Abstracts of Papers in English

JOINT REPLENISHMENT OF PERISHABLE ITEMS WITH PARTIAL BACKORDER CONSIDERING DIRECT AND INDIRECT GROUPING APPROACHES

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Abstract

Appropriate management of the inventory control system of perishable items plays an important role in organizations' total cost due to short life cycle and perishability of the items. An inventory control system includes the allocation of orders to suppliers, identification of inventory replenishment quantities, and coordination of joint orders. This paper proposes mathematical models in the multi-supplier joint replenishment problem of perishable items with partial backorder by considering direct and indirect grouping approaches. In the case of direct grouping approach, the inventory items are categorized into permanent groups and all the items in a group are ordered at the same time, while in the indirect grouping approach, each item is ordered in an integer multiple of a base cycle time. Therefore, in the indirect grouping approach, the groups are formed temporarily in each cycle with the items that have a common replenishment cycle. In order to simplify the exponential elements of the equations, Taylor's expansion is used to achieve a polynomial approximation for the model. The closed-form solution of the model is presented in a special case in which there is a single supplier and the unsatisfied demand is fully backordered. In this regard, the ratio of time with positive inventory level at each replenishment cycle is equal to the ratio of unit backorder cost to the summation of perishability rate, unit holding cost, and unit backorder costs. The two approaches are

analyzed through solving a numerical example in GAMS software. Based on the results, at small values of major ordering cost, the indirect grouping strategy is relatively more preferable. However, at larger values, the two strategies are almost similar. Based on the sensitivity analysis of numerical example, it was found that increasing the rate of perishability caused the system to increase the shortage level and hence, the total sales decreased. In addition, increasing the main ordering cost increases the replenishment cycle and the total purchasing quantity, but does not have a significant effect on the proportion of time with a positive inventory.

Key Words: Joint replenishment, perishability, direct grouping, indirect grouping, partial backorder.

REAL-TIME AMBULANCE RELOCATION MATHEMATICAL MODEL FOR EMERGENCY SYSTEM CONSIDERING MULTIPLE COVERAGE RANGE, RELOCATION COSTS, WORKLOAD LIMITATION, AND PRIORITIZATION OF EMERGENCY CALLS

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Abstract

Emergency Medical Service (EMS) managers are concerned with providing maximum possible coverage in their service area. As emergency calls arrive into the EMS system, some ambulances become unavailable. Redeployment deals with a dynamic relocation of available ambulances so as to compensate for the loss in coverage due to busy ambulances. Real-time approaches aim to select the best relocation plans, taking into account the state of the system at a moment when decisions are made. Unsystematic redeployment can impose superfluous workload and result in unnecessary fatigue for EMS personnel. This paper develops a real-time approach to maximize coverage with minimum possible total travel time, considering accumulated workload restrictions for personnel in a shift. The proposed model considers the coverage of areas by base stations in three coverage ranges and its main purpose is to cover the shortest range. Also, the model considers the workload added to the ambulances resulting from the relocation decision. At any time, ambulances move in such a way that workload on them does not exceed a certain limit. The model is presented with an online approach and some parameters are updated as time changes. The case study in this article is related to the eastern part of Tehran. The population of this area is about 3 million people: its area is 170 square kilometers and is divided into 48 areas. For sensitivity analysis, the relocation problem can be divided into two parts: pre-implementation and post-implementation. Prior to implementing the model, depending on the disruption to the system, the location of ambulances may not be appropriate to meet future demands. After running the model, the base of some ambulances may change. Following this change, the extent of coverage of demand points by the bases will change significantly. For this purpose, the criterion is the number of coverage points of demand by base stations within a coverage range of 1r minute.

Key Words: Dynamic redeployment, healthcare, EMS, response times.

SUPPLY CHAIN REDESIGN FOR NEW PRODUCT DEVELOPMENT WITH DUAL-PRODUCT ROLLOVER STRATEGY (CASE STUDY HEADPHONE INDUSTRY)

