

both the control chart with fixed sampling interval and the one with variable sampling interval while detecting various shifts is under consideration. The superiority is of paramount importance and it is strongly recommended to apply the proposed monitoring schemes instead of its existing counterparts in the literature. Finally, the proper statistical design of the proposed con-

trol charts has been thoroughly addressed and discussed which helps engineers to identify shifts more quickly and implement corrective actions in a timely manner.

**Key Words:** Multistage processes, adaptive control chart, variable sampling interval with sampling at fixed time, adjusted average time to signal.

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### Abstract

Nowadays, because of low financial ability of some of the buyers, saving natural resources and preventing unnecessary waste of energy and materials to produce new products, second-hand products have attracted extraordinary attention. Therefore, markets are divided into two parts, which are markets of new and second-hand products. Manufacturers try to give peace of mind to customers regarding their products in order to capture more share of markets and customers satisfaction. An important factor in providing customer's peace of mind is warranty. This issue becomes more important regarding the second-hand products. Since customers are usually unaware of the product's past performance, dealers consider warranty and upgrades for these products until the customer does not doubt toward buying the product. Considering warranty and upgrade have the cost, make to increase the product's sale price, and make to increase the complexity of the model as a result, making decisions in such an environment is too complex also considering upgrade action will make to increase the second-hand product's reliability during the useful life of the product. Warranty period can be considered one-dimensional or two-dimensional. But because the dealer seek to calculate exactly the expected cost and the expected number of the product's failures during warranty coverage then warranty should be considered two-dimensional and the dealer calculates the cost of expected number of the product's failures during warranty coverage and adds it to the sale price of the product. Therefore, Upgrade action has increased the sale price of the second-hand product on one hand, has decreased the expected failures number of the product and the cost of these failures on the other hand. In this paper, an upgrade action carrying out on the product right before transferring to the customer, warranty is considered two-dimensional, as well as the expected cost of upgrade action and warranty coverage is calculated. At the end, a numerical example and sensitivity analysis is presented.

**Key Words:** Two-dimensional warranty, upgrade action, second-hand product, the failures number of warranty coverage.

## DESIGNING ADAPTIVE CONTROL CHARTS WITH ADDITIONAL SAMPLING BETWEEN FIXED TIMES USING MARKOV CHAIN APPROACH

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### Abstract

Many industrial products are produced by several different process steps and not just one process step. In each step, one or more quality characteristics of interest may be monitored according to their operation sequences. It implies that in multistage processes consisting of serial value-added manufacturing operations, a parameter shift in any process variable may affect some or all of the measures in the downstream stages but none of the measures preceding it. This property of multistage processes is referred to as the cascade. Cause-selecting control charts are effectively applied to multistage processes for monitoring and detecting shifts. Due to the existence of cascade property, the underlying relationship among stages should be considered and the outgoing quality characteristic must be monitored only after the effect of incoming quality variables has been fully removed. In this paper, an adaptive monitoring procedure for a two-stage process is proposed. In the proposed control charts, extra samples are taken in addition to the samples taken regularly at fixed sampling intervals. These additional samples are taken in case the process is prone to out-of-control situations. The adjusted average time to signal, calculated with the aid of Markov chain approach with 16 transient states, is used as the performance criterion to assess the detect-ability of the proposed control charts. The results clearly reveal that the proposed monitoring scheme outperforms

lem with assembly operations and sequence dependent setup time. The objective is to minimize the completion time of all products (makespan). Since the problem is NP-hard, one particle swarm optimization (PSO) algorithm and two hybrid metaheuristic algorithms based on particle swarm optimization are proposed. The proposed hybrid algorithms are called, respectively, hybrid particle swarm optimization with a variable neighborhood search algorithm (HPSOVNS) and hybrid particle swarm optimization with a simulated annealing algorithm (HPSOSA). In these hybrid algorithms, we used particle swarm optimization (PSO) algorithm for global exploration at search space and variable neighborhood search (VNS)/ simulated annealing (SA) algorithm for local search at around solutions obtained in the each iteration.

