



# Logistics provider selection for omni-channel environment with fuzzy axiomatic design and extended regret theory

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## ARTICLE INFO

### Article history:

Received 25 January 2018

Received in revised form 29 June 2018

Accepted 10 July 2018

### Keywords:

Omni-channel

Logistics provider selection

Axiomatic design

Regret/Rejoice theory

Linguistic variables

## ABSTRACT

As e-commerce marketplaces proliferate, omni-channels will become the new engine of growth. Omni-channel retailers need to optimally determine how to select suitable logistics providers (LSPs) to help maintain their competitive advantage. Although there are many methods to solve the problem of LSP selection, most of them overlook the decision maker's psychology. Most importantly, previous studies paid little attention to the probability of success for each candidate under each criterion. To compensate for these shortcomings, this study proposes a new method of logistics provider selection in an omni-channel environment. We present the model in three phases. The first phase involves computing the probability of success of each LSP with respect to each criterion through axiomatic design method. The second phase uses the perspective of the extended regret aversion/rejoice preference to develop a bounded rational decision making model for determining the criteria weights. In this phase, the regret/rejoice levels are treated as continuous parameters, whereby decision makers can regret and rejoice simultaneously. The final phase computes the expected perceived utility values to select the best LSP. To validate the capability of the proposed model, LSPs of six from a case study are ranked based on the proposed model, and the results are compared with the traditional regret and TOPSIS. The findings suggest that the proposed method provides more reasonable and reliable results, which are in line with the psychological behavior of human beings.

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## 1. Introduction

With the growing adoption of the Internet, smartphones, and handheld devices worldwide, consumer behavior is changing drastically. Already, the rapid expansion of e-commerce marketplaces is creating enormous needs for online shopping [1]. At the same time, the rise in the number of third-party logistics providers (LSP) has pushed the growth of the overall industry. In this context, the omni-channel, as the new engine of growth, is driving the next wave of retail logistics development. Retailers are moving to create an omni-channel approach to sales, where customers have a seamless shopping experience that integrates online shopping from a desktop, mobile device or even in a physical store. However, online shopping is one thing but delivery is another. As the omni-channel retail integrates online services, offline experience, and modern logistics, many other factors determine success in the omni-channel marketplace. Already, retailers are discovering that retail logistics play a key role in the omni-channel. There-

fore, determining suitable logistics providers in an omni-channel environment has become a key consideration for retailers, which involves multi-criteria.

Urban consumers today have growing expectations for flexible delivery/pick-up and /or faster delivery options in a day or hours. This naturally means that retailers must now find ways to solve the “last mile” of delivery in an omni-channel environment. As speed to market is a now competitive imperative for omni-channel retailers, logically then, the assessment and selection of the LSP should also be managed accordingly. However, due to limited time, ability, or incomplete information collection, decision makers often face situations of uncertain or imprecise information [2]. For instance, the exact information about the criteria weights for LSP selection cannot be immediately obtained. There may be a need to use imprecise information, for example, feasible ranges or weights or the ranking of criteria in the order of their importance [3]. In our paper, we consider the value of the criteria with linguistic terms and the weights of the criteria with incomplete or unknown information, to ensure realism of the problem.

Put simply, the LSP selection problem in an omni-channel environment can be considered as a MCDM problem. This selection process includes the decision maker, operational factors, and meth-

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ods. In practice, the decision maker's attitude has a very important bearing on the decision outcomes. Although many models have applied to LSP selection [4–7], they based mainly on the assumptions of complete information and the rational behavior of the decision makers. It is difficult to explain many phenomena in real situations based on the hypothesis of completely rational decision. Moreover, these methods did not consider the probability of success for each candidate under each criterion. Therefore, there is a need to better structure the problem based on fuzzy design of the functional requirements.

Further, Simon [8] suggested that decision makers exercised bounded rationality during the decision process, and thus he proposed the principle of bounded rationality. This led research to explore the actual decision making process [9]. Based on bounded rationality, Loomes [10] and Bell [11] proposed regret theory, whose core idea is that the decision makers not only focus on the results obtained by the choice of the alternative, but also pay heed to the outcome of the other alternatives. Regret theory is now widely applied in various fields, such as route choice [12], insurance [13], and MCDM [14,15]. However, scant attention has paid to regret/rejoice with uncertain and incomplete information.

