iInteriorDesign: A Collaborative Service System Approach Towards Constructive Value Co-Creation

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ABSTRACT

There is an increasing demand toward an innovative knowledge-intensive service industry in global business. In particular, the soaring research area of service science, management, and engineering (SSME) emphasizes how people and technology can be effectively aligned to achieve value co-creation between service providers and customers through systematic service innovation. In order to address the problem of the systematic service innovation, this study proposes a machine-metaphor and adaption-metaphor approach to constructing collaborative service system (CSS) which can automate value co-creation experiences using facilitating (or assisting, mediating) the service operation management and improve service productivity and satisfaction. This machine-metaphor approach comprises two parts: simple service machine (SSM) and intelligent service machine (ISM), in which the notion of machines aims at significantly effectuates the productivity in the emergent service/experience economy. In this study, we develop a CSS application: *iInteriorDesign* that illustrates how a *CSS* application of innovative knowledge-intensive interior design service can be developed using SSM and ISM. Due to the requirements with massive communications to assure the customers' needs in the interior design service, *iInteriorDesign* use adaption-metaphor (co-evolutionary technology) to provide the effective decision support on the extraction of the significant interior-design attributes (e.g., romantic, luxurious, etc.) and the optimization of the interior-design concept style selection (e.g., victorian style, minimal & luxury etc.) with a concept style ontology (of the concept style properties like Region, Era, Category, Climate, and Culture) within the interior design services. *iInteriorDesign* provides a platform that the service participants joint efforts to determine the ideal concept styles of interior design to meet the customer's needs over Internet.

Further, the study adopts the Resource Dependence Theory (RDT) to evidence if the symbiotic interdependence relationship building can expedite the value co-creation. This study also proposes 'Symbiotic Service Model' based on the RDT to contribute the service innovation research.

Categories and Subject Descriptors

D.3.2 [Java]

General Terms

Algorithms, Management, Performance, Design

Keywords

RDT, Collaborative Service Systems, Value co-creation experiences, Systematic Service Innovation, Co-evolutionary Technology.

1. INTRODUCTION

The experience economy transforms traditional service transactions into experience-based transactions [13]. Prahalad and Ramaswamy (2004) propose that managers are concerned with co-creation experience quality, not just product and process quality [14]. Carbone (2004) indicated that experience innovation in relation to design enhances customer preferences and loyalty to create benefit [4]. Firms must measure and manage service delivery to assure experience quality [16]. Nevertheless, co-creation experience for service process refers to SSME research [5,10,16,17,19,21] and requires further exploration. This investigation recommends an approach to constructing a collaborative service system (CSS) that can automate service collaboration and be systematic value co-creation experiences.

Accordingly, we define the notion of CSS as a particular e-service that can facilitate the automation of value co-creation experiences between the service providers and customers and improve service productivity and satisfaction. This study shows how an approach to machine-metaphor (SSM and ISM) and adaption-metaphor (co-evolutionary technology) [22] are the facilitators of CSS implementation, including three procedures: (1) CSS identification, (2) CSS development, and (3) CSS verification.

However, interior design still lacks systematic design procedures using collaborative relationship. This study attempts to construct a CSS that allows decorators and customers to engage effective communication. Especially, the decorators often need the extensive communications with their customers to ascertain the real customers' needs and interior design styles, a service system that can provide the effective decision support on helping them to determine the design styles need to be addressed properly. Thus, this study has practically implemented a prototype system as an example of CSS: *iInteriorDesign* to address the problems of the automation of service collaboration and systematic value co-creation experiences.

With CSS approach, SSM offers a set of elements for analytic basis how IT can assist (co-)evolutionary coproduction relationship and the engaged service experiences between decorators and customers. ISM also can be viewed as a service system enabling systematic cognition process and knowledge representation of service exchanges required. In terms of *iInteriorDesign,* it exemplifies CSS in which users jointly endeavor to extract the style concepts of interior design (e.g. natural, artificial, light, vague *etc*.) using SSM and ISM, which comprise the four service modules: specification of design problems, design recommendations, cooperative interactive co-evolutionary genetic algorithm, and evaluation modules.

Moreover, this study adopts a single case study through 'Resource Dependence Theory (RDT)' [12] to verify the effects of CSS and further propose a deductive model. The deductive consequences of *iInteriorDesign* can test CSS in relation to the automation of value co-creation experiences between decorators and customers. According to the deductive implications of the RDT, the symbiotic interdependence relationship is able to satisfy the collaborative requirements and experience improvement within interior design service.

