Chapter XX

Social System Design using Models of Social and Human Mind Networks -CVCA, WCA and Bayesian Network Modeling

T. Maeno[1], T. Yasui[2], S. Shirasaka[1] and O. Bosch[3]*
[1]Graduate School of System Design and Management, Keio University
[2]Keio Advanced Research Center, Keio University, Yokohama, Japan
[3]University of Adelaide Business School, Adelaide, Australia
E-mail*: maeno@sdm.keio.ac.jp

ABSTRACT

Examples of CVCA, WCA and Bayesian network modeling are shown in which human minds (mental models) and behavior are modeled. First, the fundamental idea of CVCA and WCA are explained. This is followed by an example of using CVCA and WCA for modeling cause-related marketing such as the "Drink one, give ten campaign" by Volvic. A student workshop has been used to demonstrate the effectiveness of WCA to visualize and understand the needs and wants of humans. Second, an example of how Bayesian Network Modeling can be used effectively through a participatory process to design policies for child safety. Both results (CVCA/WCA and the Bayesian Network Modeling) have shown that these are useful tools for workshop-based education of service/products system design.

Keywords: system design, wants chain analysis, Bayesian network

1 INTRODUCTION

Innovation has been moved from technology-oriented to human-needs-oriented. Hence, human-centered product and service system design are becoming increasingly important. For example, causal-loop diagrams are often used in system

thinking, analyzing the relationships among behaviors of humans. However, human models are often not sufficient to fully understand the relationships and interactions involved.

First, humans are only thought to be input-output systems for developing products/service systems. It has become important in future system design, especially those that are human-centered, that human minds and behavior models will become more and more precise and reliable. For this reason CVCA (customer value chain analysis) and WCA (wants chain analysis) were used to analyze the minds and behavior of humans, with a special focus on wants and needs. In the development of products and services these analyses are useful for qualitative visualization of the wants and needs of humans.

Causal-loop diagrams are also highly useful in describing the relationships and interactions between components of the system. However, for these models to be more precise and to convert them into dynamic models, quantitative information and data are required. This is often very difficult in the social sciences, especially when the components that are involved include human behaviors, feelings, ethical considerations, cultural differences, etc. Bayesian network modeling has been found highly useful for the analysis of the minds of humans and their different behaviors.

In this paper, CVCA, WCA and Bayesian network modeling are utilized to explore their effectiveness for social system design.

2 CVCA AND WCA FOR SOCIAL SYSTEMS

2.1 CVCA/WCA

Customer Value Chain Analysis (CVCA) is one of the methods developed by Donaldson as a tool for engineering design (Donaldson, 2006). In the CVCA, the relationship of stakeholders and flow of various values (including money and products) are shown in Figure 1, using the "Drink one give ten campaign" by Volvic as an example.

It is an effective tool for understanding existing technological and social systems as well as designing new types of systems. Its usage is targeted for

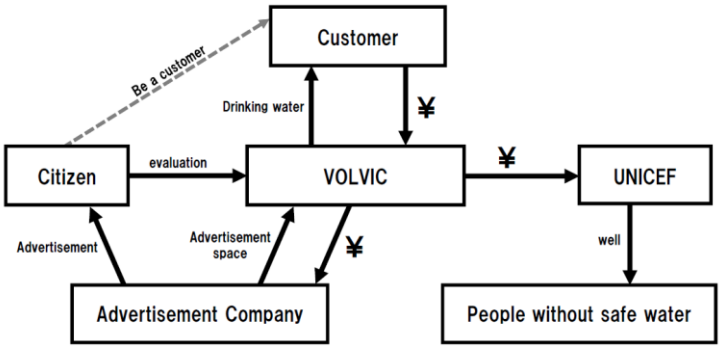

Figure 1 CVCA of "Drink one, give ten campaign" by Volvic

product/service development teams engaged in group discussions to express their thoughts and generate ideas during meetings such as design reviews and presentations. While CVCA focuses on "how" the stakeholders are related to each other, it does not explicitly focus on "why" the system structure (relationships among stakeholders) are formed.

"How and Why": Human behavior is motivated by various needs that manifest consciously or non-consciously. Hence, people's needs in their mind should be analyzed and visualized, even though it is not easily quantifiable.

Various psychologists including Murray (1938) and Maslow (1987 and 1998) have classified human needs. However, since psychologists' interests have been on the minds of persons, they seldom pay any attention to utilizing their results for analyzing or designing social systems where human relationships (between persons and groups of persons) play an important role.

