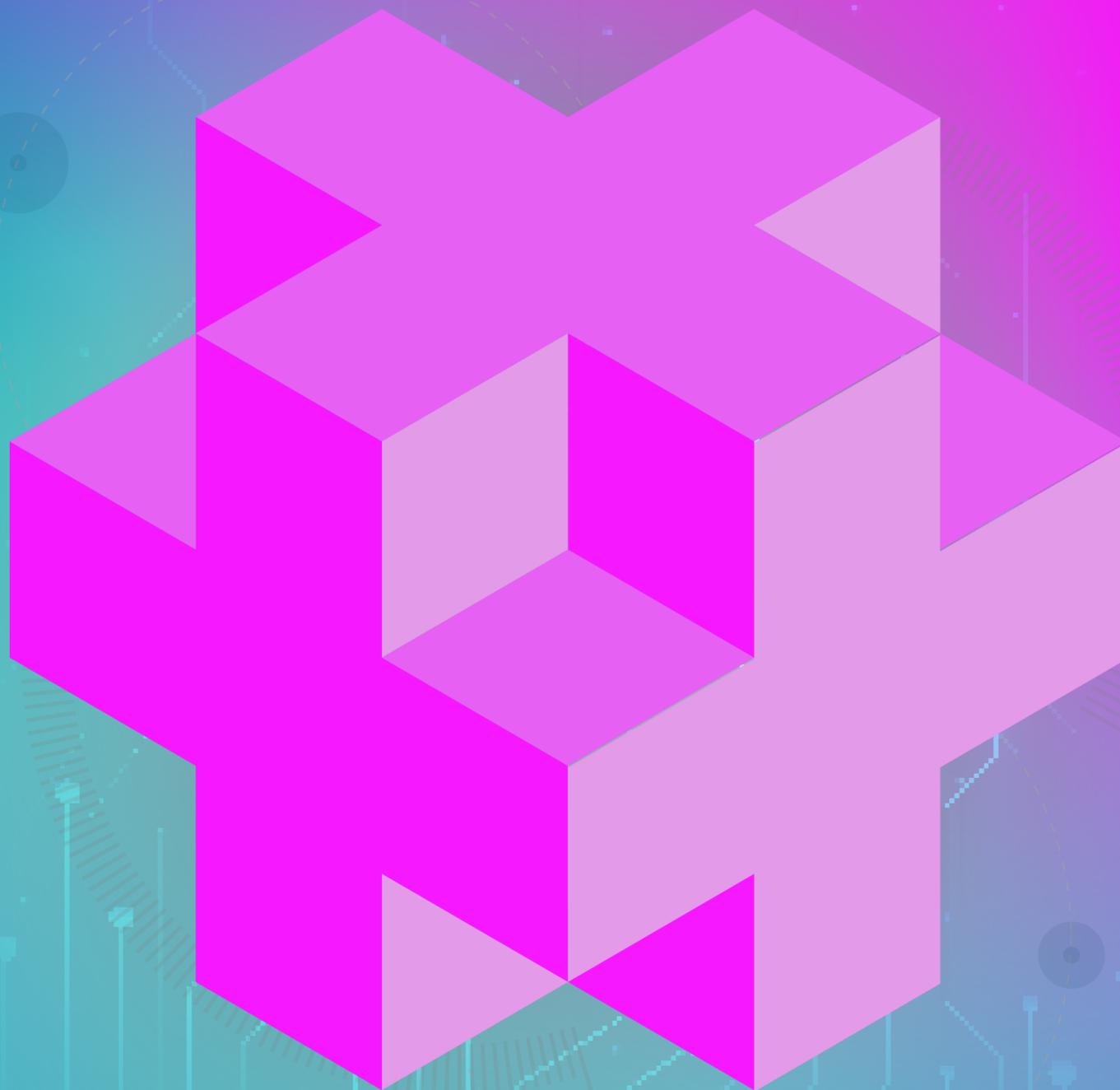


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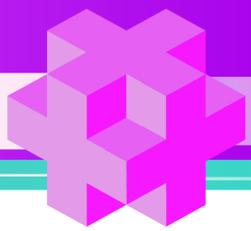
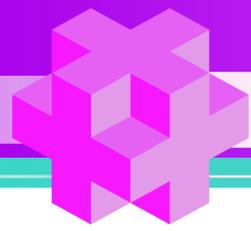
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Publicaciones de Alto Impacto

El Departamento de Ingeniería Industrial considera de vital importancia compartir con el público los resultados de investigación de excelencia alcanzados por nuestros docentes. Estos logros representan un motivo de gran satisfacción para nuestra comunidad académica. En esta undécima edición se presentan las publicaciones correspondientes al año 2024, las cuales reflejan la amplitud, relevancia e impacto de la Ingeniería Industrial. Para su inclusión en esta revista, es necesario que dichas publicaciones cumplan con los rigurosos criterios establecidos por Minciencias para ser reconocidas como de “alto impacto” en la producción académica, los cuales se resumen a continuación.

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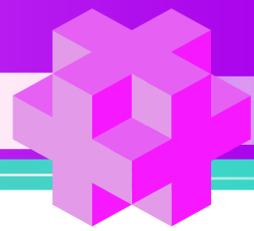
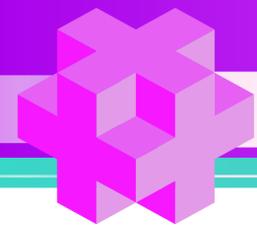
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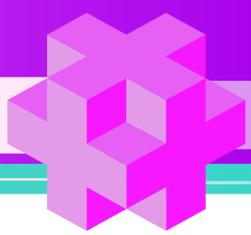
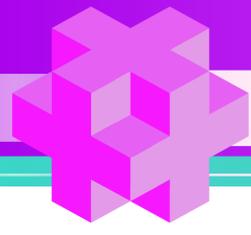
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Decision-making for circular economy implementation in agri-food systems: A transdisciplinary case study of cacao in Colombia

01 de enero de 2024

Publicado en: Journal of Cleaner Production



Andrés L. Medaglia

Bart Van Hoof
Alfaima Solano
Juan Riaño
Carolina Méndez

El artículo presenta un caso real en fincas de cacao en Colombia donde la economía circular se aplica de forma práctica para reducir residuos y mejorar los ingresos de los agricultores, destacando el vermicompostaje como una alternativa viable y sostenible basada en la toma de decisiones informada de los propios productores.

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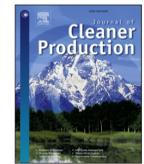
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Decision-making for circular economy implementation in agri-food systems: A transdisciplinary case study of cacao in Colombia

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ABSTRACT

Sustainable food security represents a significant challenge in advancing the global agenda expressed in the Sustainable Development Goals, including feeding the growing world population while transitioning toward a circular economy. A growing body of literature is focused on developing concepts and documenting circular economic opportunities in agricultural food systems. However, the methodologies for implementing circular economy models at the farm level remain mostly theoretical. This study proposes a transdisciplinary based approach for evaluating circular economy alternatives in agri-food systems while enhancing farmers' decision-making skills. The transdisciplinary based research methodology combines methods for simulating critical resource and production flows with multi-criteria decision-making, including training and obtaining feedback from farmers. We test the methodology on a cacao agri-food system in Meta (Colombia). Biomass waste and cost-benefit data allow evaluation for decision-making of four circular economy scenarios: composting, vermicomposting, drip irrigation, and valorization of cacao husks. Research outcomes recommend vermicomposting as a viable circular economy innovation for cacao farms to reduce biomass waste and improve economic income at farm level. Other outcomes include capacity building of farmers on circular economy –including resource flow analysis and cost-benefit calculation. Effective decision-making on circular economy adoption at farm level is evidenced by vermicomposting technology implementation. Policy recommendations call for transdisciplinary based approaches for promoting and scaling the transition towards a circular economy in agri-food systems at a farm scale involving farmers participation in operations research (analytics) modelling and interpretation. In addition, policy advice for circular economy technical assistance and finance, includes vermicomposting as a technology for scaling transition of agri-food systems such as cacao and comparable long-term crops.

1. Introduction

Resource efficiency in agri-food systems contributes to the conservation of ecosystem services, increased productivity, and improvements in farmers' quality of life (Valoppi et al., 2021). However, the ever-increasing need for food to sustain the growing world population has expanded agri-food systems, causing environmental impacts (FAO, 2017). Today's food supply chain creates ~13.7 billion metric tons of carbon dioxide equivalents (CO₂e), 26% of anthropogenic GHG emissions. A further 2.8 billion metric tons of CO₂ eq (5%) are caused by nonfood agriculture and other drivers of deforestation (Poore & Nemecek, 2018). These negative impacts contradict the low profitability of small farmers and stakeholders in the first echelon of the agricultural food supply chain (Fi-compass, 2020).

A circular economy offers a model for improving resource efficiency by regenerating ecosystems, maintaining resources, eliminating waste, and enhancing business models (Stegmann et al., 2020). The model has attracted the interest of the academic community over the last decade (Schögl et al., 2020), and many companies and countries worldwide have adopted it as part of their development strategies and policies (Gobierno de la República de Colombia, 2019; OECD & Dutch Ministry of Agriculture, 2019).

Tools provided by the industrial ecology field are often utilized to evaluate circular economy alternatives. Examples include material flow analysis (MFA), life cycle assessment (LCA), and carbon footprint calculations. The operations research literature provides complementary tools for performance assessment such as data envelopment analysis (DEA), multi-criteria decision-making (MCDM), and discrete-event

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Embracing Sustainability in the Industry: A Study of Environmental, Economic, and Exergetic Performances in Large-Scale Production of Magnetite Nanoparticles.

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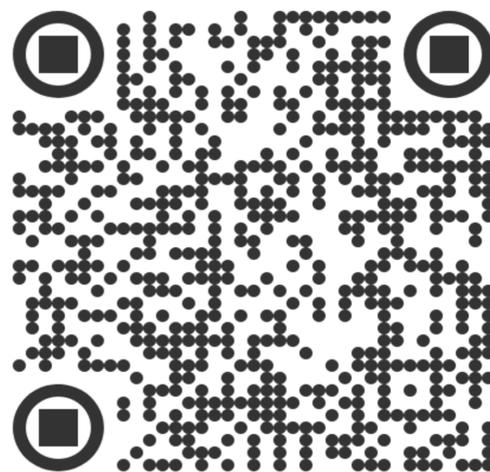


Adriana L. Abrego-Pérez

Olga P. Fuentes
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Mauricio E. Sánchez
Johann F. Osma
Juan C. Cruz

El artículo compara distintas formas de producir nanopartículas de magnetita y muestra cómo el uso de microdispositivos microfluídicos permite una producción más limpia, eficiente y rentable, ofreciendo una alternativa innovadora y sostenible para la industria a gran escala.

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Research Article

Embracing Sustainability in the Industry: A Study of Environmental, Economic, and Exergetic Performances in Large-Scale Production of Magnetite Nanoparticles

Olga P. Fuentes, Diana M. Trujillo, Mauricio E. Sánchez, Adriana L. Abrego-Perez, Johann F. Osma, and Juan C. Cruz*

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ABSTRACT: Magnetite nanoparticles (MNPs), with their distinct properties and controllability by using magnetic fields, have secured a central position in various industrial applications. Nevertheless, the surging demand for MNPs necessitates a meticulous examination of the sustainability of their production processes. This study embarks on a comprehensive evaluation of four case studies associated with the large-scale production of MNPs, specifically focused on environmental, economic, and exergy aspects. Our environmental assessment, employing life cycle assessment, revealed that the MNPs production using microfluidic devices (Case Study 4) showcased a promising environmental footprint. With the lowest electricity impact constituting only 8% of the overall environmental impact, it substantiates the efficacy of microfluidic devices in mitigating ecological repercussions. Economic analysis further reinforced the sustainability of Case Study 4. They exhibited superior financial viability, boasting a net present value of US\$ 28,033,346, a modified internal rate of return of 19.73%, and a benefit–cost ratio of US\$ 2.07. These figures underscore the economic robustness of this production methodology, suggesting an enticing prospect for large-scale MNP manufacturers. Finally, our exergetic evaluation demonstrated that Case Study 4 exhibited the least total exergy destruction, thereby displaying a superior thermodynamic efficiency. In summary, this study indicates that the adoption of microfluidic devices in MNPs production significantly enhances the environmental performance, economic feasibility, and energy utilization. These findings offer vital insights for those seeking to balance the demands of industrial production with sustainability objectives.

KEYWORDS: life cycle assessment, sustainability, scaling up, economic analysis, exergy, uncertainty, sensitivity analysis

INTRODUCTION

In recent years, the prominence of nanoparticles (NPs) has surged within various industrial applications, largely due to their remarkable properties.^{1,2} Among these NPs, magnetite NPs (MNPs) have been attracting significant attention owing to their distinctive nanoscale properties such as magnetic behavior.^{3,4} Their capability to be manipulated by using magnetic fields renders them ideal for applications demanding particle movement control. The versatility of MNPs has led to their widespread utilization across diverse sectors including electronics, medicine, environmental remediation, and beyond, offering groundbreaking solutions and promising advancements.^{5–8} Consequently, the continuous rise in MNP demand necessitates an examination of the sustainability of their large-scale production processes. Herein, a sustainability assessment proffers an exhaustive exploration of the environmental, social, and economic implications of different MNPs production methods.⁹

An environmental analysis evaluates potential environmental impacts, taking into account resource consumption, emissions, and waste generation.¹⁰ Efforts to boost the sustainability of MNPs while mitigating their environmental impact have led to multiple studies proposing enhancements to their synthesis process.^{11,12} One notable strategy involves substituting conventional raw materials with greener alternatives, thereby dramatically reducing nonrenewable resource usage and minimizing the ecological footprint of MNPs production.¹³ A recent study by Ahmed et al. demonstrated the feasibility of using natural waste residues, such as onion, potato, tea, and

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A GRASP algorithm for the bus crew scheduling problem

11 de enero de 2024

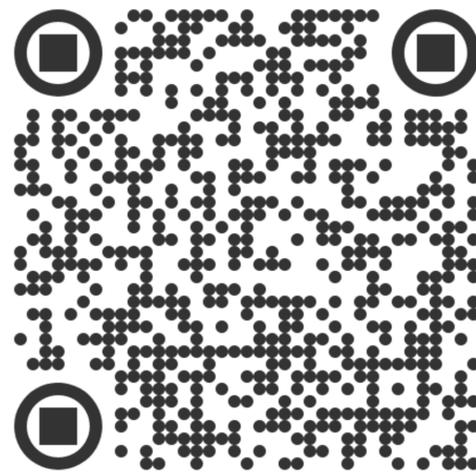
Publicado en: International Journal of Industrial Engineering Computations



David Álvarez-Martínez
David Pardo-Peña
John Willmer Escobar

El artículo propone un modelo de optimización para asignar turnos al personal de buses de manera eficiente, incorporando no solo la reducción de costos operativos sino también la satisfacción de los conductores. Los resultados muestran mejoras significativas en el ambiente laboral y soluciones de alta calidad en tiempos de cómputo reducidos, tanto en casos reales como en instancias de referencia.

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A GRASP algorithm for the bus crew scheduling problem

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ABSTRACT

This paper proposes a GRASP approach for solving the Bus Crew Scheduling Problem (BCSP) to find high-quality solutions within short computing times. The BCSP described the process related to the assignment of drivers and conductors to a bus company's regular daily operation of a mass transit system, seeking to minimize the cost of operation and, at the same time, the improvement of the working environment by considering the satisfaction of the drivers with the assigned shifts. The BCSP has drivers in charge of covering the demand for shifts, with an assignment that contains several constraints, such as minimum and maximum work blocks, minimum rest days, and shift sequences that must not be assigned. The former GRASP algorithm is proposed with a constructive procedure, a solution repair procedure, and two local search operators. Classical instances from the literature have been adapted for the shift assignment problem by adding a satisfaction variable. Besides, the proposed approach has been tested for a real company operating articulated and feeder vehicles. The results show that the satisfaction function adds value to the assignments, substantially improving the work environment and generating favorable results in terms of time and quality of the solution.

