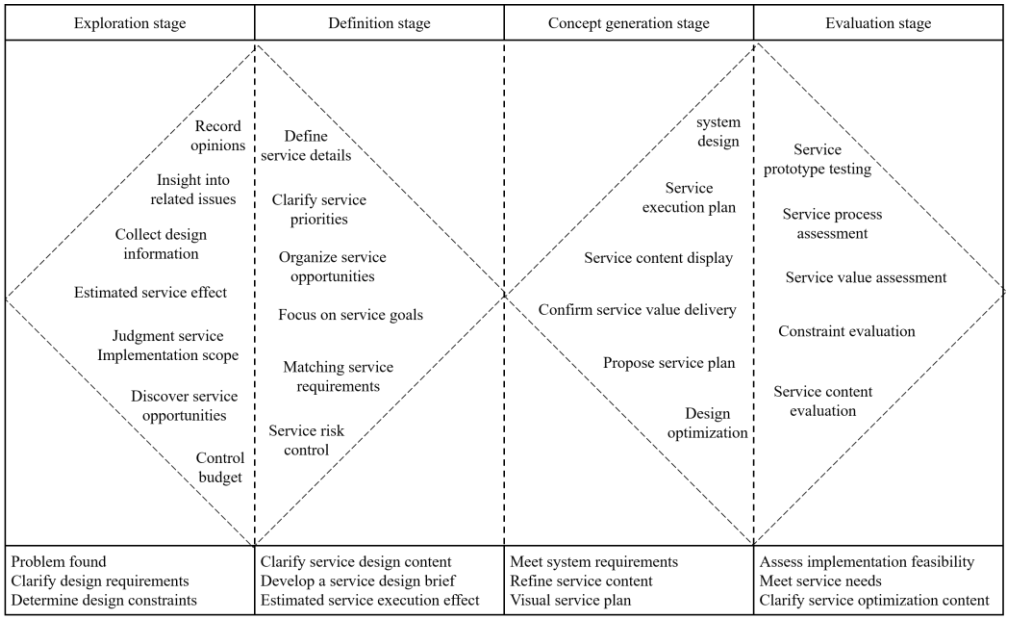

Fig. 5. Main Theories Involved in Cognitive Mechanism of Service Design

Service Design Cognitive Process

Exploration stage: The service design process is an exploratory process in which a service designer gathers various data and insights related to a project or research. Document with own overview and perspective and organize new findings to identify opportunities. These opportunities may arise from new social perspectives, emerging technologies, or new services provided by competitors (Katz 2021). These views are not necessarily true, and it is not necessary that having more service designers gathered during the survey process results in better opportunities. User engagement at this stage does not guarantee the discovery of future user approval opportunities. Normally, if there are many intellectual differences between individuals, reaching consensus is even more difficult. This leads to a less clear positioning of listed opportunities. At

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this stage, traditional design analysis tools are required to assess the value of an opportunity. In addition, service designers need to anticipate the scope and impact of service implementation.

Definition stage: This procedure usually involves analyzing the results of the survey procedure to determine the services that can be provided and their details. Service designers need to clarify the most important services for the main users to implement and the factors that affect the overall operation of the organization. The service designer organizes and evaluates opportunities, with a focus on aligning them with user needs, business interests, and commercial goals., as well as risk control and management in the later stages of design and implementation. Stakeholders are involved in this process to ensure that new opportunities meet their needs and desires.

Concept Generation stage: The main task of the concept generation phase is to design a solution. Service designers must turn the design brief into a visual service action plan or design with a suitable physical display. When designing the content of the relevant services, the entire system needs to be considered to meet the needs of the end user and stakeholders. Instead of focusing solely on a single point in contact design.

Evaluation Phase: The evaluation phase mainly involves evaluating the design proposal and proceeding with the next round of design iterations. Service designers need to balance the feasibility of stakeholder needs with the ability to implement, design, and customize services or service systems. Additionally, the evaluation process requires the establishment of an effective feedback mechanism to provide stakeholders with a communication channel. This ensures that services are continuously reproduced to meet the changing needs of the stakeholders.