From a classification point of view, "Maslow(1987)'s "hierarchy of needs" can be used. Maslow assumed five levels of needs - physiological; safety; belongingness and love; esteem; and self- actualization needs from the bottom to the top. These five steps of needs can be used as categories. Maslow (1998) also described two other needs outside the above hierarchy of five needs, called "basic cognitive needs". They include the desires to know and understand and to fulfill aesthetic needs. Hence, from a classification point of view, we utilize seven categories of human needs as shown in Figure 2.

Another important issue is that the subject and object of those needs are not usually focused on in psychological studies. For example, when humans are discussing "safety" needs, they usually think of their own safety. Some may state that the object (or subject) of personal needs is usually him or herself because humans are fundamentally selfish. Others may say that there exist altruistic needs for others. The following example of "safety" indicates that if the relationships among people are considered, there are four safety needs involved:

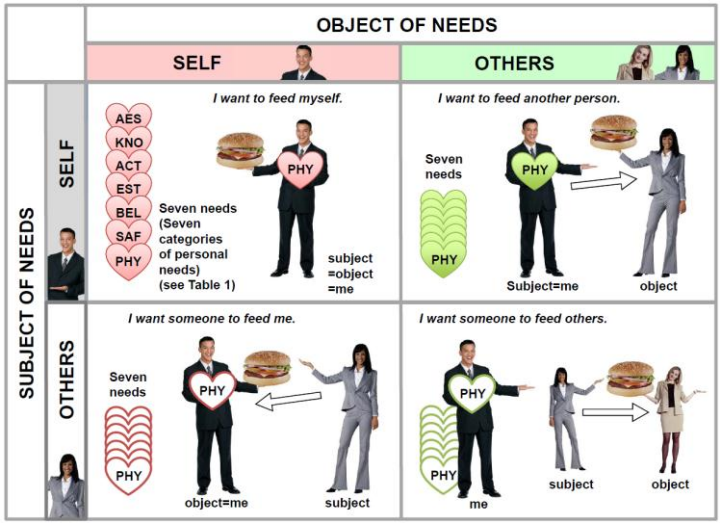

Figure 2 A two-by-two matrix of needs (Adapted from Maeno et al., 2011)

1. want to protect myself.
2. want someone to protect me (e.g. I want car companies to produce safe cars for me).
3. want to make someone safe (e.g. I want to donate to the flood victims).
4. want someone to protect someone else (e.g. I want my son's teacher to provide him with a good education).

Those four situations can be described by a two-by-two matrix based on the subject and the object of needs as shown in Figure 2. In the figure physiological needs (needs of food) are illustrated. Symbols in the hearts represent the seven categories of needs described above. They will be used in WCA figures. Colored hearts indicates that the subject of needs is himself/herself. On the other hand, a white heart with a colored outline indicates that the subject of needs is someone else. The red color indicates that the object of needs is "he or she", whereas the green color indicates that the object of needs is someone else. The four different features of marked hearts will be important for analyzing the relationship of stakeholders using WCA.

It is important that for designing systems, the various stakeholders and the structure of their personal needs should be considered. That implies that the seven categories shown in the two-by-two matrix in Figure 2 should be taken into account to visualize stakeholders' needs.

2.2 Case study: Analysis of social systems using CVCA/WCA

Figure 3 shows the result of WCA for the "Drink 1, give 10 campaign". Figure 4 shows the example of the workshop by students using CVCA and WCA.

Comparing Figure 1 and Figure 3 reveal clear differences. By adding the heart marks we can clearly see the humans' needs/wants. The color of the hearts is of special importance. The red color represents "self" needs, implying they are the "selfish" needs. On the other hand, the green hearts represent needs of others. Hence, they are relatively altruistic needs. That is why CRM is accepted by people in our current world and regarded as sufficient/good for satisfying Corporate Social Responsibility (CSR) as well. We can say that WCA is a visualizing tool of selfish or altruistic actions made by various people.

Of particular importance is that the two white hearts with the green outline in "Customer" and "Volvic" are connected by green arrows to the green heart in "UNICEF". This means that the need of "want someone to save African people without safe water" is realized by "UNICEF" through the green arrows chain. The reason why we use the heart figure is that people's hearts are connected by arrow chains to relay their wish until it is realized by a heart filled with green color.