In order to evaluate and validate the performance of the proposed algorithms, we are designed numerical experiments and results are compared with hybrid genetic algorithm and tabu search (HGATS) presented by Li and Gao. For this purpose, the proposed mathematical model is coded in GAMS software and the proposed metaheuristic algorithms are coded in MATLAB software. For obtaining better and more sustainable results of the metaheuristic algorithms, Minitab software was used to design the experiments and assign the best level to the size of problems. For the problems in the small size, the optimal solution is obtained by GAMS software. Then a randomized complete block design considered to compare the ability of algorithms at finding the best solution for medium and large problems. Computational results revealed that for medium and large problems the HPSOVNS algorithm outperforms the HPSOSA, PSO and HGATS algorithms.

**Key Words:** Flexible job shop scheduling, assembly, setup time, metaheuristic algorithms.

## AN ECONOMIC ORDER QUANTITY FOR A DETERIORATING ITEM WITH CONSIDERING LEAD TIME CRASHING COST AS A FUNCTION OF ORDER QUANTITY

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### Abstract

In this paper, an economic order quantity (EOQ) model for a deteriorating item has been investigated. Considering a constant rate of deterioration, a portion of order is certainly decayed and thus is lost during lead time; that is what the firm receives is less than the order quantity. Thus purchase cost of these lost orders and also the related deterioration cost is imposed to the firm. On the other side, with a shorter lead time, less deterioration occurs. However an additional crashing cost must be paid for shortening the lead time. Thus, the objective function includes ordering cost, purchase cost, holding cost, decaying cost and crashing cost and the aim of this problem is to find the best trade-off between crashing cost, deterioration cost and also purchase cost of the decayed products; such that the total costs per unit of time is minimized.

In the mentioned problem, lead time is considered as a decision variable and is assumed to have a number of components, each having a different crashing cost. Crashing cost depends both on the order quantity and the reduced lead time. Thus, a piecewise linear function of both the reduced lead time and the order quantity is used in our modelling. For solving the problem, the first derivations of variables have been taken and an algorithm is proposed. A numerical example has been solved and the related crashing cost and total cost has been shown. Finally, sensitivity analysis of key parameters has been performed. Based on these results, as deterioration rate of stock inventory increases, the model tries to decrease the order quantity in order to decrease the decayed items. As deterioration rate of on the way inventory increases, the model tries to prevent decaying costs from growing too much by crashing lead time. Thus, the model tries to increase the order quantity in order to prevent crashing cost from increasing too much. Also, total costs will increase as deterioration rates increases.

**Key Words:** Economic order quantity, deteriorating, variable lead time.

## COSTS ANALYSIS OF TWO-DIMENSIONAL WARRANTY FOR SECOND-HAND PRODUCT CONSIDERING UPGRADE ACTION

specifications were identified as the most important dimension of technology commercialization success factor and then dimensions: technical specifications, economic and financial specifications and rules and certificates.

**Key Words:** Technology commercialization, success of commercialization, fuzzy delphi method, analytic network process.

## FUZZY BI-OBJECTIVE REVERSE SUPPLY CHAIN PROBLEM OPTIMIZATION USING CUCKOO ALGORITHM

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### Abstract

Over product oriented course to industry one, firms' competitiveness is being complicated to gain more portion of market that lead to dynamic and more variation environment. In this situation, customers find more authority to select their favorite products and services. Response to market fluctuation to supply customers' needs is considered as an important tool to firms' promotion. Needs to reduce costs and improve organization process cause to pay more attention to supply chain concept. The main goal of each supply chain satisfies customers' needs with the lowest cost and highest efficiency. Structurally, supply chain includes retailer, wholesaler, distributor, manufacturer, and supplier. An efficient logistic network should be designed so that response to uncertainty. Since time and cost are the most important factors in reverse logistic design, a fuzzy two objectives optimization model is proposed in this study. First, a fuzzy mathematical programming model presented. The aim of this model is determining delivery

goods amount among centers so that total cost and total delay time are minimized. In this research is used fuzzy approach to cover uncertainty in reverse logistic network. A numerical example has been produced and solved by GAMS. In order to solve the problem in large scale a cuckoo optimization meta heuristic algorithm is developed. The results indicate that the total amount sent to the manufacturer of the values obtained from the exact solution and the objective function value decreases with increasing number of iterations which this indicates proper / valid operation is the proposed algorithm.