The paper is organized as follows. Section 2 introduces CSS approach. Section 3 present CSS development using SSM and ISM as well as illustrate how *iInteriorDesign* can be implemented. Section 4 explains CSS a case study. Sections 7 and 8 give the implications and conclusions.

2. CSS APPROACH

The CSS approach lists the machine-metaphor and adaption-metaphor methodology and procedures that can be streamlining the collaborative service processes: (1) CSS identification, (2) CSS development, and (3) CSS verification (see Figure 1)

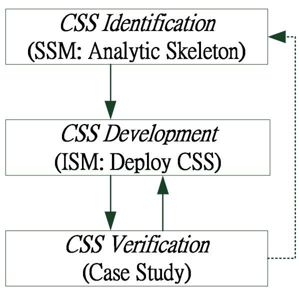

Figure 1. CSS Approach Procedures

2.1 CSS Identification: SSM as an Analytic Skeleton

With the machine-metaphor used, a service machine (i.e. service system) comprises some of service components (i.e. modules) that can shape the interactions of all relevant factors and actors, and influence the trajectory of technological and social systems. However, a Social-Technical Systems (STS) theory [3] can be taken for the study. STS is a well-known theory of information system development, which jointly independent parts to correlative interacting systems including complementary or interdependent STS [3]. Bijker (1995) notes that causal technical and social elements shape the interactions among relevant factors and actors and influence the trajectory of technological and social systems [1,2] The salient attribute elements of STS involve the goals, problem solving strategy, solution requirements, theories, tacit knowledge, and design methods.

A service system is also composed of the six elements (e.g. people, models, architectures and technologies) that together shape the interactions of all relevant factors, actors, and influence direction of technological and social outcomes (see

Table 1). Thus, the six elements of SSM can facilitate the early stage of analysis of collaborative service system design. In other words, SSM is to predefine the attribute elements of service system analysis to accomplish the goal of intelligent design of CSS.

Table 1. The Basic Definition of Simple Service Machine (SSM)

Attributes	CSS Tactic
Goal	Systematic service innovation enabling the automation of value co-creation experiences with high service productivity and customer satisfaction
Problem solving strategy	facilitated/mediated/assisted self-service and collaborative technologies
Solution requirement	High productivity and satisfaction, and minimum costs
Theories	Inter-disciplinary theories or methodologies
Tacit knowledge	Information, knowledge, and decisions of stakeholders
Design method	Design science (creating synthesized IT-artifact) [7,18]

First, the goal of SSM is to outline how a CSS can be implemented as the systematic service innovation and the automation of value co-creation experiences along with high service productivity and satisfaction. Second, the problem solving strategy can be a facilitated, mediated, or assisted collaborative technology. Third, the solution requirement seeks to minimize cost, maximize satisfaction, or both. Fourth, theory can be derived from different disciplines, for example, natural and social theories. Fifth, the service process involves a variety of tacit information, knowledge, and decisions of participants. Sixth, design methods can use style elements to create a synthesized artifact such as CSS.

2.2 CSS Example: *iInteriorDesign*

iInteriorDesign [6] can exemplify a CSS application that provides decorators and customers jointly endeavor to extract the design style and design concepts (e.g. natural, artificial, light, vague *etc.*) in the course of interior design service. *iInteriorDesign* shows how a specific CSS can be designed and developed for intelligent and collaborative interior design service. To define the SSM *iInteriorDesign* lists the tactic (Table 2)

Table 2. The SSM Definition of *iInteriorDesign*

Attribute	CSS Tactic
Goal	• Construct an innovative service system involving collaborative interior design with service productivity and satisfaction.
Problem solving strategy	• CSS is to facilitate collaborative intelligent interior design • Self-regulating control employing interactive co-evolution approaches to extract optimal solutions during the design. • *iInteriorDesign* includes the four service modules — design problem specification, design recommendation, cooperative interactive co-evolutionary GA, and evaluation — for optimizing the concepts associated with interior design style.
Solution requirement	• Extracting the style concepts of interior design by minimizing communication costs and maximizing satisfaction.
Theories	• Evolutionary theory : Co-evolutionary theory • Methods for modeling optimization : CICGA derived from both Cooperative Co-evolutionary GA and Interactive GA • System architecture (SOA, Ontology, knowledge base)
Tacit knowledge	• The design attributes, style, style concepts related to preliminary interior design
Design method	• A design science approach [7] to build artifacts for intelligent interior design service —*iInteriorDesign* [6]

(1) Goal

To provide a new collaborative interior design service and low communication costs, the automation of collaborative services can be used to support. Due to the service activity of interior design, the house styles involve the design-concepts and attributes, making it difficult to identify real customer needs, and even customers have no idea of designing style at the beginning. If knowledge-intensive collaborative e-services advance preliminary interior designs, the needs of collaborative intelligent interior design services can be satisfied.