WCA is useful in our current systems, because social values such as social safety, security, health, welfare, sustainability of environment, food, water and materials are becoming increasingly more important. For example, climate change problems cannot be solved if all people are selfish. Everybody has to get together to save the earth. However, not everybody's moral standards are high enough to try to save the earth as a first priority. It means that people's personal needs are not at the "Self-Actualization" level. Many people want to fulfill various other needs to live a

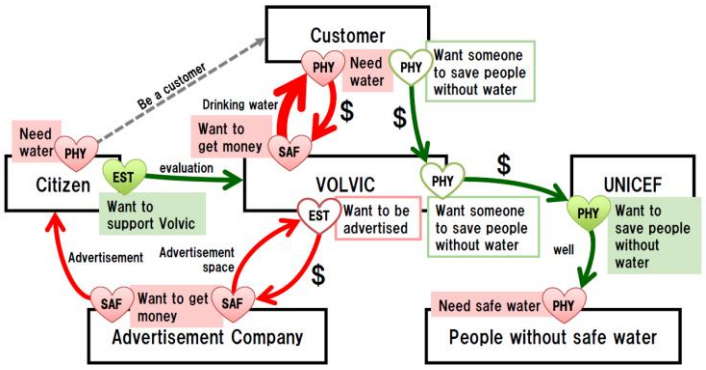

Figure 3 WCA of "Drink one, give ten" campaign by Volvic (Adapted from Maeno et al., 2011)

Figure 4 Example of workshop by use of WCA

life that is balancing with morality. That's why we should systematically construct business and social systems taking into account the various needs of people. Volvic's case implies that it is important to construct sustainable and robust systems by adding a little green heart even if the majority of people are driven mostly by a red heart.

After the workshop of CVCA/WCA, we have asked students their opinions of the outcomes and interpretations. The main positive comments included:

(1) WCA can visualize humans' wants/needs even though it is usually difficult

(2) Red and green hearts/arrows are useful to see clearly the selfish/altruistic needs

(3) Thinking of classification of Maslow's needs lead me create new ideas of service system

It can be concluded that expected opinions can be obtained by students as users of WCA. Negative opinions are that WCA is much more difficult to use compared with CVCA. However, it might not be a problem because the purpose of CVCA and WCA are different. CVCA is a simple tool for visualizing the flow of money, products and information among stakeholders and its simplicity has clear benefits. On the other hand, WCA is for visualizing the minds of humans (their needs/wants). It is not possible to visualize human minds perfectly and therefore should only be regarded as an assumption. However, it is important to think like others in order to

understand others. WCA is for helping the analyzer to think like others even though it is difficult.

3 BAYESIAN BELIEF NETWORK MODELING OF SOCIAL SYSTEMS

3.1 The Bayesian network modeling

Bayesian Belief Network Modeling is a method to formulate a visual network with calculated conditional probabilities. This modeling method is applied with the use of causal relation diagrams to achieve a particular goal for a complex problem (Nguyen *et al*., 201; Bosch *et al*., 2007; Checkland and Scholes, 1990). The process to develop a BBN is an excellent mechanism for "Participatory Systems Analysis" (PSA) (Smith *et al*., 2007) since diverse groups of stakeholders can participate in collaboratively making a decision to solve the problem of their system or achieving a particular goal (Ames and Neilson, 2001).

A key motivation for stakeholders during is the visualized co-designing process (PSA) under the theory of value co-creation (Sanders and Stappers, 2008) with the Bayesian Network software. Previous studies using BBN modeling include a wide variety of applications, e.g. policy-creation targeting specific sectors or communities with particular problems (e.g., water management in a region (Ames and Neilson, 2001), sustainability development in UNESCO defined biospheres (Nguyen *et al.*, 2011), the engineering world, medical diagnosis, etc.). This paper explores the usefulness of the model when it is applied to a national-level macro policy in Japanese society.

3.2 Case study: policy design for child safety in Japan

This subsection is to explore the usefulness of BBN modeling as a tool for designing a public policy to enhance the requirements of stakeholders. The authors selected the policy issue to prevent children from unexpected casualties by accidents. In OECD member countries, more than 125,300 children died from injuries, which amounts to 39% of all deaths in 1991-95. Japan was ranked as a medium risk performer in deaths by drowning, fire, falls and intent, whereas deaths by cars accidents were significantly lower than in other countries (UNICEF, 2001). Japanese society often regards parents as the only people responsible for child safety. Japanese parents tend to be isolated and frustrated, because there is a clear lack of a coordinated approach with other stakeholders in the society to help prevent their children from injuries (Kakefuda *et al*., 2008). A PSA for child safety could therefore be regarded as an essential and most urgent needed approach for the policy agenda to realize a more safe and secure society.

