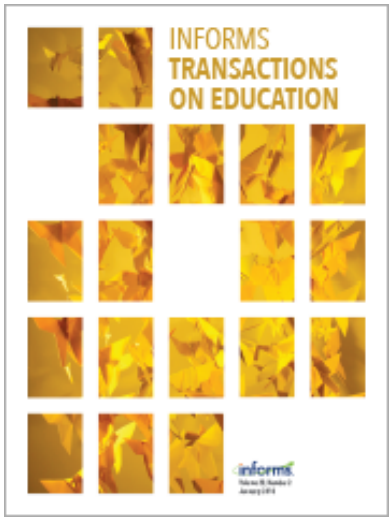

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Case Article

Beijing Opera Mask Sales in Four Cities in the United States

Xiangling Hu, Ashok Kumar
Management Department, Seidman College of Business, Grand Valley State University, Grand Rapids, Michigan 49504
{hux@gvsu.edu, kumara@gvsu.edu}

The Beijing Opera Theater Company organizes four shows a year in the United States, each in a different city. The company sells two styles of souvenir masks during each show. The case narrative is created as the retail manager of the Beijing Opera Theater Company consults her previous MBA professor to seek guidance on available resources to make cost- and service-effective ordering decisions. Available information includes historic demand data of masks and relevant costs and revenues. Other issues discussed include development of a demand forecast for a new site, analysis of the impact of exchange rate fluctuations on the orders, and leftover shipping options. EasyFitXL, a module of Excel, is used to conduct all analyses to arrive at final decisions.

The methodology used to solve the case is the newsvendor model, which is appropriate for making ordering decisions in respect to seasonal, perishable, and short life-cycle items that face uncertain demand. The case requires curve-fitting skills and use of expertise related to the the newsvendor model. It can be utilized by faculty, students, consultants, and practitioners in the areas of operations and supply chain management, operations research, management science, quantitative methods, and industrial engineering to enhance inventory planning expertise.

Key words: newsvendor; judgmental forecasting; cases; teaching production/operations management; spreadsheet modeling; developing analytical skills; developing critical thinking
History: Received: September 2011; accepted: July 2012.

Introduction

The Beijing Opera case study is a teaching resource designed to expose case users to using EasyFitXL to conduct newsvendor related analyses and to develop cost- and service-effective ordering decisions. It is designed for the faculty, students, consultants, and practitioners in the areas of operations and supply chain management, operations research, management science, spreadsheet modeling, and industrial engineering seeking to reinforce expertise in application of inventory planning tools and techniques that fit well with today's competitive environment.

This paper is structured as follows: The next section states the motivation for the case. The third section provides a brief summary of the descriptions of the case and the corresponding questions. The fourth section describes expected learning outcomes, and the fifth section addresses classroom use in various types of courses and the teaching effectiveness from several classroom implementations. The sixth section offers suggestions for successful classroom use, and the last section discusses extensions of the case supported by contemporary research that is intended for future curriculum development.

1. Motivations for the Case

The newsvendor (newsboy/single-period) model is well known in inventory theory (Khouja 1999, Petruzzi and Dada 1998) to develop ordering decisions in respect to seasonal, perishable, or short life-cycle items. Such items partially or fully lose their value after a certain length of time. For the purposes of the newsvendor model, the demand of such items is known only through their distribution over the period. The typical cash flows associated with each item in a newsvendor model are price, salvage value if unsold, purchase or procurement cost, and ill-will cost if an item was short.

The newsvendor model is applied for revenue/yield management in the service industry and for capacity and inventory management in the manufacturing industry. The newsvendor model has been

employed in the industry to substantially improve profits. Nettesine and Shumski (2002) state, "Yield management has been an enormously important motivation in service industry," and they go on to quantify the revenue increases in several industries as a result of using the newsvendor model. According to them, American Airlines saves about $500 million a year and Marriott saves about $100 million a year through newsvendor application. Boyd (1998) points out that Delta saves approximately $300 million a year using the newsvendor model for revenue management. An experiment of an NFL replica jersey business of Reebok showed that its service level increased from 86% to 96% and profit was increased by 6% by using the appropriate newsvendor model (Parsons 2004).