**Key Words:** Reverse logistic, two-objective optimization, fuzzy theory, fuzzy mathematical programming model, cuckoo optimization algorithm.

## SOLVING FLEXIBLE JOB SHOP SCHEDULING PROBLEM WITH AN ASSEMBLY STAGE AND SEQUENCE DEPENDENT SETUP TIME

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### Abstract

In this paper, a flexible job shop scheduling problem (FJSP) with assembly operations and sequence dependent setup time is studied. In this problem, each product is produced from assembling a set of several different parts. At first, the parts are processed in a flexible job shop system. Setup time is needed when a machine starts processing the parts or it changes items. Then in the second stage, the parts are assembled and products are produced. The assembly operation cannot be started for a product until the set of parts are completed in machining operations. In this paper, we presented a mathematical model for a flexible job shop scheduling prob-

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#### Abstract

We considered a two echelon supply chain with a vendor who manufactures a product to meet the demand for multiple retailers. It is assumed that demands faced by all the retailers are linear decreasing functions of their prices. The production rate is greater than the total demand rate faced by the vendor, consequently, there is no backordering. Cause of the system is under VMI contract, the vendor is responsible for the replenishment decisions of the retailers. He also bears the ordering costs. Thus, the retailers bear only their respective transportation, holding and purchase costs. In this model, the vendor makes  $n$  deliveries to retailers in a given production setup. However, the size of the delivery batch increases each time by a factor  $x$  ( $x > 1$ ) and the purchase cost decreases each time by a factor  $\alpha$  ( $0 < \alpha < 1$ ). The principle aim of the paper is to maximize the profits of the vendor and the retailers by optimizing retailer's price, replenishment cycle and production rate. The Stackelberg approach between the members of the chain is used to solve the problem. In a Stackelberg model one of the members acts as the follower and determines the optimal values of own decision variables. Then the other one acts as the leader and makes decision about his/her strategies according to the best actions of the follower. In this case, the retailers are the followers and the vendor is the leader. The retailers first establish the optimal values of their prices and replenishment cycle and then based on the reactions of the retailers, the vendor optimizes his production rate. The optimal values of decision variables were gained by proofing the concavity of the profit functions and using the first necessary condition. At the end, a numerical example is provided to illustrate the use of the production-inventory model and perform a sensitivity analysis on the holding costs of the retailer and vendor, the purchase cost of the retailer and the number of retailers.

**Key Words:** Vendor managed inventory, pricing, discounting, stackelberg game.

**IDENTIFYING AND PRIORITIZING  
TECHNOLOGY COMMERCIALIZATION  
SUCCESS FACTORS USING**

## FUZZY DELPHI AND ANALYTIC NETWORK PROCESS

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#### Abstract

Commercialization has been defined as a process by which a technology turns into a product acceptable in the market. Evidence from around the world shows that a small percentage of technologies have been successful in commercialization and most of them have not either resulted to a product or not reached to the market stage. This reflects the high complexity of the commercialization process. One of the main strategies to overcome problems of technology commercialization is to predict commercial success of the technology before having more investment in the next stages of the commercialization. In this regard, the purpose of this study was to identify factors affecting the success of commercialization of technology and determine the relative importance of these factors. Procedures can be developed based on the factors by which an investor could decide on capitalizing on the technology. In the first phase of this study, 38 components affecting the success of technology commercialization were extracted from the related literature. Then these components were classified in four dimensions: technical specifications, economic and financial specifications, market specifications and rules and certificates. In phase 2, to refine and verify the appropriateness of the factors extracted from related literature in accordance with technology commercialization actual context and conditions in Iran's firms and industries, fuzzy Delphi method was used with the survey of elected experts including 16 experienced professionals. As a result of the effective factors refinement, 32 components in 4 dimensions were specified. Then in phase 3, the relative importance of each of components and the dimensions affecting the commercialization success were determined having a survey from the same experts group and based on Analytic Network Process (ANP) method. According to the results of phase 3, market

unique optimal retail prices for retailers, unique optimal wholesale price, and an optimal green level for the manufacturer in the decentralized model. Also, there are unique optimal retail prices and an optimal green level for the supply chain in the centralized model. The findings also show that the supply chain members' profits are highly dependent on the values of some model parameters, such as demand price elasticity, the cost coefficient of the green degree per unit, and the tax imposed by the government. The results also show that the government can increase or decrease the green level of the green product by changing the amount of the tax and different government policies have significant impacts on the profit of the supply chain members as well as on the environment.