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1. Introduction

Public passenger transportation is a determining factor in the city's way of life. A good transport system provides comfort in the mobility of people and becomes one of the main measures of quality of life. In this sense, public passenger transport plays a fundamental role in decision-making from a social, economic, and environmental point of view. Indeed, planning the transport network is extremely important for providing quality service and for the transport operator and the costs it assumes. Planning is complex and challenging, so this process is generally split into three phases covering strategic, tactical, and operational decisions. Strategic decisions are related to the design of the transportation network. Tactical decisions consider the set of frequencies and schedules of the transport network. Operational decisions are related to the problem of vehicle scheduling, shift scheduling, and shift assignment to drivers. However, each problem associated with each public passenger transport planning stage has been extensively studied because they are complex problems (mathematically and computationally). All these problems are classified as NP-hard problems. Therefore, each problem must be solved separately and sequentially (Byrne, 1973).

This paper is related to crew scheduling for transportation public belonging to the operational decisions. Whenever a bus is in operation, a driver must be assigned to it. Sometimes, the waiting time of a bus could be considered, for instance, the arrival of one journey and the departure of the next. However, when a crew leaves a bus, a relieving crew must be available to take it over (Smith, 1986). For the crew scheduling problem, it is necessary to consider that a crew leaves the bus to take a break or finish their duty, and another crew must take over the bus operation just starting their duty or having already worked on another bus (Smith, 1986). The Bus Crew Scheduling Problem (BCSP) is an integral part of the logistic management of bus

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Reliable Routing Strategies on Urban Transportation Networks

08 de febrero de 2024

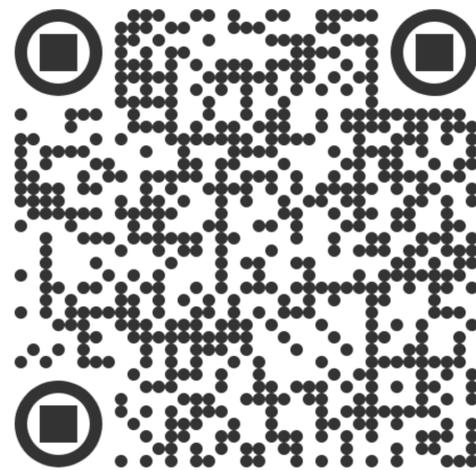
Publicado en: Transportation Science



Andrés L. Medaglia
Daniel Yamín
Arun Prakash Akkinepally

El artículo aborda cómo encontrar rutas más confiables en redes de transporte urbano bajo condiciones de incertidumbre, proponiendo un algoritmo eficiente que maximiza la probabilidad de llegar a tiempo. Probado en redes reales de gran escala, el método demuestra ser más rápido y competitivo que enfoques tradicionales, ofreciendo soluciones prácticas para mejorar la planificación de viajes urbanos.

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Reliable Routing Strategies on Urban Transportation Networks

Daniel Yamín,^a Andrés L. Medaglia,^{a,*} Arun Prakash Akkinepally^b

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Abstract. The problem of finding the most reliable routing strategy on urban transportation networks refers to determining the time-adaptive routing policy that maximizes the probability of on-time arrival at a destination given an arrival time threshold. The problem is defined on a stochastic and time-dependent network that captures real-world transportation systems' inherent uncertainty and dynamism. To solve this problem, we present a dynamic programming-based algorithm that benefits from a node-time pairs queue implementation. In addition to improving the computational running time in most cases, this implementation supports different queue disciplines, leading to different algorithmic approaches: label-correcting and label-setting methods. We prove the correctness of the algorithm and derive its worst case time complexity. We present computational experiments over real-world, large-scale transportation networks with up to ~33,000 nodes, showing that the algorithm is a viable alternative to existing state-of-the-art methods. It can be four times faster for relatively tight arrival time thresholds and is competitive for looser ones. We also present experiments assessing the different queue disciplines used within the algorithm, the gains of the node-time pairs queue implementation, and comparing optimal strategies obtained from reliability and travel time objectives.

Keywords: stochastic time-dependent networks • on-time arrival probability • most reliable routing policy • dynamic programming • label-correcting method • label-setting method • urban transportation networks

1. Introduction

Real-world transportation networks are exposed to unpredictable events, including accidents, vehicle breakdowns, and severe weather, and a systematic variability in their performance measures along the day, for example, transportation demand, traffic flow, and travel times. These intrinsic characteristics of urban transportation systems often lead to late arrivals of deliveries, pickups, and commutes. Delivering on time considerably influences customers' satisfaction and companies' performance (Al-Shboul 2017). Consequently, on-time delivery is a primary objective in supply chain management and inner-city logistics (Niemi et al. 2020). On everyday commutes, traffic is one of the most common reasons for lateness at work. The latter affects workplace morale, recurrent absences, and productivity (Clark, Peters, and Tomlinson 2005). Late arrivals can equally impact other transportation-related activities. For instance, on-demand ride-sharing transportation has shown great potential to alleviate many problems associated with urban mobility, such as traffic congestion, public transport off-peak inadequacy, and greenhouse gas emissions. However, these systems can be perceived as unreliable or inefficient mainly because of drivers' tardiness (Kucharski et al. 2021). Overall, late arrivals have

significant implications for individuals, groups, and organizations.

Researchers have investigated reliable routing problems on urban transportation networks to develop analytic tools that prevent lateness and allay its consequences. When studying inner-city routing problems, disregarding transportation networks' stochastic and dynamic nature may lead to unreliable or suboptimal solutions. In turn, finding such solutions may lead to inefficient routing guidance or poor decisions in planning applications. For these reasons, a stream of research studies urban routing problems by employing stochastic and time-dependent (STD) networks. These networks provide a precise modeling tool to represent urban transportation systems by considering arc travel times as time-dependent discrete random variables rather than deterministic values. On the one hand, uncertainty captures travel times' random variations. On the other hand, dynamism considers their fluctuations along the time of day. Nevertheless, high complexity and computational demand are associated with solving time-dependent stochastic optimization problems.

There are two ways to formulate routing problems on STD networks. When an elementary route must be specified a priori (i.e., before the travel begins) and

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Covid-19 vaccination: A mixed methods analysis of health system resilience in Latin America

12 de febrero de 2024

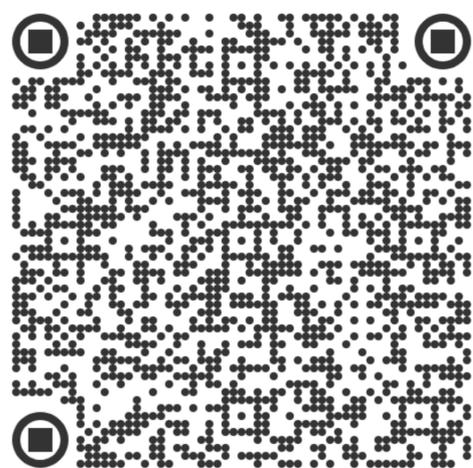
Publicado en: International Journal for Equity in Health



Ciro-Alberto Amaya
Estefanía Hernández-Pineda
Catalina González-Uribe
Andrea Herrera
Nubia Velasco

El artículo analiza cómo distintos países de América Latina enfrentaron el reto de la vacunación contra la covid-19, mostrando que la resiliencia de los sistemas de salud depende de la capacidad de adaptar estrategias, aprender durante la crisis y coordinar soluciones a múltiples niveles, dejando lecciones clave para futuras emergencias sanitarias.

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Hernandez-Pineda et al. *International Journal for Equity in Health* (2024) 23:27
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RESEARCH

Open Access



Covid-19 vaccination: a mixed methods analysis of health system resilience in Latin America

Estefania Hernandez-Pineda^{1*},
Ciro-Alberto Amaya², Catalina González-Uribe³,
Andrea Herrera² and Nubia Velasco¹

Abstract

Background This paper discusses the stages of health system resilience (HSR) and the factors underlying differences in HSR during the covid-19 pandemic, especially the vaccination challenge. We studied the relationship between vaccination strategies and macro-context backgrounds in 21 Latin American countries. Our objective was to capture the impact of those aspects in the SR and identify potential improvements for future crises and for vaccination programs in general.

Methods The study uses mixed-methods research to provide insights into how the countries' backgrounds and vaccination strategies impact the HSR. Particularly, we used explanatory sequential mixed methods, which entails a quantitative-qualitative two-phase sequence. The quantitative phase was conducted using cluster and variance analysis, in which the HSR was measured using as a proxy the covid-19 vaccination outcomes in three cut-offs of reaching 25%, 50%, and 75% of population coverage. This approach allows us to discriminate covid-19 vaccination progress by stages and contrast it to the qualitative stage, in which we performed a country-case analysis of the background conditions and the changes in vaccination strategies that occurred during the corresponding dates.

Results The paper provides a rich comparative case analysis of countries, classifying them by early, prompt, and delayed performers. The results show that differences in vaccination performance are due to flexibility in adapting strategies, cooperation, and the ability to design multilevel solutions that consider the needs of various actors in the health ecosystem. These differences vary depending on the vaccination stage, which suggests the importance of acknowledging learning, diffusion, and feedback processes at the regional level.

Conclusions We identified the importance of societal well-being as an ideal country antecedent for high and sustained levels of performance in covid-19 vaccination. Whereas in other countries where the set-up and beginning phases were rough, the value of the operational decisions and the learning on the move regarding their own and their peers' trajectories were crucial and were reflected in performance improvement. A contribution of this study is that the above-mentioned analysis was done using vaccination coverage cut-off points that allow a performance view that takes into consideration the stages of the vaccination progress and the learning process that goes with it.

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Speculative Labs:

Shaping future management practices through collaborative scenario experimentation

11 de marzo de 2024

Publicado en: Touchpoint



Ricardo Hernández

Paula Wuth
Leonel Merino
Sebastián Negrete
Camila Silva

Los acontecimientos sociales actuales; como las crisis migratorias, los movimientos sociales, la inestabilidad económica, el cambio climático y los conflictos políticos, han hecho que el entorno sea cada vez más volátil, incierto, complejo y ambiguo. Ante este contexto, las organizaciones no deben limitarse a reaccionar, sino anticipar los desafíos y prepararse estratégicamente para el futuro.

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Speculative Labs

Shaping future management practices through collaborative scenario experimentation



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Leonel Merino is an Assistant Professor of Engineering Design at UC. He received a Ph.D. in Computer Science from the University of Bern. His research interests include extended reality.

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Camila Silva is Head of Project Management at New.

Current societal events – such as the migration crisis, social revolutions, economic instability, climate change and political issues – have made today’s environment more volatile, uncertain, complex and ambiguous (Beckert, 2021; Gümüşay & Reinecke, 2022). Rather than react to the occurrence of these events, organisations need to anticipate the challenges they pose, and prepare themselves for the future.

This requires new forms of management, as decision-making based on projecting the present to visualise the future is no longer reasonable (Buehring & Bishop, 2020; Bühring & Liedtka, 2018). It has therefore become important to construct and visualise a collective future that makes sense to employees and mobilises the organisation (Verganti et al., 2021; Magistretti et al., 2023), including the involvement of internal and external stakeholders to achieve a holistic understanding of the organisation.

The role of design and service design

One way to deal with context and move towards new management practices is through design (Magistretti et al., 2023; Verganti et al., 2021). While the relevance of the intersection between management, design and future studies has been mentioned, concrete methods and tools for their application still need to be provided. Therefore, there is an opportunity to articulate different design approaches into one particular proposition to achieve the desired integration.

Our experience and knowledge have shown that speculative design, participatory design, service design and design-led innovation, are four approaches that can be integrated to create future-proof strategic planning. The combination of these approaches encourages visualising different possible futures in which the organisation could exist, actively integrating those who will be relevant in the process of building strategic planning and facilitating collaboration through artefacts and prototypes. Moreover, it allows the representation of narrative and systemic views of futures and strategic definitions under the logic of sequentiality, and the detection of initially unimaginable future meanings (Dunne & Raby, 2013; Drain & Sanders, 2019; Stickdorn et al., 2018; Verganti, 2017).

Integrated Decision Support for Disaster Risk Management:

Aiding Preparedness and Response Decisions in Wildfire Management

12 de marzo de 2024

Publicado en: Information Systems Research



Andrés L. Medaglia
Daniel Suárez
Camilo Gómez
Raha Akhavan-Tabatabaei
Sthefania Grajales

El artículo propone un marco analítico para mejorar la gestión del riesgo de desastres integrando decisiones de prevención, preparación y respuesta bajo incertidumbre. A partir de un caso de incendios forestales en Uruguay, muestra cómo pequeñas decisiones en la fase de preparación pueden tener grandes impactos en la respuesta, resaltando la importancia de sistemas de información y modelos integrados para una toma de decisiones más efectiva.

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Integrated Decision Support for Disaster Risk Management: Aiding Preparedness and Response Decisions in Wildfire Management

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Abstract. A central challenge in disaster risk management (DRM) is that there are key dependencies and uncertainty between the decisions made at the mitigation, preparedness, response, and recovery stages. Evaluating the impact of strategic decisions on the decisions and outcomes of subsequent stages is paramount to determine informed risk management policies (e.g., estimating the risk reduction that may be achieved by a mitigation strategy relative to its cost). Performing such analyses is difficult, not only because of the uncertainty inherent to disastrous events but because it implies integrating the logic and data of different processes that occur at each stage. Comprehensive decision support systems for disaster management and thus require information systems that allow timely and reliable integration of data sources from different domains, including information on hazards and vulnerabilities for risk analysis and organizational and logistical information for decision analysis. We propose an analytics-centered framework that integrates predictive and prescriptive models responding to unique characteristics of DRM. The framework relies on probabilistic risk assessment and uses optimization-based simulation of the response phase as a means to inform decisions at the preparedness stage. This paper presents a case study regarding the analysis of preparedness and response decisions for wildfire control in Uruguay. Numerical results illustrate the insights that can be derived from the integration of data and models at multiple stages. Specifically, in the Uruguay case, slight reductions in the preparedness budget can lead to disproportionate losses during the response stage, whereas slight increases have little effect unless explicitly directed to control high-consequence scenarios. Motivated by a real-world problem, this case study emphasizes the challenges for integrated information systems that enable the potential of analytical decision support frameworks for DRM.

History: This paper has been accepted for the *Information Systems Research* Special Section on Unleashing the Power of Information Technology for Strategic Management of Disasters. Ahmed Abbasi, Robin Dillon-Merrill, H. Raghav Rao, Olivia Sheng, Senior Editors; Ahmed Abbasi, Associate Editor.

Funding: This work was supported by the Departamento Administrativo de Ciencia, Tecnología e Innovación [Grant 645-2014].

Supplemental Material: The online appendix is available at <https://doi.org/10.1287/isre.2022.0118>.

Keywords: decision support systems • disaster risk management • wildfire management

1. Introduction

Disaster risk management (DRM) is a complex problem that involves the interaction of interrelated systems, including the natural environment (e.g., earth and atmospheric phenomena), the built environment (e.g., infrastructure and technological systems), and organizational systems (e.g., communities, authorities, responders), which add a layer of socio-cultural, economic, and political aspects that shape DRM decisions.