Even though the newsvendor problem is an important practice in today's competitive environment, evidence shows that students are not learning newsvendor in a way that enables them to effectively implement it. Pfeifer et al. (2001) show through a newsvendor teaching example that an important criterion often missed in operations relevant course instruction is the address of how students will actually make decisions in the workplace after taking the course. Students are often not able to adapt the methods learned in their courses to their work environments. The gaps between the course learning and actual newsvendor inventory decisions are also addressed by Schweitzer and Carchon (2000). They examined both high and low safety stock conditions in which the optimal order quantity was above or below average demand. The game was repeated, and feedback on realized demand and profitability for each round was provided to the subjects after each round. The data showed that subjects, including second-year MBA students who received classroom training in newsvendor problems a year prior, "consistently ordered amounts lower than the expected profit-maximizing quantity for high-profit products and higher than the expected profit-maximizing quantity for low-profit products." Cachon continues, stating "This too low/too high pattern of choice cannot be explained by risk aversion, risk-seeking preferences, loss avoidance, waste aversion, or underestimating opportunity costs" (p. 418).

Therefore, our purpose is to develop a realistic case to help students overcome the disconnection between the course content and real-world applications in newsvendor scenarios. In studying this "learning by doing" approach Bolton and Katok (2008) discovered that experience and feedback could have a "significant influence on whether inventory is stocked optimally" (p. 519).

To best simulate the realistic sales of masks, we consulted with Beijing Opera Mask Sellers multiple times. In developing the demand data, we took into account the theater locations, available seats, typical attendance rates in the area, and the mean and variances of the available past demands. The demand data was generated using the statistics software S-Plus with different distributions to construct a close-to-reality scenario for students to investigate.

Led by the story and the questions, students develop and discuss the decisions and methods they utilize while they explore the case problem, analyze data, and implement models and professional knowledge to come up with solutions. Thus, we expect students can practice real-life decisions in the classroom, which will later transfer to real-life workplace situations once the application worthiness of the tool or methodology is established.

Our search of case databases (such as Darden, HBS, and Google, and textbooks in operations management and supply chain management) resulted in only a limited number of cases that dealt with the newsvendor model. We found that the newsvendor cases in text books were relatively brief and focused on one given distribution (mostly normal or simple discrete) and required straightforward usage of the critical ratio formula. They are good for introducing the basic concepts and calculations of newsvendor problems but do not provide enough depth to allow retail managers to do their jobs well. Two operations management/management science textbooks (Denardo 2002, Hillier and Hillier 2010) use cases to introduce basic concepts and calculations in newsvendor problems. Denardo (2002) presents a newsvendor case about how to place chicken orders for Sunday dinners in a restaurant. Hillier and Hillier (2010) discuss a case where a newsboy needs to place orders for a certain newspaper in a downtown newsstand. In these two cases, the demand quantities and the corresponding frequencies are known; therefore, newsvendor order placing with simple discrete demands is possible. Hillier and Hillier (2010) also provide a newsvendor case in the exercises that also requires computing the critical ratio. In this case, a young man considers taking a job offer to rent wooden shakes to sell firecrackers to local customers. He needs to decide how to place an order from the wholesaler. The demand is assumed to be normally distributed.

A limited number of cases were found in Darden Business Publishing, Harvard Business School Press databases, and Informs Transaction on Education. Passover in Costa Rica (Raz 2009) deals with a restaurant and a supplier selling matzah bread to the Jewish community for Passover week. The demand distribution for bread is a simple discrete distribution for the restaurant and the supplier. Computations of critical rations are straightforward, and, hence, that of optimal order size. The case also asks for analysis of the supply chain coordination issues that lead to optimal

order size for the restaurant and the supplier combined. Hamptonshire Express (Narayanan and Raman 1998) is written to demonstrate the sensitivities of stock out costs with respect to fill rates, service levels, and profits. Demand is assumed normal. The case write-up is atypical—five problems are presented that sequentially develop insights into the newsvendor model and issues underlying supply chain coordination. Uncle Coco's Magic Shop: A Negotiation Exercise (Raz and Snir 2011) is dedicated to supply chain coordination issues, and contains no teaching notes, whereas the basic setting for our case is the newsvendor model. Yo Wear, Inc. (Weiss 2006) illustrates a "make" or "buy" decision for Yo Wear's trademark shirts: make in the United States versus buy from a foreign country (Hong Kong, China). The newsvendor model can be applied to explore buy decisions to determine the profits from optimal ordering. Demand is assumed normally distributed, and the impact on demand of outsourcing needs is discussed in a qualitative, what-if manner; no data is provided to substantiate this impact. Further, Robb et al. (2010) propose an in-class multi-item newsvendor game in which several items are sold in the class and each student picks one to buy. Then, the students also play the role of a business owner who sells the items to the whole class, and the student needs to decide the order quantity for each item to maximize profit. The game introduces basic concepts of newsvendor, like demand estimation, demand uncertainty, and costs of leftover and shortages.

