Journal of Applied Operational Research (2014) **6**(3), 158–173

ISSN 1735-8523 (Print), ISSN 1927-0089 (Online)

An integer linear programming model for a university timetabling problem considering time windows and consecutive periods

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Abstract. This paper presents various instances using an Integer Linear Programming model that consider the institutional rules of the UPAEP University. This problem mainly arises in the allocation design of many known variables, such as courses with professors previously assigned, rooms and timeslots. Also availability and capacity rooms are considered. In the reviewed papers a general model that covers the requirements of any Institution have not been found owing to operational rules are determinants for constraints modeled; therefore normally a mathematical model is designed for each Institution. The proposed model takes into account professor´s time windows and consecutive periods in the moment of building the constraints. The model was validated in the graduate education area, attempting to tackle a real-world problem; considering 83,304 combinatorial variables, courses modes, special equipment of the rooms, student enrolled in each course, between other constraints. The mathematical model was solved with LINGO 13 unlimited version, a commercial optimization software, to found successfully a solution to UPAEP Timetabling Problem.

Keywords: integer programming; timetabling problem; combinatorial optimization; time windows

Received September 2013. Accepted March 2014

Introduction

The Timetabling Problem (TP) in Educational Institutions, has been studied extensively in the literature (Avella *et al*. 2007), due to the great importance of the consumption of time and human resources for their solution. The problem is to create an assignment schedule for courses-professors and rooms, trying to satisfy at the best possible conditions and requirements of institutional policies. The universities, in the search to solve this problem, commonly performed manual procedures or spreadsheet support, which is often tedious because it is a time consuming task, requiring several days to find an acceptable solution. The difficulty mainly is for its combinatorial nature, because if one problem takes a number of "large" variables are difficult to solve exactly. For this kind of problem there is not a general classification, because of different operational rules issued by each institution (Crovo *et al*., 2007). Consequently there is no a general model that covers each of the requirements of any institution, so it is mandatory to design a special mathematical model that satisfies the requirements of each institution.

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© International Journal of Combinatorial Optimization Problems and Informatics, Vol. 8, No. 3, Sep-Dec 2017, pp. 71-82. ISSN: 2007-1558.

Case Study: A Comprehensive Integer Programming Model for Improving an Educational Timetable

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Abstract. This paper summarizes our work towards developing a solution to the Curriculum Based Timetabling Problem (CB-TTP) at a Mexican university and providing significant insights into timetable processing. We first, identified a data structure using a Mediation Software (MS). This software can read, analyze, and organize data from different institutional log files. Additionally, the MS makes groups of courses without interference in the curricula in order to eliminate this constraint of the Integer Programming (IP) model. Then, we present a comprehensive IP model, which use a set of complex constraints, e.g., professor's availability, consider the course modality in order to assign an appropriate room, consecutive and isolated period of the courses, among others. Also, consider the constraint that ensures do not cancel courses of interest due to parallel assignments of the mandatory courses. With this methodology was possible to assign 2101 lectures and improve the efficiency of the current scheduling process.

Keywords: Timetabling Problem, Resource Allocation, Mediation Software, Integer Programming model.

1. Introduction

Many researchers have investigated the practice and theory of automated timetable scheduling, focusing on education, transport, business, sports, and health. The scheduling is an activity that occurs under any planning scheme and resource allocation process. There are many publications that have provided knowledge and diverse methods for solving the educational timetabling problem (TTP) some example are [1, 2, 3, 4].

There are many researches trying to classify TTPs, but the classification depends on the structure of the problem. This structure may depend on the different organizational settings of the schools, and on a large variety of additional conditions such as balancing the workload of teachers and classes, preferences about timeslots, and/or room availability [5].Nevertheless, Schaerf [6] classified the TTP into three different groups: school timetabling, university course timetabling, and examination timetabling. Thereafter, the university course timetabling term was split into three problems like the Curriculum Based Timetabling Problem (CB-TTP), the Post Enrollment Timetabling Problem (PE-TTP) and Classroom Assignment Problem (CA-TTP) [7, 8, 2, 9, 4]. The UPAEP University is a Mexican institution that offers undergraduate and graduate studies. The institution has six departments that manage 71 faculties, 14 modalities, and 57 academic coordinators. Many of these faculties share teaching spaces and professors, which is a common situation in universities [4]. The university currently uses a manual two-stage process. First, each coordinator constructs a timetable that only considers their own faculties, without seeing the available rooms. Then, the administrative staff verify the feasibility of the timetable and book the room. This process is not recommended due to the staff wastes time because the results frequently are rescheduling.

Propuesta de Mejora en los Niveles de Inventario en una Empresa TIER Uno

Proposal of Improvement in Inventory Levels at TIER One Company

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Recibido el 10 de Septiembre de 2018. Aceptado el 12 de Diciembre de 2018.

