



## Expert Systems with Applications

Volume 39, Issue 8, 15 June 2012, Pages 6994-7003

---


# An experience-based system supporting inventory planning: A fuzzy approach

Suphattra Ketsarapong <sup>a</sup> , Varathorn Punyangarm <sup>b</sup> , Kongkiti Phusavat <sup>c</sup> , Binshan Lin <sup>d</sup>  

Show more 

 Share  Cite

---

<https://doi.org/10.1016/j.eswa.2012.01.048> 

[Get rights and content](#) 

---

## Abstract

The study aims to extend the Uncapacitated Fuzzy Single Item Lot Sizing Problem (known as F-USILSP) model and extend it for inventory planning. The F-USILSP model is a good choice when there is no statistical data collection, but where there is verbal or qualitative information from experts with experience. Previously, the mixed integer linear programming (MILP) relied on the crisp assumption which hinders the use of the F-USILSP. In this paper, a Possibility Approach is adapted to convert the F-USILSP to a mathematically solvable equivalent crisp USILSP (EC-USILSP). The EC-USILSP model is tested with a case. The organization under study is a petrochemical company power plant with trapezoidal fuzzy demand and triangular fuzzy unit price. The overall results show that the EC-USILSP is more practical and exhibits more flexibility when there is a need to add more realistic situations.

---

## Introduction

Lot sizing problems are production planning problems of order quantity between purchasing or production lots (Brahimi, Dauzere-Peres, Najid, & Nordli, 2006). Small lot sizes lead to many orders and low inventory levels while large lot sizes lead to few orders and high inventory levels (Lee, Kramer, & Hwang, 1991). The consideration of lot sizes is, therefore, an economic problem in that the objective of inventory models is to minimize total inventory cost, which comprises unit price,

ordering cost, and inventory holding cost, while satisfying demand (Brahimi et al., 2006, Hilmola and Lorentz, 2011, Lee et al., 1991). The first inventory planning model, namely Economic Order Quantity (EOQ), was proposed by Harris (1913). It was used to find an optimal order quantity in the case of an uncapacitated single stage and single item of inventory control with a well-defined demand pattern. Wagner and Whitin (1958) proposed an inventory model with time-vary demand, namely dynamic lot sizing, and used dynamic programming techniques to find an optimal order quantity. Other subsequent inventory models have been developed, based on the above models (Askin and Goldberg, 2002, Barançsi et al., 1990).

The USILSP is a type of inventory model with time-vary demand. Brahimi et al. (2006) stated that there are four basic formulations of the USILSP in the form of mixed integer linear programming or MILP; i.e., aggregate formulation (AGG), formulation without inventory variables (NIF), the shortest path formulation (SHP), and facility location-based formulation without inventory variables (FAL). In addition, Brahimi et al. (2006) added that USILSP modeling is popular for inventory planning for three reasons. Firstly, some industries can aggregate products to obtain a single product, for example, products that differ only in color can be treated as a single product. Secondly, the USILSP is a basic model but can be easily extended for more complex circumstances. Lastly, many complex lot sizing problems must employ USILSP as sub-problems (see Cattrysse et al., 1990, Merle et al., 1999).

Typically, when a classical inventory model is used, the Crisp Deterministic Assumption is required. However, often the information can be uncertain such as a situation in which only qualitative information from experienced operators or personnel. As a result, the fuzzy set theory is applied to resolve this information uncertainty (Dubois and Prade, 1980, Gumus and Guneri, 2009, Ketsarapong and Punyangarm, 2010, Zadeh, 1965, Zimmermann, 1996). In addition, Tütüncü, Aköz, Apaydin, and Petrovic (2008) suggested that some uncertainty within inventory systems should not considers the probability applications. Therefore, since 1980s, the fuzzy set theory has been widely used in modeling of inventory systems when dealing with vagueness and uncertainty (Cakir and Canbolat, 2008, Chang et al., 2006, Chen and Chang, 2008, Dutta et al., 2007, Green et al., 2011, Halim et al., 2011, Hsieh, 2002, Mandal et al., 2005, Pai, 2003, Yao and Lee, 1999).