Compared to the above cases, our case more resembles a story-like narration and is therefore easier and more interesting to read. Furthermore, unlike other cases where discrete or normal distribution details are provided, we include distribution fitting to the historic demand data as a key feature. This is necessary since the correct order size depends on how well the distribution represents the demand pattern. We also require the knowledge of judgmental forecasting to fully analyze decision-makers' options while placing orders. The case addresses other newsvendor important decisions rarely included in the other cases. For instance, there is a determination of the order size when (i) a predetermined service level is required, (ii) there are purchasing cost fluctuations driven by foreign currency exchange rate fluctuations, and (iii) there is a determination of multilocation orders. Also, different levels of complexities built into the questions allow instructors to choose questions that suit different levels of curricula, e.g., undergrad or MBA. Through these features, we believe the case users will gain more extensive and in-depth understanding of newsvendor related problems and their applications.

2. The Case and Teaching Notes Descriptions

The case includes six sections:

1. Beijing Opera Background—background information on the Beijing Opera
2. Demand Management Issues of Beijing Opera—demand information and current ordering methods
3. Record of Discussions of the Meeting—suggestions on demand data analysis and order size decisions
4. The Forecasting Option—methods to forecast demand for the first time for a Beijing Opera show in Grand Rapids
5. A Suggestion for Cutting the Leftover Costs—shipping leftover masks to upcoming shows as a new approach to cut costs
6. A New Challenge from the Potential Cost Changes—making decisions based on the currency exchange rate fluctuations between the United States and China

The story begins when a graduate student named Jia becomes involved with a Beijing Opera Theater company, Art in Motion Ltd., through a career fair on her former college campus. This initial interaction leads to a job interview. She is then hired as the new retail manager for the company.

As a retail manager, one of her jobs is to prepare the sales of two types of masks during Beijing Opera shows. This show has been performed seven times a year for four years in the Steppenwolf Theatre in Chicago, Illinois, and the Purple Rose Theatre in Chelsea, Michigan. Inspired by the success of the show, a new site—the Wharton Center in East Lansing, Michigan—was selected last year.This year, the company decided to have yet another site for a new show at the Circle Theatre in Grand Rapids, Michigan.

Jia needs to decide how many masks of each type should be ordered for each show. When she first started as the retail manager, Jia recorded the demand for each type of mask from each site and placed orders according to the demand from the previous show in the same location. The leftover could be returned to the wholesaler to get partial refunds. This year, Jia consults a local professor in operations management for suggestions on how to improve the profit. The professor offers helpful suggestions on how to effectively analyze the demand data and fit demand distributions. She provides insights into software resources that can be used, forecasting demand from historical data, investigating purchasing costs due to exchange rate fluctuations, and comparing costs associated with the decision of shipping leftover masks to the next performance or selling masks back to the wholesaler.

Along with the case, the teaching notes (available as supplemental material at http://dx.doi.org/10.1287/ited.2013.0107) provide resources to instructors interested in teaching the following skills:

1. Determination of end-of-period leftover and shortage costs.
2. Curve-fitting skills using EasyFitXL (add-on to Excel with free 30-day trial).
3. Computing the cost-optimal order size for a newsvendor type scenario.
4. Computing cost-optimal order size when service level must be complied with.
5. Computing expected cost associated with 2 and 3 above, as well as for any arbitrary order size for selected common distributions, such as normal, Poisson, Johnson SB, uniform (discrete and continuous), and empirical/discrete distributions.
6. Carrying out numerous what-if analyses to develop insights into the Trade-offs of costs and distribution parameters.
7. Juxtaposing forecasting and distribution-based analysis—an in-depth discussion of merits and demerits.

