How "Hard Science" and Engineering Enhance Service-Dominant Economy

Morrakot Raweewan

National Electronics and Computer Technology Center, National Science and Technology Development Agency, Ministry of Science and Technology, 112 Thailand Science Park, Phahollyothin Road, Klong 1, Klong Luang, Pathumthani 12120 Thailand
{morrakot.raweewan}@nectec.or.th

William G. Ferrell Jr.

Department of Industrial Engineering, Clemson University, Box 340920, Clemson, SC 29634-0920, USA
{fwillia}@ces.clemson.edu

Abstract

Service dominant and quality of life economies change the world to a new pattern requiring information and knowledge, high-skill development of the workforce, and a use of IT and IT enabler services. A combination of globalization, advanced technology in ICT, particularly the Internet, and increasing of free trade across border drives such emerging market as offshore outsourcing, which requires global supply chain and value management in order to satisfy needs in customer responsive market. This paper presents that customer satisfaction, customer relationship management, and engineering and science (especially the supply chain) are highly related and then describes methodology of user-centered design where science and engineering is used to enhance customer satisfaction in service-dominant economy.

Keywords

Service science, SSME, service-dominant logic, industrial engineering, supply chain, customer satisfaction, user-centered design

1. Introduction

Nowadays, the service sector has grown to dominate economy in industrialized countries. GDP growth and workforce increment in this sector were shown in several studies (Abe ([1]), Chesbrough and Shohrer ([2]), Maglio *et al.* ([3]), and Sheehan ([9])). The new pattern increases a use of information and knowledge, high-skill development of the workforce, and a use of IT and IT enabler services (Sheehan ([9]). With a combination of globalization, the advance in ICT, particularly Internet, and increasing free trade across border; such a new market as offshore outsourcing is emerged. TJ Singh ([8]) presented that BPO (Business Process Outsourcing) is an example of IT and service outsourcing. Obviously, managing large global supply and demand chains composed in a value-creation network becomes a challenge in trade of services across broader in customer responsive market.

The service economy drives many organizations in private sector, academic institution, and government worldwide including in developing countries to adjust and give more attention to improve the service sector and create service innovation. An interdisciplinary of Service Science, Management and Engineering (SSME) is introduced to the study, design, and implement service to become more systematic in a new era. SSME: "*Science* is a way to create knowledge. *Engineering* is a way to apply knowledge to create value. Business Strategy and Models are a way to apply knowledge to create and capture value. *Management* is a way to improve the processes of creating and capturing value." – IBM. Therefore we might have two opportunities here: 1) engineers could use social science input to the design process so that the chances of success are increased and 2) people who use social science to measure customer satisfaction could use engineering design to construct new products/services or improve existing ones. This paper presents that customer satisfaction, customer relationship management (CRM), and engineering and science (especially the supply chain) are highly related and then describes the framework of user-centered design where science and engineering is used to enhance customer satisfaction in a service-dominant mindset. The rest of this document consists of 1) differences between goods and services (e.g. IHIP characteristics and service-dominant logic), 2) transition for practitioners and R&D, 3) connection of customer satisfaction, CRM and science and engineering (e.g. supply chain), and 4) methodology of user-centered design in enhancing customer satisfaction in service-dominant mindset.

978-0-7695-3473-2/08 $25.00 © 2008 IEEE
DOI 10.1109/APSCC.2008.158

2. Differences between goods and services

There are four characteristics distinguishing services from goods, namely, Intangibility, Heterogeneity, Inseparability, and Perishability or IHIP characteristics, as called by Lovelock and Gummesson ([5]). However, services can be dependant on labor-intensive and commodity goods and Vargo and Lusch ([10], [11]) debated that IHIP characteristics are too limited when exchanging services dependant on goods.

The market can also be viewed in two logics: a goods-dominant (G-D) and a service-dominant (S-D) logic. While G-D logic looks at service as plural and as units of output (somehow inferior to goods), S-D logic treats service as singular and as a process of doing something for and with another party. (Lusch and Vargo ([12])). The same paper also presented that S-D logic closely fits to business marketing, especially to B2B market. Therefore, a shift of market view from G-D to S-D exists.