Service Design Cognitive Process Model

The design of services and cognitive process model comprise the majority of the cognitive mechanisms of design that describe the process of repetition of cognitive activity. Iteration is the most common feature of a design process (Gibson et al.,2002). The iterations of the design process can be divided into two main types: design iteration and design intellectual activity iteration. Design iteration refers to designers incorporating new data and repeating a completed design. In the field of service design, the iteration of design work mainly occurs because of failure to achieve the expected service value during service (Katzenbach, 1999). Repetition of cognitive activity in design refers to the repetitive cognitive activity that the service designer engages in solving a design problem. The focus is on the transition from the job level to the cognitive level of design thinking. This is the type of design iteration on which this study focuses.

The evolution and changes between data processing and decision-making activities form the foundation of cognitive process modeling (Adams, 2001). The design process in this study is related to the intellectual activity of design and its role in the service design process. The service design process is important in creating the cognitive mechanism of the service design process. The cognitive process model applied to service design comprises two main design cycles: data processing and solution presentation. The data processing cycle is mainly concerned with finding and filtering data, and scoping design problems. The solution presentation cycle focused on explaining the design solution and adjusting the scope of the design problem during the evaluation process. Under the influence of the self-monitoring cycle, the change in design intellectual activity iteratively promotes refinement of the design solution, gradually approaching the design objectives, as shown in Fig. 6.

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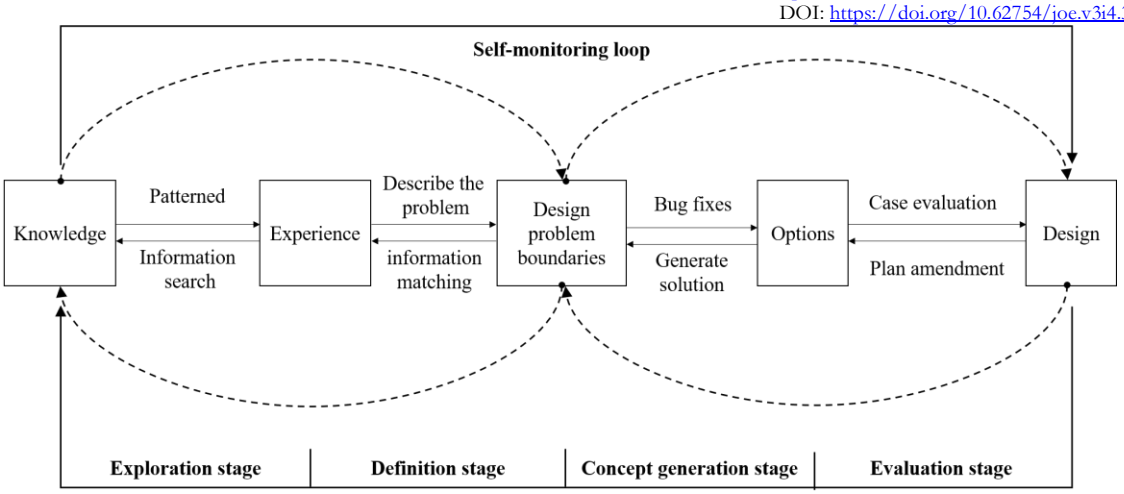

Fig. 6 Service Design Cognitive Process Model

Service Design Team Formation

The final performance of most teams (60 percent) is determined by the quality of the initial organizational work, which mainly includes the composition of the team (Amabile, 1983). Team member optimization is an important way for management teams to improve team quality and performance based on the creative component theory of contemporary American creative professionals. However, the creativity of the design team is often influenced by factors (Reiter-Palmon R, Leone S., 2019) such as the motivation orientation of the team members, the level of knowledge, and the ability to innovate, the modeling of the elements of creativity in the service design team can be shown as Fig. 7. Therefore, this study proposes the establishment of a service design team based on a motivational orientation.