3. Pedagogical Objectives

First, faculty and students are expected to grasp basic concepts and assumptions associated with the newsvendor model. Students should not only learn the features and characteristics of the newsvendor model, but should also be able to implement newsvendor technologies (Excel, EasyFitXL) in real decision-making situations that they may encounter after taking the course. In addition to the technologies mentioned above, the other required newsvendor expectations include but are not limited to (1) determining an order size that guarantees a service level stipulated by the business as well as determining expected shortages, expected excess/leftovers, and expected profits for commonly used distributions, such as normal, Poisson, Johnson SB, uniform (discrete and continuous), and empirical/discrete distributions; (2) calculating the profit for different order quantities when the exact demand is known and comparing expected profit for different order quantities when only the demand distributions are known; (3) understanding the impact of exchange rates on the unit price, cost, and salvage value, and, therefore, on the order quantity and expected profits, followed by analyzing the patterns of order size and expected profits through the sensitivity analyses plots.

In addition, case users gain experience through comparisons and decisions they make among different judgmental forecasting methods. Therefore, the case users are fully versed in the characteristics, advantages, disadvantages, assumptions, and limitations of using the newsvendor model. This allows them to understand how to use the methodology for a range of possible scenarios.

Moreover, the case familiarizes the users on how to find the best fit distributions for data using EasyFitXL. The users will learn how to choose the correct fit in the event there is conflict between various fit measures. In this case, five groups of data with the distributions of normal, Poisson, Johnson SB, uniform (discrete and continuous), empirical/discrete distributions, as well as approximation of Poisson to normal, are provided for two products in three cities. Students should be able to use the Excel add-in within EasyFitXL to fit a large number of distributions to the demand data for the two types of masks from previous shows. Then, they select the best fitting model by analyzing the graphs and reports.

Finally, built upon the knowledge base listed above, actual application skill is the ultimate goal. Normally, reality is not so "pure" and straightforward as the textbook examples, and conditions and variables are also not well defined. After practicing with the newsvendor model, students are expected to understand how to eliminate the "noise" and grasp the key information, know how to define the variables and set up models correctly, and then to solve the problems through accurate procedures. Overall, students are expected to not only learn the features and characteristics of the newsvendor model but should also be able to implement the newsvendor methodology, including the use of associated technologies, to real decision-making situations they may encounter after taking the course.

4. Classroom Experience and Teaching Effectiveness

Successfully, this case is currently used, and has been for the past four semesters, with college seniors in the undergraduate course Operations Management. The data analysis portion of the case is also being implemented in another undergraduate course, Computers in Operations Management. This case is even used at the graduate level for the course Operations and Supply Chain Management. As students join these classes, basic knowledge of statistics and Excel they acquire through appropriate courses are a prerequisite. This prepares them to use Excel and EasyFitXL, as well as to understand the concepts of mean, standard deviation, and fractiles related to distributions as they solve the Beijing Opera case.

In teaching the case, the instructor first explains the concepts related to newsvendor problems and shows a video of the Beijing Opera. Many free Beijing Opera videos are available online; for example, a search for "Beijing Opera" on www.youtube.com lists several pertinent clips. On the first day, the instructor describes the Beijing Opera, has students read

background material on the Beijing Opera in §1 of the case, and allows them to wear example souvenir masks. The assigned reading for the following class is the actual case. This helps students to develop background knowledge and to connect with the story prior to engaging with the case itself. Therefore, students readily associate the case with realistic situations and start the lesson on an exciting note.

In the next class, the instructor leads a discussion, guiding students through the story questions. Listening to student feedback will determine how well students are understanding computations and the practical aspects of the decisions involved. The instructor shows the students how to use EasyFitXL to fit distributions using one group of data and has students complete the rest in or after class. The instructor also shows how to calculate order quantity using different distributions and has the students practice these calculations after class by changing the costs and service levels correspondingly. Through practice, students become more proficient in data fitting and newsvendor related calculations.