3. Transition for practitioners and R&D

The differences of G-D and S-D logic are listed in eight areas with six transitions for practitioners shifting from one to the other shown in Table 1 and 2, respectively. Further details can be seen in Lusch and Vargo ([6]) and Vargo, S.L. and Lush, R.F. ([13]).

Table 1. Contrasting G-D and S-D logics (source, Lusch and Vargo, ([6]))

	Goods Dominant Logic	Service-Dominant Logic
1	Goods	Service(s)
2	Tangible	Intangible
3	Operand Resources	Operant Resources
4	Asymmetric Information	Symmetric Information
5	Propaganda	Conversation
6	Value Added	Value Proposition
7	Transactional	Relational
8	Profit Maximization	Financial Feedback

Table 2. Transition for practitioners (source, Vargo, S.L., & Lush, R.F. ([13]))

	Goods logic	Service logic
1	Making something (goods or services)	Assisting customers in their own value-creation processes
2	Value as produced	Value as co-created
3	Customer as isolated entities	Customers in context of their own networks
4	Firm resources primarily as operand	Firm resources primarily as operant
5	Customers as targets	Customers as resources
6	Primary of efficiency	Efficiency through effectiveness

Service in S-D logic is seen as a process thus process driven system. As mention in Section 2, S-D logic fits to the business market where dynamic and customer focus is very common. However, this logic considers customers as resources and co-creation. Therefore, practitioners and R&D should think of adaptation and collaboration in the process when design and implement service for customers. Next, a connection of customer satisfaction, CRM, and science and engineering (especially supply chain) and then methodology enhancing customer satisfaction in product and non-product scenario will be described.

4. Connection of customer satisfaction, customer relationship management (CRM) and science and engineering (especially the supply chain)

Coming from industrial engineering's view, we try to answer two issues: 1) interface between social sciences and physical science and engineering especially with respect to customer satisfaction and 2) methodology of science and engineering enhancing customer satisfaction. While the first issue will be answered here, the latter will be presented next section.

While "Science & Engineering" refers strictly to the technical side of designing and improving products and services and application of math and physical sciences are utilized to solve well-defined problems, "Social Science" focuses on the human and human perception, especially with respect to customer perceptions and expectations. On the surface, one could argue that there is no connection between "Science & Engineering" and "Social Science" – engineers design products and services while customers use the products and services that the engineers design. Customers, however, have the final vote on the products and services that succeed and those that fail and social science studies on how humans perceive the value and utility of products and services. Therefore, we might have two opportunities here: 1) engineers could use social science input to the design process so that the chances of success are increased and 2) people who use social science to measure customer satisfaction could use engineering design to construct new products/services or improve existing ones. We asked that are there really a connection of customer satisfaction, CRM, and science and engineering? If so, what is the nature of links and interactions? To answer the questions, we study three connections of 1) customer satisfaction and CRM, 2) science & engineering and customer satisfaction, and 3) science & engineering and CRM.

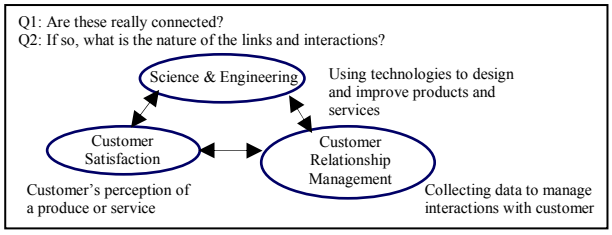

Figure 1. Three connections to study

We now investigate the first connection. To avoid problems of semantics we define scope of CRM and customer satisfaction. Customer Relationship Management (CRM) is a broad term that covers concepts used by companies to manage their relationships with customers, including the capture, storage and analysis of customer, vendor, partner, and internal process information. The primary motivation is to track customer behavior to gain insight into customer tastes and evolving needs. Customer satisfaction is a measure of how customers perceive products and services relative to their expectations.