(2) Problem Solving Strategy

The problem solving strategy of the collaborative interior design service is to construct CSS, enabling the self-regulating controls to determine the optimal evolution relationships. CSS provides an e-service that is capable of providing the customers jointly and collaboratively to get the optimal interactions and solutions as the preliminary interior designs results.

(3) Solution Requirements

Minimizing communication costs and maximizing satisfaction are the main requirements of collaborative interior design service. *iInteriorDesign* enables the decorators and customers efficiently identify the determinants of design style. Further, a self-regulating control can be used to create the mechanism for systematic service collaboration.

(4) Theories

It is easy to see that adopting the co-evolutionary theory can help to implement the value co-creation experiences of interior design services. Based on the strategy, requirement, tacit knowledge, and design method, the co-evolutionary theory is responsible for modeling the optimization problem within the collaborative service process of interior design. In the *iInteriorDesign*, integrating cooperative co-evolutionary GA (CCGA) and interactive GA (IGA) can be an optimization methodology that can extract the optimized the style elements when the decorators and customers use the services. However, the predefined ontology, knowledge base, and the specific service modules involved then would make a CSS (*iInteriorDesgn)* described later in ISM.

(5) Tacit Knowledge

The tacit knowledge generally depends on the type of service industry. However, the tacit knowledge of *iInteriorDesign* includes the universal category, for example, the design styles (i.e., styles) and the style concepts (i.e., concepts). The ten styles include Victorian, Minimal & Luxury, Neo-Classical, European Royalty, Mediterranean, Wild West, Minimalist, Post-Modern, Bali, and Chinese. These styles involve various descriptions of design concept (i.e. concepts) (natural, artificial, light, etc). The customers' ideas are classified by the four categories (vision, hearing, touch, and smell) The designer ideas are classified by the four additional categories (light, water, stone, and tree)

(6) Design Method

Design science research [7] attempts to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts, which perform research through establishing and evaluating artifacts to meet identified business needs. *iInteriorDeisgn* is an innovative IT-artifact namely prototypal service system, and it can be justified by the simulation experiments and case study.

3. CSS DEVELOPMENT: DEPLOY ISM

Intelligent service machine (ISM) is to automate the specific cognitive processes and knowledge representations (characterized by the predefined six attribute elements of SSM with STS aspects) ISM aims to advance systematic and quantitative methodologies for creating service systems with value co-creation for high service productivity and customer satisfaction. That is, an ISM can be treated as a CSS. The CSS can perform the systematic required service exchanges and operation with value co-creation experiences. By collaborative intelligent interior design service, the adaptive technologies enable a more successful deployment of new solutions and supports collaborative service.

3.1 CSS Example: *iInteriorDesign*

iInteriorDesign is an ISM that provides a new preliminary collaborative service of interior design according to a pre-designed SSM. This particular ISM involves how an interior designer's cognitive processes and knowledge representations are modeled properly to effectively facilitate the interactive service collaborations (i.e., reducing communication costs) with a customer to achieve for high service productivity and customer satisfaction.

The study utilizes an ontology-based co-evolution as a system framework to develop the systematic collaborative interior design service, which both designers and customers can cooperate to procure the change of co-evolution and mutual adaptation during the extraction process of style determination to meet the customer needs. The decorators first created a style knowledge base, after which the customers provides the style concepts based on the concept knowledge base for design problem specifications.

The idea of using an integrated cooperative interactive co-evolution GA (CICGA) is to perform the automation of value co-creation experiences. However, the Cooperative Co-evolutionary GA (CCGA) is a basis for the extraction process and the Interactive GA (IGA) is an evaluating customer feedback. Afterwards CICGA examines the extraction of optimal solutions via interactive co-evolution methodology and then provides their results to the co-evolutionary knowledge base. This work involves a defined ontology, knowledge base, and service components. Finally, the prerequisite of CSS is to estimate if the optimized results are achieved.

The ISM comprises the four service modules: design problem specification module, design recommendation module, cooperative interactive co-evolutionary GA module, and evaluation module (see Figure 2) The design problem specification and recommendation modules require initial design concept matrix. The cooperative interactive co-evolutionary GA module comprises the optimized design concept matrix. Finally, the evaluation module examines whether the results fit customer needs.