Resumen

En este caso de estudio, realizado en una proveedora del ramo automotriz, se encontró un exceso de costos por desabastecimiento de inventario, provocando paros de línea en la empresa. Lo que pone en alto riesgo a la empresa con penalizaciones por parte del cliente, ya que podría no abastecer los sub-ensambles solicitados. Para dar solución a este problema, se utilizaron herramientas cómo el diagrama de Pareto para seleccionar un cliente; la clasificación ABC para seleccionar un producto; el análisis de la demanda para identificar el patrón de comportamiento; pronósticos de Holt para predecir con mayor certeza la demanda; y un modelo de revisión continua con demanda incierta (q*, R) para fijar el adecuado nivel de inventario considerando que el cliente maneja una estrategia Justo a Tiempo (JIT). Los resultados indican que con esta propuesta de mejora se puede garantizar un nivel de servicio al cliente del 99.9% y al mismo tiempo reducir los costos logísticos de inventario sin que se reciban penalizaciones.

Palabras Clave: clasificación ABC; método Holt; modelo de revisión continua con demanda incierta (q*, R), JIT.

Abstract

In this case study, carried out in a supplier of the automotive industry, it was found an excess of costs due to inventory shortages, causing line stoppage in the company. That puts the company at high risk with penalties from the client, as it may not supply the requested sub-assemblies. To solve this problem, tools were used such as the Pareto diagram to select a client; the ABC classification to

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International Journal of Combinatorial Optimization Problems and Informatics, 10(2), May-Aug 2019, 26-38. ISSN: 2007-1558.

Heuristic of the Nearest Neighbor in the delivery of supports within the State of Veracruz

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Abstract. The supply of products of first necessity is one of the most important problems inside to the humanitarian logistics for, this activity must have attributes such as a) quantity; b) propitious derived from the physical and social aspects of the area; c) speed, and d) reliability. This document addresses this problem during the emergency phase of the disaster; two methods of solution are put to evaluation and comparison, with their different characteristics, attributes, advantages, and disadvantages, but with the same objective, to find the routes of delivery of products that allow the worthy survival of the victims. These methods are tested in the municipality of La Perla, Veracruz, Mex., houses 46 localities and it has been impacted by a natural phenomenon in repeated occasions. Through the heuristic technique of the nearest neighbor (NN), five delivery routes of products are obtained, and a locality is omitted. While the exact programming through the classic vehicle routing problem with capacity (CVRP) throws six paths.
Keywords: Hydrometeorological phenomenon; Logistics; Supports; Multiple Vehicle Routing;VMC Heuristics.

Article Info
Received Oct 24, 2018
Accepted Dec 2, 2018

1. Introduction

In recent years, the frequency of occurrence of destructive natural disasters in the world has caused serious damage to social construction and economic development, such as the Indonesian tsunami in 2004, the earthquake of 5.12 Richter scale in Wenchuan in 2008, the freezing rain disaster in southern China in 2008, the devastating 2011 earthquake in Japan, the flood disaster in India in 2013 and the hail disaster in Yancheng in 2016, Jiangsu. Especially in July 2016, heavy rains continue to hit northern China, with heavy flooding in southern China at the same time [1].

Natural disasters refer to the natural processes that occur in the eco-system, which can lead to the loss of the stability of the socio-economic system and to the serious imbalance between the supply and demand of social resources. Natural disasters can be divided into six categories: geological disasters, meteorological disasters, environmental pollution disasters, fires, marine disasters and biological disasters [2]. In Mexico, the National System of Civil Protection has adopted the classification based on the type of disturbing agent that produces them. The risks of geological, hydrometeorological, chemical, sanitary and socio-organizational origin are thus distinguished. With this approach, defines hydrometeorological phenomenon as the disturbing agent that is generated by the action of atmospheric agents, such as tropical cyclones, extreme rains, rain, river, coastal and lake floods, snowstorms, hail, dust and electricity, frost, droughts, warm and cold waves and tornadoes [3].

Hindawi
Mathematical Problems in Engineering
Volume 2018, Article ID 2517460, 12 pages
https://doi.org/10.1155/2018/2517460

Research Article

Dynamic Reduction-Expansion Operator to Improve Performance of Genetic Algorithms for the Traveling Salesman Problem

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Received 10 January 2018; Revised 7 July 2018; Accepted 24 July 2018; Published 2 September 2018

Academic Editor: Erik Cuevas

The Traveling Salesman Problem (TSP) is an important routing problem within the transportation industry. However, finding optimal solutions for this problem is not easy due to its computational complexity. In this work, a novel operator based on dynamic reduction-expansion of minimum distance is presented as an initial population strategy to improve the search mechanisms of Genetic Algorithms (GA) for the TSP. This operator, termed as *RedExp*, consists of four stages: (a) clustering to identify candidate supply/demand locations to be reduced, (b) coding of clustered and nonclustered locations to obtain the set of reduced locations, (c) sequencing of minimum distances for the set of reduced locations (nearest neighbor strategy), and (d) decoding (expansion) of the reduced set of locations. Experiments performed on TSP instances with more than 150 nodes provided evidence that *RedExp* can improve convergence of the GA and provide more suitable solutions than other approaches focused on the GA's initial population.