3.3 Sequential Approach

The PSA for child safety was carried out on 22 September 2011 on the Keio University Campus near Yokohama.

Figure 5 Experts at the Focus Group Meeting and CLD Result

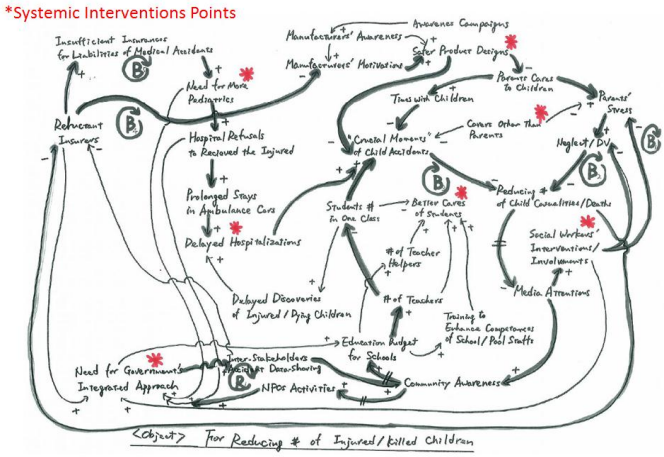

Figure 6 CLD and Systemic Interventions Points for the Child Safety

This approach was used to develop a Bayesian network model for child safety. This was done in two main steps:

Constructing a Causal Loop Model

A focus group meeting was convened to hold a brainstorming session to identify and visualize all factors related to child injuries as shown in Figure 5. The participating stakeholders collaboratively draw a causal loop diagram to identify loops, that is the interactions and relationships between the components of the model. This was followed by the identification of possible leverage points and systemic interventions by the stakeholders. This was carried out through "visual" scenario testing (observing the potential degree of change that will be caused by changes to particular components of the system). The leverage points were identified as the most effective points in the model that will help achieving the policy goal (Senge, 1990) and are indicated in Figure 6 for the case of child safety. Seven systemic interventions points were identified: safer product designs, caring volunteers to support frustrated parents, social worker's involvement, more integrated approach by government, more pediatricians, shortened time before hospitalization, and better care of students in schools.

3.4 Policy Implications by the Bayesian network modeling

Constructing a Bayesian network Model

The focus group experts collaborated to establish a Bayesian Network Model, using the Causal Loop model as a basis. This included the identification of possible root causes affecting the unintentional injuries of children in Japan.

Participating experts used the seven systemic interventions points to structure the Bayesian belief network model for designing policies on child safety (Figure 7). To populate the model, they jointly decided the probabilities of how the parent nodes will determine the probability that a child node would be achieved. For example, what are the probabilities that more scholarships and better insurance policies will increase the probability that there will be more pediatricians (see Fig. 7, right hand side). Through this co-designing process, the stakeholders recognized that their populated Bayesian model indicated that there is under current policy only a 21.5% probability to reduce the child injury ratio (Figure 8).

A sensitivity analysis of the model indicated that the most effective parameter to reduce child injuries was the policy to increase the number of volunteer nursing councilors. The populated model showed that the probability of decreasing child injuries will rise from 21.5% to 46.7% if the number of volunteer nursing councilors is set at 100%. Therefore this policy was determined by the participating experts to be the leverage point for improving child safety.

By completing the above sequential steps, the Bayesian network model proved to be highly effective for creating a public policy with stakeholders' involvement.