High levels of customer satisfaction produce nothing but positive impacts. It improves economic performance; reduces customer complaints; increases customer loyalty; increases usage levels; secures future revenues; minimizes likelihood of defections; and reduces costs related to warranties, defective goods and service costs. Research published in 2005 (Mithas, S., M.S. Krishnan and C. Fornell ([7]) investigated the relationship between CRM and customer satisfaction and obtained two results. The fist result was that the use of CRM applications was associated with greater customer satisfaction. There were three primary reasons for this. CRM allows firms to customize offerings thereby increasing perceptions of quality, to improve reliability of consumption experiences (e.g., timely and accurate processing or orders), and to manage customer relationships more effectively across the spectrum of interactions. The second result concluded that customer knowledge mediated the effect of CRM application on customer satisfaction. This is important because analytically defined the causal mechanism. This probably sounds obvious but the result says that the value of CRM lies in the collection, analysis and dissemination of customer knowledge gained through repeated interactions. Therefore, we conclude that customer satisfaction and CRM are connected.

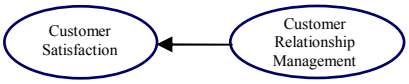

Figure 2. Existence of customer satisfaction and CRM connection

Next, we investigate the second connection of science and engineering and customer satisfaction. We need to make an assumption that really focuses our discussion. Engineering and science is incredibly broad. If we only consider engineering, the vast majority of practitioners design products. But we are interested on services and process improvement. Hence, the assumption we would like to make is switch our thinking from engineering and science to supply chain for reasons that we now discuss. We are industrial engineers who literally see everything in the world as a process. We honestly believe that process and service improvements are best facilitated by viewing the underlying structure as a supply chain. We know the interactions between customer satisfaction, customer relationship management and the supply chain are real and important to understand. So we replace "Science & Engineering" in Figure 1 with "Supply Chain" presented in Figure 3.

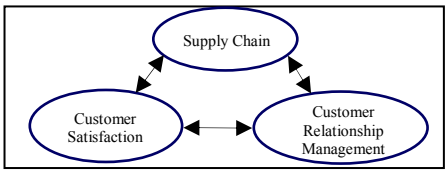

Figure 3. New connection when replacing science & engineering with supply chain

Why is the supply chain important and how does it fit into customer satisfaction and CRM? There are studies showing that supply chain is important – for example Deloitte survey of 600 companies in 22 countries worldwide indicated that only 7% effectively managed their supply chain but these 7% had 73% greater profit margins (*Business Wire*, October 2003), "The design of the supply chain is the key factor that will determine whether or not a company will survive, let alone whether it will maintain a competitive advantage." (*Management Review,* April 1999), and a survey of 142 companies indicated that "three out of four respondents said their CEO considers supply chain management to be a source of competitive advantage" (*Newswire*, October 2003). Thus defining your business as a supply chain has advantages:

- The process structure allows you to see the flow of materials, services, and information, including interactions and human touch points.
- Unlike logistics that does not include the customer, a supply chain approach involves the customer in system.
- Our personal experience is that sustainable process and service improvements require systemic changes. Those are most easily understood using a supply chain framework.

Now in stead of investigate the second connection of science & engineering and customer satisfaction, we investigate whether or not supply chain and customer satisfaction are connected.

There was some interesting empirical research out of Taiwan published on this in 2006 (Lin and Tseng ([4])). They wanted to explore a very interesting and highly practical issue – investigating the direct and indirect impact that various elements of supply chain strategies have on each other. Their approach included constructing a basic model of how these elements might interact, proposing various hypothesis to test, collecting data using survey of leading companies in Taiwan, and using statistical techniques to analyze the data and

drawing conclusions. The supply chain elements they selected, are very helpful for us and listed as following:

- Supply chain participation strategy (SCPS): degree to which partners are involved in the overall decision making
- Information technology application (ITA): degree to which a firm uses IT in routine business decisions
- Manufacturing participation strategy (MPS): does the company use manufacturing concerns as an element of its competitive strategy or does manufacturing just react to plans developed by other groups?
- Customer satisfaction (CS): dimensions include product, salespeople, product related information, order handling, technical services, internal personnel, complaint handling
- Organization performance (PER): productivity, cost, profitability, competitiveness, sales growth, profit growth, market share.

We understand that this says manufacturing participation strategy. We can not prove this, but we have never seen anything that suggest replacing "service" for "manufacturing" make any difference in the results. From these very strong relationships result shown in Figure 4, we conclude that the supply chain has an indirect impact on customer satisfaction through better execution. A higher level of participation throughout the supply chain targets products and services towards customers that increase customer satisfaction. Thus the second connection of supply chain and customer satisfaction exists.