1. Introduction

As defined by [1], *routing* is the process of selecting "best" routes in a graph $G = (V, A)$, where V is a *node* set and A is an *arc* set. Within this context, *route planning* is the calculation of the most effective route (route of minimum distance, cost, or travel time) from an origin to a destination node on a network, and the *Traveling Salesman Problem* (TSP) is one of the most studied and applied routing models in the transportation, manufacturing, and logistic industries [2]. As presented by [3] the TSP "is the fundamental problem in the fields of computer science, engineering, operations research, discrete mathematics, graph theory, and so forth". This is the reason why the TSP has frequently been considered a touchstone for new strategies and algorithms to solve combinatorial optimization problems as commented by [2].

The TSP can be modeled as an undirected weighted graph where locations (i.e., *nodes*) are the graph's vertexes, paths are the graph's edges (i.e., *arcs*), and the path's distance, cost, or time is the edge's length [4]. Then, the objective of solving the TSP consists on minimizing the total distance of a complete sequence of paths (total route) which starts and finishes at a specific vertex (i.e., depot node) after having visited all vertexes once and only once. Figure 1 presents a solution example for the TSP which is also known as a *Hamiltonian Circuit* of minimum cost.

Finding optimal solutions for the TSP is a challenging task due to its computational complexity which is defined as NP-hard (nondeterministic polynomial-time hard) [5]. In example, if 15 cities are considered, there are 1.31e+12 ways of performing a Hamiltonian Circuit to visit them. In such case, finding the optimal solution (i.e., finding the Hamiltonian Circuit of minimum cost) can be a time-consuming task which becomes infeasible when larger number of cities is considered. As reported in [2] only small TSP instances (up to approximately 100 nodes) can be solved to optimality.

Due to this situation, development of metaheuristics has been performed to provide high-quality solutions in

© International Journal of Combinatorial Optimization Problems and Informatics, Vol. 9, No. 3, Sep-Dec 2018, pp. 55-63. ISSN: 2007-1558.

ILS Metaheuristic to solve the Periodic Vehicle Routing Problem

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Abstract. This article presents a methodology for solving the Periodic Vehicle Routing Problem (PVRP) with an Iterated Local Search Metaheuristic (ILS). The problem is solved in two phases: the first step is to assign days of visit to each customer, and in the second step to determine the routes that each vehicle must perform each day. The heuristic for a local improvement in ILS is Clarke & Wright Heuristic, and perturbation is made on the days of visit assigned to some customers. The instances generated by Cordeau for PVRP with 51, 102 and 153 customers are used. The results are compared to the best-known solutions. The gap between the results presented by the proposed metaheuristic range from 15% to 5% above the best known solutions. The time to find the solutions with the proposed metaheuristic goes from 6.76 seconds for instances of 51customers, to 172.09 seconds for instances of 153 customers.

Keywords: Periodic Vehicle Routing Problem, Iterated Local Search, Two-Opt, Clarke & Wright Savings Algorithm.

1 Introduction

Within the logistics costs transport is the highest, and therefore there are several studies to reduce it. The main focus is on land transport, although it has also studied transport by water, air and even in space. [34] analyzed transport in space, in which the problem is to minimize the time, energy and economic costs of moving resources from one place to another in space. [32] analyzed the Oil Platform Transport Problem (OPTP), and conclude that is an NP-hard problem, which opens the door to the resolution of the water transport problem through Metaheuristics. The impact on the decrease in transport costs begins with a good strategy for locating the plants and facilities, as mentioned [33] which presents a proposal that allows establishing the relationships between the facilities location problem and the client allocation within a dense demand environment in territorial design. The location obtained means having available the decimal geographic coordinates in longitude and latitude from the location point in such a way that the products or services transfer has a minimum cost. The organization can design an efficient logistics plan to benefit its supply chain.

The Vehicle Routing Problem (VRP) is a widely studied problem of Combinatorial Optimization. The first publications about this problem were made around 1959 [15], where routes were generated at a minimum cost for a set of vehicles of homogeneous capacity [1]. Variations of the VRP have been studied including characteristics of real-world transport models, like: vehicles with heterogeneous fleets, time windows, periodic visits, more than one depot, etc. The main variants of VRP can be found in work presented by Toth and Vigo [31]. The PVRP can be thought of as a generalization of a conventional VRP, which seeks to determine an optimal set of daily routes for a given time horizon. Customers need to be visited on different days during the planning horizon, according to their demands, storage space, sales, etc. We call itineraries for the combinations of visits requires for each customer.

Solve the PVRP implies solve two entangled problems: assignment problem, and the vehicle routing problem. In the first, the decision is determinate a set of visiting days (itinerary) for each customer within the planning horizon. The other problem is the routing of vehicles for each day. The PVRP is an NP-Hard problem [13], [25], because includes the VRP with single period as a special case, and the most efficient solution techniques for these problems are metaheuristics. Among the most used metaheuristics for VRPs are Tabu Search [11], GRASP [28], Ant Colony Optimization [4], Variable Neighborhood Search [19] and Hybrid Heuristics based on Coverage of Sets [5].

