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Development of a module based service family design for mass customization of airline sector using the coalition game

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ABSTRACT

The Airline industry faces various issues and difficulties related to its management, which have a peculiar and a complex solution. The objective of this paper is to introduce new and simplified methodologies for improving the airline sector by introducing cost efficient and relatively high payout services. In this paper, we have applied strategic sharing of modules in service family design using coalition game and Cournot game theories to model the related situations. Service family design is a cost-effective way for achieving mass customization by developing highly differentiated products from a common platform while laying emphasis on individual products. A coalitional game is applied which is used to model the potential module sharing and thus determines which modules that are being used in the platform proves to be the most beneficial ones. The empirical evidence suggests that convenience, safety and service quality also have a major influence on the choice of airline passengers. In a Cournot model, new services are predicted to be introduced by an airline and the effect of that service on its profits and thus response from other competitor airlines are carefully examined and result of this, decides the layout of the service in the functionality of the airline. This research can be efficiently used to assist the working of airline companies and help them to select services and have a better understanding of the role of quality of different services in the airline sector as a whole, thus giving them an edge over its competitors.

1. Introduction

The process of "effectively postponing the task of characterizing a product for a particular customer until the latest point in the supply network" is termed as Mass customization. It depends on a company's ability to provide tailored products or services based on the economical development and production systems (Silveria, Borenstein, & Fogliatto, 2001). For mass customization, companies are aspiring to reduce cost and lead-time while development of new products and services takes place satisfying individual customer needs. By reusing and sharing assets like process, components, information and knowledge over a family of products and services, companies and enterprises can efficiently produce a set of differentiated economic offerings by improving responsiveness and flexibility of product and service development.

Mass Customization is defined as the process of distributing wide-market goods and services that are revised to satisfy a specific customer need. Mass customization is a marketing and manufacturing technique that combines the personalization and flexibility of "custom-made" with the small unit costs correlated with mass production. Many applications of mass customization include software-based product configurations that allow end-users to add and/or change certain functionalities of a core product.

Product family design is a cost-effective way for achieving mass customization by allowing highly differentiated products to be developed from a common platform while targeting products to distinct market segments. Recent behavior tends to apply and extend principles and methodologies from product family design to new service development. Families of services and thus service platforms have been developed and are being applied in various service industries. (Hidaka, 2006). For example, an airline industry can develop a family of services by combining common services (e.g., booking, cancellation, change of dates), and various options (e.g., Internet Booking, Personal Insurance) for offering varied services. The common services are considered to be a service platform for the service families to be worked on. Thus, a typical approach so as to create varied services is to provide customers with various choices and options related to specific customer needs, which often lead to additional charges as they add richness to the initial offering. For example, in the IBM service unit of Malaysia, the modularization of the scope of work and methodologies is being applied to service level design for the purpose of mass customization (Peters & Saidin, 2000).

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Now-a-days, most products in industries include additional services for the purpose of satisfying customers' needs and to survive in today's competitive market. For example, GM introduced its On Star 1(OS 1) service to provide maintenance and safety services. Apple-iPod + iTunes too provide various customized services which include operating software and accessories for its iPod MP3 player users. Apple and Nike developed new products for customized services related to exercising by combining their products. Therefore, services should be regarded as an integral factor of product design. These examples in products and services have shifted in many enterprises and industries that produce customized goods and are keen on maximizing resource utilization with the help of sharing and reutilizing distributed design knowledge and vital information when developing new good.