We will use the term system-of-systems (SoS) referring to this characteristic, especially including cyber-physical-social systems (CPSS), which explicitly account for the pervasiveness of information systems. At the core, DRM deals with high uncertainty and *low-probability, high-consequence events* that challenge the *business-as-usual* intuition. Risk-informed decision making is thus a necessary frame to ponder the value of efforts toward resilience of the overall SoS.

Exploring Dengue Dynamics: Multi-Scale Analysis of Spatio-Temporal Trends in Ibagué, Colombia

13 de marzo de 2024
Publicado en: Viruses



Alejandra Tabares
Julián Otero
Mauricio Santos-Vega

El artículo analiza cómo factores climáticos, sociales y demográficos influyen en la incidencia del dengue en Ibagué, mostrando que el riesgo varía según la escala espacial de análisis. Los resultados revelan que los niveles intermedios permiten identificar mejor los focos locales de riesgo, ofreciendo información clave para diseñar intervenciones de salud pública más precisas y efectivas.

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Article

Exploring Dengue Dynamics: A Multi-Scale Analysis of Spatio-Temporal Trends in Ibagué, Colombia

Julian Otero ^{1,2,*}, Alejandra Tabares ^{3,†} and Mauricio Santos-Vega ^{2,4,†}

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Abstract: Our study examines how dengue fever incidence is associated with spatial (demographic and socioeconomic) alongside temporal (environmental) factors at multiple scales in the city of Ibagué, located in the Andean region of Colombia. We used the dengue incidence in Ibagué from 2013 to 2018 to examine the associations with climate, socioeconomic, and demographic factors from the national census and satellite imagery at four levels of local spatial aggregation. We used geographically weighted regression (GWR) to identify the relevant socioeconomic and demographic predictors, and we then integrated them with environmental variables into hierarchical models using integrated nested Laplace approximation (INLA) to analyze the spatio-temporal interactions. Our findings show a significant effect of spatial variables across the different levels of aggregation, including human population density, gas and sewage connection, percentage of woman and children, and percentage of population with a higher education degree. Lagged temporal variables displayed consistent patterns across all levels of spatial aggregation, with higher temperatures and lower precipitation at short lags showing an increase in the relative risk (RR). A comparative evaluation of the models at different levels of aggregation revealed that, while higher aggregation levels often yield a better overall model fit, finer levels offer more detailed insights into the localized impacts of socioeconomic and demographic variables on dengue incidence. Our results underscore the importance of considering macro and micro-level factors in epidemiological modeling, and they highlight the potential for targeted public health interventions based on localized risk factor analyses. Notably, the intermediate levels emerged as the most informative, thereby balancing spatial heterogeneity and case distribution density, as well as providing a robust framework for understanding the spatial determinants of dengue.

Keywords: dengue; spatio-temporal analysis; geographically weighted regression; integrated nested Laplace approximation; spatial aggregation levels



Citation: Otero, J.; Tabares, A.; Santos-Vega, M. Exploring Dengue Dynamics: A Multi-Scale Analysis of Spatio-Temporal Trends in Ibagué, Colombia. *Viruses* **2024**, *16*, 906. <https://doi.org/10.3390/v16060906>

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1. Introduction

Dengue fever, a mosquito-borne viral disease [1], has become a critical public health issue globally, particularly in tropical and subtropical regions [2,3]. The country of Colombia, located in the tropical region of Latin America, has reported the highest dengue case fatality rate in the continent, and it has experienced four major outbreaks in the last two decades, occurring in 2010, 2013, 2019, and 2023 [4,5]. Ibagué, is a city in the department of Tolima, Colombia, and it exemplifies an urban area significantly affected by dengue, with its incidence rising notably over the past years [6]. Ibagué's rapid urbanization over the past two decades has led to densely populated, low-income neighborhoods that often lack regular access to water and adequate infrastructure. These socioeconomic conditions have been linked to higher dengue incidence and mosquito populations [7–9]. Additionally, the

Impact assessment of an active transport intervention via systems analytics

Marzo de 2024

Publicado en: Transportation Research Part D: Transport and Environment

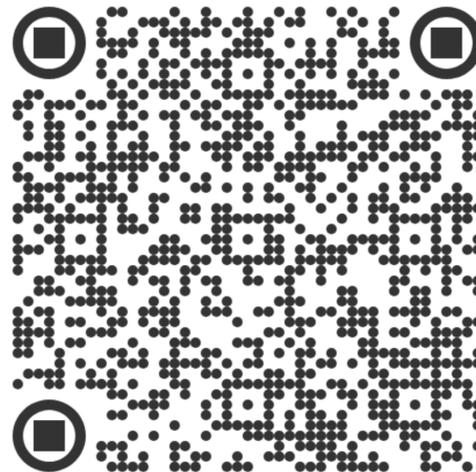


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Felipe Montes

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Olga L. Sarmiento
Luis A. Guzmán
Mauricio Sánchez-Silva
Darío Hidalgo
Karla Parra
Andrés F. Useche
José D. Meisel
Hansel Ochoa-Montero
Natalia Rodríguez Castañeda

El artículo evalúa el impacto de las ciclorrutas temporales implementadas en Bogotá durante la pandemia, mostrando que estas contribuyeron a reducir accidentes, mejorar la seguridad vial y salvar vidas. A través de un enfoque de sistemas, el estudio ofrece herramientas útiles para diseñar políticas de transporte activo más seguras y sostenibles.

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Impact assessment of an active transport intervention via systems analytics[☆]

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ARTICLE INFO

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Systems analytics
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Active transport
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ABSTRACT

The assessment of urban transport interventions is complex, multi-faceted, and context-dependent. This study proposes a multi-methodology approach called *systems analytics* to evaluate the potential impact of the implementation of temporary bike paths during the COVID-19 pandemic on Bogotá's bicycle complex system. The proposed methodology applies systems theory to identify the complexity, barriers, and facilitators of the system and uses statistical and simulation methods to assess the potential impact of temporary bike paths on the safety and quality of life of bicycle users in Bogotá during the COVID-19 pandemic. The results of the case study indicate that the temporary bike paths could have been a factor that helped reduce bicycle collision rates (by 56%), increased the use of street segments classified with low levels of traffic stress (by 6.22%), and prevented premature deaths (145 per year). The proposed methodology is helpful for policymakers who aim to design active transport interventions in support of a sustainable and healthy environment.

1. Motivation and background

Transportation systems play a critical role in modern society, providing the crucial infrastructure necessary for moving people and goods. However, creating, using, and transforming these systems is much more complex than only meeting the demand for movement. In fact, transportation systems share several characteristics with complex systems, including adaptability, self-organization, stability, and phase transitions, according to the *OECD Global Science Forum (2009)*. Urban transport systems have a significant impact on environmental, social, and economic outcomes (*Faulin et al., 2018*). In this context, research has linked congestion in motor vehicles to

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Evaluation of the safety profile of the quadrivalent vaccine against human papillomavirus in the risk of developing autoimmune, neurological, and hematological diseases in adolescent women in Colombia

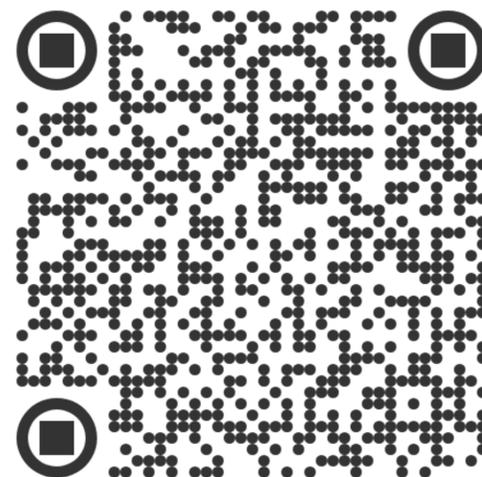
02 de abril de 2024
Publicado en: Vaccine



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Ivette Maldonado
Nicolás Rodríguez Niño
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El artículo evalúa la seguridad de la vacuna cuadrivalente contra el VPH en adolescentes colombianas, analizando su posible asociación con enfermedades autoinmunes, neurológicas y hematológicas. Aunque se observaron asociaciones estadísticas para algunos diagnósticos, los resultados no mostraron un patrón temporal claro, lo que resalta la necesidad de más estudios y aporta evidencia local clave para fortalecer la confianza en la vacunación y avanzar en la prevención del cáncer de cuello uterino.

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Evaluation of the safety profile of the quadrivalent vaccine against human papillomavirus in the risk of developing autoimmune, neurological, and hematological diseases in adolescent women in Colombia

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ARTICLE INFO

Keywords:
Human Papillomavirus
Vaccine
Safety
Adolescent Health
Women Health

ABSTRACT

Background: Cervical cancer eradication is one of the main goals for 2030 by the World Health Organization, which can only be achieved with high vaccination rates against Human Papilloma Virus. In Colombia, more and better scientific evidence is required to increase confidence in vaccination. The objective of this study is to evaluate the safety profile of the quadrivalent vaccine against HPV in the risk of developing autoimmune, neurological, and hematological diseases in adolescent women in Colombia.
Methods: We designed a cohort study based on national HPV vaccination records and incident diagnostic data for the diseases of special interest during 2012 and 2021. We included adolescent women between 9 and 19 years old and compared vaccinated and non-vaccinated cohorts using an Inverse Probability of Treatment Weighting (IPTW) method for each scenario disease and follow-up period (180 and 360 days).
Findings: The Odds Ratio (OR) of developing diseases of interest was estimated during two follow up periods, 180 and 360 days after the follow-up index date (Vaccination Day). The OR for developing rheumatoid arthritis was 4.4; CI95% (1.74 – 11.14), juvenile idiopathic arthritis was 2.76 IC95% (1.50 – 5.11), idiopathic thrombocytopenic purpura was 2.54 IC95% (1.28 – 5.02) and thyrotoxicosis was 2.86 IC95% (1.03 – 7.95), when comparing the vaccinated versus unvaccinated population. However, the temporal distribution of cases incident did not reveal a clear difference between the cohorts, since the rate of appearance of new cases has a constant linear behavior for the two groups.
Interpretation: For rheumatoid arthritis, juvenile idiopathic arthritis, idiopathic thrombocytopenic purpura, and thyrotoxicosis; the application of the vaccine had an effect on the development of the disease. Nevertheless, our results should be interpreted with caution and be further studied, considering that the biological plausibility of the events occurred without a clear temporal pattern in relation to the exposure to the vaccine.

1. Introduction

In August 2020, the World Health Organization proposed a global strategy to accelerate the elimination of cervical cancer, whose goal is to achieve and maintain an incidence rate lower than four cases per

100.000 women / year.[1] Developed countries like Sweden, Australia and the United Kingdom have an incidence rate of 5-6 to 10-4 cases per 100.000 women / year. Colombia has a rate that exceeds 14 cases per 100.000 women / year, making it one of the main causes of death for women in this country.[2].

Abbreviations: AUC, Area under the Receiving Operator Curve; CUPS, Unique Classification of Procedures, in Spanish; HPV, Human Papilloma Virus; ICD-10, International Classification of Diseases, Tenth Revision; IPTW, Inverse Probability of Treatment Weighting; OR, Odds Ratio; PAI, Expanded Program on Immunization, in Spanish; qHPV, Quadrivalent vaccine against Human Papillomavirus; RIPS, Individual Records for the Provision of Health Services, in Spanish.

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Assessing botanical compatibility in gin production:

A mathematical model and network analysis approach

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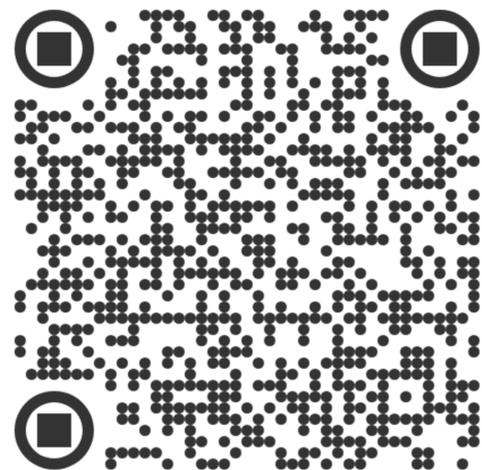
Publicado en: Food and Bioproducts Processing



Rafael Amaya-Gómez
 Javier Ramírez
 Juan Camilo León
 Nicolás Ratkovich

El artículo presenta una metodología innovadora para evaluar la compatibilidad entre botánicos usados en la producción de gin, combinando análisis químico, modelos matemáticos y visualizaciones en red. La propuesta permite diseñar recetas más equilibradas y creativas, ofreciendo una herramienta práctica y científica para mejorar y reinventar la formulación de gin artesanal e industrial.

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Food and Bioproducts Processing 145 (2024) 158–174



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IChemE



Assessing botanical compatibility in gin production: A mathematical model and network analysis approach

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ARTICLE INFO

Keywords:

Botanical compatibility
 Gin
 Volatile compounds
 Aroma classification
 Recipe development
 Network analysis

ABSTRACT

This study introduces a novel methodology for evaluating volatile-compound-based compatibility in 160 botanicals essential for gin production. It establishes a comprehensive botanical pairing system through network analysis, mathematical modeling, and indicator development. Key findings include the benefits of strategic botanical inclusions to recipes for compatibility improvement and a numerical compatibility assessment, revealing an average indicator of 1.78 across thirty validated gin recipes, with a significant threshold at 1.36 indicating superior compatibility. Additionally, two distinct indicators were formulated—one focusing on the percentage of shared compounds due to a specific botanical and another on the botanical's representation in the recipe. A visual network analysis replaces the traditional aroma classification wheel, offering a comprehensive view of aromatic profiles. This research transforms gin formulation, supported by an extensive database and validated methods.

1. Introduction

Gin has its origins in ancient Greece, and it was used in the sixteenth century as a juniper-infused tincture to cure fevers. The origin of gin has thus always been linked to juniper berries, and to botanicals in general. As stated by Thorogood and Hiscock (2020) gin is defined by the plants with which is made. Several botanicals, including roots, seeds, barks and fruit have been used in gin production since its beginnings, each combination produces a unique aroma result.

It is necessary to understand each botanic's origin, quantities and aroma profile to appreciate the complexities and subtleties of gin Thorogood and Hiscock (2020). Botanical tasting wheels have been developed in order to classify botanicals by their aroma profiles, such as herbal, sweet, fruity, floral, citrus, bitter, roasted, and spicy, among others. However, each botanical has more than one aroma profile, and this is crucial at the moment of pairing botanicals in a gin recipe.

Clutton and Evans (1978) identified the principal aroma volatiles in London Dry Gin by gas chromatography assisted with continuous extraction with Freon 11. The principal volatile compounds obtained, such as β -pinene, myrcene, limonene, γ -terpinene, linalool, and α -terpineol were matched with the main botanicals used in London Dry Gin recipes, such as juniper berries, coriander, orange peel, cassia bark, cinnamon, among others in order to predict the flavor level of each botanic in different samples of gin.

Dussort et al. (2012) used an original approach to gas chromatography-olfactometry (GC-O) to identify key aroma compounds in two types of gin, obtaining as the main result an aroma classification wheel to categorize the descriptors obtained in 12 super-categories, as shown in Fig. 1.

Furthermore, Dussort et al. (2014) developed an integrative approach based on gas chromatography-olfactometry (GC-O) and gas chromatography-mass spectrometry (GC-MS) for aroma compounds identification. A multi-block and single-block approach were applied to data in order to describe the origin of key aroma compounds. Two categories were determined: the “gin background” group, with compounds perceived with equal intensity in both gins, and the “gin characteristic” group, with botanicals having a different intensity in each sample.