During the project, students are comfortable implementing the equations in Excel to compute order sizes but have difficulty in understanding how the equations were initially derived. Demand forecasting allows the students to discuss methods to make accurate and informed decisions by utilizing historical data from the case and by speaking with experts from the community who provide insights into the causal factors that are responsible for a given demand level. Bonus questions are also provided to both graduate and undergraduate students. However, specifically, graduate students are challenged with questions involving monetary exchange rate issues between the United States and China, as well as relative possible benefits of shipping leftover masks to upcoming shows versus selling them back to the wholesaler.

Teaching this case achieves numerous benefits. First, students develop in-depth skills in curve fitting, judgmental forecasting, and proficiency in newsvendor model applications. They also develop skills in using Excel and EasyFitXL for real-life applications, which will help them to become better analyzers and mangers.

Exam and homework scores provide evidence that the teaching and learning strategies developed in this case study are effective. Exam and homework results show that 92% of the undergraduate students, and 100% of the graduate students, grasp basic calculations and key terms and concepts, such as leftover, shortage, trade-offs, stocking level, order quantity, and their myriad interrelationships. These numbers are vastly better than observed when the case was not part of the curriculum.

Second, the case provides an entertaining and enjoyable way for users to gain knowledge, practice skills, and hone Excel competency in newsvendor problems. Students enjoy the realization that a typically monotonous subject with simplistic equations has a direct connection with an interesting, real-life story. Most students respond enthusiastically to the case, information on the Beijing Opera, and the souvenir masks. They express an appreciation for the opportunity to work on comprehensive, realistic problems, rather than the traditional, mechanical homework. The discussions between the retail manager and the professor make the abstract concepts easy to understand, vivid, and meaningful from a real-world standpoint.

Third, the case compels students to engage in critical thinking, especially as they figure out the overage and underage costs and service level related issues. When students have experienced and overcome the emotional difficulty of implementing the concepts and equations related to the newsvendor model, they begin to realize the complexity and richness of the subject.

Fourth, students appreciate the opportunity to apply concepts and tools from multiple topics to a single practical problem. Further, as also discussed in §6, the variety of course content combined in the project allows the sections and questions to be used separately for different topics. Level of difficulty, scope, and time requirements may also be adjusted. For example, data analysis (question 1 in the teaching notes) requires material from a statistics course as well as the use of computer skills. A full analysis of Cases §§1–3 requires the understanding of newsvendor model calculations. Case §4 exposes the users to judgmental forecasting methods taught in the forecasting chapters of most operations management textbooks and allows comparative analysis among four judgmental forecasting methods: sales force opinions, executive opinions, consumer surveys, and the Delphi method. Cases §§5 and 6 are designed to challenge students' critical thinking about newsvendor model problems.

Lastly, this case provides useful flexibilities in modeling and constitutes a stepping stone for further extensions (see §6).

5. Suggested Classroom Use

This case is appropriate for undergraduate and MBA classes in operations management, supply chain management, operations research, management science, and industrial engineering and other related spreadsheet modeling classes. If the case appears to be a good fit within the framework of a course's learning objectives, the next step is to ensure that the project is administered effectively.

Students can explore this case in groups or as individuals. However, working in groups will allow students to more easily discuss and collaborate when deciding how to develop solutions to the various distribution and forecasting issues that arise. Groups also foster confidence in students who may get stuck on the more challenging aspects of the case. Some vital resources that are needed to teach the case include access to MS Excel 2007 or later, EasyFitXL (can be downloaded for free for a limited trial period), and a computer data projection system to display instructions, data, and other necessary information.

Depending on skill level, the case can be modified to meet the needs and learning styles of students. For example, undergraduate as well as graduate students should work through §§1, 2, 3, and 4 of the case to practice their skills with the newsvendor model and judgmental forecasting. Section 5 in the case provides an extension activity that gives the instructor the option to further challenge both undergraduate and MBA students on how to transform a special multilocation newsvendor problem to a solvable problem using four simple independent newsvendor problems. MBA students should exhibit analysis skills, be comfortable with formula development, and understand how changes in parameters impact the final solution. Thereby, they will be better prepared to handle the sensitivity analyses based on costs and demand parameters.

Correspondingly, the teaching notes document that is included provides the instructor with appropriate questions to match the skill levels of the students. Questions 1, 2, 3, 4, and 5 in the teaching notes are intended for undergraduate students but can be utilized with MBA students as well. Questions 6, 7, 8, and 9 are more suitable for MBA students. However, if time permits, they can also be assigned at the undergraduate level. Question 10 is the optional question that can be used to extend the discussion for all students (for a list of the questions to be used with students, please refer to the teaching notes).