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Abstract

Introducing new products for companies in a competitive business environment is imperative. Designing an appropriate supply chain for the successful development of new products leads to growth and success in the competition. Supply chain design or configuration is essential to the success of a business since it can increase the profit of the whole supply chain. Supply chain management aims to determine the link between network components and specify the inventory level in each part of the supply network, production quantity, manner of transportation, and other related problems. Also, during the new product development process, companies encounter decisions such as producing independent products, immediate replacement of a new product with an old one (single-product rollover strategy), or gradual replacement over several periods (dual-product rollover strategy). A dual-product rollover strategy can be more efficient and less costly in some cases, although it has received less attention. In the present study, the four-level supply chain (including suppliers, manufacturers, distributors, and customers groups) model for old and new products is presented by considering a dual-product rollover strategy. Objective function consists of net profit for manufacturers and distributors, cost of customer dissatisfaction, cost of unemployment resources, and cost of designing new products. Also, constraints control the equality between production and inventory with the flow of products, production capacity, product rollover strategy, shipping the goods after that connection determined, and level of initial inventory. The model is solved by GAMS software using actual data from a company that is active in the digital appliance industry and produces wired and wireless headphones as non-independent products (it is implied that with launching the wireless headphone, demand for wired headphones is reduced). After presenting the results, sensitivity analysis is performed on the parameters to determine the most effective ones on the objective function. Then, the results of solving this model under a dual-product rollover strategy are compared with those of the single-product rollover strategy (the model can be converted into a single-product rollover strategy by modifying rollover parameter), and managerial insights are presented.

Key Words: New product development (NPD), dual-product rollover strategy, supply chain design, supplier selection, product lifecycle.

SIMULATION BASED OPTIMIZATION IN MULTI-PRODUCT THREE-LEVEL PRODUCTION SYSTEM BY MULTIFUNCTIONAL MACHINES (CASE STUDY: SINGLE AND DOUBLE POLYETHYLENE PIPE AND FITTINGS)

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Abstract

Production planning is one of the most important functions in the production process and operations management. Production planning should be carried out under uncertainty and in consideration of these uncertainties, it leads to the real model of production planning. Considering that the goal is to minimize the cost and maximize profits from the inventory, it can be said that the cost and benefits of each system are affected by decisions related to inventory. Therefore, recognizing and finding solutions to optimize such a complex system can help improve production. In this paper, a multi-product manufacturing company with geographical dispersion under the uncertainty of customer entry is investigated. One of the innovations of this paper is the use of simulation to solve the three-level supply chain using multipurpose machines with geographical dispersion. At each level, there are several selections with geographical distribution, where all producers are subsets of a single company. Other innovations include the heterogeneity of machines and the ability of retailers to meet demand from surrounding warehouses if critical conditions arise. Production control policies are based on inventory control. This includes production and maintenance of products aimed at attracting customer satisfaction to avoid the shortage, which is possible with the cooperation of factories and warehouses. The final product demand in the given system is under uncertainty and the generated

waste can be converted into a final product after the remanufacturing. Such a shortage will lead to the loss of the client. Due to the uncertainty and complexity of these systems, system simulation has been carried out using ARENA software version 14.0. Then, to optimize this system, the OptQuest software has been used to optimize the model, which results in determining the optimal production rate. The results of the numerical example show that the costs of this system have decreased significantly.

Key Words: Simulation, multilevel supply chain, production optimization, multipurpose machines, uncertainty.

A MATHEMATICAL MODEL FOR SELECTING INVESTMENT PROJECTS BASED ON SUSTAINABLE DEVELOPMENT GOALS IN THE FACE OF UNCERTAIN CONDITIONS AND LIMITED RESOURCES

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Abstract

The investment project selection problem is one of the most pressing challenges confronting organization managers, and its primary goal is to assist investors in selecting the best set of projects given the circumstances of their decision-making environment. In this work, a multi-objective mathematical model is developed for choosing investment projects across a multi-period horizon based on sustainable development goals. The gains from project execution are maximized in terms of the economic dimension of the sustainability. The quantity of greenhouse gas emissions, produced waste, and energy spent to supply the needed raw materials are minimized in accordance with the environmental dimension. The number of job openings, the number of individuals covered by insurance, the work satisfaction of employees as a result of delivering welfare services, the project's influence on the local economy, and the number of days lost are all factors to consider in the social component of sustainability. Real-world limitations like machinery, labor, raw materials, and the capacity of suppliers to deliver the needed raw materials for projects are all taken into account in the suggested model. As it is seldom feasible to determine the precise value of parameters, uncertainty in the strategic and operational parameters of the project selection model is also taken into consideration. To cope with uncertainty in the model parameters, the fuzzy possibilistic programming technique is utilized. A two-stage solution technique is provided for solving the proposed model. The importance weight of environmental and social goals is calculated in the first stage using the group best-worst approach. The multi-objective mixed integer programming model is then transformed into a single-objective model using a fuzzy interactive programming in the second stage. The efficacy of the suggested model is demonstrated by numerical findings, which indicate that incorporating sustainable development goals allows investors to analyze strategic project selection decisions from three perspectives: profit, environment, and social.

Key Words: Project selection, limitation of resources, sustainable development, uncertainty, fuzzy possibilistic programming.