Ickes et al. (2017) developed a rum flavor lexicon by compiling and evaluating more than 1000 web rum reviews. This study confirmed web-based material analysis as a useful tool for synthesizing and minimizing time and cost in evaluating products exhibiting a wide variation in flavor profiles and where sensory fatigue is a large issue. The developed lexicon seeks to establish a standardized language for the rum industry and to aid in term generation for further descriptive analysis panels on rum.

In their pioneering work, Miller et al. (2021) established a comprehensive dataset for the systematic characterization of novel whiskies

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Seat assignment recommendation in airlines purchase flow to increase ancillary revenue considering weight and balance constraints

16 de abril de 2024

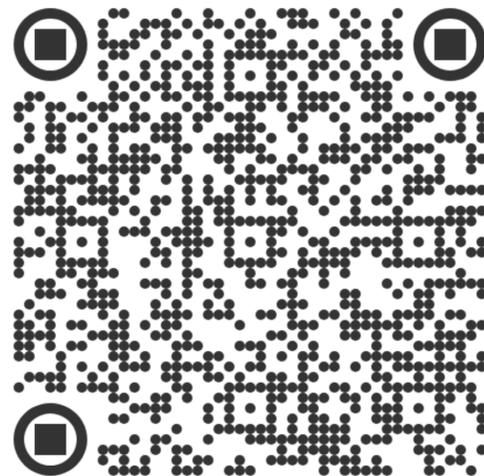
Publicado en: Journal of Air Transport Management



Alejandra Tabares Pozos
David Álvarez-Martínez
 Germán Pardo González
 Camilo Quiroga

El artículo propone un modelo de optimización para aerolíneas de bajo costo que maximiza los ingresos por servicios adicionales, específicamente los cambios de asiento. Mediante una asignación estratégica de asientos que incentiva a los pasajeros a pagar por ubicarse juntos o en mejores posiciones, el modelo permite aumentar los ingresos de forma dinámica y eficiente en tiempo real.

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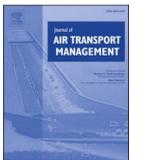
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Journal of Air Transport Management

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Seat assignment recommendation in airlines purchase flow to increase ancillary revenue considering weight and balance constraints

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ARTICLE INFO

Keywords:
 Network flows optimisation
 Integer programming
 OR in airlines
 Multi-criteria optimisation
 Seat assignment

ABSTRACT

In the highly competitive and cost-sensitive realm of low-cost carriers, ancillary services have emerged as a pivotal revenue source, supplementing the basic fare with optional extras that enhance the passenger experience. This research propels this concept forward by introducing a sophisticated Mixed Integer Linear Programming (MILP) model specifically designed to optimise revenue from seat change fees, a key ancillary service. Our model is particularly crucial for low-cost carriers, where the natural decomposition of pricing strategies allows passengers to pay for a basic service, with the option to enhance their flying experience through additional paid services. The model introduces a novel approach to encourage seat changes, particularly for passengers booked together under the same reservation. The core strategy to promote seat changes involves maximising the seating distance between passengers who opt for the automatic seat selection feature, based on the current aircraft configuration. By intentionally allocating these passengers the furthest seats apart, the model creates a natural incentive for them to pay for seat changes, aiming to sit closer together. This approach not only generates additional revenue through seat change fees but also optimises the utilization of seat inventory by encouraging the purchase of premium seat options. To address the inherent unpredictability of seat sales, the model strategically reserves premium seats and places passengers less inclined towards seat changes in less desirable locations. This ensures an optimised allocation of seats that maximises revenue potential. Incorporating computational acceleration techniques, the model is designed for real-time application, allowing airlines to dynamically adapt to booking changes and maximise ancillary revenue opportunities. This rapid response capability empowers airlines to adapt swiftly to changing dynamics in seat bookings, thereby maximising their revenue generation potential. By offering a sophisticated tool for increasing profits from passenger accommodation services, this research bridges an essential gap in existing airline industry strategies, proposing a transformative approach to ancillary service optimisation.

1. Introduction

The airline industry faces increasing competition and pressure to improve revenue and profitability. In 2016, Latin American airlines earned around \$2.15 net profit per passenger, while the industry-wide airlines' mean was over \$9.13 and Latin American carriers were four times lower. Commercial aviation within Latin American countries has often been limited due to high fuel costs and political challenges. Furthermore, the currency exchange for these countries makes acquiring fuel more complex,

as it is generally purchased in US dollars. Specifically, in Colombia, the charges and taxes for international passengers are excessively high, amounting to over \$110 per traveller (O'Connell et al., 2020).

Research suggests that airlines are exploring ways to optimise their operations and increase revenue through ancillary services in today's competitive environment. One such service is the unbundling of flight products, where airlines sell products or services separately, such as the option to reserve a specific seat. In recent years, the revenue generated from unbundled flight products has become increasingly common among low-cost and traditional airlines.

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The policy is dead, long live the policy—Revealing science, technology, and innovation policy priorities and government transitions via network analysis Open Access

01 de mayo de 2024

Publicado en: Quantitative Science Studies



Catalina Ramírez
Julián D. Cortés

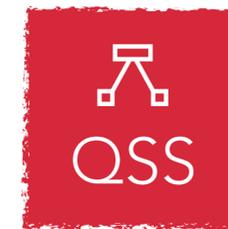
El artículo examina cómo evolucionan las prioridades en ciencia, tecnología e innovación en Colombia a lo largo de distintos gobiernos, a partir del análisis de convocatorias públicas de investigación entre 2007 y 2022. Aunque la agenda se vuelve más diversa y compleja, el estudio identifica un grupo reducido de áreas estratégicas que mantienen su relevancia a largo plazo, independientemente de los cambios políticos.

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RESEARCH ARTICLE

The policy is dead, long live the policy—Revealing science, technology, and innovation policy priorities and government transitions via network analysis

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Keywords: Colombia, content analysis, network analysis, science policy, text mining

ABSTRACT

Each government has priorities for science, technology, and innovation policies (STIP). How can we identify the changing or reinforced STIP research priorities induced by government transitions? This study aims to unveil the STIP changing structure in the public funding research call contents in Colombia from 2007 to 2022, applying a co-word and network analysis approach to 389 funding research calls. We showed each government's changing distribution of the betweenness centrality of 334 fields from Health, Life, Physical, and Social Sciences. We found that STIP priorities are getting denser and more diverse in terms of research fields. Despite this complexity, just 14 fields of Life, Physical, and Social Sciences, such as drug discovery, general business, management & accounting, and nature and landscape conservation, maintained their higher strategic relevance despite the government in office. This study maps the short and long-term focus of STIP regardless of the changing political tide inherent in democratic countries.

1. INTRODUCTION AND BACKGROUND

The policy is dead. Long live the policy! This alteration of the traditional proclamation unveils the political essence of STIP (science, technology, and innovation policies). Because STIP priorities change with every new government in office, what are the changing or reinforced STIP research fields induced by government transitions? We aim to unveil the STIP changing structure in the public funding research calls (RCs) content in a middle-income country employing a co-word and network analysis approach. Our proposal provides a methodological and empirical incursion to study the content's changing structure of STIP and identifies strategic research areas or fields adopted or discarded according to priorities established by the government while in office.

Our insights rely on the intersection between STIP studies and SciSci (science of science). STIP are rules, guidelines, and practices produced by governments to develop basic and applied research and their implementation in the economy within national borders (Edler, Berger et al., 2012; Meyer-Krahmer, 1984; Neal, Smith, & McCormick, 2008). SciSci, on the other hand, is a set of theoretical and quantitative techniques to unveil the determinants

Incremental Healthcare Costs of Diabetes Mellitus in a Middle-Income Country Using Administrative Healthcare Data

06 de mayo de 2024

Publicado en: Value in Health Regional Issues



Carlos Felipe Valencia
Santiago Castro
Adriana Beltrán Ruíz
Sara Miksi

El artículo estima el costo adicional que genera la diabetes en el sistema de salud colombiano, mostrando que esta enfermedad duplica el gasto médico anual, especialmente cuando aparecen complicaciones como las renales. Los resultados evidencian el fuerte impacto económico de la diabetes y la importancia de prevenir y manejar oportunamente sus complicaciones.

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Economic Evaluation

Incremental Healthcare Costs of Diabetes Mellitus in a Middle-Income Country Using Administrative Healthcare Data

Santiago Castro-Villarreal, MSc, Sara Miksi, MSc, Adriana Beltrán-Ostos, MD, MSc, Carlos F. Valencia, MSc, PhD

ABSTRACT

Objectives: To estimate the incremental medical cost of diabetes mellitus using information from administrative databases in Colombia.

Methods: We carried out a retrospective cohort study with administrative health databases from Colombian population affiliated in the contributory health insurance scheme. We used an operative definition to select the cohort with diabetes. Incremental cost and cost ratio of diabetes were estimated using an inverse probability weighting of treatment approach to find the causal effect of having the disease. Weights were calculated by a propensity score method using a Random Forest model. The flexibility of this machine learning algorithm allows to have a better specification and bias reduction. Additionally, we reported incremental costs and cost ratios with confidence intervals using bootstrapping and analyzed costs by age groups and complications associated with diabetes.

Results: The estimated prevalence of diabetes was 2834 per 100 000 cases, in 2018. The group with diabetes was comprised 634 015 people and the control group 1 524 808. The calculated annual direct medical cost was \$860, for which the incremental cost was \$493 and the cost ratio 2.34. The incremental annual cost for some type of complication ranges from \$1239 to \$2043, renal complication being the most expensive. Incremental cost by age groups ranges from \$347 to \$878, being higher in younger people.

Conclusions: Although the cost of diabetes in Colombia ranges among the global averages and is similar to other Latin-American countries, a greater incremental cost was found in patients with renal, circulatory, and neurologic complications.

Keywords: administrative databases, diabetes, incremental cost, inverse probability weighting estimation, medical cost estimation.

VALUE HEALTH REG ISSUES. 2024; 43:100992

Introduction

Diabetes imposes a significant burden on individuals, societies, and economies globally. In Latin America and the Caribbean, expenditure in diabetes already represents a substantial portion of the gross domestic product (GDP).¹ The total costs of diabetes in the region in 2015 was estimated to be in the range of 102 to 123 billion USD,² and it is expected to rise from 2.4% of regional GDP to 3.4% by 2030.^{1,3} The region is considered to have one of the highest burden relative to GDP in the world.³

Although there are several studies that estimate the burden the disease in the region, few of them assess the cost of diabetes in individual countries. In addition, there is a lack of consistency and homogeneity in the methodological approaches to assess the cost of diabetes, not only because of differences in methods for data analysis but also because of discrepancies in the scope of health services included. Only 4 countries in the region (Mexico, Brazil, Argentina, and Colombia)¹ have used microcosting studies to estimate diabetes-related costs. This highlights the need for more

comprehensive studies that accurately assess the economic impact of diabetes in this region.

In the case of Colombia, some studies have estimated the direct medical cost of diabetes.⁴⁻⁶ Most of them have conducted a descriptive analysis, but they have not used a causal approach when comparing with a group of people without diabetes to get the incremental cost attributable to diabetes. In this respect, incremental cost approach for this kind of studies has been recommended.⁷ To our knowledge, there are no studies of incremental costs of diabetes in Colombia.

The aim of this study is to use a national health administrative database to estimate the annual incremental cost of diabetes in Colombia with a disaggregated analysis by age groups and severity of the disease. Because we use observational data on a national scale, we also provide information about the prevalence of diabetes in Colombia. We propose a causal estimation methodology, in which the results are obtained from a retrospective cohort study that uses inverse probability of treatment weighting (IPWT) to find the causal effect of having diabetes on the medical cost.

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An Innovative Approach to Radiality Representation in Electrical Distribution System Reconfiguration: Enhanced Efficiency and Computational Performance

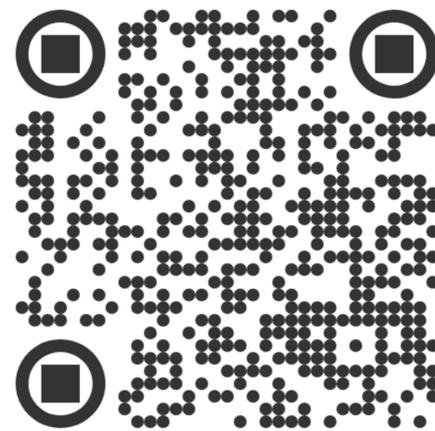
29 de mayo de 2024
Publicado en: Energies



Alejandra Tabares Pozos
David Álvarez-Martínez
Pablo José Cortés Sanabria
Diego Alejandro Noriega Barbosa

El artículo propone un nuevo modelo matemático para la reconfiguración de sistemas de distribución eléctrica que simplifica la representación de la operación radial y acelera los cálculos del flujo de potencia. Los resultados muestran mejoras significativas en tiempos de cómputo y calidad de las soluciones, ofreciendo una alternativa más eficiente y competitiva para optimizar redes eléctricas modernas.

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Article

An Innovative Approach to Radiality Representation in Electrical Distribution System Reconfiguration: Enhanced Efficiency and Computational Performance

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Abstract: The reconfiguration problem (DPSR) in electrical distribution systems is a critical area of research, aimed at optimizing the operational efficiency of these networks. Historically, this problem has been approached through a variety of optimization methods. Regarding mathematical models, a key challenge identified in these models is the formulation of equations that ensure the radial operation of the system, along with the nonlinear equations representing Kirchhoff's laws, the last often necessitating complex relaxations for practical application. This paper introduces an alternative representation of system radiality, which potentially surpasses or matches the existing methods in the literature. Our approach utilizes a more intuitive and compact set of equations, simplifying the representation process. Additionally, we propose a linearization of the current calculation in the power flow model typically used to solve DPSR. This linearization significantly accelerates the process of obtaining feasible solutions and optimal reconfiguration profiles. To validate our approach, we conducted rigorous computational comparisons with the results reported in the existing literature, using a variety of test cases to ensure robustness. Our computational results demonstrate a considerable improvement in computational time. The objective functions used are competitive and, in many instances, outperform the best reported results in the literature. In some cases, our method even identifies superior solutions.

Keywords: power distribution system reconfiguration; radial operation; mathematical modeling; linearization techniques; computational efficiency



Citation: Cortés Sanabria, P.J.; Tabares Pozos, A.; Álvarez-Martínez, D.; Noriega Barbosa, D.A. An Innovative Approach to Radiality Representation in Electrical Distribution System Reconfiguration: Enhanced Efficiency and Computational Performance. *Energies* **2024**, *17*, 2633. <https://doi.org/10.3390/en17112633>

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1. Introduction

In contemporary power distribution systems, a significant evolution is essential to accommodate the rising energy requirements and the increasing focus on sustainability and reliability. Central to this evolution is the reconfiguration challenge, which is crucial for optimizing network efficacy and augmenting operational efficiency [1]. Reconfiguration entails modifications in the topology of the power distribution network, primarily aimed at minimizing losses, enhancing load balancing, and improving fault response capabilities. This strategy is not merely vital for the effective operation of power grids but is also integral to incorporating renewable energy sources and adjusting to the dynamic characteristics of contemporary energy demands [2].