The total cost to be minimized may include the costs associated with the distances travelled, vehicle capacity, transit time, fuel, etc. For this work, the distance traveled is directly related to the cost. To have a detailed discussion about costs, the reader can

Received Dec 26, 2016 / Accepted Dec 11, 2017
Editorial Académica Dragón Azteca (EDITADA.ORG)

Routing Analysis and Improvement for the Pick-up Service of Raw Material for a Company Specialized in Plastic Injection

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Abstract. For all organizations in the manufacturing and service sectors, transportation has become an important topic for the economic decision-making process. This is due to the high quality and versatility standards that today the industries have established to follow a strict guideline focused on Just-In-Time (JIT). In this context, the present paper extends on the analysis and improvement of a real-world routing problem of a Mexican company dedicated to the manufacturing of plastic products. The value chain of the company has its origin at the gathering (picking-up) of raw materials and components from different suppliers located in the United States. Currently, a third-party company (carrier) has been hired to perform the pickup process, however there is uncertainty regarding the optimality of its routes and their associated costs. The present research analyses the current routing scheme that is performed by the carrier to verify compliance of the requirements of the company which are minimization of costs and travel times. Then, the Capacitated Vehicle Routing Problem (CVRP) is performed for improvement of the current routing scheme. In addition, a new location for a depot (or collection center) is proposed to allow the company to manage its own raw material, avoiding the need to consider a third-party company for the picking-up services by means of the p-Median Problem (PMP). Optimization for the CVRP and PMP was performed with a specialized software and the results obtained by this research present an improved cost-efficient routing scheme for the picking-up process of the plastic company.

Keywords: Capacitated vehicle routing problem · Capacitated p-Median problem · Optimization · Operations research

1 Introduction

In the present globalized world, logistics strategies for efficient movement and constant flow of the value chain in the business, products and services industries, has become a crucial element of the supply chain. Some examples of the practical application and

J.C. Figueroa-Garca et al. (Eds.): WEA 2017, CCIS 742, pp. 532–543, 2017.
DOI: 10.1007/978-3-319-66963-2_47

GESTIÓN DE INVENTARIO A TRAVÉS DE PUSH & PULL E INVENTARIO MANEJADO POR EL PROVEEDOR – EN PRODUCTOS RISA, S.A. DE C.V.

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Recibido: 14/feb/2015 - Aceptado: 8/jul/2015 - DOI: http://dx.doi.org/10.6036/MN7565

INVENTORY MANAGEMENT THROUGH PUSH & PULL AND VENDOR MANAGEMENT INVENTORY– CASE OF STUDY: RI SA PRODUCTS

ABSTRACT: The inventories management is a key element, which must be incorporated to any organizations regardless of its size, with the main objective of optimizing profitability. For this purpose it is important that the inventory management is an observed guideline by the administrative and operational staff. This study was conducted in RI SA Products, which is a Mexican SME (Small and Medium Enterprises) company dedicated to the production of candy. When analyzing the company´s context, no financial strategy implementation and inventory management systems were found. Therefore the ABC classification was used to delimit the study area and also to review the behavior and pattern of demand. Likewise, a seasonal behavior was detected, resulting in 45% of the products being deterministic and the remainder probabilistic, based on the sales balance sheets from 2011 to 2014. As a result of the analysis, the usage of Economic order quantity (EOQ) and continuous and transit inventory review models was determined. The main objective is to propose and to incorporate the inventory management, the Pull & Push production scheme and the Vendor Management Inventory (VMI).

Key Words- ***q, R model, EOQ model, push &pull systems, VMI.***

RESUMEN: La gestión de inventarios es un elemento clave el cual deben incorporar las Organizaciones independientemente de su tamaño, con el objetivo de optimizar la rentabilidad. Para ello es importante que la gestión de inventarios sea una directriz a observar tanto por el personal administrativo como operativo. Este caso de estudio se realizó en la empresa Productos RI SA, S.A. de C.V., dedicada a la elaboración de dulces y clasificada como mediana dentro del rubro de las Pequeñas y Medianas empresas en México. Al analizar el contexto de la empresa se detectó que no tiene implementadas estrategias financieras y sistemas de control de inventarios Por lo cual se utilizó la clasificación ABC para delimitar el área de estudio; analizando también el comportamiento y patrón de la demanda. Así mismo se detectó un comportamiento estacional, siendo un 45% de los productos determinísticos y el resto probabilísticos, basándose en la información de los balances de ventas del periodo 2011 al 2014. A consecuencia de este análisis, se determinó emplear los modelos de cantidad económica de pedido (EOQ), revisión continúa e inventarios en tránsito. El objetivo es proponer e incorporar la gestión de inventarios y un esquema de producción Push & Pull y Vendor Management Inventory (VMI).