MONITORING AND FORECASTING QUALITY OF TWO-STAGE THYROID CANCER SURGERY USING RISK-ADJUSTED TIME VARYING STATE SPACE MODEL

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Abstract

Health services research (HSR) is of great importance to communities because decision-makers and public consider HSR as the primary source of information to determine how well health systems are meeting their specifications. Nowadays, in healthcare, there are many therapeutic processes whose results are obtained by some related stages. For studying these kinds of processes, commonly referred to as multi-stage processes, two concepts are important: one is risk adjustment, and the other is considering the cascade property. An example of a multi-stage therapeutic process is thyroid cancer surgery, which is usually performed on patients in two stages and part of the cancerous tumors are removed at each stage. In the two-stage thyroid cancer surgery, the quality of second surgery will be affected by the results of the first stage operation. For monitoring these processes, various control charts are used including model-based control charts. To design such charts, an appropriate model should be identified at first; then, control charts could be proposed based on the identified model. In this research, a risk-adjusted time-varying linear state space model is introduced for analyzing the multi-stage therapeutic processes. The state space models are statistical models that many researchers have used to analyze multi-stage processes. These models are based on engineering knowledge and the physical laws of real systems. Then, the model order and its parameters are estimated by Hankel singular value decomposition (HSVD) and prediction error minimization (PEM) methods, respectively. This is called input-output identification. The model performance is evaluated using numerical simulation and a real world two-stage thyroid surgery dataset. Based on the satisfactory results, one can use the model while simultaneously considering risk adjustment, cascade property, transmission error, and test error to forecast and monitor multi-stage therapeutic processes.

Key Words: Multi-Stage therapeutic processes, risk adjustment, state space model (SSM), System identification, thyroid cancer surgery.

OPTIMIZATION OF GOLD CLOSED-LOOP SUPPLY CHAIN PERFORMANCE WITH EMPHASIS ON SOCIAL RESPONSIBILITIES UNDER UNCERTAINTY (CASE STUDY: ZARSHOURAN GOLD FACTORY)

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Abstract

Mining supply chain management is important because successful chain implementation reduces costs, increases profits and productivity, and reduces risk. The extraction of these mines and the processing of mineral products, despite the positive effects on the economy and job creation, have many negative effects on the environment. The need to pay attention to the positive economic and social effects and adverse environmental effects of supply chains has led researchers to model social responsibilities. In fact, by modeling the supply chain and optimizing it, in addition to increasing the economic benefits of the supply chain, we can have a more accurate view of the potential decisions and future effects of these decisions. The purpose of this study is to mathematically model the supply chain of the Zarshuran gold mine with the aim of maximizing the economic benefits and social responsibilities simultaneously in the condition of uncertainty. Gold prices and customer demand are considered uncertain in the proposed model. This two-objective supply chain optimization model is one of the NP hard problems that cannot be solved by using precise methods. Therefore, meta-heuristic algorithms, Strength Pareto Evolutionary Algorithm II (SPEA-II), and Nondominated Sorting Genetic Algorithm (NSGA-II) are used here to optimize the supply chain. The results showed that there was an inverse relationship between supply chain economic profit and corporate social responsibility. It was also shown that with factors such as increasing production efficiency, both economic profits and social responsibilities of the company could be increased simultaneously. Sensitivity analysis of gold

sales capacity showed that upon increasing sales, economic profits and social responsibility would increase. In fact, with the increase of production, the amount of greenhouse gas production and the amount of waste soil production as well as the amount of water consumption increase, but the welfare benefits divided by the region and the employment created overcome these negative factors and promote social responsibility.

Key Words: Optimization, closed-loop supply chain, sustainable supply chain network, social responsibility, gold supply chain, mining industry, uncertainty.