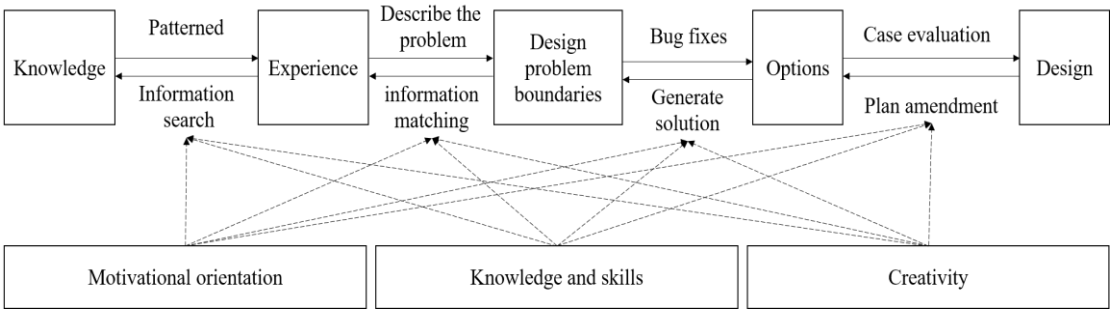

Fig. 7. Service Design Teams Creativity Components Model

Motivational Orientation Measurement Method

This Motivational Orientation Measurement method often uses the WorkPreference Inventory (WPI) to assess the motivational orientation of service design team members [34]. This is divided into two parts: internal motivation (IM) and external motivation (EM). The sub-indicators of true motivation included enjoyment motivation (IM-E) and challenge motivation (IM-Ch). The sub-indicators of extrinsic motivation include relational motivation (EM-O) and compensatory motivation. (EM-C). The questionnaire used to assess the orientation and motivation of the service design team members used a 5-point rating scale. where 1 means "strongly disagree" and 5 means "strongly agree." Similarly, from Internal Motivation (IM) and External Motivation (EM), there are sub-indicators, as shown in Table 1.

Table 1. The Structure of The WPI Work Orientation Scale

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Index	Sub-Indicators	Questions Number
IM	IM-E	8
	IM-Ch	7
EM	EM-O	10
	EM-C	5

Team Member Selection Method

The team member selection methodology from this study summarizes the problem into an internationally applicable multipurpose optimization model. Members were selected from a number of applicants with a variety of objectives (Achakul et al., 2013), each of which aimed to build a team to achieve maximum performance. However, this study used genetic algorithms to solve a widely used multipurpose problem (Marler Arora J al., 2004). This genetic algorithm can select the most suitable solution from the candidate population. This makes it particularly useful for solving multipurpose problems, as illustrated in Fig. 8.

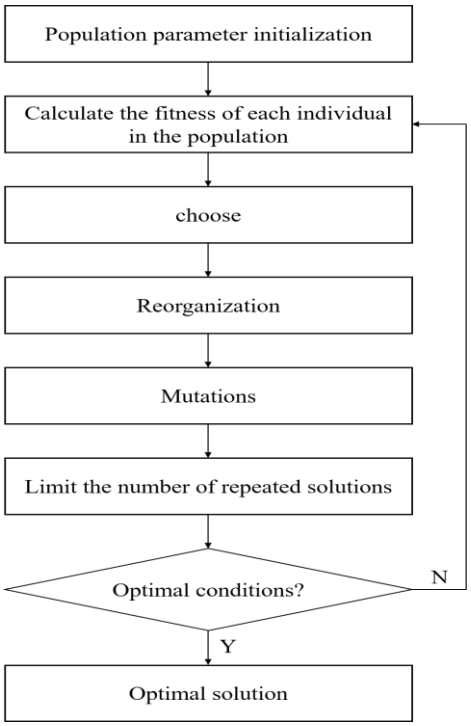

Fig. 8. Genetic Algorithm Operation Process

WPI Data Collection

The WPI data collection to examine the effectiveness of this study's algorithm focuses on the scope of urban tourism services. This study used an experimental method centered on an innovative urban tourism service design platform. After analyzing the service design project, experts in this field determine that the team should consist of four service designers out of all the service designers. Applicants to be considered as potential members for the trial and participate in the WPI-based motivation orientation test are 26 people.

WPI Data Analysis

The experimental algorithm used in this study employs a set of genetic algorithm tools developed by the University of Sheffield. This experiment excluded the correlation coefficient between designers and

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assumed that there were four service designers in the team. Thus, there were a total of 26 participants in the experiment.

Result of Research

The findings of the cognitive Modelling of the service design team based on Genetic Algorithms can be described as follows. Based on the experiment, a genetic algorithm was used to determine the best function that a member chose based on the number of members. To find the most appropriate answer for the best function value, sorted by the coefficient that gives the best result, the results are displayed in Table 2.