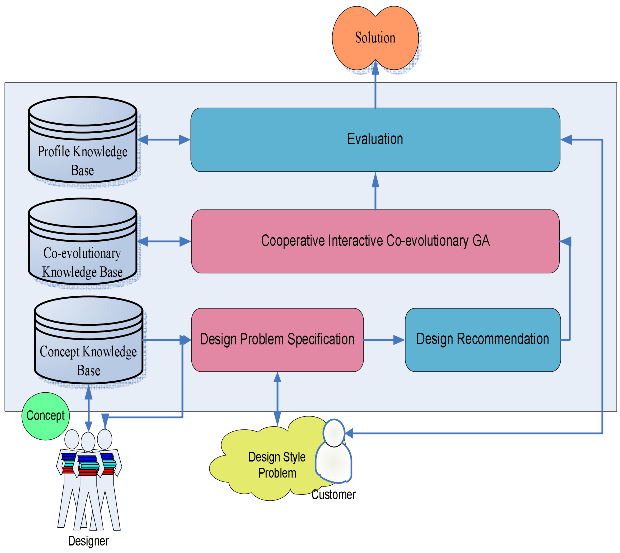

Figure 2. *iInteriorDesign* System Framework

3.1.1 Design Problem Specification Module

The module is responsible for classifying, selecting, and encoding a set of concepts into concept array according to the initial customer preferences (see Figure 3) The service system first provides a default concept array, and then the customers are able to determine the selected concepts according to their preferences. In a word, the initial preferences of customers can be first stored in the concept array of service system.

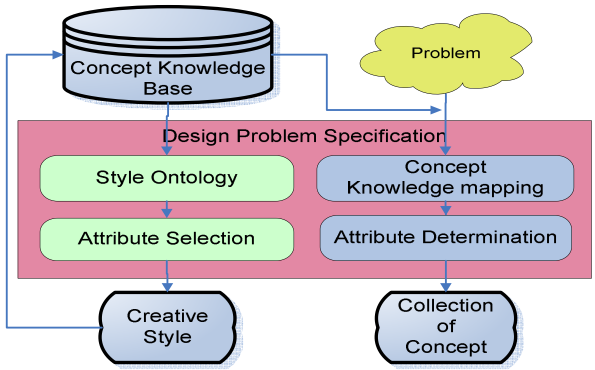

Figure 3. Design Problem Specification Module

The module can be divided into two procedures: (1) the decorators need to first create the style ontology (e.g., Victorian, Minimalist, and Luxurious etc.) and the selected attributes (e.g. Region, Era, Category, Climate, and Culture), and (2) the customers need to conduct the concept knowledge mapping and attribute determination (see

Figure 4) [6]

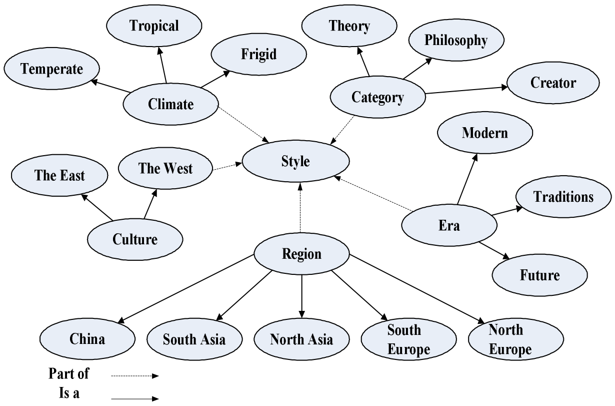

Figure 4. Style Ontology

The decorators need to identify the style attributes, for example, technical type with the two bipolar types and their corresponding weights of style attributes (e.g. technical with weight 0.3, delicate with weight 0.7). The service system can effectively integrate the various concepts. In order to conduct the concept knowledge mapping, there are two concept arrays for customers and decorators respectively. In terms of the concept arrays of customers, there are the four concept arrays: vision, hearing, touch, and smell. In term of the concept arrays of interior design, there are alternative four concept arrays: light, water, stone, and tree transformed by vision, hearing, touch, and smell respectively.

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3.1.2 Design Recommendation Module

When the design problem specification module is achieved, the concept arrays were stored in the concept knowledge base. The decorators can take into account and further offer their suggested attribute classifications and the corresponding weight suggestions based on the concept arrays, and then add the new concepts into the concept matrix (see Figure 5) Thus, a new concept matrix involving the decorators' ideas can be emerged.