It may take three to five class hours (one to two weeks) to cover the required materials in detail, including the discussion time for an undergraduate course that focuses on questions 1 through 5 only. At the MBA level, a thorough discussion of all 10 questions is necessary, so we recommend six hours of class teaching and discussion. At the undergraduate and MBA level, supplemental problems may be constructed for each question to demonstrate the computations.

Apart from undergraduate and graduate courses, this case is also suitable for advanced courses for Ph.D. students in the areas previously listed. At the doctoral level, in addition to answering all 10 questions asked in the teaching notes, students can be asked to derive expected leftover, expected shortage, and expected profit equations for a given order quantity when demand is distributed according to normal, Poisson, Johnson SB, uniform (discrete and continuous), empirical/discrete distributions. The equation derivations are provided in §4.1 in the teaching notes. More advanced calculations are suggested in the next section.

Finally, this case can also be used for a midterm or term project after the students have mastered the necessary newsvendor skills. The selection of questions assigned in the homework can be calibrated with the level of weight and complexity expected from the term paper.

6. Advanced Applications and Extensions of the Newsvendor Model

By adding appropriate questions or adding new data to the original case, the Beijing Opera case provides opportunities for extensions to suit different levels of students and serve different content focuses. One extension is about multilocation newsvendor methods and characteristics. For example, if the company Art in Motion Ltd. places one order for four cities altogether so that a lower unit price is given by the wholesaler, how to place the order? The corresponding research in multilocation newsvendor problems include but are not limited to Ho et al. (2010), as well as Federgruen and Zipkin (1984) and Eppen and Schrage (1981).

Another beneficial extension of this paper involves joint pricing and inventory decisions. In the case, Art in Motion Ltd. can change its selling prices to attract more or less customers. When the selling prices increase, customers are less likely to buy, but the profit gained from each sold item increases. Therefore, students need to find the trade-off between marginal profit and demand to maximize the total profit. Petruzzi and Dada (1998) review literature about joint pricing and inventory decisions when demand is stochastic and negatively impacted by selling price. Further related work includes Agrawal and Seshadri (2000) and Elmaghraby and Keskinocak (2003), among others.

The demand data can also be altered to provide students the opportunity to work with time-series effects on demand. Seasonal effect is a concept that can be added to the case by including increasing and decreasing trends in a cyclic fashion that will affect inventory decisions. Some resources that are available to guide the process of extending this case to deal with seasonal variations include Smith and Achabal (1998), who review the concept of seasonal effect involving end of season inventory management

in retailing. Similar research can be found in Fadıloglu et al. (2008), and Bitran and Mondschein (1997).

7. Conclusion

This case can be used for classroom teaching in the area of operations management, supply chain management, operations research, management science, and industrial engineering and in other related spreadsheet modeling classes, The basic aim therein will be to enhance students' capabilities in effectively managing inventories of seasonal, perishable, and short life-cycle items using the newsvendor model for analysis, Excel for computations, and EasyFitXL for distribution fitting.

Through the use of the teaching notes, the case sharpens students' ordering skills such that the expected cost of inventory carrying for such items may be minimized, or a predetermined service level may be maintained as the items face stochastic demand. Students also learn how to compute expected shortages, expected overages, and expected costs associated with the order quantity when demand is distributed according to normal, Poisson, Johnson SB, uniform (discrete and continuous), and empirical/discrete distributions. The teaching notes are developed around 10 questions related to the newsvendor model of inventory management and judgmental forecasting issues. A judicious selection from these questions allows desired flexibility in levels of complexity and teaching time required, thus permitting the case to be adapted to undergraduate or graduate levels. In addition, the questions can be covered inside or outside the classroom, depending on the level of challenge the instructor wants to implement. The case can be used as a term project, and the suggested extensions allow the case to be taught at Ph.D. levels as well. Our experience in using this case at the undergraduate and master's levels in a business school has shown that students believe the case is developed around an interesting topic and that helps them learn inventory-planning skills through valuable activities.

Supplemental Material

Supplemental material to this paper is available at http://dx.doi.org/10.1287/ited.2013.0107.

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