Palabras clave: *modelo q,R, modelo EOQ, sistemas de producción pull y push, VMI.*

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Paper:

Mathematical Model for Locating a Pre-Positioned Warehouse and for Calculating Inventory Levels

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[Received July 6, 2018; accepted January 4, 2019]

A mixed integer non-linear mathematical model is proposed to efficiently provision necessary supplies for the dignified survival of people affected by hydrometeorological disasters that are usually experienced in the state of Veracruz, Mexico. In the context of damages to property and infrastructure in the municipalities affected by such natural disasters and to develop resilience, a model that combines the problem of locating facilities with the problem of determining inventory levels for uncertain demand is developed, facilitating the timely supply of survival kits. The number of survival kits required is determined according to the needs of the affected people in terms of food products, equipment, water, and medicine. Requirements for food products and equipment are based on the human life cycle, from the stages of early childhood until old age; those for water and medicine on total demand. The model is tested in the Capital Region, one of the ten regions within Veracruz, because the municipalities that comprise the region have experienced numerous declarations of emergency registered in the Natural Disasters Fund. The Capital Region comprises 33 municipalities, 17 of which have experienced this type of declaration in 2016. Therefore, our model has been developed to determine the optimal location of a pre-positioned warehouse in the Naolinco municipality, including the optimal levels of inventory that would satisfy 99% of the affected population in this region. Our model can serve as a tool through which individuals involved in the decision-making process can select the locations that have not been impacted by the hydrometeorological events, including pre-positioned warehouses that in turn safely store the survival kits. This model can be utilized not only in Mexico but in any part of the world by individuals involved in the decision-making process associated with providing relief to affected people.

Keywords: pre-positioned warehouse, humanitarian logistics, facilities localization problem, hydrometeorological event

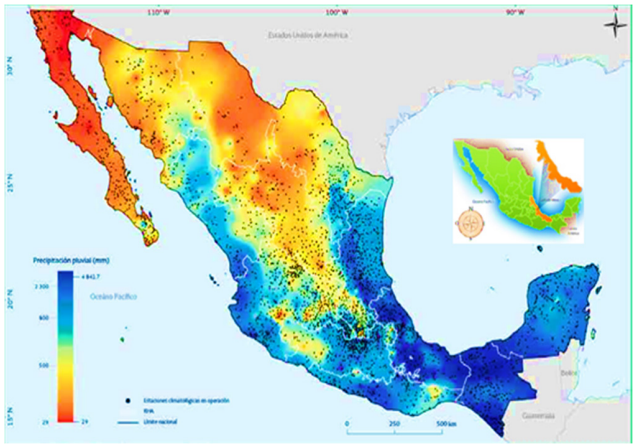

Fig. 1. Distribution of rainfall in 2014 [5], framing the state of Veracruz, Mexico [6].

1. Introduction

Mexico is a country of vast differences and climatic diversity because of its geographical location, maritime borders, complex topography, valleys, mountains, and highlands among orographic shadows. The southern and south-eastern states of the country experience a considerable amount of rainfall, amounting to more than 1000 mm of average annual rainfall, which exposes the country to extreme hydric events that primarily affect the coastal areas, flood areas, and mountain slopes [1–4].

Figure 1 illustrates the spatial distribution of rainfall in Mexico in 2014. This distribution exhibits anomalies in terms of the differences in the amount of rainfall received between 1981–2010 compared with the amount of rainfall received in 2014. The gradation of colors goes from red, which means that the annual rainfall in 2014 is lower than the average rainfall between 1981–2010, to blue, which means that the annual rainfall is greater than normal. It can be visualized that, in general, there is less rainfall than usual along the Sierra Madre Occidental, with a significant zone in the Isthmus of Tehuantepec; while above normal rainfall was generally witnessed in the basin of the Gulf of Mexico [5]. Similarly, **Fig. 1** illustrates the area

Acta logistica - International Scientific Journal about Logistics
Volume: 5 2018 Issue: 3 Pages: 79-86 ISSN 1339-5629

doi:10.22306/al.v5i3.98
Received: 28 Aug. 2018
Accepted: 20 Sep. 2018

FACILITY LOCATION MODEL WITH INVENTORY TRANSPORTATION AND MANAGEMENT COSTS

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Keywords: supply chain networks, model, facility location problem, inventory management
Abstract: This work is focused on the integration of the standard EOQ (Economic Order Quantity) model within the facility location decision model. This is proposed to extend on the facility location task which is usually performed based on just the overall demand of the customer locations to be served. If the inventory costs are considered within the demand supply process, these may affect the overall transportation costs as these are not linearly dependent of the demand. As such, the extended model considers, besides the distances, performance and capacity of the vehicles, the order quantities and the period in which they should be fulfilled. This model was tested with a reference instance of 200 suppliers and one distribution centre. The distances were estimated by considering the geographical locations of all elements in the network and the spherical model of the Earth's surface to obtain the metric in kilometres. As analysed, by considering the inventory costs within the facility location model, it can lead to refine the location to obtain long-term savings in transportation.

1 Introduction

Several efforts have been performed to improve supply chain operations, developing practical tools and instruments that have contributed to company competitiveness and also for researchers who seek to provide real and useful results. This has involved the use of mathematical decision models for the optimization of resources. Among these models, some have contributed to the design of distribution networks by integrating the modelling of real factors such as demography data, times, capacities, speeds, and restrictions. The importance of solving problems related to distribution networks lies in the fact that all services and products require them for an efficient delivery to customers and industries. Thus, mechanisms to reduce delivery and production times, improve quality and reduce waste, are frequently sought.