**Key Words:** Pricing, green supply chain, game theory, government intervention.

## IDENTIFYING AND RANKING ENERGY SOURCES IN ELECTRICITY INDUSTRY BASED ON THE PRINCIPLES OF SUSTAINABLE DEVELOPMENT WITH GREY RELATIONAL ANALYSIS

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### Abstract

Nowadays supply chain management and following it supplier selection has become a vital and effective topic. This issue in major industries such as power industry is more significant. In recent decades, determining the most appropriate energy suppliers is considered as a strategic factor in the supply chain of country's electricity industry to move towards sustainable development. The massive increase consumption of fossil fuels

for producing electricity during the 20th century was accompanied by several problems in economic, social and environmental levels. Thus, the energy as it is produced, distributed and consumed currently does not meet the requirements of sustainable development. Power industry plays a significant role in achieving economic development and welfare of a country. Therefore, predicting a bright and reliable future for it is very important. Traditionally, organizations consider criteria such as price, quality, flexibility, etc. when evaluating supplier performance. While the articles on the selection and evaluation of suppliers are abundant, those that consider sustainability issues are rather limited. The main purpose of this research is to rank energy suppliers in electricity industry based on the principles of sustainable development. For this purpose, a comprehensive review of literature and doing some exploratory interviews with academic experts and experts of Renewable Energy Organization of Iran (SUNA) was performed and main factors affecting the sustainability assessment of energy suppliers were recognized. Then the experts working in SUNA as our research's decision makers judged and evaluated the energy suppliers via a survey based on 20 Qualitative criteria. We used grey number to express linguistic values of expert's subjective preferences and GRA (Grey Relational Analysis) technique to rank suppliers. In this research Criteria of energy supplier evaluation are summarized from environmental, social, economic, technical and political-governmental aspects that are the five dominant aspects of energy sustainable development. Results indicate that natural gas, solar energy and wind power are ranked first to third among the options allocated to power generation.

**Key Words:** Sustainable development, sustainability assessment, energy producers of power industry, grey number, grey relational analysis.

## JOINT OPTIMIZATION OF THE RETAILER'S PRICE, REPLENISHMENT CYCLE AND PRODUCTION RATE IN A VMI SYSTEM WITH DISCOUNTING USING GAME THEORY

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chain's members than the Nash game. Furthermore, optimum production level for each manufacturer and optimum range of wholesale price of the second manufacturer during disruption periods are obtained.

**Key Words:** Dual-Channel supply chain, pricing, reference price, disruption, game theory.

## A LOCATION MODEL IN BLOOD SUPPLY NETWORK CONSIDERING BLOOD DONOR'S UTILITY

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### Abstract

Blood supply chain design plays an important role in health care systems. Even though there are technological developments in the field of substitutes for blood products, the need for donor blood and its derived products will always exist. Locating blood facilities in the appropriate location with considering utility from blood donors' viewpoint is important in supply management of blood products. In this paper, a dynamic location problem in blood supply network including blood donors, blood facilities (temporary and permanent blood donation stations) and blood center with considering social aspects like blood donors' utility is proposed. Mobile blood donation facilities (temporary facilities) location is considered in the proposed model for better management the blood donation process. Mixed integer linear programming (MILP) model is applied to formulate the mentioned problem. In order to formulate blood donors' utility, model is developed by utility function considering distance between blood donors and blood facilities separately, blood donors' experience in blood facilities and advertising cost spend in blood facilities. Application of proposed models is evaluated by a case study in Tehran province in Iran. Also, the impact of various utility factors on blood supply in network and location

decisions in proposed model is investigated by using sensitivity analysis. The obtained results show that, taking into account the utility of blood donors in the blood supply chain can increase blood volume and also satisfying more donors' desirability will be provided.

