A study on MCIN model in intelligent clothing industry

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Abstract

Purpose – This paper aims to study the material conscious information network (MCIN) to present new models of clothing products and persons and propose new crowd-designing patterns to reconstruct an improved supply–demand relationship in clothing industry.

Design/methodology/approach – This paper aims to study the MCIN to present new models of clothing products and persons and propose new crowd-designing patterns to reconstruct an improved supply–demand relationship in clothing industry.

Findings – At last, this paper implements a prototype system of novel e-commerce platform based on the CDCI to illustrate the effectiveness and soundness of the CDCI modeling.

Originality/value – Different from most related works just focusing on the physiology dimension in the matching of customer and clothing, this paper proposes that the dimension of physiology, character, knowledge and experience should be synthetically considered.

Keywords E-commerce, Crowd-designing clothing industry, MCIN model, Supply–demand relationship

Paper type Research paper

1. Introduction

With the dramatic growth of global "Internet +", the integration of traditional industry and internet has constantly innovated the organization of economics and society. E-commerce, defined as the purchase and sale of information, products and services using any one of the thousands of computer networks that make up the internet (Lawrence *et al.*, 2003), has brought a holistic and strategical impact on business practice.

Focusing on clothing industry, there are many serious problems existing, such as the decline of the whole industry, the crisis that the traditional sales model is facing with, backlog of inventory and severe products homogeneity. Consumer dissatisfaction with clothing fit today is recorded to be as high as 62 per cent in men and 50 per cent in women. The causes for this lack of good fit of the population can be found in every stage of clothing design and production (Shen *et al.*, 2017). Thus, the revolution of business models, especially the supply–demand relationship in clothing industry is extremely urgent.

In latest decades, with the development of Internet of Things, cloud computing, big data and other information technology, the overall goal is to raise the intelligence of economic and social network. Thus, intelligence and interconnection are characteristics of this age.

Individuals, enterprises and government agencies all have a material conscious information network-based model (material conscious information network – MCIN) that performance desires and intentions in an interconnected and intelligent network. The MCIN, evolved from traditional internet to a large-scaled, open-styled, self-organized and ecological intelligent network, is required by the future networked system that with the characteristics of proactive personalized consumption, direct centralized distribution, intelligent decentralized manufacture and ecological self-organized system (Ashdown and Dunne, 2006). Any relationship between the MCIN nodes is a supply–demand relationship.

Crowd science nowadays has come into people's insight, which also reflects on clothing industry. Clothing design is the sole duty of professional designers, but everyone has a choice to supply his/her own design. That is what we called crowd-designing. Some related patterns have been provided but not in common use, and further research will be made in this paper.

To address the aforementioned problems, we present new models of clothing products and person (including customers and designers) based on MCIN models, integrated with new design patterns to reconstruct an improved supply–demand relationship in clothing industry. Furthermore, we develop a prototype of novel e-commerce platform based on the new model to prove the effectiveness of the CDCI modeling.

The reminder of paper is organized as follows. Section 2 reviews existing related work for designing patterns and MCIN-based models and also highlights the key contributions of this study of work. Section 3 formulates some new clothing design patterns based on Crowd Science. MCIN-based models of persons and products are presented in Sections 4 and 5. Implementation of the prototype system is developed in Section 6. The last section summarizes the work and provides a direction of future work.

2. Related work
Great importance has been attached to supply–demand relationship in clothing industry, with great meaningful research, and practice on 3D modeling of clothing and customers has been done and of course have made great contributions.

With technological advances, such as 3D body scanning for body measurement and automated computer-aided design (CAD) programs for custom pattern generation, along with new manufacturing developments, such as single-ply laser cutting and unit production systems, can make customization a viable option for clothing manufacturers.

At present, 3D modeling of customers has a variety of classification methods, including body-characteristics-based modeling, body-parametric-based modeling, body-polyhedron-based modeling and surface-based modeling (Serra, 1982). The most important thing is the accurate data of body-parametric. Body scanners can capture reliable data collection and electronic communication of the collected measurements [Cyberware, Cyberware website (online), 2017; Hamamatsu, Hamamatsu website(online), 2017].