Recently, research has been focused on the integration of location and inventory decisions in a single framework, with the motivation that integration can bring substantial cost savings. Integrated supply chain network design involves several core components among which facility location and inventory management are the main components [1]. The benefit of the integration depends on the relative size of the facility location costs and inventory management costs. Since traditionally facility location decisions are made before the inventory policy is decided, the benefit of integration increases as inventory costs increase [2].

In this work we describe an integrated inventory-facility location model to minimize distance, transportation and inventory management costs. For this, the proposed model considers vehicle-dependent fuel consumption costs and management-dependent inventory costs to adjust the demand of each customer to be gathered by a distribution centre.

The paper is structured as follows: in Section 2 the technical background and research from the literature is presented. Then, the justification of the research is discussed in Section 3. In Sections 4 and 5 the development of the integrated distribution-inventory model and the results on the test instance are presented and discussed. Finally, the conclusions are presented in Section 6.

Nowadays it is very important that a plant or facility, independently of its qualification or size, has a strategic location according to its supplies and customers. In general, its resources must be as close as possible for the purpose of avoiding setbacks that generate high repair costs, so that the raw material arrives on time. In general, the location of a plant is strategic for its success, and the employees must have the appropriate infrastructure and means of transportation.

CADENA DE SUMINISTRO EN EL CONTEXTO E-BUSINESS

Norma Eugenia Castrezana-Monge[1], Diana Sánchez-Partida[2],
José Luis Martínez-Flores[3] y Patricia Cano-Olivos[4]

Resumen— **El objetivo de este trabajo se ha enfocado a la elaboración de una Revisión Literaria de los procesos de *e-Business, e-Manufacturing, e-Commerce, y e-Procurement,* vinculados a *e-Supply Chain Management (e-SCM)* término referente a la cadena de suministro en el contexto e-Business o cadena de suministros electrónica, analizando el impacto de los sistemas digitales en el proceso de las compañías e identificando futuras investigaciones, marcando con esto tendencia para los profesionales y académicos interesados en este tema. Este estudio revisa la literatura de 59 artículos publicados en bases de datos, todos en idioma inglés, con el objeto de recolectar, analizar y encontrar áreas de mejora en el conocimiento de e-SCM.**

De nuestra selección de artículos 63% es cualitativo y el 37% cuantitativo. Como resultado del análisis se sugiere que es importante enfocar los nuevos trabajos de investigación aplicando métodos de Investigación de operaciones y Teoría de Juegos, como cimientos para el posicionamiento estratégico, establecimiento de políticas y toma de decisiones de las empresas.

Palabras clave—e-SCM, e-Procurement, e-Business, e-Manufacturing, e-Commerce.

Introducción

Este artículo está orientado a la revisión de literatura disponible en varias bases de datos para entender la evolución de la cadena de suministro en la era digital, explorando métodos aplicados en diversas áreas dando paso a la innovación en las empresas y contribuyendo al mejor desempeño de la cadena de suministro. Los cambios tecnológicos particularmente la caída en los costos de la comunicación ha permitido cambios en coordinación entre los miembros de la cadena de suministro. En este artículo analizaremos la relación que existe entre los diferentes procesos de *e-Business: e-SCM, e- Manufacturing, e-Procurement, e-Commerce, e-Integration.*

Este estudio revisa la literatura de 59 artículos disponibles en varias bases de datos internacionales como SCI-Hub, Redalyc, Dialnet, Science Research, Google Scholar, etc , todos en idioma inglés que van del año 2001 a 2016, con las palabras clave: *e-SCM, e-Procurement, e-Business, e-Manufacturing, y e-Commerce*, con el objeto de recolectar, analizar y encontrar áreas de mejora en el conocimiento en e-SCM; se clasificaron los artículos por proceso*: e-Business, e-Commerce, e-Manufacturing, e-Procurement, y e- SCM.*

Se da especial atención a los artículos que explican métodos cuantitativos para la toma de decisiones, entre ellos están los que aplican Investigación de Operaciones, Teoría de juegos, Algoritmos de Lógica Difusa, Colonia de hormigas, Redes de Petri, etc, basado en estos resultados se sugieren nuevas investigaciones para la mejora de e-SCM.

Para entender el desarrollo de la gestión de la cadena de suministro haremos una breve revisión de su evolución hasta lo que hoy conocemos como e- SCM.

Revisión Literaria

e-Business surge al inicio de los años 90's y ha agregado velocidad a todo lo que hacemos en la industria impactando procesos de negocios como: Adquisiciones, Gestión de Cadena de Suministro, Gestión de relación con el cliente y Planeación de recursos de la empresa.