The inherent complexity of the DPSR in power distribution systems largely stems from the necessity to optimize network configurations while strictly maintaining a radial topology [3]. A radial topology is fundamentally a tree-like structure where each consumer

Using Stochastic Dual Dynamic Programming to Solve the Multi-Stage Energy Management Problem in Microgrids

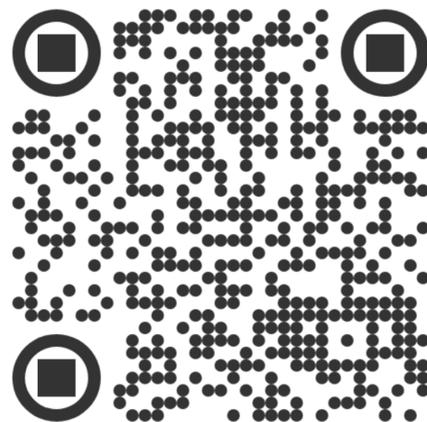
29 de mayo de 2024
Publicado en: *Energies*



Alejandra Tabares Pozos
Pablo Cortés

El artículo analiza cómo optimizar la gestión de microredes eléctricas bajo incertidumbre, proponiendo un modelo estocástico que mejora la toma de decisiones frente a la variabilidad de precios, generación y demanda. Los resultados muestran que este enfoque permite operar microredes de forma más eficiente y económica, superando métodos determinísticos tradicionales.

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Article

Using Stochastic Dual Dynamic Programming to Solve the Multi-Stage Energy Management Problem in Microgrids

Alejandra Tabares ^{*} and Pablo Cortés

Departamento de Ingeniería Industrial, Facultad de Ingeniería, Universidad de los Andes, Cr 1 Este No. 19A-40, Bogotá 111711, Colombia; pj.cortes716@uniandes.edu.co

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Abstract: In recent years, the adoption of renewable energy sources has significantly increased due to their numerous advantages, which include environmental sustainability and economic viability. However, the management of electric microgrids presents complex challenges, particularly in the orchestration of energy production and consumption under the uncertainty of fluctuating meteorological conditions. This study aims to enhance decision-making processes within energy management systems specifically designed for microgrids that are interconnected with primary grids, addressing the stochastic and dynamic nature of energy generation and consumption patterns among microgrid users. The research incorporates stochastic models for energy pricing in transactions with the main grid and probabilistic representations of energy generation and demand. This comprehensive methodology allows for an accurate depiction of the volatile dynamics prevalent in the energy markets, which are critical in influencing microgrid operational performance. The application of the Stochastic Dual Dynamic Programming (SDDP) algorithm within a multi-stage adaptive framework for microgrids is evaluated for its effectiveness compared to deterministic approaches. The SDDP algorithm is utilized to develop robust strategies for managing the energy requirements of 1, 2, and 12 prosumers over a 24 h planning horizon. A comparative analysis against the precise solutions obtained from dynamic programming via Monte Carlo simulations indicates a strong congruence between the strategies proposed by the SDDP algorithm and the optimal solutions. The results provide significant insights into the optimization of energy management systems in microgrid settings, emphasizing improvements in operational performance and cost reduction.

Keywords: energy management system; dynamic programming; microgrid; SDDP



Citation: Tabares, A.; Cortés, P. Using Stochastic Dual Dynamic Programming to Solve the Multi-Stage Energy Management Problem in Microgrids. *Energies* **2024**, *17*, 2628. <https://doi.org/10.3390/en17112628>

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1. Introduction

The quest for novel and efficient energy sources, their distribution, and the transformation for use in industrial and residential sectors while mitigating environmental impact stands as a pivotal aspect of societal progression. Central to this endeavor is the electrical grid, a complex system that channels energy from generation sites to the final consumers. This grid encompasses generation plants, transmission lines, and distribution networks. Generation plants convert primary energy sources into electrical energy, which is then conveyed through transmission lines to distribution networks, reaching various load centers.

As economies grow and the well-being of citizens improves, the demand for electrical energy escalates. Traditionally, this growing demand has been met by expanding and reinforcing the electrical grid, constructing new power generation facilities, and enlarging substation capacities. However, this traditional approach, while effective, exerts considerable pressure on natural resources and the environment and demands substantial investment. Consequently, governments are exploring alternative strategies, with the integration of Distributed Energy Resources (DER) being a notable example [1].

Large-scale school building infrastructure improvement:

The case of the city of Cali, Colombia

Junio de 2024

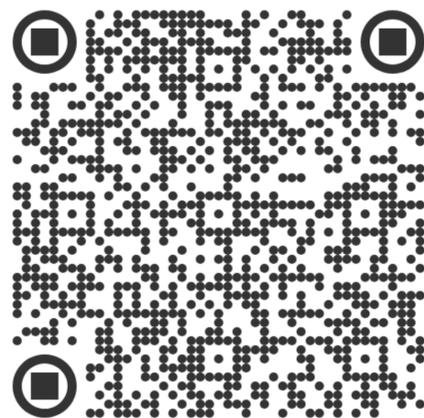
Publicado en: Socio-Economic Planning Sciences



Andrés L. Medaglia
Rafael Fernández
Andrés Calvo
Juan Francisco Correal
Dina D'Ayala

El artículo propone un modelo analítico para priorizar inversiones en infraestructura escolar, equilibrando seguridad y funcionalidad en contextos con recursos limitados. Aplicado en Cali, el enfoque ofrece una herramienta práctica para apoyar decisiones estratégicas y planificar mejoras sostenibles en edificios educativos.

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Large-scale school building infrastructure improvement: The case of the city of Cali, Colombia

Rafael Fernández^{a,b,*}, Andrés Calvo^a, Juan Francisco Correal^a, Dina D'Ayala^b, Andrés L. Medaglia^c

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ARTICLE INFO

Keywords:
Quality education
School building infrastructure
Functionality
Safety
Disaster risk reduction
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ABSTRACT

Quality education is influenced by various factors, including infrastructure, curricula, and educators. Among these factors, school infrastructure significantly impacts the learning process. However, managing and improving existing school infrastructure in low- and middle-income countries presents complex challenges due to limited resources, inadequate regulations, and poor maintenance practices. To effectively prioritize limited funds and balance short-term needs with long-term sustainability, decision-making processes must consider simultaneously functionality and safety aspects. This paper introduces an extended decision-making framework for enhancing school buildings, by determining optimal investment levels and prioritizing interventions in the building portfolio. The framework comprises multiple analytic models that are interconnected. The methodology starts with the identification of building typologies using a clustering algorithm; then, through a multi-criteria utility function with parametrized decision-maker profiles, it considers the trade-offs between safety and functionality; last, an optimization model prioritizes the buildings' interventions. The framework is adapted to a regional context in the city of Cali (Colombia). The outcome of this implementation provides analytics to decision-makers at an early stage in the formulation of school building improvement programs. This helps unveiling the extent of the project by defining the needs of improvement and the budget required to implement a large-scale intervention program.

1. Introduction

The United Nations Sustainable Development Goals (SDG) serve as a pressing global mandate for collective action towards achieving peace and prosperity for all individuals. These goals are designed to eradicate poverty, diminish inequalities, foster economic growth, preserve the environment, and enhance health and education. Of particular relevance is the fourth goal, which emphasizes the need for inclusive and equitable access to quality education for all [1]. This laudable objective is also in line with Article 26 of the Universal Declaration of Human Rights, which asserts that everyone has the right to education [2]. However, there are various factors that impact the quality of education, including accessibility, inclusivity, teacher qualifications, use of technology, and school infrastructure. Particularly, ageing infrastructure and limited maintenance budgets increase the current problems of school infrastructure [3]. Thus, improving school infrastructure, can positively impact the

quality of education [4]. Understanding how this infrastructure can be improved is the main topic of this paper.

A recent example of decision-making framework to prioritize interventions and improve infrastructure in school facilities has been proposed by the authors [5]. The decision-making framework prioritizes school buildings' investment within limited budgets, using an unsupervised learning (clustering) procedure, an *a-priori* multi-criteria utility function, and an optimization model. This framework requires key input from decision makers and technical experts. Its purpose is to obtain a prioritized set of interventions, given a particular decision-maker set of preferences and a fixed budget. The original framework has been illustrated with an application to the public school system infrastructure in Dominican Republic [5].

Considering the difficulties of involving several decision-makers at the early stages of a large-scale improvement project, the objective of the present study is to switch the framework towards an *a-posteriori*

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Organizational Value Framework for Asset Management Decision-Making

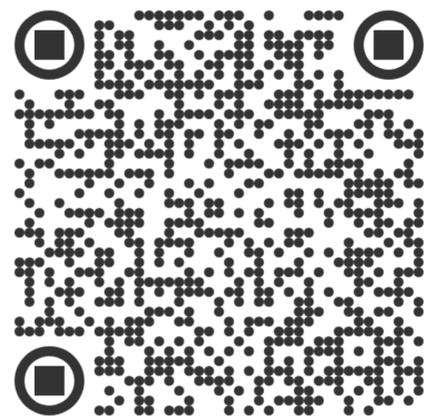
01 de junio de 2024
Publicado en: IFAC-PapersOnLine



Camilo Olaya
Giacomo Barbieri
Ana María Benavides
Luis Alfredo Esteves
Freddy Zapata

El artículo presenta una metodología para construir marcos de valor organizacional que alinean la gestión de activos con los objetivos estratégicos de la organización. Esta propuesta facilita una toma de decisiones más coherente y consistente, fortaleciendo la conexión entre la gestión organizacional y la creación de valor.

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Organizational Value Framework for Asset Management Decision-Making

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Abstract:

Within an organization, diverse conceptualizations of value exist based on the considered perspective. In Asset Management (AM), decision-making criteria should align with stakeholders, organizational, and asset perspectives. To achieve this alignment, value frameworks can be employed as they define elements worthy of proper control because they influence value realization. While existing literature primarily focuses on establishing value frameworks representing the AM conceptualization of value, there is a gap in methodologies for conceptualizing the organizational perspective of value. Such a framework would be an important tool to ensure alignment (line of sight) between organizational management and AM. In response to this gap, this study integrates organizational management and design to provide a systematic approach capable of developing Organizational Value Frameworks (OVFs) that encapsulate an already defined concept of organizational value. The methodology is applied to a case study for validation, simultaneously illustrating how OVFs can enhance decision-making in AM. Given the universality of the tools and elements used, the methodology has the potential for broad applicability across diverse domains and enterprises.

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Keywords: Asset Management, Decision-Making, Value Framework, Value Optimization, Value Elements, Value Dimensions, Value Drivers, Design Thinking, Design Strategy.

1. INTRODUCTION

Asset Management (AM) is defined as the coordinated activity of an organization aimed at realizing value from its assets (ISO 55000). In AM, Value is obtained by acquiring assets that allow an organization to fulfil its strategic objectives (El-Akruti et al., 2013), and ensuring that the assets keep fulfilling those objectives throughout their lifecycle. However, defining what constitutes value for an enterprise remains a challenging task.

Value Conceptualization is highly contingent upon the company's mission, the characteristics of its assets (both tangible and intangible), its organizational objectives, and the expectations and needs of its stakeholders (Crespo et al., 2020). Furthermore, the definition of value can vary depending on the perspective taken. In this context, Almeida et al. (2022) propose a conceptual framework illustrated in Figure 1 to facilitate value conceptualization across different perspectives.

Within the Figure, Value Perception denotes the manner in which the organization's delivered value is perceived from the standpoint of its stakeholders. It involves assessing how users perceive a product or service, considering the balance between the benefits and sacrifices associated

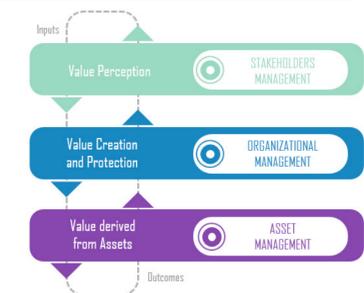


Fig. 1. Conceptual construct on value adopted from (Almeida et al., 2022). 'Inputs' represent the higher-level value elements to consider for value conceptualization within the given perspective, while 'outcomes' illustrate the transformation of the generated value across various perspectives.

with its consumption or use (Ulag and Chacour, 2001). This perspective encompasses not only the user but also the broader external context of the organization, including social, cultural, economic, and physical environments, as well as regulatory, financial and other constraints.

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A workflow to systematically design uncertainty-aware visual analytics applications

07 de junio de 2024

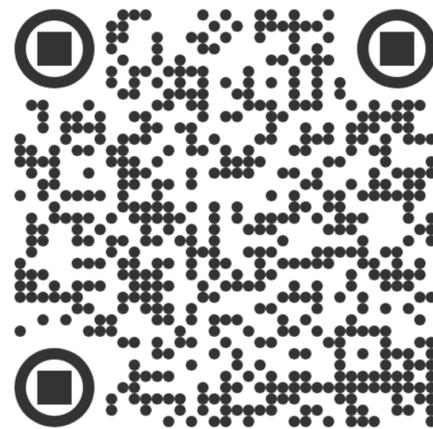
Publicado en: The Visual Computer



Juan F. Pérez
Robin G. C. Maack
Felix Raith
Gerik Scheuermann
Christina Gillmann

El artículo propone un nuevo enfoque de analítica visual que incorpora explícitamente la incertidumbre en el proceso de análisis y toma de decisiones. A través de un ciclo de analítica visual consciente de la incertidumbre, el estudio muestra cómo mejorar la generación de insights mediante aplicaciones reales.

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<https://doi.org/10.1007/s00371-024-03435-x>

ORIGINAL ARTICLE



A workflow to systematically design uncertainty-aware visual analytics applications

Robin G. C. Maack¹ · Felix Raith² · Juan F. Pérez³ · Gerik Scheuermann² · Christina Gillmann⁴ 

Accepted: 8 April 2024
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Abstract

Visual analytics (VA) is a paradigm for insight generation by using visual analysis techniques and automated reasoning by transforming data into hypotheses and visualization to extract new insights. The insights are fed back into the data to enhance it until the desired insight is found. Many applications use this principle to provide meaningful mechanisms to assist decision-makers in achieving their goals. This process can be affected by various uncertainties that can interfere with the user decision-making process. Currently, there are no methodical description and handling tool to include uncertainty in VA systematically. We provide a unified workflow to transform the classic VA cycle into an *uncertainty-aware visual analytics (UAVA)* cycle consisting of five steps. To prove its usability, three real-world applications represent examples of the UAVA cycle implementation and the described workflow.

Keywords Visual analytics · Uncertainty analysis · Workflow generation

1 Introduction

The increasing amount of data to be analyzed led to a novel data processing concept, defined as visual analytics (VA) [1]. Keim et al. [2] described VA as a connected process of four major components (*Dataset S*, *Hypothesis H*, *Visualization V*, and *Insight I*). These components are connected by functions that allow the transformation and analysis of the given input dataset while creating new insights. By now, VA is a discipline utilized in many applications to find novel insights in datasets, enabling effective decision-making [3].

Real-world applications and the resulting datasets used in VA are often affected by uncertainty originating from data incompleteness, unknown parameters, reconstruction artifacts, or the recognition process [4]. Hypothesis tests may use incomplete models and visualizations map data to color values, potentially suppressing information. In addition, the

user introduces uncertainty through his cognitive abilities and personal biases. As a result, each component in the VA cycle can be affected by uncertainty, which needs to be quantified, propagated, and communicated throughout a VA cycle. Maack et al. [5] provided a general description of an uncertainty-aware visual analytics (UAVA) cycle, used as the basis for the workflow here.

They describe a VA cycle consisting of six components. The *Dataset (S)* is transformed into a *UA Dataset (\bar{S})* that is processed by the *UA Hypothesis* and *UA Visualization* components to create *UA Insight*. This process is carefully monitored by the *Provenance* component to ensure the communication and understanding of uncertainty development throughout the cycle.

However, a general workflow to construct such a UAVA cycle and the process of including various sources of uncertainty is not available, as shown in Sect. 2. This forms the motivation of the presented work, starting with a brief recap of the basics of uncertainty that includes the definition and quantification of uncertainty, as shown in Sect. 3.