CAD pattern-making systems have been developed for efficient clothing pattern-making, grading and marking. Computerized grading makes it possible to develop complex grade rules, allowing the creation of sophisticated sizing systems that include multiple special grades to address a wide range of body proportions. Some advanced CAD systems can also create automated custom-made patterns to fit individuals based on body measurements. Automated mini-markers can be generated for these patterns (Lee and Chen, 1999).

One apparent problem existing in the above research is that they only consider about one dimension of information, i.e. physiology. But what we want to improve in supply–demand relationship is based on the comprehensive of physiology, belief, character, knowledge, experience and context that represents the intrinsic and extrinsic factors of customer's

humanity. MCIN nodes provide the model that we can apply in the modeling of customers and clothing, integrating the information of physiology, preferences, experiences, etc., enhancing the performance of the matching and recommender system.

3. Design patterns
First, we will propose some new design patterns in supply–demand relationship based on Crowd Science. According to the source of designers and design patterns, the classifications can be defined as follows.

3.1 Professional design
Customers propose demands of clothing customization, and then professional designers make customized design based on the design library and materials.

3.2 Crowdsourcing
Customers still propose demands of clothing customization, whereas the system automatically adds requirements that designers could co-design, modifying and optimizing the design.

3.3 Design maker
Design maker will publish his/her unique design to the space to be evaluated or even crowdfunding to small-lot manufacture.

3.4 Crowdfunding
For some high-evaluated design that maker published to the space, the platform can organize crowdfunding to achieve a goal of financing amount and then offer opportunities to volume production and sales.

3.5 Integration of crowdfunding, crowdsourcing and design maker
- *Ordinary designers publish his/her design to the space*: Ordinary makers can design assisted with pictures, and there is no need of professional designers.
- *Crowdsourcing services*: As painting is not the common skill for most people, the platform will match special designers and illustrators to some less-professional design drafts to restore exquisite renderings, making the design close to the real ones for better experience of customers. Users can also publish crowdsourcing needs, inviting designers to participate in co-design.
- *Vote in space*: Each uploaded design has a time limit for voting and discussing. If users vote a design that be sold in the future will draw extra dividends, avoiding the phenomenon of voting-followed, the number of votes does not appear in the page until deadline. To avoid a wide range of voting, the voting limits is 5 per user. Only canceling the casted voting or waiting to exceed the period of validity can users vote new designs.
- *Evaluation*: For the high-voted and hot-discussed designs, the platform will assess the manufacturing cost, uploaded time and other elements. After this segment, the platform will select a certain amount of excellent designs to make sample production, product photography, picture processing and pass it to the crowdfunding segment.

- *Crowdfunding*: Products in this period will be sold at 50-70 per cent discount of retailing price. At this stage, users can get their preferences at a very low price. The products also receive the inventory support of first mass production at the same time. So it is a win–win strategy.
- *Production and sales*: Products can eventually be sold on the platform through the crowdfunding segment. Based on the data analysis, the platform can take flexible supply chain policy of "multi-style and small-batch". Only some high-sold designs can retain a certain amount of inventory. Production of the first batch of small-lot production is in charged by some processing manufacturers, especially responsible for crowdfunding.
- *Reward mechanism*: A total of 20 per cent of sales can be allocated to the design users and voting users. For example, design users can get 70 per cent and voting users get 30 per cent. The dividends are about "sales" rather than "profits", so that users will get more intuitive understanding of their own dividends and have more confidence on the dividend system. As long as the product is selling, each sold will produce dividends. User's design can become reality and be shared with more people, resulting in a sense of accomplishment for users (Figure 1).

This design pattern can support original design and solve the clothing homogenization problem from the characteristics of consumers' experience. In fact, the first round of publicity and marketing starts from the voting segment. And the crowdfunding segment can predict the scale of mass production, which is similar to ZARA model called "multi-style and small-batch". This also reduces the risk of over-inventory. Users are motivated to promote their own designs such as publishing it to space to improve the sales to get more profits. It is just like that the users themselves open a shop to sell their own products. Once accumulating to certain active users and achieving a certain conversion rate, it will form a positive cycle.