We have used game theoretical approach and evolutionary algorithms to integrate the configuration of supply chain and platform products. In particular, we have built up winner determination algorithms, auction based mechanism to solve product platforms and manufacturing scheduling problems. Auction based algorithm was developed to solve operation-resource problem in numerous type of service scenario. Huang, Zhang, and Lo (2007) has been extended by us in the context of supply chain and manufacturing. In Sikhar, Gaurav, Chris Zhang, Mahanty, and Tiwari (2012) we look for a synergetic alliance between the environmental and commercial benefits by establishing coordination between the producer and the retailer to adjudicate their strategies to trigger green practices with the focus on maximizing economic profits by leveraging upon the product's greenness. A two player game has been developed to stand synonymous to the situation considered. Formulates a multi-objective problem to select a product family and design its supply chain and uses an Interactive Particle Swarm Optimization (IPSO) approach. A case study for a wiring harness supplier of an Automated Guided Vehicle (AGV) manufacturer is considered and IPSO is implemented to solve it. The results establish that the platform-based product development serves the purpose of maintaining market diversity with near optimal cost and profits. In Lyes, Jean-Claude, and Manoj Kumar (2013) we discussed the application of Multi-criteria and Game theory in Manufacturing and Logistics. Vijay, Sujay Deo, Cheikhrouhou, and Tiwari (2012) proposes a scheme for generating optimal process plans for multi jobs in a networked based manufacturing system. An N-person non-co-operative game with complete information is proposed and a mathematical model has been developed to generate the payoff functions. Through this paper we extend our research to different forms of schemes and strategies for the service sector so that resources can be used wisely and in an optimized manner.

The rest of this article has been structured as follows. Section 2 takes us through the related and relevant literature and knowledge about product and service family design along with its typical background information. Section 3 proposes a method for designing customized service families using a coalitional game and a module-based service model. In addition, Cournot's model is discussed to consider the effect of service quality on airline competition. Section 4 presents an illustrative example using airline services provided by different airline providers. Section 5 presents the results and discussion and Section 6 gives the final conclusion and future work.

2. Background and the relevant information

2.1. Service analysis and its ontology

The activity of improving the quality of the product and interaction between the service provider and the customer by emphasizing on the field of managing people, communication, infrastructure, and material components of a service is known as service family design (Hidaka, 2006). Service family design is a cost-effective way for achieving mass customization by developing highly differentiated products from a common platform while laying emphasis on individual products. The basic terms of service family design, for developing customized services, are defined below:

i. A service family is a collection of set of services which results from a service platform, and by the promotion of customer value puts forward the concept of mass customization and provides a varied service for different market segments optimally.
ii. A service platform consists of processes, objects, activities, and/or features that are meant for sharing purpose and remains constant from one service to another, within a given service family and provides a common basis to choose from.
iii. A service module comprises of service components essential for performing a service.
iv. A service component is an activity to satisfy certain services, which further compromises of processes, affairs, people, and/or features.

Thus, by making these definitions a foundation, we extend methodologies from platform-based product family design for the development of module-based service family. A service platform comprises of common service modules. By making use of the service platform, we can develop a variety of families of services and individual services for that matter, for satisfying various market segments which depend on service-related design factors such as location and its layout. This is done for achieving effective customer and work flow, procedures and processes and job definitions for the service providers, extent of customer involvement, equipment choosing and adequate service quality. Formulation of service family design is shown in Fig. 1 (Simpson, 2004).

2.2. Game theoretical model

A game is a detailed analysis of strategic interaction which includes the players' interests and the constraints on the actions and strategies that the players can perform, but it does not specifically tell us about the actions that the players take. The solution space is a systematic and analytic description of the outcomes that can emerge from a family of games (Lariviere & Van Mieghem, 2004). Game theory suggests moderate and acceptable solutions for a family of games and examines their properties.

According to the different constraints and situations, game-theoretic models can be divided into three categories:

a. Cooperative and Non Cooperative Games-A cooperative game is one in which players enforce their contracts through third parties whereas in non-cooperative game players make decisions independently.
b. Strategic and Extensive Games-A strategic game model specifies for each player a set of possible actions and a preference ordering over the set of possible action profiles. Extensive games are used to explicitly represent player's action, their available options and payoffs.
c. Games with complete and incomplete information-In complete information games players at least know that much as those who preceded him/her. While in incomplete information games the player who has to make a choice knows less than those who preceded him/her.