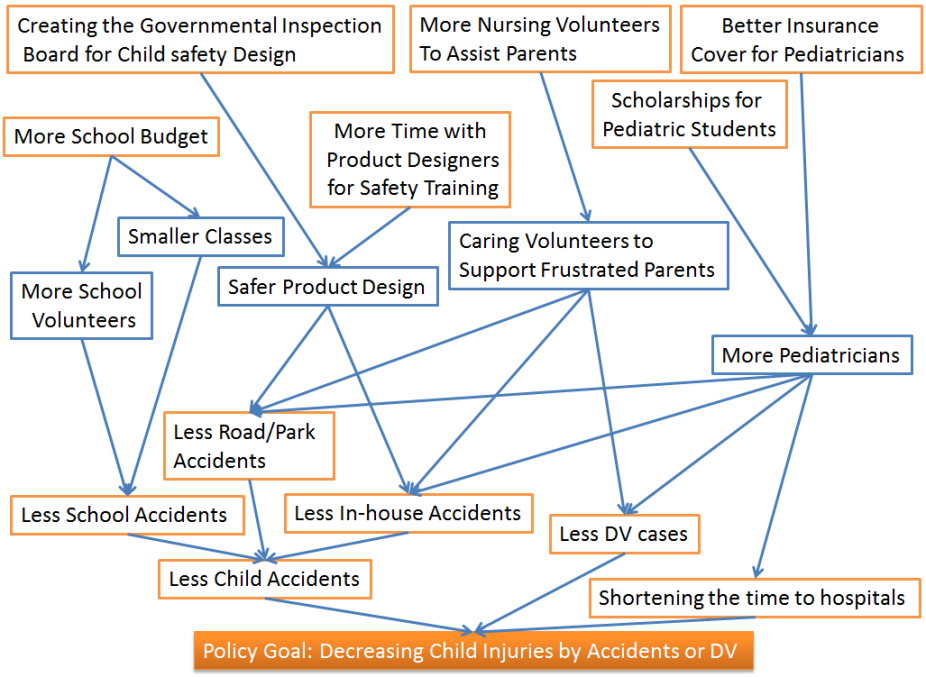

Figure 7 Factors for Injury-free children: The descriptive Bayesian Model

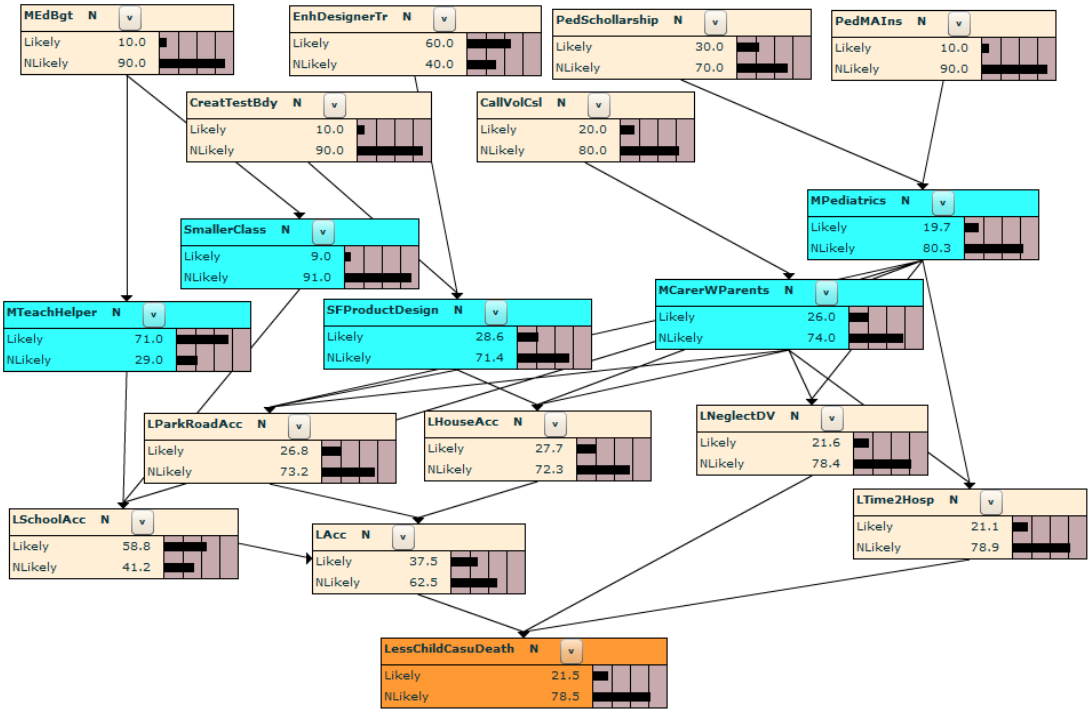

Figure 8 Populated Bayesian Model for Child Safety:

4 CONCLUSIONS

It is clear that CVCA/WCA and BBN modeling are in all cases useful tools for studying human needs/wants in a workshop-based situation. These methods should not only be used for education but are highly valuable in practice and for generating innovative ideas in the real world.

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