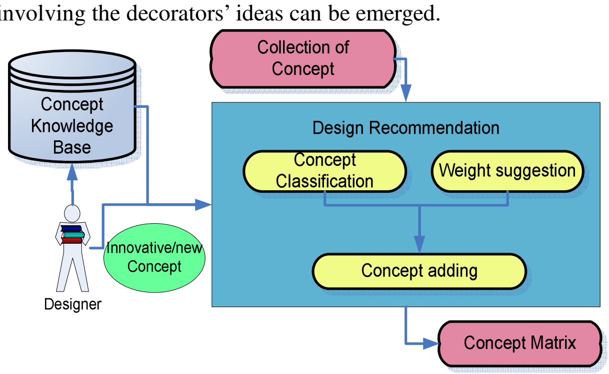

Figure 5. Design Recommendation Module

圖 1.1 A concept matrix includes at most 96 concepts to describe the styles. There are four subsets: light, water, stone, and tree in the concept matrix. Each subset has 24 concepts (see Table 3) that can be encoded in the concept matrix. Namely, the style concepts were determined by the 96 concepts with binary encoding and were stored in the concept knowledge base after the decorators recommend the concepts and associated weights. Each concept is represented by three-row strings starting with the subset number (1,2,3,…48), followed by the concepts denoted by number (1, 3, 5,… 93, 95) and those denoted by number (2, 4, 6,… 94, 96), as illustrated in the concept matrix (Table 3 and Figure 6), For example, $\begin{bmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 \\ 1 & 3 & 5 & 7 & 9 & 11 & 13 & 15 & 17 & 19 & 21 & 23 \\ 2 & 4 & 6 & 8 & 10 & 12 & 14 & 16 & 18 & 20 & 22 & 24 \end{bmatrix}$ where [1 2 3 4 5 6 7 8 9 0 11 12] represents the subsets numbers, [1 3 5 7 9 11 13 15 17 19 21 23] specifies design concepts corresponding to natural, light, rigid, etc., and [2 4 6 8 10 12 14 16 18 20 22 24] represents concepts corresponding to artificial, vague, soft, etc. Similarly, the design concept subsets for hearing/water contain subset numbers 13-24 and design concepts 25-48, touch/stone contains subset numbers 25-36 and design concept numbers 49-72, and the smell/tree contains subset numbers 37-48 and design concept numbers 73-96. The four categories of subsets are determined and created into a concept-mapping-matrix (see Figure 6)

Table 3. The Concepts Identified For Vision/Light

NO / concept	subset no	concept denoted by number	
[X00000000000]	1	Natural (1)	Artificial (2)
[0X0000000000]	2	Light (3)	Vague (4)
[00X000000000]	3	Rigid (5)	Soft (6)
[000X00000000]	4	Strong (7)	Cold (8)
[0000X0000000]	5	Romantic (9)	Rational (10)
[00000X000000]	6	Colored (11)	Plain (12)
[000000X00000]	7	Luxurious (13)	Simple (14)
[0000000X0000]	8	Classic (15)	Modern (16)
[00000000X000]	9	Monotone (17)	Plentiful (18)
[000000000X00]	10	Sensitive (19)	Rational (20)
[0000000000X0]	11	Fancy (21)	Complicated (22)
0000000000X]	12	Coordinate (23)	Conflicting (24)

$$\begin{bmatrix} L & \begin{bmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 \\ 1 & 3 & 5 & 7 & 9 & 11 & 13 & 15 & 17 & 19 & 21 & 23 \\ 2 & 4 & 6 & 8 & 10 & 12 & 14 & 16 & 18 & 20 & 22 & 24 \end{bmatrix} \\ W & \begin{bmatrix} 13 & 14 & 15 & 16 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 \\ 25 & 27 & 29 & 31 & 33 & 35 & 37 & 39 & 41 & 43 & 45 & 47 \\ 26 & 28 & 30 & 32 & 34 & 36 & 38 & 40 & 42 & 44 & 46 & 48 \end{bmatrix} \\ S & \begin{bmatrix} 25 & 26 & 27 & 28 & 29 & 30 & 31 & 32 & 33 & 34 & 35 & 36 \\ 49 & 51 & 53 & 55 & 57 & 59 & 61 & 63 & 65 & 67 & 69 & 71 \\ 50 & 52 & 54 & 56 & 58 & 60 & 62 & 64 & 66 & 68 & 70 & 72 \end{bmatrix} \\ T & \begin{bmatrix} 37 & 38 & 39 & 40 & 41 & 42 & 43 & 44 & 45 & 46 & 47 & 48 \\ 73 & 75 & 77 & 79 & 81 & 83 & 85 & 87 & 89 & 91 & 93 & 95 \\ 74 & 76 & 78 & 80 & 82 & 84 & 86 & 88 & 90 & 92 & 94 & 96 \end{bmatrix} \end{bmatrix}$$