Table 2. Alternative Service Designer WPI data

Member	EM	1M	Member	EM	1M
D_1	2.7	3.2	D_{14}	3.0	3.4
D_2	3.1	3.4	D_{15}	3.1	2.9
D_3	3.3	2.9	D_{16}	3.1	2.8
D_4	2.4	2.8	D_{17}	2.6	3.1
D_5	3.0	3.1	D_{18}	2.4	2.8
D_6	2.5	3.3	D_{19}	3.0	3.4
D_7	3.3	2.8	D_{20}	3.1	2.9
D_8	3.2	3.3	D_{21}	2.2	2.8
D_9	3.2	3.5	D_{22}	2.4	3.3
D_{10}	2.6	3.3	D_{23}	2.6	2.8
D_{11}	2.3	3.2	D_{24}	3.1	2.9
D_{12}	2.1	3	D_{25}	3.2	3.4
D_{13}	2.9	3.1	D_{26}	2.4	3.2

From Table 2, after conducting a statistical analysis of the WPI data, the overall average IM score for the 26 service designers was 3.1., which was slightly higher than the overall average EM score of 2.8. This shows that these candidate designers demonstrated a strong subjective willingness to participate in the design process. However, to set the weights of IM and EM, we use the same, that is, $T= (0.5,0.5)^T$. Similarly, using genetic algorithm tools, the default values were found to be in the optimal direction of the flow. Therefore, the highest answer was converted to the lowest and had a coefficient of 1. However, in general, the standard range is normalized to–0-1. Information on the WPI motivation orientation of the 26 service designers is presented in Table 2. The results are presented in Fig. 9 and Table 3.

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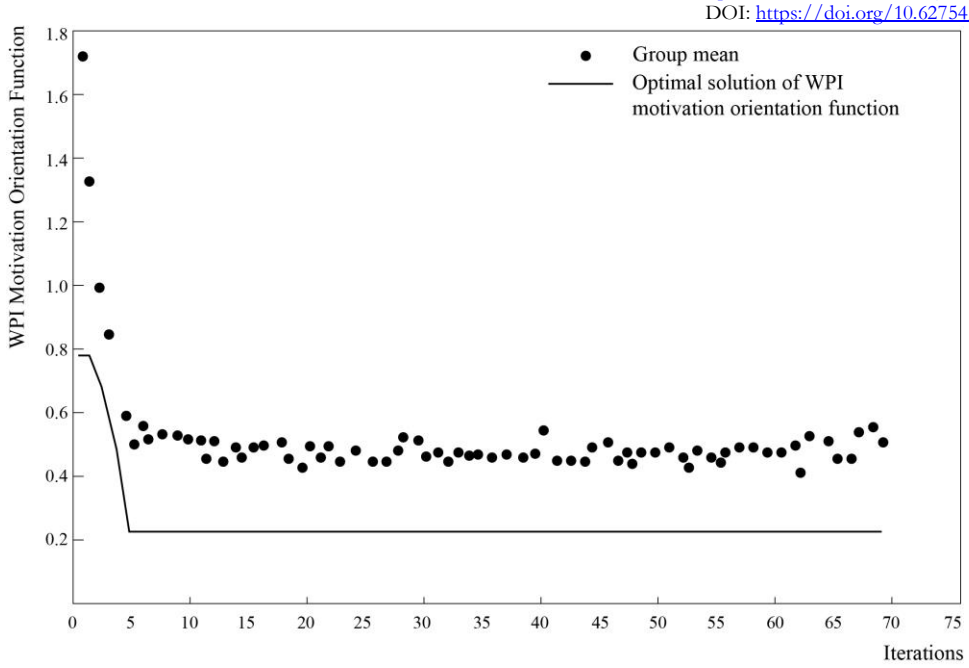

Fig. 9. Wpi Motivation-Oriented Genetic Algorithm Solution

Table 3. Comprehensive Solution of WPI Motivation Orientation

Member	Result	Member	Result	Team results
D_1	0	D_{14}	0	
D_2	1	D_{15}	0	
D_3	0	D_{16}	0	
D_4	0	D_{17}	0	
D_5	0	D_{18}	0	
D_6	0	D_{19}	0	P2
D_7	0	D_{20}	0	P8
D_8	1	D_{21}	0	P9
D_9	1	D_{22}	0	P25
D_{10}	0	D_{23}	0	
D_{11}	0	D_{24}	0	
D_{12}	0	D_{25}	1	
D_{13}	0	D_{26}	0	

Similarly, from Fig. 9, it was also found that genetic algorithms can identify the most suitable solution globally in just five iterations. This demonstrates the effectiveness of the recombination and mutation algorithms. In addition, the stable convergence of population averages suggests that genetic algorithms are not only search for the most suitable solutions. However, we also explored other solutions that were closest to it. Genetic algorithms are probability-based search algorithms that can generate local jitter results. However, from Table 3, when considering the motivational orientation data of the 26 service designers

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who participated in the D_2, D_8, D_9, and D_{25} experiments, it was also found that service design was the best solution.