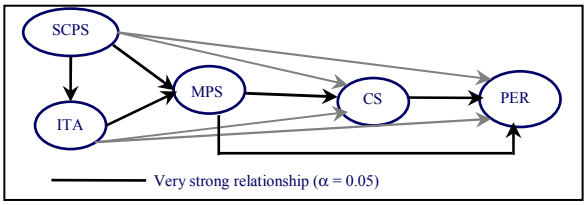

Figure 4. Proposed model of Lin and Tseng ([4]) and result

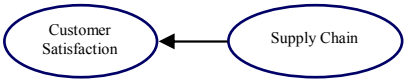

Figure 5. Existence of customer satisfaction and supply chain connection

Next, we investigate the last connection of supply chain of science & engineering and CRM. This one is pretty straightforward in one sense. A number of empirical research efforts have confirmed that organizing and using CRM data, firms can design and develop better products and services. CRM data is typically used to analyze data about each customer transaction so future interactions can be made in the correct context and to analyze data to profile customers and identify latent needs based on similarities between their purchase behaviors and those of other customers. The research mentioned previously also addressed this link. That is, CRM applications are positively associated with an improvement in customer knowledge; and greater supply chain integration facilitates improved customer knowledge from CRM applications.

It has been shown that CRM tends to have a positive effect on how the supply chain is operated to improve customer satisfaction. It has also been shown that a more integrated supply chain better communicates CRM information. The third connection, thus, has a two way effect.

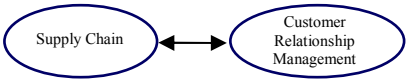

Figure 6. Existence of CRM and supply chain connection

We have shown that the technologies of engineering and science, especially within the context of the supply chain, CRM, and customer satisfaction are highly related. These three are strongly correlated to higher profits and greater market share. Next, we will present what we can actually do to gain these advantages.

5. Methodology of user-centered design in enhancing customer satisfaction in service-dominant mindset

This section discusses how "hard science" and engineering with respect to user-centered design can be used to enhance customer relationship management in the service industry. The methodology consists of two tasks:

Step 1. Identify the problem and root cause(s) and document the supply chain.

Step 2. Develop and implement a solution and ensuring that the problem stays fixed.

Each of these steps is now described in detail.

Step 1. Identify the problem and root cause(s) and document the supply chain.

Because of the importance of this step, each of the three primary tasks that it comprises are discussed individually and identified as steps 1A, 1B, and 1C.

Step 1A. Identify problem and root cause.

The first step we need to figure out the real problem and we have to act like a physician – typically observe the symptoms but need the cause. And we can use three methods – "Ask why 5 times", cause and effect diagrams and root cause analysis.

Step 1B. Analyze supply chain.

After problem and root cause are identified, then look at the total system as a supply chain – lowest tier supplier through final use. Some say that the strength of

an industrial engineering is that they view things as processes and do our work on processes and systems. We think this is exactly right and the supply chain identifies the opportunities because if we focus on just the problem at hand we might ignore a much larger opportunity to fix this problem and a lot more. Additionally, if we do not have a specific problem, this is where we start.

Step 1C. Document the process.

Document the process means that it is on paper and gain consensus. This is much harder than it sounds. You will be amazed as the same people view the same thing and see it totally different. The "truth" is typically some composite of the different views. Some applicable tools in documenting the process are process mapping and value stream mapping.

We now have identified the problem and root cause(s) and have documented the supply chain. What comes next is only developing and implementing a solution and ensuring that the problem stays fixed.

Step 2. Develop and implement a solution and ensuring that the problem stays fixed.

In this step user centered design is a complex idea but it has three important tenets that we can use. That are,

- Early and continual focus on users and their tasks.
- Measure the impact of your design using empirical testing.
- Utilize an iterative approach to refine the design.

We will use such tool as Quality Function Deployment (QFD) to design process, or a non-product. In order to understand a non-product design, we will present outline of product design then integrate QFD into the discussion later.

There is a simple outline of product design that we can use. We ask the users what they want, design a prototype, ask the users what they think, refine the prototype, and ask customers and ourselves whether or not we are "good enough". If not, go back to ask the users what they think and repeat the processes. See Figure 7.