4. A material conscious information network-based model of the crowd-designing clothing industry

In the modeling of CDCI, we need to consider a number of important issues: How to model different types of nodes? How can we model the basic information/supply information from different types of nodes? How to model the relationships between different nodes?

In this section, we will introduce generic node model and node-relationship model. The node model describes the consumer node, designer node and clothing node, aims to present new models with dimension of physiology, character, knowledge and experience to support the development of clothing industry. The node-relationship model describes the relationship between the consumer node and the clothing node, along with the relationship between the consumer node and the designer node, aims to illustrate the matching node in clothing industry.

4.1 Model of CDCI node

The CDCI describes a model of automatic matching of consumer and clothing based on basic information and supply–demand information. The CDCI nodes correspond to actual persons or clothes, where persons can also be divided into two categories: consumers and designers. According to the concept of crowd-designing, a person can be a consumer and a designer at the same time. In this way, we can abstract consumer/designer node as one node. Each node is mainly composed of basic information and supply–demand information. The basic
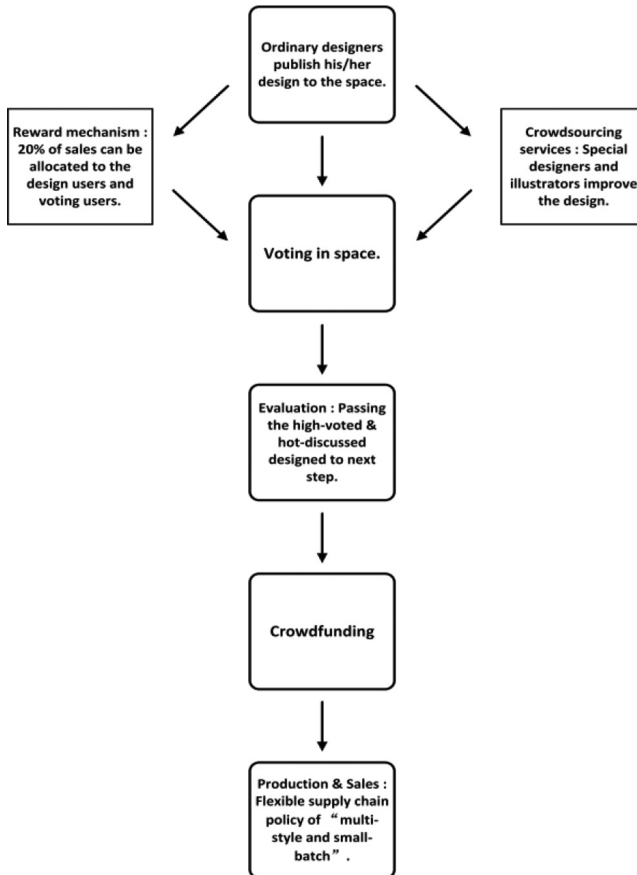
information includes the physical attributes, characteristics of persons and clothes. The supply–demand information includes the demand information, supply ability and historical information. The clothes node is consistent with the person node. The node can be abstracted into the above content, which is defined as follows:

Definition 1 (Model of the CDCI node): A CDCI node contains a consumer node, a designer node or a clothing node. We use an ancestor N to represent a CDCI node, contained with two attributes:

$$N :: \ = Np|Nc|Nd$$
$$:: \ = \langle B, R \rangle$$

where:
Np = is the clothing node in the CDCI node;
Nc = is the consumer node in the CDCI node;
Nd = is the designer node in the CDCI node;

B   = is the basic information of the node; and
R   = is the supply–demand information of the node.