Based on the statistical analysis described above, experiments were conducted to investigate the scientific nature of the method of using genetic algorithms to create the proposed design team. This experimental method uses comparative conditions between the established and traditional designs. The design abilities of the participating designers are maintained at the same level. Before the experiment, the two experimental teams were given a detailed background introduction to the project and provided detailed information about the project. The experimental and control groups were classified by the arrangement of the relevant design elements of the scenic spot service platform in the urban tourism project. From the experiment, it was found that the established experimental and traditional groups could produce design elements at different levels, as shown in Fig. 10 and 11.

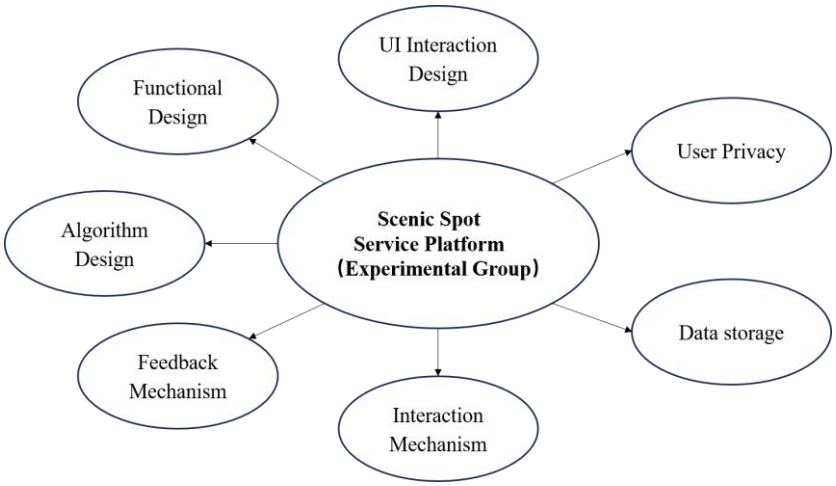

Fig. 10. Experimental Group Design Elements

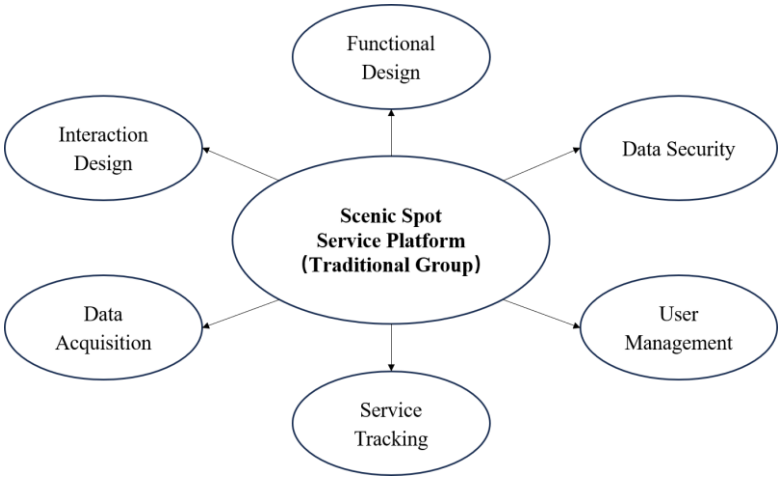

Fig. 11. Traditional Group Design Elements

Similarly, the design elements of the experimental and traditional groups are numbered, as shown in Table 4.

Table 4. Design Element Number

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Experimental group number	Design element	Traditional group number	Design element
01	UI Interaction Design	01	Functional Design
02	Functional Design	02	Interaction Design
03	Algorithm Design	03	Data Acquisition
04	Feedback Mechanism	04	Service Tracking
05	Interaction Mechanism	05	User Management
06	Data storage	06	Data Security
07	User Privacy	-	-

However, it was also found that it is possible to write both design elements using causal relationships and arrange views from designers and users to obtain a path-search network diagram, as shown in Fig. 12 and 14.