SUSTAINABLE MULTI-PERIOD HUB LOCATION: A DYNAMIC PROGRAMMING APPROACH

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Abstract

Today, many transportation systems use hub and spoke structures to transfer flow (good, message, passenger, etc.) from origin to destination. In such systems, the manager must plan for the location of the hubs and the allocation of other demand points to the hubs and other decisions during the planning horizon. Also, if the planning horizon is continuous time, the manager must also determine the timing of implementing the decisions. To determine the optimal decisions during the planning horizon and the best time for implementing decisions (i.e., breakpoints) according to sustainability aspects. In this research, a mathematical programming model is presented for a sustainable multi-period hub location problem in which the transportation demand between different origin-destination pairs is time-dependent and the planning horizon is continuous-time. The problem is formulated as a nonlinear multi-objective mixed integer programming model. Sustainability aspects are considered as objectives of the model. These objectives are minimizing transportation system costs, minimizing emissions in the transportation network, and maximizing fixed and variable job opportunities created by hubs during the planning horizon. Also, some valid inequalities are presented for strengthening the formulation of the problem. To solve the problem, we first use the Augmented Epsilon Constraint method version 2 (AUGMECON2) and then, use a dynamic programming approach to determine the optimal values of the breakpoints of the planning horizon. Using the proposed dynamic programming method, in each stage, some of decision variables are fixed and the number of variables in the original problem is reduced and instead of a nonlinear mixed integer programming problem, we solve a mixed integer linear programming problem that is easier to solve. The results of the solution methods are presented for a sample problem on the Turkish network dataset. Also, the CAB dataset is used to validate the dynamic programming method. The results show that the dynamic programming approach can solve problems with up to 25 nodes and 6 time periods.

Key Words: Hub location problem, sustainability, multi-period planning, continuous-time planning horizon, dynamic programming.

DESIGNING A RUN SUM CONTROL CHART FOR MONITORING MULTIVARIATE COEFFICIENT OF VARIATION IN THE PRESENCE OF MEASUREMENT ERRORS

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Abstract

Most Shewhart control charts are designed to monitor changes in the mean or variance of the process. There are some situations when the process mean fluctuates from time to time, but is still considered as in-control and the process standard deviation is a linear function of the process mean. In addition, in some cases, the

mean and the variance of the process are actually dependent on each other. Also, in many processes, monitoring the mean or variance of the process is unreasonable due to the nature of the process, and it is recommended that the coefficient of variation be used to monitor the process. Although monitoring multivariate coefficient of variation was studied at both Phases I and II, the design of chart for monitoring multivariate CV considering measurement errors was not thoroughly studied in previous studies; hence, it has been considered in this research. In this paper, a run sum control chart is developed for monitoring multivariate coefficient of variation in the presence of measurement errors at Phase II and the performance of the proposed chart with and without the assumption of measurement errors was compared through Average Run Length (ARL) criterion based on Markov chain approach. The results show that the presence of measurement errors has a negative effect on the performance of the run sum control chart. In other words, ARL of the run sum chart in the presence of measurement errors gets far away from the corresponding value without measurement errors as the magnitude of measurement errors increases. This research considers multiple measurements approach to reduce the effect of measurement errors on the performance of control charts in monitoring the multivariate coefficient of variation at Phase II. The results of the proposed chart's performance show that ARL decreases in the presence of measurement errors due to increasing the effect of measurement errors on the performance of control chart. The results show that by using the multiple measurements approach, the results become closer to the case without measurement errors.

Key Words: Control chart, monitoring coefficient of variation, measurement errors, multivariate coefficient of variation, markov chain.

MATHEMATICAL MODELING AND FUZZY ε -CONSTRAINT METHOD FOR CLOSED-LOOP MASK SUPPLY CHAIN DESIGN

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Abstract

The outbreak of the deadly coronavirus, which is increasing the number of victims every day, has created many changes in today's world. The use of masks is the most important social tool against this virus. This pandemic has caused a dramatic shortage in the medical supplies needed to treat the virus due to a massive surge in demand as the disease circled the globe during the first half of 2020. Given the importance of rapid and efficient supply of masks in the current situation, it is necessary to study its supply chain in particular. A supply chain is a set of activities including purchase, production, and transportation in order to deliver goods or services to customers.

In this research, the design of the closed chain supply chain network for different types of masks is assessed. The studied supply chain includes suppliers, manufacturers, distributors, and retailers in the forward flow and collection centers, separate centers, recycling centers, and disposal centers in the backward flow. In this regard, a bi-objective mathematical model with the objectives of increasing the total profit and reducing the total environmental impact is presented. In this problem, there are some potential locations for collection, recycling, and disposal centers and the model should decide on the location of the established centers as well as the number of produced masks and raw materials. The optimization of this mathematical model was done using fuzzy epsilon-constraint method in GAMS software. The epsilon-constraint method has an advantage that generates Pareto solutions to multi-objective problems. The sample problems are generated using the data of a company in Isfahan, Iran. This company produces 3-layer medical masks and N95 masks, and three raw materials of fabric, mask band, and exhalation valve are used. The results show that maximizing the total profit and minimizing the environmental effects are in contrast to each other, because reducing the environmental impact leads to an increase in total costs and thus, reduction in the organization's profit. Also, increasing demand for mask types increases the profit of the supply chain linearly, but its impact on the chain's environmental impact is completely nonlinear.

Key Words: Mask supply chain, supply chain network design, closed-loop supply chain, fuzzy optimization approach, environmental effects.