In the above equation, B represents the basic information of a node. Consumers and designers share the same basic information. Clothing node is consistent with the classification but different in the specific information. R represents the supply–demand information of a node, containing the information of supply history, supply ability, demand history, demand information, etc. The person node includes consumer and designer, where the former only needs demand information, but the latter needs supply information. Similarly, the clothing node only needs supply information. In the next stage, the supply–demand information is subdivided into supply information and demand information. The model is as follows:

Definition 2 (Model of the supply–demand information): The supply–demand information includes supply information and demand information:

$$R :: = Rs | Rd$$
$$:: = \langle Isd, Ih, Ist \rangle$$

where:
Rs   = is the supply information;
Rd   = is the demand information;
Isd   = is the supply–demand information;
Ih   = is the supply–demand history information;
Ist   = is the supply–demand statistical information.

4.2 Model of the consumer node and designer node
In the previous section, we described the abstract model of the CDCI node in detail. This section describes the specific design of the consumer node and the designer node. Because of the different functions, consumer node and designer node contain different information apart from basic information. So the basic information of CDCI can be divided into two categories: person and clothing. The basic information model is defined as follows:

Definition 3 (Model of the basic information):

$$B :: = \langle Ii, Ic, Is \rangle$$

where:
Ii   = is the identity information;
Ic   = is the property information; and
Is   = is the space information.

According to Definition 3, the basic information of the CDCI node contains the identity information (Ii), the property information (Ic) and the spatial information (Is). For person node, the identity information indicates that the person's identifier in the society is name, gender and ID card number. The property information indicates the physical attributes such as height, weight and waistline, etc. The space information indicates the status about related persons, business, government and some historical interactive information. Table I describes the details of the sub-information of the basic information of the person node.

According to Definition 2, the supply–demand information of the CDCI node contains the basic information, historical information and statistical information. Person node contains

consumers and designer nodes, the supply–demand information of these two nodes is completely different. Table II-III respectively describe the demand information of consumer node and the supply information of designer node.

4.3 Model of the clothing node

This section focuses on the basic information and supply information of clothing nodes in CDCI. The clothing node is similar to the designer node, both containing supply information. The former mainly discusses about clothing inventory, price and other information, and the latter focuses on individual supply skills and ability. Table IV describes the details of the sub-information of the basic information of the clothing node.

The supply information of the clothing node is extremely similar to the designer node, especially in history information *(Ih)* and statistical information *(Ist)*. But the supply–demand information *(Isd)* is different, whose details in clothing node are product inventory, price and delivery time, etc.

Information	Detail	Description
Identity information (Ii)	Name, gender, age, ID card number, location, contact information	Authentication information
Property information (Ic)	Height, weight, chest perimeter, waist line, shoulder width, arm length, leg length	Data from 3D body scanners and can be modified by users
Space information (Is)	Circles of friends, relatives, business government and work	Information of social interaction

Table I.
Basic information of person node

Information	Detail	Description
Supply–demand information (Isd)	Requirements of style, material, color, etc.	Describe the relevant demands of consumers and make a reasonable quantification
History information (Ih)	Purchasing and demand history	Historical records of demand
Statistical information (Ist)	Statistics of clothing transaction: distribution of price, color, style and type	Analyze consumers' preferences based on the statistics of demand history

Table II.
Demand information of consumer node

Information	Detail	Description
Supply–demand information (Isd)	Design style, product price, uploaded time, etc.	Describe the supply ability, supply context and other related basic information
History information (Ih)	Sale and supply history	Historical records of supply
Statistical information (Ist)	statistics of clothing supply: distribution of price, color, style and type	Analyze characteristics of consumer group based on the statistics of supply history

Table III.
Supply information of designer node

5. Model of supply–demand relationship

The last section introduces the MCIN-based CDCI node, making a holonomic description of the consumers, designers and clothing. To achieve the concept of crowd-designing and improve the supply–demand relationship, we have to come up with intelligent matching method.

Based on the design patterns we proposed in the previous work, we can divide the relationship in two classifications: consumer–clothing relationship and consumer–designer relationship. Design pattern A (professional designers) and B (crowdsourcing) mainly belong to the consumer–designer relationship, whereas pattern C (design maker) and D (crowdfunding) mostly in the range of consumer–clothing relationship.

If consumers choose a designer to buy customization clothing, the platform adopts addressing method based on six-degrees-of-separation blockchain theory to match the corresponding designer, where the matching process needs to calculate the distance between consumer and designer. Therefore in this section, we propose the model of consumer–designer relationship and consumer–clothing relationship in CDCI nodes.