**Key Words:** Blood supply network, dynamic location, blood facility, utility function, donor behavior.

## PRICING AND GREENING POLICIES IN A GREEN AND NONGREEN PRODUCTS SUPPLY CHAIN: A GAME THEORETIC APPROACH

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### Abstract

Nowadays, policymakers, organizations, businesses and even ordinary people are concerned about the environment and related issues. Considering environmental issues has led to complexity in supply chains; in recent years, green supply chains have received more and more attention from policy makers, academics, and scientists. Businesses consider environmental issues in their supply chains for a variety of reasons, including government pressure, popular demand, wanting to increase their market share, and attracting new customers. The present study considers a supply chain consisting of one manufacturer and two retailers. The manufacturer produces two products, one green and the other nongreen. Based on its policies and to protect the environment, the government imposes a tax on the nongreen product. We discuss pricing and greening policies for the manufacturer in a green and nongreen supply chain. Game theory is utilized to derive optimal pricing policies for the manufacturer and retailers and the optimal green level of the green product for the manufacturer in both the centralized and decentralized models. The effects of government intervention in the supply chain are also investigated. Finally, numerical examples and sensitivity analyses are presented. The results show that there are

## Abstract

A Bi-objective redundancy allocation problem in series-parallel systems with repairable components is addressed in this paper. A new method is proposed for this problem. In the repairable systems with multiple components the concept of availability is used instead of reliability concept and the stability of the system is important. Stability of the system can be defined as availability before the first corruption of the system. There are two main strategies to increase system reliability. The first strategy, raising the reliability of system components and another one is to add the surplus components in parallel. Due to economic and technological limitations, the best and most practical way to increase system reliability is second strategy as we considered in this research. In this paper, non-exponential distribution is considered for failure rate and repair time of components. The first objective aims to maximize the availability of the complex system. Simultaneous with the availability of the system, the total operating cost related to components is the second objective of interest to be minimized. The target of this optimization problem is to allocate adaptable redundant components to increase the system's availability considering all limitations like system's volume and budget. Due to the complexity of the problem is that because of steady distribution, the series-parallel system, for each subsystem with parallel components the scale of availability is separately calculated by simulation approach and the result used as an archive in the solution method. In order to solve this multi objective problem, the authors used an evolutionary algorithm named the simulated annealing based multi objective genetic algorithm (SAMOGA) for solving the mentioned problem. In order to evaluate the efficiency and performance of the suggested algorithm, the experimental results obtained on designed instances are compared statistically with Non-dominated Sorting Genetic Algorithm (NSGA-II) and multi objective particle swarm optimization (MOPSO) according to the multi objective comparison measures. The results confirm that the implemented simulated annealing based multi objective genetic algorithm is better than other solution algorithms.

**Key Words:** Redundancy allocation problem, series - parallel system, repairable components, simulated annealing-based multi-objective genetic algorithm.

## DYNAMIC PRICING IN A DUAL-CHANNEL SUPPLY CHAIN WITH A FIXED AMOUNT OF PRODUCTS IN DISRUPTION

## OCCURRING CONDITIONS AND STOCHASTIC DEMAND

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## Abstract

Sanctions imposed by the West led to a period of economic stagnation in Iran in recent years. Automobile industry is among the industries that suffered from substantial losses from the sanctions. These sanctions were originated generally due to uncompensated damages incurred to automobile manufacturing supply chain process. Iran Khodro Company (IKCO) had been prohibited from Peugeot Company of France; hence, IKCO supplied its parts and components requirements via an intermediate country like Turkey in sanctions periods. Saipa proceeded to purchase production lines of Chinese automobiles and launched producing this country's automobiles in order to respond to disruptions caused by the sanctions. These Chinese automobiles have been considered as competitors of IKCO's products since they were produced. For these reasons and the profound importance of dual-channel supply chain for profitability and its widespread use in world industries, this study examines a decentralized dual-channel supply chain which comprises two competing manufacturers producing a different but substitutable product, and offering their product through internet called E-direct channel, and common retailer namely retail channel. Stochastic demand faced all the channels is reference price and other channels' selling price dependent. This issue faces multiple periods and in some periods, one manufacturer confronts with disruption in production cost that is excluded to cost of parts and components.

