

# Multiagent System-Based Simulation of Service Diffusion in Consumer Networks: Introducing Heterogeneity into Consumer Utility

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## ABSTRACT

*Service design methodologies have been discussed mainly in the service engineering research domain. However, service with good quality does not always diffuse because consumers cannot confirm the quality of a service before purchase. Service quality is also heterogeneous because of the nature of service characteristics. Therefore, the service diffusion process must be studied using computer simulations to clarify the process of acceptance among consumers. This paper presents a multiagent system-based model for examining service diffusion among consumer interactions that are modeled as complex networks incorporating heterogeneity of consumer utility. Computer simulation results show that the heterogeneity of consumer utility affects the service diffusion process as well as the network structure of consumers.*

*Keywords:* Complex Networks, Diffusion, Externality, Heterogeneity of Utility, Multiagent System, Service Engineering

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## INTRODUCTION

Recently, studies of services have become important throughout the world, and particularly in economically developed nations. Not only in the marketing field but also in the engineering field, research activities such as Service Science (Hidaka, 2006; Spohrer, 2007) initi-

ated by IBM, Product-Service System (Mont, 2002) and Service Engineering (Shimomura, 2005) are studied. In the service science and the service engineering research fields, studies mainly analyze services and improving service productivity. They also build new service design methodologies. Nevertheless, because of characteristics of services, good service does not always diffuse. Studies about service diffusion

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processes are necessary in addition to studies of service design methodologies.

Contrasted with products, services have characteristics of intangibility, inseparability, heterogeneity, and perishability (Walok, 1998). Intangibility (Regan, 1963) is an important characteristic: services have no shape because service is a performance. Inseparability (Regan, 1963) of production and consumption is another characteristic: services are produced and consumed simultaneously. Heterogeneity (Zeithaml, 1985) is a characteristic by which service quality is often inconsistent because of the nature of service delivery systems: they involve humans. Perishability (Rathmell, 1966) is another characteristic: it is impossible to stock services. Because of those characteristics, the following influences can be identified in the purchase decisions of consumers: expectations before a purchase become heterogeneous because consumers can not check the quality of the service a priori. The utility from service use also becomes heterogeneous because of the heterogeneity of service quality. It is also said that service quality should be evaluated not by the viewpoint of service providers but by the viewpoint of consumers (Fisk, 2004; Parasuraman, 1985). Therefore, the service diffusion process in service purchases is specifically examined in this study, particularly considering the heterogeneity of consumer utility.

Additionally, it is necessary to consider the communication between consumers to study about service diffusion process. Because enough information is not provided only by the broadcast-type advertisement, communication with other consumers is also important in service diffusion when consumers evaluate service quality (Miyata, 2008). It is said that externality is an important factor affecting diffusion in the economic field. Externality is definable as a situation by which a certain economic subject affects other economic subjects without passage through a market, perhaps by word-of-mouth or through fashion (Figure 1). Therefore, not only the heterogeneity of service quality evaluated by

a consumer but also externalities influenced by the circumference of the consumer are considered to analyze service diffusion process. The influence of the externality occurs as a result of interaction among consumers. Therefore, it is necessary to consider the connections among consumers to study service diffusion.

As an early study of externality, Katz and Shapiro examined and formulated network externality circumstances in which users acquire greater utility as the number of other users increases (Katz & Shapiro, 1985). Furthermore, based on Katz and Shapiro's formula for network externality, Kawamura created a multiagent system-based model of the market in which the connection network of consumers is expressed as complex networks (Kawamura, 2005). In Kawamura's study, the connection networks of consumers were modeled using some kinds of networks with different structural characteristics, and the difference of the network structure affected the product diffusion process. It was also reported that when companies tried to intervene in the market by present strategies, the effects of the presents were influenced by the network structure of consumers and the method of consumer selection to give the product also affected the diffusion of the product. Furthermore, there is a study to introduce consumer's heterogeneity into the Kawamura's market model; it is reported that consumer's heterogeneity and structure of consumer network affects product diffusion process (Eda, 2009). However, although those earlier studies investigate consumer connections as well as the externality, they target products and do not consider differences between products and services. Therefore, this study examines service diffusion processes, particularly considering the heterogeneity of consumer utility by service characteristics and connections of consumers; heterogeneity of consumer utility is introduced into market model where the connection of consumers is expressed as complex networks. Then the service diffusion process is analyzed.

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