Determining what the customer wants, however, can be tricky if we are not careful. It has been shown that tools like data mining and CRM data can help. As an engineer, this is really appealing because it is data driven and quantitative. Unfortunately, data sometimes can not always tell the whole story so we have to use a blended approach. We can use data analysis to determine customer needs and always "ask the customers what they want". What we think a customer wants and what they want can be two different issues entirely – for example, being able to find information on a web page is not necessarily related to the speed at which the page loads and comfort in a car might not be related to seat firmness. Fortunately, user experience design (formerly known as usability) has some ideas for us.

Here are some key metrics that user experience designer uses to do their job – time required for the user to perform the task, number of errors, time required to learn how to do the task, time required to re-learn the task, subjective satisfaction (ex. do you like it?), and experience of pleasure (ex. was the out-of-box experience good?). But the questions must be different at different stages of the design. We need to add the time dimension, i.e. early prototypes and later prototypes. Early prototypes that might just be ideas on paper cannot be used to actually measure the performance of the user so we have to simply ask them what they think. Later prototypes can be real enough to measure performance as well as ask opinion. Thus there are "formative" and "summative" questions involved in early prototype and later prototype, displayed in Figure 8 and 9, respectively.

Now, attention is turned to integrate QFD into process or non-product design. There are many tools that can be used to design prototypes but non-product design can be hard. QFD is one obvious choice that can help design processes when translate voice of the customer into design parameters and it is easy to use. Our model gets modified.

The first thing is to define the problem and process, which require the following tasks.

- Data collection and analysis – separating symptoms from causes
- Process identification – process flowcharting or value stream mapping, etc.
- New system specification – CRM, data mining, knowledge management, and always "ask the customer"
- Iterative improvements

QFD is now integrated into the design task. The initial design task can be completed with formative questions and QFD to gather customer data and to translate it into design parameters, see Figure 10. QFD is also integrated in early refinement, however, formative questions are replace by summative ones, displayed in Figure 11. Next, in later design displayed in Figure 12, summative questions are utilized here and measure of how users interact with the prototypes is taken. At this stage, we need to use anything and everything we have to refine the design fitting customer needs. In closing, there are three key messages:

1. Customer service, CRM, and engineering and science (especially the supply chain) are highly related.
2. The literature has both theoretical and practical support that a well designed and integrated supply chain along with an active CRM problem analyzed by solid techniques impacts customer service – and profits.
3. We believe that the framework of user-centered design provides a path to success that is understandable and dependable.