Figure 6. Concept Matrix

The selection matrix is encoded using the previously specified concepts via the concept matrix. Each concept in this matrix uses two bits for the encoding with the 12-pair concepts and their individual weights being represented as the matrix. For example,

$\begin{bmatrix} 1 & 3 & 0 & 0 & 9 & 12 & 14 & 0 & 18 & 19 & 0 & 24 \\ 9 & 7 & 0 & 0 & 0 & 6 & 8 & 0 & 10 & 9 & 0 & 3 \end{bmatrix}$ represents the natural concept with weighting of nine, the rigid concept with weighting of seven, romantic concept with weighting of zero, plain concept with weighting of six, simple concept with weighting of eight, plentiful concept with weight of ten etc. Furthermore, the selection matrix requires four subsets for the encoding, including L (light), W (water), S (stone), and T (tree) (see Figure 7)

$$\begin{bmatrix} L\begin{bmatrix} 1 & 3 & 0 & 0 & 9 & 12 & 14 & 0 & 18 & 19 & 0 & 24 \\ 9 & 7 & 0 & 0 & 0 & 6 & 8 & 0 & 10 & 9 & 0 & 3 \end{bmatrix} \\ W\begin{bmatrix} 25 & 0 & 29 & 31 & 0 & 35 & 0 & 0 & 0 & 43 & 45 & 0 \\ 6 & 0 & 8 & 3 & 0 & 4 & 0 & 0 & 0 & 6 & 8 & 0 \end{bmatrix} \\ S\begin{bmatrix} 0 & 51 & 0 & 55 & 0 & 0 & 0 & 63 & 65 & 0 & 0 & 0 \\ 0 & 5 & 0 & 9 & 0 & 0 & 0 & 8 & 6 & 0 & 0 & 0 \end{bmatrix} \\ T\begin{bmatrix} 73 & 0 & 0 & 0 & 0 & 83 & 0 & 87 & 89 & 91 & 0 & 95 \\ 7 & 0 & 0 & 0 & 0 & 8 & 0 & 6 & 0 & 9 & 0 & 9 \end{bmatrix} \end{bmatrix}$$

Figure 7. Selection Matrix

Further, the selection matrix can be defined the four subsets of parents of the GA chromosome and implement the evolution of the optimized solutions in the next module.

3.1.3 Cooperative Interactive Co-evolutionary GA Module

Genetic algorithm (GA) is able to address the problems of optimization. The cooperative co-evolutionary GA (CCGA) can decompose the concepts into the subset of concepts, and divide them into four subsets. The interactive GA (IGA) complements customer evaluations if the solutions to CCGA differ according to customer needs. Offspring are produced by evolution after ever ten generations of running GA. Customers can select the results of offspring and create their profile based on their preferences. Integrating CCGA and IGA can obtain advantages in terms of co-evolution and interactions (see Figure 8)

In CICGA, the concepts of the concept knowledge base must be encoded and compared with the project matrix of the design recommendation module, after which the evolution matrix with two rows and 48 bits is obtained using the four strings (vision/light, hearing/water, touch/stone, and smell/tree), thus further identifying the optimal solutions.

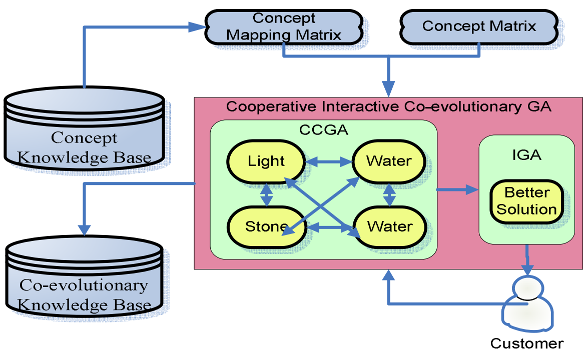

Figure 8. Cooperative Interactive Co-evolutionary GA Module

CICGA oversees compares and encodes procedures between the design concepts in the concept knowledge base and the project matrix derived from the design recommendation modules. Strings have put in a matrix using 4-categories and 48 bits and then evolution is used to determine the optimal solutions. In the matrix, the 1st row represented the selected style concepts and the 2nd row represented their weights. The styles are identified by a population of GA during the process of defining the evolutional chromosome. The system creates four sub-populations of light, water, stone, and tree. Consequently, the co-evolutionary knowledge base includes the optimized solutions and fitness values required to run GA at intervals of ten generations. IGA is to adjust the possible deviation of running GA through fitness function. Furthermore, the customers can select the 5 solutions every 10 generations until the optimal solutions are achieved.