We provide a workflow that transforms a classic VA cycle, as provided by Keim et al. [2], into a UAVA cycle [5]. It covers the sources and effects of uncertainty in VA (see Sect. 4). The steps show the quantification of various types of uncertainty and to properly include them in a VA cycle. As a result, it con-

✉ Christina Gillmann
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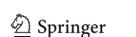
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 Springer

Strategically Influencing Seat Selection in Low-Cost Carriers:

A GRASP Approach for Revenue Maximization

18 de junio de 2024

Publicado en: Lecture Notes in Computer Science



Alejandra Tabares Pozos

David Álvarez-Martínez

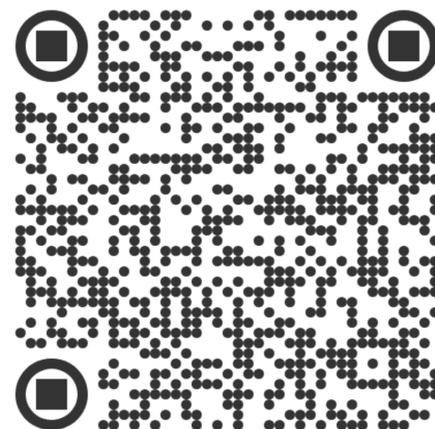
Andrés Merizalde

Gustavo Rubiano

Germán Roberto Pardo

El artículo propone una estrategia innovadora para la asignación de asientos en aerolíneas de bajo costo, orientada a incentivar la compra de servicios adicionales. A través de un algoritmo flexible y eficiente, el estudio muestra cómo una asignación inteligente puede mejorar los ingresos operativos sin aumentar la complejidad ni los costos tecnológicos para la aerolínea.

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Strategically Influencing Seat Selection in Low-Cost Carriers: A GRASP Approach for Revenue Maximization

Conference paper | First Online: 18 June 2024

pp 65–79 | [Cite this conference paper](#)



Andrés Merizalde, Gustavo Rubiano, Germán Roberto Pardo, Alejandra Tabares Pozos & David Álvarez-Martínez

Part of the book series: [Lecture Notes in Computer Science](#) ((LNCS, volume 14754))

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Abstract

In the competitive passenger air transport market, low-cost airlines continue strengthening their position, contrasting sharply with traditional carriers. This article delves into the unique operational strategies of these airlines, focusing on their reliance on ancillary services. Among these services, seat selection stands out as a crucial revenue enhancer. The study emphasizes the importance of low-cost carriers ensuring the availability of specific seats for direct purchase, thereby avoiding their allocation through automatic seat assignment algorithms, commonly activated for passengers who do not opt for specific seating. A notable consumer behavior observed is the preference for passengers on the same booking to be seated together. Low-cost airlines can capitalize on this trend by encouraging seat purchases and using automated seat assignments to strategically separate passengers traveling together unless they opt for paid seat selection. This work presents a novel approach to the seat assignment problem based on a GRASP algorithm; this approach is beneficial due to its low requirement for extensive parameter calibration, intuitive nature, and adaptability to different airline scenarios. Using an actual flight database of a low-cost Colombian airline, we have compared the airline's rule-based heuristics, a network flow model, and our metaheuristic approach; the results obtained are satisfactory in terms of solution quality and computational cost. The proposed solution offers a viable, cost-effective alternative to specialized software solutions, aligning with the financial constraints typical of low-cost carriers while effectively enhancing their seat assignment process to optimize revenue generation.

A Matheuristic Multi-start Algorithm for a Novel Static Repositioning Problem in Public Bike-Sharing Systems

18 de junio de 2024

Publicado en: [Lecture Notes in Computer Science](#)



David Álvarez-Martínez
Julio Mario Daza-Escorcía

El artículo aborda la optimización de la redistribución de bicicletas en sistemas públicos, considerando tanto bicicletas operativas como dañadas. Mediante un enfoque híbrido que combina heurísticas y modelos matemáticos, el estudio demuestra que es posible mejorar el equilibrio del sistema y reducir tiempos operativos de forma eficiente.

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A Matheuristic Multi-start Algorithm for a Novel Static Repositioning Problem in Public Bike-Sharing Systems

Conference paper | First Online: 18 June 2024

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Abstract

This paper investigates a specific instance of the static repositioning problem within station-based bike-sharing systems. Our study incorporates operational and damaged bikes, a heterogeneous fleet, and multiple visits between stations and the depot. The objective is to minimize the weighted sum of the deviation from the target number of bikes for each station, the number of damaged bikes not removed, and the total time used by vehicles. To solve this problem, we propose a matheuristic approach based on a randomized multi-start algorithm integrated with an integer programming model for optimizing the number of operatives and damaged bikes that will be moved between stations and/or the depot (loading instructions). The algorithm's effectiveness was assessed using instances derived from real-world data, yielding encouraging results. Furthermore, we adapted our algorithm to a simpler problem studied in the literature, achieving competitive outcomes compared to other existing methods. The experimental results in both scenarios demonstrate that this algorithm can generate high-quality solutions within a short computational time.

A GRASP Algorithm for the Meal Delivery Routing Problem

18 de junio de 2024

Publicado en: Metaheuristics

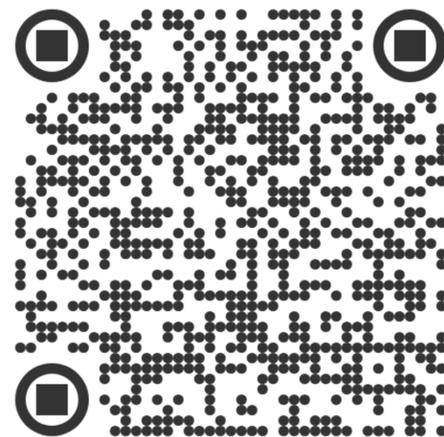


David Álvarez-Martínez

Daniel Sebastian Giraldo Herrera

El artículo presenta un enfoque innovador para optimizar la asignación de repartidores y rutas en plataformas de domicilios, utilizando un algoritmo GRASP probado con datos reales de una app colombiana. Los resultados muestran mejoras significativas en eficiencia operativa y cumplimiento de pedidos, ofreciendo una solución práctica para los retos de la logística de última milla en la industria de entregas de comida.

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A GRASP algorithm for the Meal Delivery Routing Problem

Daniel Giraldo-Herrera ^[0009-0003-8243-723X] and David Álvarez-Martínez ^[0000-0001-8411-1936]

Department of Industrial Engineering, Universidad de Los Andes, Bogotá, Colombia
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Abstract. With the escalating demand for meal delivery services, this study delves into the Meal Delivery Routing Problem (MDRP) within the context of last-mile logistics. Focusing on the critical aspects of courier allocation and order fulfillment, we introduce a novel approach utilizing a GRASP metaheuristic. The algorithm optimizes the assignment of couriers to orders, considering dynamic factors such as courier availability, order demands, and geographical locations. Real-world instances from a Colombian delivery app form the basis of our computational analysis. Calibration of GRASP parameters reveals a delicate trade-off between solution quality and computational time. Comparative results with a simulation-optimization based study underscore GRASP's competitive performance, demonstrating strengths in fulfilling orders and routing efficiency across diverse instances. This research enhances operational efficiency in the burgeoning food delivery industry, shedding light on practical algorithms for last-mile logistics optimization.

Keywords: GRASP, Last-mile logistics, Meal Delivery Routing Problem (MDRP), Order fulfillment

1 Introduction

With the fast growth of the food delivery industry, mainly driven by the increasing demand for home delivery services, efficiency in meal delivery has become a critical factor for both businesses and consumers. Since the pandemic, meal delivery applications have taken on a solid position in everyday life worldwide, as meal delivery applications have become more visible to the average citizen and have established their position in the market. The companies operating as intermediaries between stores, restaurants, and end consumers reported significant growth during the pandemic; an example of this is the Domicilios.com application, which had an approximate growth of 50.6% between 2019 and 2020 [1]. Similarly, it is worth noting that the number of couriers working for these meal delivery applications increased significantly; an approximate increase of 62.5% was recorded between 2019 and 2020, reaching approximately 195,000 delivery drivers this last year in Colombia [2]. This problem manifests itself in a wide variety of contexts, from local restaurants to global meal delivery platforms,

Spatial segregation patterns and association with built environment features in Colombian cities

25 de junio de 2024
Publicado en: Cities



Juan F. Pérez
Pablo Medina

Andrés F. Useche
Olga L. Sarmiento
María José Álvarez-Rivadulla
Diana Higuera-Mendieta

El artículo analiza la segregación espacial en ciudades colombianas y su relación con la forma urbana, utilizando datos satelitales y métricas sociales clave. Los resultados revelan patrones de desigualdad asociados a educación, etnicidad y empleo, y ofrecen insumos valiosos para diseñar políticas urbanas más equitativas, especialmente en ciudades intermedias.

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Spatial segregation patterns and association with built environment features in Colombian cities

Andrés F. Useche^{a,b}, Olga L. Sarmiento^c, María José Álvarez-Rivadulla^d, Pablo Medina^a, Diana Higuera-Mendieta^{c,e}, Felipe Montes^{a,*}

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ARTICLE INFO

Keywords:
Spatial segregation
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Built environment

ABSTRACT

Spatial segregation is a pressing issue in Latin American cities due to high urbanization, population density, and inequalities. This study examines segregation patterns in 84 middle to large cities in Colombia and their relationship with the spatial configuration of cities using satellite data. The analysis focuses on evenness and isolation metrics of segregation for ethnicity, education level, and employment status. The findings reveal higher segregation in education level and race/ethnicity in terms of evenness dimension, and in education level and employment status in terms of isolation dimension. The study also identifies associations between segregation and built environment metrics. Negative associations are observed between education level and race/ethnicity segregation and fragmentation, as well as between employment status and patches of isolation. Positive associations exist between education level and fragmentation, race/ethnicity and patches of isolation, and a negative association between employment status and street density. These results have implications for public urban policies, particularly in small and medium cities, where there is limited understanding of segregation dynamics. The study highlights the need to consider factors beyond income, such as ethnicity, in addressing spatial segregation in urban planning and policy-making.

1. Introduction

Spatial segregation is a recurrent problem in the design of public policies in cities with different typologies. The importance of spatial segregation has grown as social inequalities have become more prominent in public policy in the 20th and 21st centuries (Dosh et al., 2003). Studies have found a negative relationship between spatial segregation and quality of life, highlighting its importance in shaping people's social circles and access to goods and jobs. In the United States, it has been shown that concentrations of vulnerable populations lead to greater exposure to crime, resulting in high rates of violence and asymmetries among different social groups (Greenstein et al., 2000; Peterson & Krivo, 2005). In Europe, its effects are seen particularly in the migrant population (Benassi et al., 2020; Benassi et al., 2023) and in areas with disparities in access to the labor market (Nielsen et al., n.d.; Arbaci, 2007; Vaughan & Arbaci, 2011), which expose immigrants and multiethnic

groups to lower well-being.

Latin America has unique urban characteristics that could shape segregation patterns. The region is dense and highly urbanized (United Nations - Department of Economic and Social Affairs - Population Division, 2014; United Nations Human Settlements Programme, 2010). It is also notoriously unequal, with a Gini coefficient above 0.45 (OECD, 2015; World Bank Group, 2020). Around 80 % of the population lived in urban areas in 2020 (Benassi et al., 2023), and 24 % of the population lives in dense informal settlements (Inostroza, 2017). These informal settlements tend to be located on the cities' peripheries, where access to services is scarce and levels of violence are high. Additionally, unplanned policies exacerbate the appearance of these settlements (dos Santos et al., 2021; Dosh et al., 2003; Greenstein et al., 2000). Lower-income groups tend to occupy these peripheral, homogenous, and poorly serviced areas, while high-income groups cluster in central areas of the cities, with little or no interaction with their counterparts

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Comprehensive Review of Robotized Freight Packing

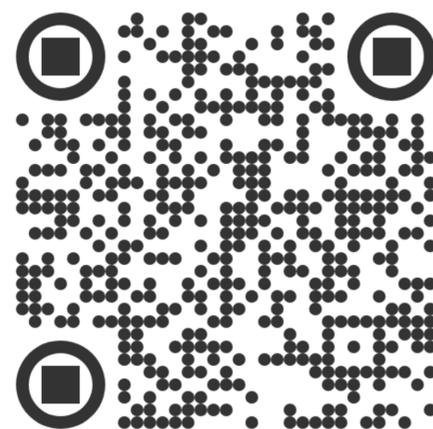
08 de julio de 2024
Publicado en: Logistics



David Álvarez-Martínez
Germán Pantoja-Benavides
Daniel Giraldo
Ana Montes
Andrea García
Carlos Rodríguez
César Marín

El artículo revisa el estado del arte en celdas de empaquetado automatizadas, integrando por primera vez de forma sistemática la robótica y los problemas de empaquetamiento. Identifica tendencias, vacíos de investigación y desafíos prácticos, ofreciendo una guía clave para el desarrollo de sistemas de empaquetado más eficientes y aplicables en la logística y el comercio electrónico.

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Review

Comprehensive Review of Robotized Freight Packing

German Pantoja-Benavides ¹, Daniel Giraldo ¹, Ana Montes ¹, Andrea García ², Carlos Rodríguez ^{1,*}, César Marín ² and David Álvarez-Martínez ¹

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Abstract: *Background:* This review addresses the emerging field of automated packing cells, which lies at the intersection of robotics and packing problems. Integrating these two fields is critical for optimizing logistics and e-commerce operations. The current literature focuses on packing problems or specific robotic applications without addressing their integration. *Methods:* To bridge this gap, we conducted a comprehensive review of 46 relevant studies, analyzing various dimensions, including the components of robotic packing cells, the types of packing problems, the solution approaches, and performance comparisons. *Results:* Our review reveals a significant trend towards addressing online packing problems, which reflects the dynamic nature of logistics operations where item information is often incomplete. We also identify several research gaps, such as the need for standardized terminologies, comprehensive methodologies, and the consideration of real-world constraints in robotic algorithms. *Conclusions:* This review uniquely integrates insights from robotics and packing problems, providing a structured framework for future research. It highlights the importance of considering practical robotic constraints. It proposes a research structure that enhances the reproducibility and comparability of results in real-world scenarios. By doing so, we aim to guide future research efforts and facilitate the development of more robust and practical automated packing systems.

Keywords: automated systems; load management; logistics; materials handling; palletizing



Citation: Pantoja-Benavides, G.; Giraldo, D.; Montes, A.; García, A.; Rodríguez, C.; Marín, C.; Álvarez-Martínez, D. Comprehensive Review of Robotized Freight Packing. *Logistics* **2024**, *8*, 69. <https://doi.org/10.3390/logistics8030069>

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1. Introduction

The fourth industrial revolution, characterized by the convergence of cutting-edge technologies, has ushered in a new era of logistics and packing processes. Logistics 4.0 has introduced innovative technologies such as automation, big data analytics, twin simulation, human-robot interaction, and autonomous vehicles. Within this context, 3D robotic packing has emerged as a cutting-edge solution, revolutionizing traditional packing methodologies and presenting novel opportunities for the industry [1].

In the dynamic world of e-commerce and logistics, efficient packing processes are crucial to optimizing shipping and storage operations. As the global e-commerce market continues to soar, with an increasing number of consumers opting for online shopping, the demand for efficient packing operations has never been more critical. E-commerce companies face immense pressure to deliver products to customers quickly and accurately, making 3D robotic packing an invaluable asset in this competitive landscape.