Existe una confusión considerable en la literatura concerniente a las varias terminologías usadas para describir e-Business, considerando como adecuada la siguiente: "e-Business: es un enfoque para lograr las metas de negocios en la cual la tecnología de la información intercambia, permite y facilita la ejecución de actividades en y a través de la cadena de valor, así como también apoya la toma de decisiones que subyace en estas actividades" (Chen y Holsapplee 2013). Los principales componentes de e-Business son (Chuang et al. 2005):

- **Enterprise Resource Planning (ERP):** Planeación de recursos de la empresa, sistema para integrar procesos de negocios en ambientes de manufactura.

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ISBN: 978-1-939982-16-2

Estudios Gerenciales 32 (2016) 387–396

ESTUDIOS GERENCIALES

www.elsevier.es/estudios_gerenciales

Caso de estudio

Análisis de series de tiempo en el pronóstico de la demanda de almacenamiento de productos perecederos

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INFORMACIÓN DEL ARTÍCULO

Historia del artículo:
Recibido el 15 de agosto de 2016
Aceptado el 17 de noviembre de 2016
On-line el 8 de diciembre de 2016

Códigos JEL:
L15
L23
L25

Palabras clave:
Almacenamiento
Cadena de frío
Pronósticos
Series de tiempo
Productos perecederos

RESUMEN

Los pronósticos son una herramienta que proporciona un estimado cuantitativo de la probabilidad de eventos futuros. La relevancia de incorporar pronósticos en la demanda de almacenamiento en productos perecederos dentro de la cadena de frío deriva de su importancia económica y social. Este caso de estudio presenta una empresa con tendencia de crecimiento dedicada al almacenamiento de productos perecederos e incorpora técnicas de pronósticos de series de tiempo, en el volumen de ingreso y egreso de los productos en una cámara frigorífica, con el fin de estimar el volumen de almacenamiento para prever los requerimientos de instalaciones adicionales, personal y materiales necesarios para la movilidad de los productos.

Analysis of time-series on the forecast of the demand of storage of perishable products

JEL classification:
L15
L23
L25

Keywords:
Storage
Cold chain
Forecasts
Time-series
Perishable products

ABSTRACT

The forecasts are a tool that provide an estimated quantitative of the probability that future events occur. The relevancy of incorporating forecasts in the demand of storage in perishable products inside the cold chain, drifts of both its economic and social importance. This case of study presents a company with growth trend devoted to the storage of perishable products, and identifies that the applied forecasts nowadays do not contemplate methodological technologies. The present article incorporates technologies of forecasts of time-series in the volume of revenue and expenditure in a cold-storage room, in order to estimate the volume of storage to foresee the requirements of personnel and materials needed for the mobility of the products.

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http://dx.doi.org/10.1016/j.estger.2016.11.002

Simulation

Applications

Simulation: Transactions of the Society for Modeling and Simulation International
1–16

DOI: 10.1177/0037549718825299
journals.sagepub.com/home/sim
SAGE SCS

Relocation of the distribution center of a motor oil producer reducing its storage capacity: A case study

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Abstract

Enterprises face the challenge of identifying, following, and controlling the performance of their processes in the whole supply chain (SC) to guarantee an adequate level of service to the client. Since the delivery of orders on time has a direct impact in the client's satisfaction, the managers of the SC face the challenge of choosing the best location, number, and capacity of the facilities to deliver the client's orders on time. In this paper, we address a facility relocation problem. A motor oil manufacturing company currently has a distribution center (DC) with 17,800 storage locations and 20 docks for loading and unloading, operated traditionally, and it wishes to relocate the DC to a smaller one of 10,800 storage locations operated in an automated way. However, they do not have the certainty that the relocated DC will support the distribution logistics operation to deliver the clients' orders on time. In this research, we make a feasibility analysis of the distribution logistics operation when relocating the DC through a simulation model. For that, it was essential to analyze the main storage and distribution processes of the new DC. The main contribution of this work is the development of a simulation model that can be used to analyze the feasibility of relocating a warehouse or DC to a specific location; the model establishes the main key performance indicators that must be evaluated in the simulation. The results of the simulation show that it is feasible to implement the relocation.

Keywords

Simulation, logistics operations, distribution of goods, warehouse management

1. Introduction

Today, enterprises are facing a more competitive and technological market (trading through e-commerce and industry 4.0); due to this competition, the management of the supply chain (SC) represents one of the most critical factors in the profitability of the business. In such a complex market, the design and integration of the SC are strategic elements to produce and distribute a good or service. In addition, efficient management of the chain allows enterprises to achieve their competitive strategies and success, with the purpose of gaining an advantage in the market and guaranteeing the adequate level of the client's service. Enterprises face the challenge of identifying, following, controlling, and improving the performance of all of the processes in the chain. Therefore, the importance of SC efficiency as a competitive advantage has generated significant challenges for the development of more robust chains.[1,2]

In this context, enterprises are restructuring their SC distribution networks to provide flexibility, to increase the response rate, to guarantee the availability of stock, to improve the quality of the service, to reduce the operational and logistics costs, to minimize the stock in the distribution network, and to minimize the investments in the logistics infrastructure. To this end, the configuration of the network might change gradually in the medium-term and long-term horizons by opening one or several facilities and closing existing ones.[3–5]