5.1 Model of consumer–clothing relationship

The relationship between CDCI nodes can be described with distance. The distance is described by the degree of association between the basic information and the supply–demand information. Therefore, one of the two nodes must have supply information, whereas the other must have demand information. There are only two kinds of nodes in CDCI: Np-Nc and Nd-Nc. The model of the node relationships are as follows:

Definition 4 (Model of node-node relationship):

$$\text{Re}lation ::= \langle N, N \rangle$$

where:

Distance is the distance calculation algorithm; and

N is the CDCI node.

The description of the distance is determined by the basic information of the two nodes and the matching degree of the supply information and the demand information. For the model of consumer–clothing relationship, let us see an example of distance calculation. The consumer a requirement that the clothing should be red, and if the basic color of the clothing is not red, the distance is zero. If red one existing, the distance is k (k > 0). This distance is one of the most important parameters to calculate the distance between the consumer and the clothing. The demand of consumer and the basic information of the clothes can match directly in this example, but in some certain circumstances, the demand

Information	Detail	Description
Identity information (Ii)	Name, category, number, manufacturer, materials, processing methods, etc.	Unchanged information of authentication, sources, etc.
Property information (Ic)	Size, style, color, material, price, weight, sleeve type, neckline	Describe the main attributes of the clothes, data from supply chain
Space information (Is)	Circles of products, business and related concerns	Relationship between product–product, product–person

Table IV.
Supply information
of designer node

information/basic information of customer and supply information/basic information of designer cannot correspond directly. Table V makes some reference.

5.2 Model of consumer–designer relationship
As shown in part A, the consumer–designer relationship model and the consumer–clothing relationship model are both based on Definition 4. As can be seen from Section IV, the difference between the two relationships is that the supply information of the designer and the supply information of the clothing are not exactly the same. For example, the concept of inventory is common in clothing supply information. If consumers want to purchase goods in stock when it is in short supply, then the distance in this transaction is relatively large, that is, the relationship between consumers and clothing is not close, resulting in unmatched consequence. For the supply information of designers, there is no concept of inventory but a description of design style. If a designer provides simplicity design style, it will meet the requirement of simplicity and purity that consumer proposes; thus it is more possible to match.

Similar to the model of consumer–clothing relationship, there is also the problem existing that the information cannot directly correspond in the model of consumer–designer relationship model. We can refer to Table V as well.

6. Prototype implementation
The CDCI is proposed to reconstruct an improved supply–demand relationship in clothing industry, which has to build a novel e-commerce platform.

In the last sections, we have generically proposed some new design patterns, modeled the MCIN-based CDCI nodes and presented the matching method of demand and supply. In this section, we implement the prototype system of the novel e-commerce platform and illustrate the functionality and interface of the developed system.

This platform is a personalized portal for every unique CDCI node, which means each CDCI node is the owner of its own dependent portal. The platform is driven by the CDCI node for the information counterpart of its owner autonomously and also can be operated manually.

The models of clothing node and person node are shown in Figure 2 and 3. These two modules are snapshots of the owner's model of the CDCI node, where we can overview related basic and supply–demand information of the two kinds of models. They both show physique-related concepts of structure dimension, values-related concepts of character dimension, trade-related concepts of experience dimension, etc. In addition, the person node also shows the 3D virtual image.

Then we present the demand–supply relationship between customer–clothing and customer–designer. The customer proposes the demand that she is going to buy a certain kind of clothing or designer; then the platform searches the network based on six-degrees-of-separation blockchain theory. The results of intelligent matching of clothing and designers are shown in Figure 4 and 5, which display several products or designers sorting by the

Consumer node	Clothing node
Arm length (basic information)	Sleeve length (basic information)
Leg length (basic information)	Pants length (basic information)
Hipline (basic information)	Hem width (basic information)
Goods in stock (demand information)	Stock (supply information)