Due to the above analysis, the core focus of this paper is to propose a novel approach for LSP selection in an omni-channel environment based on the axiomatic design method and regret/rejoice theory. Another focus is to identify relevant decision criteria that are important to the LSP selection problem.

The novel aspects of the paper can be summarized as follows:

- (1) To best of the authors' knowledge, this paper first presents an evaluation system of logistics provider selection for omni-channel environment, which is able to not merely capture the bounded rationality of decision maker under uncertain conditions, but also can avoid the mutual complementarities among attributes.
- (2) This study quantifies the behavior of the decision maker in a fuzzy and incomplete information environment using a regret aversion (or rejoice preference) and determines the probability of success for each candidate under each criterion through the axiomatic design method.
- (3) The paper analyzes sensitivity and compares the proposed method with the traditional regret and TOPSIS, which show that the proposed method is more in line with the psychological behavior of human beings.

The rest of this paper is organized as follows. Section 2 reviews the literature. Section 3 introduces some concepts and theory related to triangular fuzzy numbers, axiomatic design method, and regret theory. Section 4 presents the study framework based on the axiomatic design method and regret/rejoice theory for LSP selection in an omni-channel environment. Section 5 discusses a numerical example on LSP selection to show the feasibility of our proposed method, and applies sensitivity analysis to validate the proposed integrated model. Finally, the conclusions are given in Section 6.

## 2. Literature review

We will first provide an overview of the evaluation criteria for logistics services in an omni-channel environment. Next, we focus on the methods used in the selection of an LSP. The third subsection positions this paper in the context of the existing research gaps.

### 2.1. Logistics evaluation criteria in omni-channel environment

Omni-channel retail deep integrates online services, offline experience, and modern logistics. According to a UPS Pulse of the

Online Shopper survey (2016), consumers want more flexibility in shipping and fulfillment, including the ability to select delivery dates and times, and to re-route packages based on personal preferences. While the LSPs are familiar with bulk orders for delivery, in an omni-channel mode, the storing and packing have become smaller. Today, logistics in the omni-channel allows a retailer to tailor how a product is purchased and delivered. For example, a consumer can walk into a store, find a product, purchase that same item online, and have it delivered to the home the next day. This expectation of instant consumer gratification in turn has retailers scrambling to shore up their supply chain to ensure on time delivery. This place a higher premium on logistics flexibility in procuring, storing, delivery, and last mile service. Logistics is thus a key enabler for the omni-channel. Thus, the LSP needs to combine reliability, performance, agility, and productivity to maintain retailer competitiveness and margins.

From prior studies [16–20] and the characteristics of logistics development in an omni-channel environment, we identify some key criteria relevant to this environment, as follows:

#### 2.1.1. Flexibility and reliability

To ensure enhanced customer service experience, the LSPs need to provide more flexibility to geographic distribution and may offer a larger variety of services to its customers, particularly on special or non-routine requests as reported by Eft [21]. Reliability is the ability of the system to perform its required functions under stated conditions [20]. In this sense, the LSP's service must be seen and accepted as reliable, without the customer having to return the goods the next day for refund or seek refunds for missing delivery consistently.

#### 2.1.2. Service quality

In an omni-environment, consumer demand is the driver. Therefore, service quality reflects a service encounter, which includes the accuracy of order fulfilment, on-time delivery, pre and post-sale services to customers, promptness in attending to complaints. This level of service quality encompasses the product purchase stage and the return stage for unhappy customers [16].

#### 2.1.3. Reputation

It refers to market beliefs of an LSP e.g. how good the LSP is in satisfying customer needs. There are actually no studies done on reputation of LSPs in an omni-channel [20].

#### 2.1.4. Financial record

It is reflected in the firm's return on investment, return on assets, and value added services. Sound financial performance of the logistics provider ensures that the services used in the logistics operations can be continuously upgraded [16,20].

#### 2.1.5. Information system strength

An LSP can collect, aggregate and analyse transactional data. A provider with a robust information system can help to not only increase visibility for the client by way of continuous status updates via dispatch management, but also to continually control the target criteria and to react responsively to exceptional situations in an omni-channel environment [17,18].

#### 2.1.6. Expected cost

The omni-channel retailers need to weigh the cost of the outsourcing of logistics services, which may comprise elements such as contract price, expected leasing cost, cost saving, and operational cost [18,19].

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