While human operators have traditionally handled packing processes, the rise of robotic technology has opened new horizons for automation in the packing domain. Robotic and human packing have several advantages and disadvantages that are mentioned below:

Working time: Robots can work uninterrupted for longer than humans, increasing productivity. While operators have fixed schedules, need resting time, and may get sick, robots can work 24 h a day, seven days a week, and have scheduled maintenance.

Latent Space Representations for Marker-Less Realtime Hand–Eye Calibration

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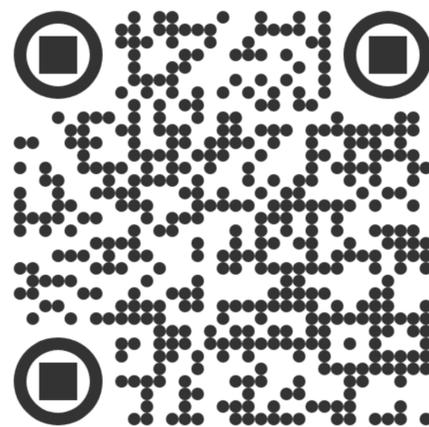


Alejandra Tabares
David Álvarez-Martínez

Juan Camilo Martínez-Franco
Ariel Rojas-Álvarez
César Augusto Marín-Moreno

Este trabajo presenta un método de calibración mano–ojo sin marcadores que utiliza una cámara monocular y un autoencoder aumentado para estimar orientaciones de forma robusta. A partir del análisis del espacio latente, el enfoque supera las limitaciones de los modelos que regresan directamente la transformación espacial, logrando un desempeño eficiente y en tiempo real incluso bajo condiciones variables de iluminación y oclusión, con resultados comparables a los métodos tradicionales basados en marcadores.

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Article

Latent Space Representations for Marker-Less Realtime Hand–Eye Calibration

Juan Camilo Martínez-Franco¹, Ariel Rojas-Álvarez¹, Alejandra Tabares¹ , David Álvarez-Martínez^{1,*} and César Augusto Marín-Moreno²

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Abstract: Marker-less hand–eye calibration permits the acquisition of an accurate transformation between an optical sensor and a robot in unstructured environments. Single monocular cameras, despite their low cost and modest computation requirements, present difficulties for this purpose due to their incomplete correspondence of projected coordinates. In this work, we introduce a hand–eye calibration procedure based on the rotation representations inferred by an augmented autoencoder neural network. Learning-based models that attempt to directly regress the spatial transform of objects such as the links of robotic manipulators perform poorly in the orientation domain, but this can be overcome through the analysis of the latent space vectors constructed in the autoencoding process. This technique is computationally inexpensive and can be run in real time in markedly varied lighting and occlusion conditions. To evaluate the procedure, we use a color-depth camera and perform a registration step between the predicted and the captured point clouds to measure translation and orientation errors and compare the results to a baseline based on traditional checkerboard markers.

Keywords: computer vision; robotics; hand–eye calibration; deep learning; synthetic data; autoencoders



Citation: Martínez-Franco, J.C.; Rojas-Álvarez, A.; Tabares, A.; Álvarez-Martínez, D.; Marín-Moreno, C.A. Latent Space Representations for Marker-Less Realtime Hand–Eye Calibration. *Sensors* **2024**, *24*, 4662. <https://doi.org/10.3390/s24144662>

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1. Introduction

Reliable hand–eye calibration, performed to find the relationship between the frames of reference of a robot and a visual sensor or camera whether the latter is mounted on the end-effector (eye-in-hand) or statically with respect to the base of the robot (eye-to-hand), is often based on specialized markers or patterns with easily discernible visual features and known physical dimensions. Said relationship is typically described as a square transformation matrix where the coefficients of said matrix are estimated through the capture of several images and feature matching of the known markers in the robot and its workspace until a suitable projection model can be calculated or inferred. This process must be repeated when either the camera or the base of the manipulator is moved or rotated with respect to the other in eye-to-hand systems, which may prove cumbersome in highly dynamic workspaces [1].

In contrast, marker-less hand–eye calibration methods seek to find the calibration matrix relationship without the need for physical markers. This approach offers several advantages:

- **Efficiency:** With marker-less calibration, the robot can be recalibrated easily if the camera, the base of the robot (in eye-to-hand scenarios), or its end-effector is changed or repositioned, without the need to reapply physical markers.
- **Flexibility:** Marker-less calibration eliminates the need for specialized markers, reducing the cost of setup and maintenance as well as increasing the range of viable workspaces.

Extended high-frequency hearing loss among Afro-Colombian adolescents from a rural area in Colombia: a cross-sectional study

18 de julio de 2024
Publicado en: BMJ Open



Felipe Montes
Lucía C Pérez-Herrera
Daniel Peñaranda
Sergio Moreno-López
Ana María Guerra
Sharon C Sánchez-Franco
Olga Lucía Sarmiento
Nancy Suetta-Lugo
Augusto Peñaranda

El estudio muestra que la pérdida auditiva adquirida es frecuente en adolescentes afrocolombianos rurales y está asociada a la edad y a la exposición a música a alto volumen. Además, resalta la audiometría de altas frecuencias como una herramienta clave para detectar daño auditivo temprano y la necesidad de acciones preventivas.

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BMJ Open Extended high-frequency hearing loss among Afro-Colombian adolescents from a rural area in Colombia: a cross-sectional study

Lucía C Pérez-Herrera^{1,2}, Daniel Peñaranda^{2,3}, Sergio Moreno-López^{1,2}, Ana María Guerra⁴, Felipe Montes⁴, Sharon C Sánchez-Franco¹, Olga Lucía Sarmiento¹, Nancy Suetta-Lugo⁵, Augusto Peñaranda^{1,2,6}

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ABSTRACT

Objectives Research trends concerning hearing loss within teen rural populations are limited and current evidence suggests that extended high-frequency audiometry can be a sensitive tool to detect subclinical hearing loss. Moreover, current research emphasises the importance of representing different ethnic populations in science. This study aimed to determine the prevalence of acquired hearing loss through conventional pure-tone (0.25–8 kHz) and extended high frequency (EHF) (9–20 kHz) audiometry in Afro-Colombian adolescents from a rural area in Colombia.

Design Observational, cross-sectional study.

Participants 230 Afro-Colombian adolescents aged 13–17 years who attended high school in a rural population from Cartagena, Colombia.

Interventions Otoscopic examination, conventional (0.25–8 kHz) and EHF (9–20 kHz) audiometry tests were performed during February–March 2021.

Sociodemographic and associated factor questionnaires were also applied to assess probable factors associated with EHF hearing loss.

Main outcome measures Prevalence of acquired hearing loss using conventional and EHF audiometry, and factors associated with hearing loss.

Results Of 230 adolescents who met the eligibility criteria, 133 (57.82%) were female. The mean age was 15.22 years (SD: 1.62). The prevalence of hearing loss in at least one ear assessed with conventional audiometry was 21.30% and with EHF audiometry 14.78%. The main abnormal otoscopic findings included: neotympanum (1.30%), myringosclerosis (0.87%) and monomeric scars (0.43%). Factors associated with a higher probability of EHF hearing loss found through logistic regression were older age (prevalence ratio (PR): 1.45; 95% CI 1.16 to 1.80), attending the 'Picó' four or more times a month (PR: 6.63; 95% CI 2.16 to 20.30), attending bars more than three times a month (PR: 1.14; 95% CI 1.03 to 1.59) and self-reported hearing difficulties (PR: 1.24; 95% CI 1.22 to 4.05).

Conclusions Our results suggest that acquired hearing loss is already widespread among this young rural population.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ Given that the studied sample is from an under-researched population and is of an adequate size, the findings are pertinent to the growing literature on extended high-frequency hearing.
- ⇒ The audiometry testing and questionnaires applied to the population were performed by experts in the audiology and otology fields, and the application of these instruments was standardised.
- ⇒ The cross-sectional design of this study can prove association but not causality between the variables.
- ⇒ There is heterogeneity in the literature about the definition of a standardised threshold of normal hearing in young populations which may have affected the interpretation of this study.

INTRODUCTION

Hearing loss in younger populations can lead to reduced physical health, quality of life and academic performance.¹ The WHO has stated that up to 60% of childhood hearing loss can be attributed to preventable causes.² A meta-analysis reported a prevalence of hearing loss due to social noise exposure in standard frequencies (0.25–8 kHz) ranging from 11.5% to 15.8% in adolescents aged 10–19 years.³ Evidence has displayed disparities between low-income and high-income communities with regards to the prevalence, early diagnosis and treatment of hearing loss.^{4,5} McDaid *et al* estimated a global economic cost of hearing loss that exceeded US\$981 billion, with up to 57% of this burden falling on low-income and middle-income countries. Moreover, 6.5% of these costs were attributed to children aged 0–14 years.⁶ Social determinants associated with hearing loss among school-age children and adolescents include low socioeconomic level, household income, education level and low maternal education level.⁷ Health interventions for the prevention, diagnosis



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The Normalized Direct Trigonometry Model for the Two-Dimensional Irregular Strip Packing Problem

02 de agosto de 2024

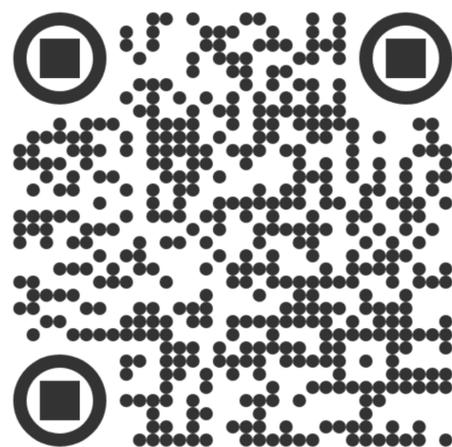
Publicado en: Mathematics



David Álvarez-Martínez
Germán Pantoja-Benavides
Francisco Parreño Torres

Este trabajo propone un nuevo modelo matemático para el Irregular Strip Packing Problem que mejora la calidad de las soluciones y permite incorporar una distancia mínima entre piezas. Los resultados computacionales muestran que el modelo propuesto supera al enfoque tradicional, logrando más soluciones factibles y óptimas, y ofreciendo una herramienta más flexible para problemas de empaquetamiento con restricciones reales.

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Article

The Normalized Direct Trigonometry Model for the Two-Dimensional Irregular Strip Packing Problem

Germán Pantoja-Benavides ^{1,2}, David Álvarez-Martínez ^{1,*} and Francisco Parreño Torres ²

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Abstract: Background: The Irregular Strip Packing Problem (ISPP) involves packing a set of irregularly shaped items within a strip while minimizing its length. Methods: This study introduces the Normalized Direct Trigonometry Model (NDTM), an innovative enhancement of the Direct Trigonometry Model (DTM). The NDTM incorporates a distance function that supports the integration of the separation constraint, which mandates a minimum separation distance between items. Additionally, the paper proposes a new set of constraints based on the bounding boxes of the pieces aimed at improving the non-overlapping condition. Results: Comparative computational experiments were performed using a comprehensive set of 90 instances. Results show that the NDTM finds more feasible and optimal solutions than the DTM. While the NDTM allows for the implementation of the separation constraint, the number of feasible and optimal solutions tends to decrease as more separation among the items is considered, despite not increasing the number of variables or constraints. Conclusions: The NDTM outperforms the DTM. Moreover, the results indicate that the new set of non-overlapping constraints facilitates the exploration of feasible solutions at the expense of optimality in some cases.

Keywords: Irregular Strip Packing Problem; mixed-integer linear programming; separation constraint

MSC: 05B40



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1. Introduction

The Irregular Strip Packing Problem (ISPP) is a real-world challenge with significant implications. Its goal is to optimally arrange a set of irregular items on a strip of material with a fixed width and infinite length. By minimizing the strip length required, the ISPP directly contributes to reducing waste and cost, making it a critical issue in industries ranging from textile and garment manufacturing to sheet metal cutting [1–3], where material efficiency directly translates to economic and environmental benefits.

Acknowledged as an NP-hard problem [4] the ISPP has attracted substantial interest due to its inherent computational complexity and significant real-world implications. Researchers have frequently employed metaheuristic approaches to tackle this complexity, balancing the quest for optimal solutions and manageable computational time. However, with the evolution of computational technologies and capacities, there is an increasing focus on developing more precise and efficient mathematical models [5].

In this context, this paper introduces the Normalized Direct Trigonometry Model (NDTM), an innovative adaptation of the Direct Trigonometry Model (DTM) proposed by [6]. The NDTM stands out by utilizing a distance function between a line and a point rather than relying on the D-function. The NDTM also introduces flexibility in the search space by allowing multiple separating lines between convex sub-polygons. Utilizing the distance function allows the incorporation of a separation constraint among the pieces, i.e., a minimum separation distance between pieces. Therefore, this study

The Parallel Machine Scheduling Problem with Different Speeds and Release Times in the Ore Hauling Operation

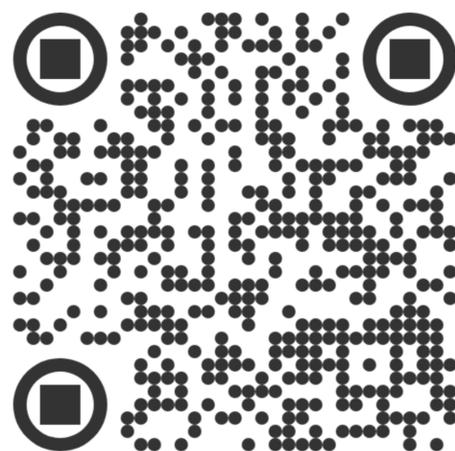
08 de agosto de 2024
Publicado en: Algorithms



Camilo Gómez
Ciro Amaya
David Álvarez M.
Luis Tarazona-Torres
Álvaro Paipilla

El estudio presenta un modelo y algoritmos para determinar el número mínimo de equipos de acarreo necesarios en minería, optimizando tiempos y costos, y apoyando una planificación más eficiente del uso de recursos.

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Article

The Parallel Machine Scheduling Problem with Different Speeds and Release Times in the Ore Hauling Operation

Luis Tarazona-Torres , Ciro Amaya *, Alvaro Paipilla, Camilo Gomez and David Alvarez-Martinez

Industrial Engineering Department, University of Los Andes, Cra 1 N18A12, Bogota 111711, Colombia; le.tarazona@uniandes.edu.co (L.T.-T.); a.paipilla@uniandes.edu.co (A.P.); gomez.ch@uniandes.edu.co (C.G.); d.alvarezm@uniandes.edu.co (D.A.-M.)
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Abstract: Ore hauling operations are crucial within the mining industry as they supply essential minerals to production plants. Conducted with sophisticated and high-cost operational equipment, these operations demand meticulous planning to ensure that production targets are met while optimizing equipment utilization. In this study, we present an algorithm to determine the minimum amount of hauling equipment required to meet the ore transport target. To achieve this, a mathematical model has been developed, considering it as a parallel machine scheduling problem with different speeds and release times, focusing on minimizing both the completion time and the costs associated with equipment use. Additionally, another algorithm was developed to allow the tactical evaluation of these two variables. These procedures and the model contribute significantly to decision-makers by providing a systematic approach to resource allocation, ensuring that loading and hauling equipment are utilized to their fullest potentials while adhering to budgetary constraints and operational schedules. This approach optimizes resource usage and improves operational efficiency, facilitating continuous improvement in mining operations.