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A FUZZY EXPERT SYSTEM FOR THE INTEGRATION OF COLLABORATIVE SUPPLY CHAINS

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ARTICLE INFO

Article details
Submitted by authors 6 May 2015
Accepted for publication 7 Jun 2016
Available online 12 Aug 2016

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DOI
http://dx.doi.org/10.7166/27-2-1241

ABSTRACT

The integration of supply chains has become a global operations strategy for many organisations because it allows them to improve customer service, minimise operating costs, and synchronise channels across the supply chain. This paper presents the design and implementation of a fuzzy expert system for the integration of collaborative supply chains. A measurement instrument that was statistically validated and formulated using a mathematical model was designed to implement the fuzzy expert system. This instrument was applied in 44 small-, medium-, and large-sized Mexican enterprises to determine their integration level. Specific actions were proposed, based on the results, to improve the attained integration level.

OPSOMMING

Die integrasie van voorsieningskettings is deesdae ‘n omvattende strategie vir baie organisasies, omdat dit hulle toelaat om kliëntediens te verbeter. Die ontwerp en implementering van ‘n wasige ekspertstelsel word voorgehou. ‘n Statisties gevalideerde meetinstrument wat met ‘n wiskundige model geformuleer is, is ontwerp om die wasige ekspertstelsel te implementeer. Dié meetinstrument is in 44 klein, medium en groot Meksikaanse ondernemings toegepas om hulle integrasievlak te bepaal. Spesifieke aksies, gegrond op die resultate, is aanbeveel om die integrasievlak te verbeter.

1 INTRODUCTION

Organisations and business activities are comprised of supply chains (SC) that are necessary to design, manufacture, and deliver a product or service. Companies depend on their SC to stay in the market and prosper. Each business fits into one or more SC, and each SC plays a different role in every organisation [1].

The goal of integrating SC is to synchronise the customer’s requirements with the flow of materials from the suppliers, and to achieve efficiencies between customer service, inventory costs, and unit cost per product. The design and operation of an effective SC is essential for all organisations [2].

The integrated supply chain (ISC) deals with strategic issues, such as integrating internal and external business processes, developing solid links between members across various channels, and managing products and information. Within business and organisational boundaries, the ISC can also be a tactical tool applied to the management of operational activities. These activities can include customer service, control of the input and output flows of materials and information, and elimination of inefficiencies throughout channels and costs that extend from acquiring raw materials to manufacturing, distributing to the final consumer and, when necessary, product return through recycling or destroying [3].

Nova Scientia
Revista de Investigación de la Universidad De La Salle Bajío

Revista Electrónica Nova Scientia

Case study: Simulated annealing for improving the educational timetable
Estudio de caso: Recocido simulado para mejorar el calendario educativo

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Resumen

Introducción: En ocasiones, los problemas de Optimización Combinatoria (COP), tal como el Problema de Calendarización de horarios (CTTP), se puede resolver utilizando técnicas Investigación Operativa (IO); sin embargo, cuando el problema aumenta de tamaño, la búsqueda de una solución se vuelve más compleja. Este tipo de problema es NP-duro por lo que requiere de procedimientos como métodos metaheurísticos con el fin de resolver el problema. Este trabajo aborda un Problema real en una Institución de Educación Superior Mexicana acerca de la Calendarización de horarios basada en la Curricula (CB-CTT). Cada institución tiene sus propias reglas operacionales, por lo tanto la modelación del problema es único ya que conserva sus propias características. Primero como parte de la aportación a la solución del problema, se elaboró un Software de Mediación (MS) con el fin de organizar los datos en bruto y eliminar la restricción dura en relación con los planes de estudio. Posteriormente, el problema se dividió en cinco instancias, de acuerdo a los cursos que comparten el mismo espacio físico, los cuales fueron resueltos mediante el algoritmo tradicional de Recocido Simulado (SA).El problema fue resuelto de manera satisfactoria, obteniendo la asignación de 9620 sesiones en 174.5 horas aproximadamente, aportando una solución sin particionar el problema en dos subproblemas, impactando positivamente la reducción del tiempo de elaboración de los horarios, proporcionando un horario factible y sin errores para toda la universidad.

Método: El Algoritmo de Recocido Simulado, cristalización simulada o enfriamiento simulado, es un algoritmo de búsqueda metaheurística para problemas de optimización; el objetivo general de este tipo de algoritmos es encontrar una buena aproximación al valor óptimo de una función en un espacio de búsqueda grande. A este valor se lo denomina "óptimo local u óptimo global". El nombre e inspiración viene del proceso de recocido del acero y cerámicas, una técnica que consiste en calentar y luego enfriar lentamente el material para variar sus propiedades físicas. El calor causa que los átomos aumenten su energía y que puedan así desplazarse de sus posiciones iniciales (un mínimo local de energía); el enfriamiento lento les da mayores probabilidades de recristalizar en configuraciones con menor energía que la inicial (mínimo global). El método fue descrito independientemente por Scott Kirkpatrick, C. Daniel Gelatt y Mario P. Vecchi en 1983.