Table V.
Parameter comparison of supply–demand relationship

Figure 2.
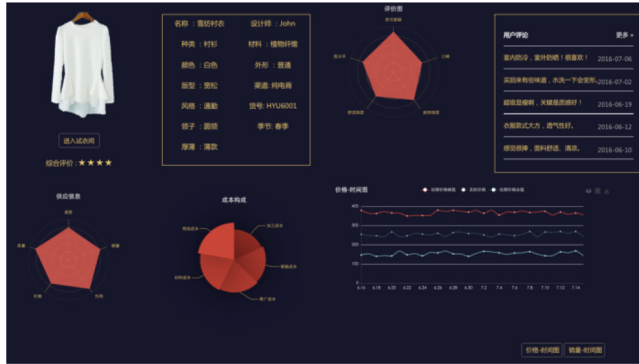The model of clothing
node
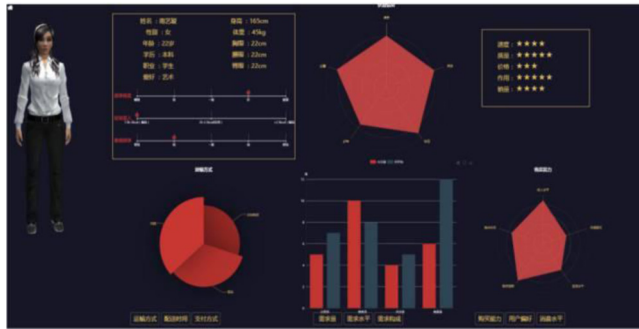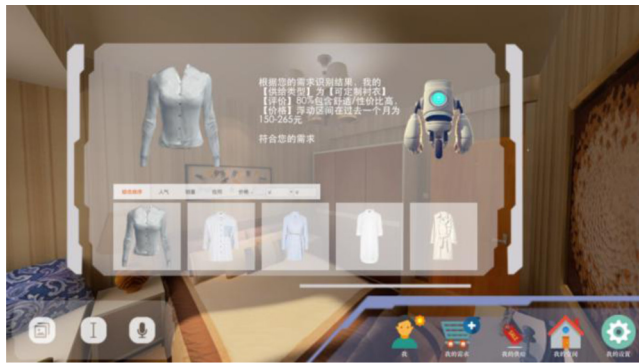

Figure 3.
The model of person
node

Figure 4.
Intelligent matching
of clothing

degree of matching, show the key elements in the procedure of matching and illustrate how the result is suit for the owner's demand.

Take the customer–clothing matching, for example. After the customer chooses one product, she can put it on through the 3D model at once. Meanwhile, as shown in Figure 6, she can adjust the key parameters of the cloth such as size, color, material,

Figure 5.
Intelligent matching
of designers

Figure 6.
VR fitting room

etc. and watch the trail effect synchronously. Furthermore, the customer has the chance to co-design with the designer if she is not satisfied with some details. Figure 7 shows the on-line real-time interaction of clothing design between customer and designer.

Figure 7.
Co-design between
customer and
designer

Compared to traditional platforms, the novel e-commerce platform enhanced by the CDCI has advantages in:

- personalized portal based on CDCI nodes; and
- improved supply–demand relationship through the intelligent matching and the practice of crowd-designing patterns.

7. Conclusion and future works

The CDCI is defined to be a comprehensive model including identity, physiology, structure, character, knowledge and experience, which evolves to the next generation of e-commerce and clothing industry. The CDCI nodes are information counterparts of person and clothing integrated with material and conscious. And interactions between CDCI nodes take the most important part in supply–demand relationship. We have conquered some main challenges to model the CDCI nodes.

To this end, we present some new design patterns to meet the need of customization in clothing industry and come up with an approach based on MCIN to model the CDCI. And we develop a prototype of novel E-commerce platform to prove the effectiveness of the CDCI modeling and intelligent matching in supply–demand relationship through six-degrees-of-separation blockchain theory.

Despite the current achievement, we intend to continue our research in the following directions:

- propose the intelligent matching algorithm in the distance calculation in CDCI nodes;
- enhance the function of the prototype system and guide further research in clothing industry; and
- conduct a series of user study to evaluate the system.

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