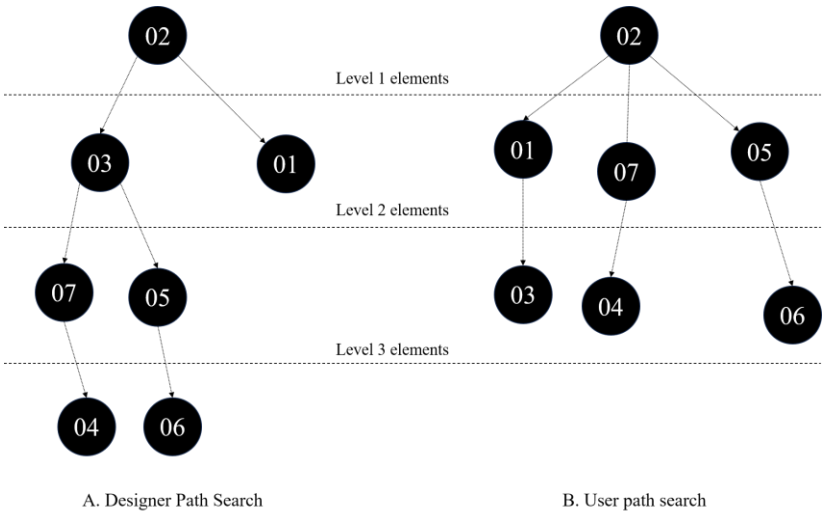
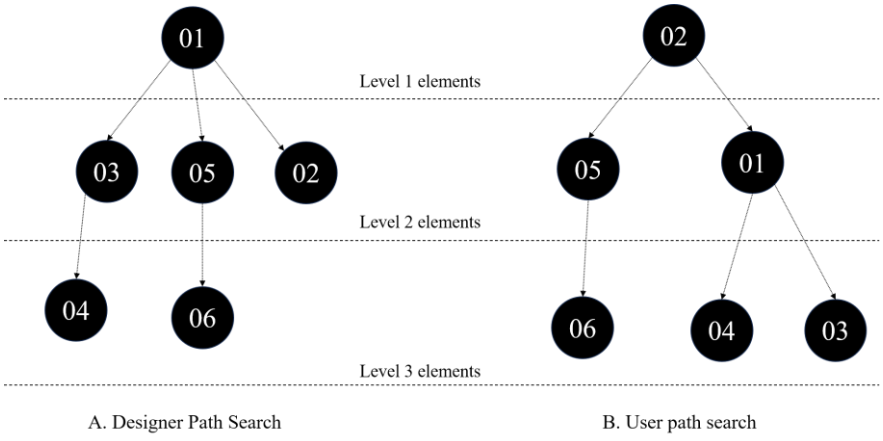


Fig. 12. Experimental group path search



Journal of Ecohumanism
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DOI: https://doi.org/10.62754/joe.v3i4.3827

Fig. 13. Traditional Group Path Search

Similarly, from designer A's path finding distance vector and the user path finding distance vector B of the experimental group and the traditional group described above. If the calculation was made using a statistical equation to find the global correlation coefficient of the designer and user pathfinder in the experimental group and the traditional group, it was found that the global correlation coefficient of the experimental group was 0.76, and the global correlation coefficient of the traditional group was 0.71. Similarly, the designer path search distance vector and the user path search distance vector of the experimental and traditional groups. The central correlation coefficient of the experimental group was better than that of the traditional group. This proves that the difference in the model between the outline designer and the experimental group was smaller. This shows that the design results of the experimental group were better than those of the traditional experimental group were. However, as a result of experiments investigating the scientific nature of the method using genetic algorithms, the results are significantly satisfactory and reliable.

Conclusion

In this study, the cognitive processes involved in team service design were analyzed based on cognitive mechanisms, leading to the development of a cognitive process model specifically for service design. This model serves as a valuable guide for managing service design teams. Drawing from the componential theory of creativity, this study introduces preliminary criteria for team formation using the Work Preference Inventory to assess motivational orientation. In addition, a genetic algorithm was proposed to address the challenge of selecting members for the initial stages of service design team formation. The structure of potential team members was thoroughly analyzed, allowing for the initial selection of a team that best meets the specific needs of the design project. Furthermore, experiments were conducted to validate the effectiveness, convergence, and stability of the proposed algorithm. By solving the model, optimal candidates for early stage team formation were identified, demonstrating the practical utility of the proposed approach.

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