The game that is used in this study is Nash game due to the independency of the chain's members in decision-making. This study also employs cooperative game as a strategy to respond to the disruption. Solution methods used in the Nash and cooperative games are respectively heuristics algorithm and League Championship Algorithm (LCA) metaheuristic. Results obtained from solving the problem with the data acquired from IKCO (these data are related to 2011 and 2012) demonstrate that the cooperative game is more profitable for all



developed. To choose the optimal scenario, an interval for reliability, serve as the target reliability, is considered and then based on the total cost, the best scenario is chosen. In order to demonstrate the application of the proposed model, a numerical example is illustrated. Furthermore, the results of the sensitivity analysis show that the cost of system failure and the cost of redundancy are two key factors to determine the optimal scenario. The variations of the other costs results in choosing scenarios without redundancy.

**Key Words:** Acceptance sampling, reliability, k-out-of-m system, optimal scenario.

## A SINGLE PERIOD INVENTORY MODEL WITH CAPACITATED PRODUCTION UNDER UNCERTAINTY OF BUDGET AND STOCKOUT COST

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### Abstract

Nowadays all business scenarios are in a competitive area, while dealing with single-period products, the basic and major problem is to manage its inventory in the best way. In traditional single-period inventory models, a business strategy is described where only a single procurement is made for a specific period under probabilistic demand. But through the developing inventory models, different aspects should be considered such as forecasting the stockout level, budget, the suitable production capacity as well as demand in order to optimize the profit. This paper investigates a single period multi-product inventory model in which products are stochastically defective and demands are random and continuous and the model constrains the production capacity,

budget and stockout cost. Initially, the expected profit in general form in terms of density functions of the demand and the percentage of defective is represented; then, the required descriptions for these functions are given. Considering the uncertainty on budget and stockout cost, these two constraints are presented in stochastic and fuzzy forms. Though, the production capacity is deterministic in every constraint. Therefore, these constraints are of three types: 1) budget and stockout cost constraints are both stochastic. 2) One of the budget and stockout cost constraints is stochastic and the other is fuzzy. 3) Both budget and stockout cost constraints are fuzzy. It should be noted that the possibility and necessity representations of fuzzy constraints are considered. By using chance constrained programming and possibility/necessity programming techniques, stochastic and fuzzy constraints are respectively determined. The problem is solved using SQP algorithm utilizing MATLAB. In addition, an example has been provided to clarify the model completely and at last sensitivity analysis is performed on the profit function with respect to various parameters in order to figure out the profit dependency of each parameter that is so useful in implementing the real world models.

**Key Words:** Inventory, stochastic demand, possibility/, necessity constraints, fuzzy.

## BI-OBJECTIVE OPTIMIZATION OF REDUNDANCY ALLOCATION IN SERIES-PARALLEL SYSTEMS WITH REPAIRABLE COMPONENTS USING SIMULATED ANNEALING-BASED MULTI-OBJECTIVE GENETIC ALGORITHM

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# Abstracts of Papers in English

## ACCEPTANCE SAMPLING AND COMPONENT REDUNDANCY: CHOOSING OPTIMAL SCENARIO IN K-OUT-OF-M SYSTEMS

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### Abstract

In this paper, a sampling policy involving system reliability is proposed. A k-out-of-m system is considered

for this purpose. Acceptance sampling and component redundancy both affect the reliability of k-out-of-m systems. According to the cost of sampling and redundancy, it is essential to define an economical procedure to achieve a specified value of reliability. In this paper, we propose a model to specify the optimal scenario considering both sampling and redundancy. A scenario consists of sample number, acceptance number and redundancy in a k-out-of-m system. Proper distributions to construct the reliability function are specified. Decision is made based on the number of defective items in an inspected sample. This is done by specifying a prior distribution on the number of defects in a lot, as the probability of detecting a defective is unknown, and then based on the information of the acceptance sample; the posterior distribution on the number of defects into a distribution on reliability for a given system is defined. Then a total cost function, including the cost of rejecting the batch, the cost of inspection, the cost of defective items detected during operation, the cost of system failure and the cost of redundancy, is defined as a criterion to choose the optimal scenario. The probability of the system failure is obtained based on the system reliability. Furthermore, based on lot defective items, two constraints for producer's risk and consumer's risk are