The rest of the paper is organized as follows: Section 2 presents the research premise; Section 3 presents the research objectives; Section 4 present the four steps of research methodology including, (1) the data collection process, (2) developing an inventory model, transforming the F-USILSP to an EC-USILSP model, developing the EC-USILSP model in the form of MILP, and an illustrative numerical example, (3) data analysis process, and (4) the decision making process. In Section 5, the case application of a petrochemical company is presented. Finally, the last Sections are the conclusions and recommendations for future studies.

---

## Access through your organization

Check access to the full text by signing in through your organization.

Access through your organization

---

## Section snippets

### Research problem

Generally, there are two types of uncertain parameter in a typical inventory model; i.e., fuzziness and randomness, which lead to the fuzzy inventory model and the stochastic inventory model respectively. Most stochastic inventory models are described by statistical or probabilistic information, which deals with the probability distributions of inventory parameters. Since statistical information is collected from a lot of sampling data, high cost and time lost for data collection must be ...

### Research objectives

The objective of this research is to develop an inventory planning model to deal with a single item lot sizing problem with fuzzy parameters. This inventory planning model is designed in response to circumstances where there is lack of quantitative data but abundant experiences from operators or personnel. ...

### Research methodology

The research methodology consists of four parts; (4.1) the data collection process (4.2) a developing inventory model (4.3) computing results and (4.4) a decision making process (see Fig. 1). The steps of each part are as follows. ...

### The case study of a petrochemical company

The case study of this paper focuses on the inventory planning of bituminous coal in a power plant of a petrochemical company. The main purpose of this power plant is to produce electrical power for the company's petrochemical plants, which is the core business of this company. Bituminous coal is the main raw material for the generation of electrical power. Demand for bituminous coal, measured in metric tons, is dependent on the demand for electrical power, which is required for petrochemical ...

### Conclusions

The F-USILSP model was developed mainly for inventory planning. This model is suitable for inventory planning in cases where there is no information from statistical data collection, but there is verbal information from experienced operators or personnel. Such situations frequently occur for SMEs or in cases where there is information from statistical data collection which cannot be used for inventory planning due to unexpected circumstances such as natural disasters resulting in rapid changes ...

## Future studies

In this paper, SILSP with fuzzy parameters, which is a small problem, was selected as the sample to study. Future work could focus on, firstly, using other more sophisticated inventory models, such as a multiple item lot sizing problem in a single-stage and multiple-stage production; and secondly, a study of SILSP over several periods, where these problems would be more complex. Consequently, solving these problems requires a lot of time. For future work, comparisons should therefore be made ...

[Recommended articles](#)

---

## References (37)

N. Brahim *et al.*

### [Single item lot sizing problems](#)

European Journal of Operation Research (2006)

O. Cakir *et al.*

### [A web-based decision support system for multi-criteria inventory classification using fuzzy AHP methodology](#)

Expert System with Applications (2008)

H.C. Chang *et al.*

### [Fuzzy mixture inventory model involving fuzzy random variable lead time demand and fuzzy total demand](#)

European Journal of Operational Research (2006)

S.H. Chen *et al.*

### [Optimization of fuzzy production inventory model with unrepairable defective products](#)

International Journal of Production Economics (2008)

D. Dubois

### [Possibility theory and statistical reasoning](#)

Computational Statistics & Data Analysis (2006)

P. Dutta *et al.*

[Continuous review inventory model in mixed fuzzy and stochastic environment](#)

Applied Mathematics and Computation (2007)

A.T. Gumus *et al.*

[A multi-echelon inventory management framework for stochastic and fuzzy supply chain](#)

Expert Systems with Applications (2009)

C.H. Hsieh

[Optimization of fuzzy production inventory models](#)

Information Sciences (2002)

S. Lertworasirikul *et al.*

[Fuzzy data envelopment analysis \(DEA\): A possibility approach](#)

Fuzzy Sets and Systems (2003)

T.F. Liang *et al.*

[Application of fuzzy sets to manufacturing/distribution planning decisions with multi-product and multi-time period in supply chains](#)

Expert Systems with Applications (2009)



View more references

---

## Cited by (28)

[A cost-minimized two-stage three-way dynamic consensus mechanism for social network-large scale group decision-making: Utilizing K-nearest neighbors for incomplete fuzzy preference relations](#)

2025, Expert Systems with Applications

Show abstract

[A novel rough numbers based extended MACBETH method for the prioritization of the connected autonomous vehicles in real-time traffic management](#)

2023, Expert Systems with Applications

Show abstract