3.1.4 Evaluation Module

iInteriorDesign executes the subsystem of CICGA, which is capable of providing five optimized solutions for customers every ten generations. The customers can utilize the fourth module, the evaluation module, to select and sort the results of the optimized solutions of the preliminary interior design. The system can revise the combinations of style concepts so they once again agree with the optimizing procedures of CICGA if the results do not fit the goal thresholds. In this module, the service experiment directs the IGA process, and the solution of the optimized design-concept. Its design content can be assessed if the style concepts meet customer needs and the service process assesses user coproduction ability (see Figure)

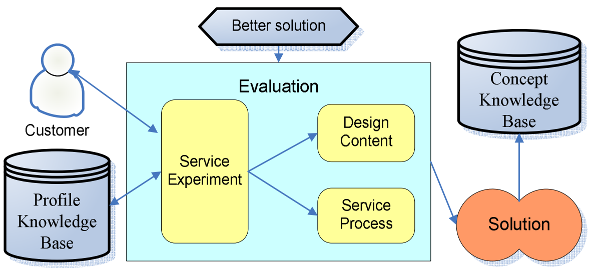

Figure 9. Evaluation Module

4. CSS VERIFICATION: CASE STUDY

This section elucidates how a single case study can examine theory and articulate theory development [9,11,23] According to the research method of design science, the case study can refine and assess an artifact through social science theory and further acquire a new deductive model or theory. Thus, this study uses the descriptive case study to generate a theory: the resource dependent theory (RDT) [8, 12] This study analyzes the data obtained through expert investigations and addresses the four requirements for deducing symbiotic collaborative services. Further, this study also proposed a new conceptual model as theory building, symbiotic collaborative services model, validated by the collected, presented and analyzed data from the expert interviews [6].

4.1 Examine CSS by RDT

In the case study of *iInteriorDesign*, the problem formulation baseline comprises explanations of how the purpose of systematic service innovation with high service productivity and high customer satisfaction can be achieved. The investigation adopts expert interviews with two decorators (one is from legally registered company which provides interior designer services, another is from SOHO), who answered the various questions and practical experiences related to interior design. They provided the detailed opinions and experiences by several in-depth interviews through one month.

To examine symbiotic relationship strategy if the influence and the effects of collaboration service systems (CSS) is worth considering. With *iInteriorDesign* as a prototype system, the interviews' results can examine the RDT to further verify the effects of symbiotic relationship strategy between decorators and customers. However, the property of symbiotic interdependence relationships relates to the automation of value co-creation experiences underlying CSS in nature. RDT can be used to evidence the effects of CSS enabling automatic value co-creation experiences and service productivity and satisfaction. The two contrasted interdependent relationships among organization from RDT are proposed and analyzed (symbiotic and competitive)

4.2 Research Assumptions

Table 4 outlines the underlying assumptions of *iInteriorDesign* related to the symbiotic and competitive interdependences within RDT respectively.

Table 4. Two Interdependence Types of RDT

	Symbiotic Interdependence	**Competitive Interdependence**
***iInteriorDesign* can facilitate collaborative interior design services**	● Adequate service collaboration ● Service exchanges and interactions with value co-creation	● Inadequate service collaboration ● One-side value due to the competitive relationship

Two assumptions related to CSS and RDT:

(1)iInteriorDesign can facilitate collaborative interior design services if the service provision is based on symbiotic interdependence
(2)iInteriorDesign can facilitate collaborative interior design services if the service provision is based on competitive interdependence

The decorators responded our interviews after they used *InteriorDesign*. Their responses are partially extracted as follow owing to the space limitation:

> *It seems to me that the e-service is designed to help customers determine the style elements, and significant interdependence between providers and customers can simplify demand and choice in design style. I feel that the system can reduce the deterministic risk in relation to the uncertain design styles and customers' preferences. Regarding the determination of design requirements, for example, new classical style, customers generally rely on decorators to offer what classical style is, and the decorators also want to know what classical style the customers presume and want.*

> *During the initial stage of engaging in interior design, there are two types of customers: first, customers searching for a specific design style; second, customers searching for the designers who are capable of various styles. We can show the samples of our design works to the customers, and let the customers can choose. Selecting the design style can be blended. . Generally speaking, we present some of works to customers, for example, the customers can choose the three from the ten design styles. Customers might just want partial of these styles not all of them. Therefore, blending two or more styles can produce the other styles that can satisfy customers. The optimization programs can expedite the blending of design styles.*

In this case study, these qualitative data (interviews of decorators) can justify and evaluate the effects of CSS and further explore if symbiotic interdependence relationship building is a significant factor to result in the benefits of CSS (value co-creation experience). Based on the interviews, the assumption (1) is supported and the assumption (2) is not supported.