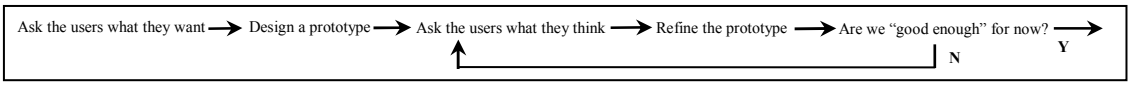

Figure 7. Outline of product design

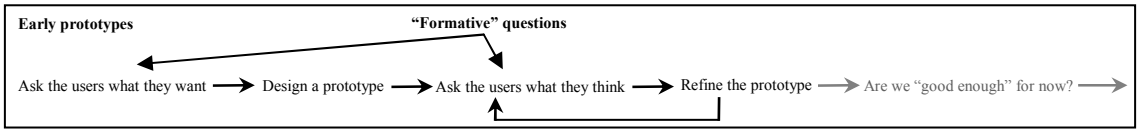

Figure 8. "Formative" questions in early prototype

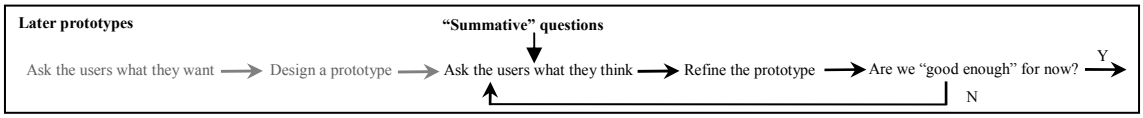

Figure 9. "Summative" questions in later prototype

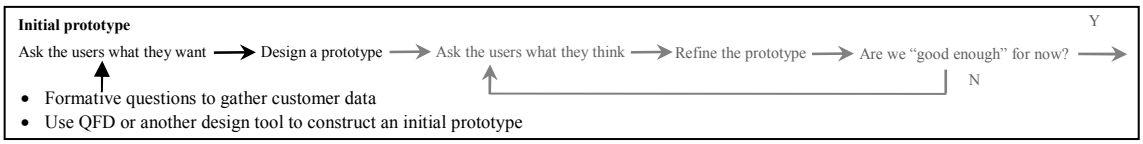

Figure 10. QFD during initial prototype of non-product design

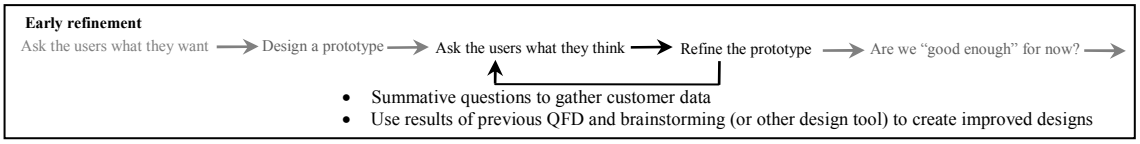

Figure 11. QFD during early refinement of non-product design

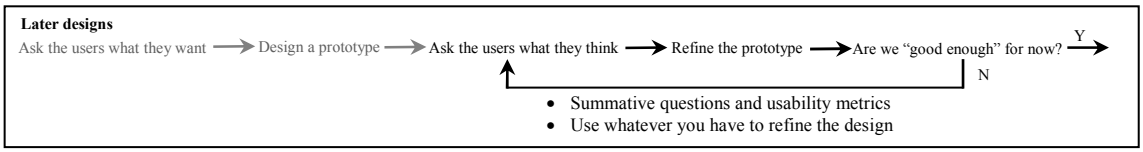

Figure 12. Later design of non-product design

6. Conclusion

Customer satisfaction, CRM, and engineering and science (especially the supply chain) are highly related. Methodology of user-centered design in enhancing customer satisfaction in service-dominant economy is presented.

References

[1] Tadahiko Abe, "What is Service Science?" *Fujitsu Research Institute Research Report*, No.246 (December 2005).

[2] Henry Chesbrough and Jim Spohrer, "A research Manifesto for Services Science," *Communications of the ACM*, (July 2006), pp. 35–40

[3] Paul P. Maglio, Savitha Srinivasan, Jeffrey T. Kreulen, Jim Spohrer, "Service Systems, Service Scientists, SSME, and Innovation," *Communications of the ACM*, (July 2006), pp. 81–85

[4] Lin and Tseng. "Identifying the pivotal role of participation strategies and information technology for supply chain excellence." *Industrial Management & Data Systems* 106(5), (2006), pp. 739-756.

[5] Lovelock, Christopher, and Gummesson, Evert. "Wither service marketing?" In search of new paradigm and fresh perspectives. Journal of Service Research, 47(2004), 9-10 (Summer)

[6] Lusch and Vargo, "A Service-Dominant Mindset", Service Science: Research and Innovations in the Service Economy, Service Science, Management and Engineering Education for the 21st Century, Bill Hefley and Wendy Murphy, Eds (2008).

[7] Mithas, S., M.S. Krishnan and C. Fornell. *Why do customer relationship management applications affect customer satisfaction*. Journal of Marketing, 69 (2005), pp. 201-209.

[8] T J Singh, "Major Trends in BPO-What You Need to Know", *Gartner*, (2007).

[9] Sheehan, J. "Understanding service sector innovation". *Communications of the ACM*, 49(7), (2006), pp 42–47.

[10] Vargo, S.L., & Lush, R.F. "Evolving a services dominant logic". *Journal of Marketing,* 68 (2004a)*,* pp.1-17.

[11] Vargo, S.L., & Lush, R.F. "The four service marketing myths: Remnants of a goods-based, manufacturing model". *Journal of Service Research,* 6 (4)*,* (2004b), pp. 324-335.

[12] Vargo and Lusch. "A Service Logic for Service Science", Service Science: Research and Innovations in the Service Economy, Service Science, Management and Engineering Education for the 21st Century, Bill Hefley and Wendy Murphy, Eds (2008a)

[13] Vargo, S.L., & Lush, R.F. "From goods to service(s): Divergences and convergences of logics" *Industrial Marketing Management* 37(2008b), pp. 254-25