This research also proposes a new deductive theory: Symbiotic Service Collaboration Model (see Figure 10), including the automation of symbiotic interdependence relationship building and have the two advantages of reducing service exchange barriers and acquiring the customers' requirements. The two advantages can improve the value co-creation experiences and the creation of mutual adaptability during the service processes for service providers and customers. Meanwhile, the high service productivity and customer satisfaction will progressively increase experience quality when the service stakeholders are using a CSS.

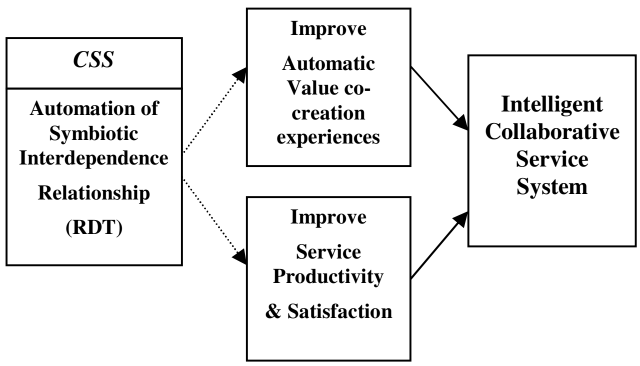

Figure 10. Symbiotic Service Model

5. MANAGERIAL IMPLICATION

The study gives service industries to take into account how a CSS can be achieved. CSS approach can streamline the automation of value co-creation experiences, together with high productivity and satisfaction. SSM and ISM lead to the consideration of determining the six attribute elements in order for systematic service innovation. Based on the SSM analysis, ISM mediates the automation of value co-creation experiences process and the collaborative service process through machine-metaphor and adaption-metaphor technologies (e.g. co-evolutionary GA algorithm)

From the applications perspective, *iInteriorDesign* is a CSS for extracting the style concepts for preliminary interior design. The system is in for an entirely new interior design experience due to collaborative design provisions. With the emergence of collaborative effects from the collaborative service delivery process, the service system provides a cooperative platform that can systematic the preliminary process of interior design. For interior design, architects or decorators can use the adaptive technology to help customers determine their design requirements. In fact architects and decorators can even draw inspiration from the interactions with customers. Such a collaborative service system can be applied not only for interior design, but also to other services. This system introduces the SSM and ISM methodologies and concludes by presenting a prototype service system for demonstration and verification. SSM, ISM, and *iInteriorDesign* provide practical service providers or service researchers with a perspective on service system design.

The symbiotic service model can be viewed as a reference model for CSS application design. Building a symbiotic interdependence relationship can improve automatic value co-creation experiences and service productivity and satisfaction. The case study has proved that underlying behaviors can enhance the advantages the CSS to achieve high service productivity and customer satisfaction.

6. CONCLUSION

For service system engineering, the study contributes to CSS approach for intelligent service systems enabling automated value co-creation experiences with good service productivity and satisfaction. The proposed SSM and ISM can be an analytic and design thinking and methodology for systematic service innovation. As such, the service process and provision of style determination of interior design service can also be streamlined by SSM and ISM. On the other hand, the decorators and customers can effectively determinate the styles of interior design by means of symbiotic interdependence relationship building. However, the problem of assuring the service collaboration design can be addressed in this study.

One possible concern on the limitation of the *iInteriorDesign* is its reliance on the preliminary style determination rather than whole design job at the early stage of interior design. SSM and ISM are applicable not only to *iInteriorDesign* but also to other types of collaborative service systems. If the interior design provider requires an additional intelligent co-design system, the required determinants and methods must be reconsidered in response to more complex situations and more varied domain-dependence problems. Future work includes the results of surveys and interviews with a number of service system users. The empirical study can be designed to understand the attitudes and thoughts. Additionally, the more explicit methodologies and technologies of SSM and ISM should helpful to design CSS. Replacing CSS using competitive interdependence relationships is also worth to further explore.

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