Keywords: parallel machine scheduling problem; ore hauling equipment; mathematical model; mining industry



Citation: Tarazona-Torres, L.; Amaya, C.; Paipilla, A.; Gomez, C.; Alvarez-Martinez, D. The Parallel Machine Scheduling Problem with Different Speeds and Release Times in the Ore Hauling Operation. *Algorithms* 2024, 17, 348. <https://doi.org/10.3390/a17080348>

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1. Introduction

One of the most essential activities in mining operations is ore hauling; this process involves moving fragmented rock from the blasting site using loading and hauling equipment [1]. The ore rocks are then transported to the crushing process to reduce their size before being sent to the recovery plant, where valuable metals such as copper, gold, molybdenum, and aluminum, among others, are extracted [2–4]. Figure 1 illustrates the schematic of the described process. Poor planning of ore hauling operations can decrease productivity levels, affect the achievement of production targets within the established timelines, and consequently impact operational costs. Several factors must be considered to effectively plan ore hauling operations, such as the amount of available loading and hauling equipment and their scheduled maintenance [5]. It is also essential to account for the established production targets, working hours, and topographic levels. Other important aspects include the ore grade, the number of available loading ramps for loading operations, and the environmental impact [6].

Mining companies have a defined amount of loading and hauling equipment allocated based on the production targets set for a specific period. It is crucial to determine the necessary amount of this equipment to efficiently transport ore rocks to control associated costs, which can be substantial depending on the time required to meet these targets [7]. Knowing the minimum amount of equipment needed optimizes operations and facilitates tactical analysis. This analysis enables better decision-making in the face of contingencies, ensuring the achievement of production targets at the lowest possible cost.

Compatibility Model between Encapsulant Compounds and Antioxidants by the Implementation of Machine Learning

17 de septiembre de 2024
Publicado en: Algorithms



Rafael Amaya
Juliana Quintana Rojas
Nicolás Ratkovich

El estudio propone un modelo de machine learning para predecir la compatibilidad entre compuestos antioxidantes y materiales de encapsulación, evitando ensayos experimentales costosos. Mediante análisis estadístico, PCA y un modelo KNN, se logró una alta precisión (0.92), demostrando una clasificación confiable de combinaciones compatibles e incompatibles.

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Compatibility Model between Encapsulant Compounds and Antioxidants by the Implementation of Machine Learning

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Abstract: The compatibility between antioxidant compounds (ACs) and wall materials (WMs) is one of the most crucial aspects of the encapsulation process, as the encapsulated compounds' stability depends on the affinity between the compounds, which is influenced by their chemical properties. A compatibility model between the encapsulant and antioxidant chemicals was built using machine learning (ML) to discover optimal matches without costly and time-consuming trial-and-error experiments. The attributes of the required antioxidant and wall material components were recollected, and two datasets were constructed. As a result, a tying process was performed to connect both datasets and identify significant relationships between parameters of ACs and WMs to define the compatibility or incompatibility of the compounds, as this was necessary to enrich the dataset by incorporating decoys. As a result, a simple statistical analysis was conducted to examine the indicated correlations between variables, and a Principal Component Analysis (PCA) was performed to reduce the dimensionality of the dataset without sacrificing essential information. The K-nearest neighbor (KNN) algorithm was used and designed to handle the classification problems of the compatibility of the combinations to integrate ML in the model. In this way, the model accuracy was 0.92, with a sensitivity of 0.84 and a specificity of 1. These results indicate that the KNN model performs well, exhibiting high accuracy and correctly classifying positive and negative combinations as evidenced by the sensitivity and specificity scores.

Keywords: antioxidant compounds; encapsulant compounds; wall materials; decoys; principal component analysis; machine learning; K-nearest neighbors; compatibility model

1. Introduction

Encapsulation is widely used in numerous industries, including food, cosmetics, biology, agriculture, and pharmacy [1–3]. The nature of the encapsulation technique involves stabilizing active compounds using building systems to preserve their physical, chemical, and biological properties under various conditions. There are two main kinds of encapsulation techniques: physical and chemical. The first uses techniques that influence intensive properties, such as temperature and pressure [3], whereas the second, chemical encapsulation, leverages the active compounds' chemical properties [4]. Due to the method's complexity, significant obstacles exist [5] despite the technique's extensive range of applications. One of these obstacles is the compatibility between the active compound and the shell material (encapsulant compound) [6,7]. Among the widespread use of the technique and the varying amounts of compounds, antioxidant compounds (ACs) are significant for their properties in the abovementioned industries.

Antioxidants include polyphenols, carotenoids, anthocyanins, catechins, vitamins, and polyunsaturated fatty acids. They can be found in fruits, vegetables, cereals, and plants [8,9]. These compounds serve multiple functions. Plants, for example, offer structural support and defense against environmental factors such as biotic and abiotic stress,



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Understanding the obesity dynamics by socioeconomic status in Colombian and Mexican cities using a system dynamics model

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El estudio proyecta la evolución de la obesidad por nivel socioeconómico, edad y género en ciudades de Colombia y México, mostrando un aumento especialmente en adultos de bajos ingresos y patrones diferenciados entre países y sexos.

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Heliyon 10 (2024) e39921

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Research article

Understanding the obesity dynamics by socioeconomic status in Colombian and Mexican cities using a system dynamics model

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ARTICLE INFO

Keywords:
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Obesity transition
Public health
System dynamics model
System science

ABSTRACT

Purpose: This paper aims to enrich understanding of the obesity transition among socioeconomic status (SES) strata by gender and age in cities of Colombia and Mexico. The study uses harmonized data from the Salud Urbana en América Latina (SALURBAL) study.

Methods: A population-level system dynamics model was developed using 2010 and 2015 data from Colombia and 2012 and 2016 data from Mexico (national health surveys). The model simulates the prevalence of different BMI categories (i.e., not overweight, overweight, obese) stratified by gender, age, and SES, in the SALURBAL cities (aggregated to the country level) of Colombia and Mexico from 2010 to 2050. Sample sizes for Colombia in 2010 and Mexico in 2012 were 7420 and 5785 children (<5 years), 21601 and 14413 children and adolescents (5–17 years), and 46597 and 20464 adults (18–64 years), respectively. Sample sizes for Colombia in 2015 and Mexico in 2016 were 4450 and 907 children, 12468 and 2350 children and adolescents, and 90430 and 3413 adults, respectively.

Results: For men in Colombia and Mexico, the burden of obesity is projected to increase among lower SES adults over time. Colombian women show similar patterns observed in men but the burden of obesity was already greater in the lower SES groups as early as 2012. In Mexican women, the burden of obesity in 2012 is higher in the lower SES population; however, the

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Approaches for the On-Line Three-Dimensional Knapsack Problem with Buffering and Repacking

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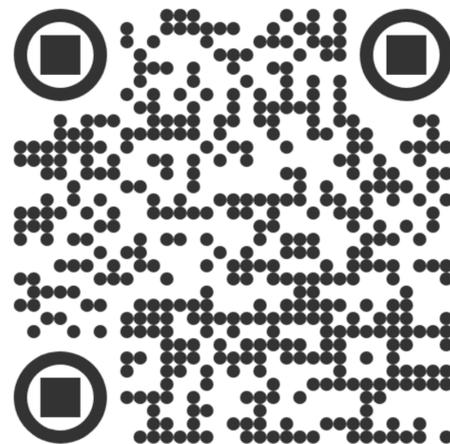


David Álvarez-Martínez

Juan Manuel Huertas Arango
Germán Pantoja-Benavides
Sebastián Valero

El artículo propone heurísticas para el problema online de empaquetado 3D en sistemas automatizados, incorporando estrategias de buffering y repacking para enfrentar la llegada incierta de productos. Los resultados, validados con simulaciones y pruebas en una celda robótica real, muestran una mejora significativa en la utilización del espacio, aunque con un aumento en el tiempo de empaquetado.

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Article

Approaches for the On-Line Three-Dimensional Knapsack Problem with Buffering and Repacking

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Abstract: The rapid growth of the e-commerce sector, particularly in Latin America, has highlighted the need for more efficient automated packing and distribution systems. This study presents heuristic algorithms to solve the online three-dimensional knapsack problem (OSKP), incorporating buffering and repacking strategies to optimize space utilization in automated packing environments. These strategies enable the system to handle the stochastic nature of item arrivals and improve container utilization by temporarily storing boxes (buffering) and rearranging already packed boxes (repacking) to enhance packing efficiency. Computational experiments conducted on specialized datasets from the existing literature demonstrate that the proposed heuristics perform comparably to state-of-the-art methodologies. Moreover, physical experiments were conducted on a robotic packing cell to determine the time that buffering and repacking implicate. The contributions of this paper lie in the integration of buffering and repacking into the OSKP, the development of tailored heuristics, and the validation of these heuristics in both simulated and real-world environments. The findings indicate that including buffering and repacking strategies significantly improves space utilization in automated packing systems. However, they significantly increase the time spent packing.

Keywords: buffering; repacking; heuristics; online packing problem

MSC: 00A69; 90B06



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1. Introduction

E-commerce, the process of buying and selling goods and services online, has fundamentally transformed the way people shop, establishing itself as a dominant force in the retail industry. Over time, the rapid growth of this field has led to a significant rise in demand for automated distribution centers, which are essential for managing the high volume of orders and the speed of delivery that online shoppers expect [1–3]. These automated centers enhance efficiency and productivity by employing conveyor belts and robotic solutions to pick and pack various orders [4,5].

A key challenge in these automated distribution centers is efficiently packing assorted boxes that arrive randomly via conveyor belts onto pallets for distribution. The stochastic nature of demand adds complexity to this task. The literature highlights various optimization challenges associated with container packing, especially in retail scenarios where vehicles or pallets are dispatched as soon as they are complete, and new ones are immediately introduced to continue the process. This scenario requires precise space optimization to maximize the number of boxes per vehicle or pallet. Such challenges are typically classified as the Online Single Container Loading Problem in academic studies. Depending on the range of box sizes, this may also be referred to as the Online Single Knapsack Problem (OSKP) or the Online Single Large Object Placement Problem (OSLOPP) [6]. In this study, the OSKP is the primary focus.

A value chain modeling approach for upscaling the production of fine flavor cocoa in Arauca (Colombia)

18 de octubre de 2024

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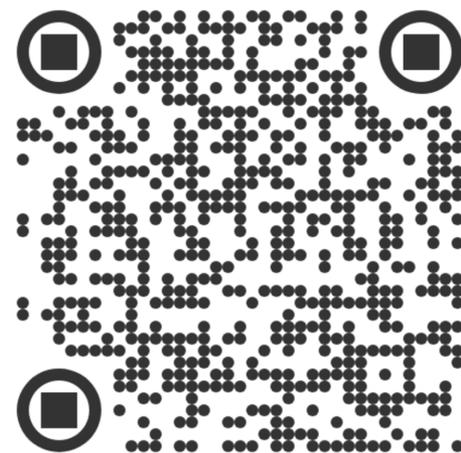


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El estudio propone un modelo colectivo de poscosecha para cocoa fino de aroma que integra decisiones operativas, tácticas y estratégicas a lo largo de la cadena productiva. Mediante modelos de optimización y simulación aplicados a un caso en Arauca (Colombia), se identifican factores clave como la capacidad del centro de poscosecha, el precio del cocoa y el tipo de mercado, mostrando cómo su articulación mejora la calidad y el valor para pequeños productores.

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A value chain modeling approach for upscaling the production of fine flavor cocoa in Arauca (Colombia)

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Abstract

The fine flavor cocoa (FFC) market offers additional income for small farmers. Despite the potential of several Latin American countries to produce FFC, their lack of standardized postharvest processes hinders compliance with high-quality standards demanded by the FFC market, as these processes have a direct impact on cocoa's organoleptic characteristics. This work supports the design of a collective postharvest transformation model that coordinates the main steps in the cocoa agri-food chain: transport of the cocoa harvest, classification, fermentation, drying, storage, and commercialization. Our methodology includes a modeling scheme combining optimization and simulation models, considering variability in the processes, and covering operational (transport and resource allocation), tactical (design and sizing of the processing plant), and strategic (sales dynamics) decisions across the cocoa value chain. We illustrate this methodology in a case study in Arauca, Colombia. Our findings emphasize the importance of combining these operational and strategic models since their inputs and outputs are interconnected influencing the decision-making within the cocoa value chain. Our study also identifies key determinants for the postharvest design, highlighting the postharvest center capacity, FFC prices, and the market selling mode (export or local).

Keywords: cocoa agri-food chain; postharvest center; fine flavor cocoa; cooperative model; operational research; optimization; simulation

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Fostering collective action for adolescent well-being:

Citizen science in a Colombian semi-rural area

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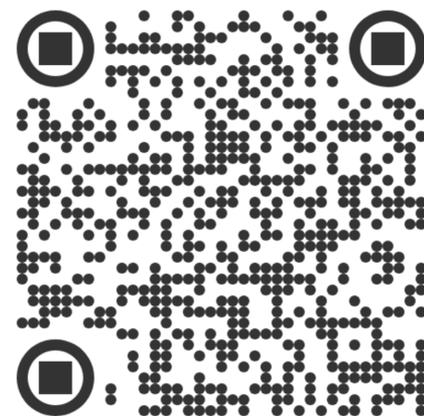


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El proyecto **Our Voice en Barú** empoderó a adolescentes afrodescendientes para identificar barreras y facilitadores de su bienestar y promover acciones comunitarias. Mediante ciencia ciudadana, lograron mejoras en infraestructura, espacios recreativos y salud comunitaria.

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Fostering collective action for adolescent well-being: citizen science in a Colombian semi-rural area

Ana María Guerra^{1,2,*}, Eduardo De La Vega-Taboada³, Olga L. Sarmiento⁴, Ann Banchoff⁵, Abby C. King⁵, Dionne Stephens³, Luis D. Revollo⁶, Ana P. Revollo⁷, and Felipe Montes^{1,2}

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Abstract

We present findings from the Our Voice in Barú project, examining adolescent engagement in citizen science to address environmental and social factors affecting well-being in a semi-rural Afro-descendant community in Latin America. The project aimed to identify barriers and enablers of well-being, informing adolescent-led actions for sustainable environmental changes relevant to adolescent health. Utilizing the Our Voice citizen science method, which involved technology-enabled walks, participatory cartography workshops and community meetings, we engaged adolescents and other community members. Complex systems framework was employed to analyze results and assess the promotion of collective action and local change. Local enablers of well-being included availability of quality sports and recreational venues as safe spaces, educational settings and cultural aspects, fostering safety, community pride, and personal growth. Conversely, barriers included environmental contamination, deteriorated sports venues and drug addiction, indicating the community's limited access to services and exposure to harmful substances. Adolescent citizen scientists, in partnership with the research team and relevant community decision-makers, successfully achieved changes aimed at identified barriers, including infrastructural enhancements like the repair of pumps to remove stagnant water, improvements in the quality and safety of recreational venues, and the implementation of community-led initiatives to address substance abuse and promote healthier behaviors. The Our Voice in Barú project empowered adolescents to advocate for change and promoted collective action to tackle barriers identified as significant to their well-being.

Keywords: adolescent well-being, citizen science, participatory research, physical environment, *Our Voice*, social environment, community engagement, collective action

Contribution to Health Promotion

The project:

- Demonstrated the power of collective action in promoting health equity and well-being in the Santa Ana community.
- Engaged Santa Ana's youth in identifying and presenting local health concerns to relevant community decision-makers.
- Empowered adolescents to advocate for infrastructure improvements to enhance sanitation and overall community health in Santa Ana.
- The promoted awareness on the importance of creating safer spaces for community well-being.
- Contributed valuable insights to the field of health promotion by showcasing effective strategies for fostering community engagement and advocating for structural improvements to support population health.

BACKGROUND

On July 2022, the General Assembly of United Nations declared the right to a clean, healthy and sustainable environment as a human right, and called all relevant actors to

adopt good practices and policies to ensure this right (*The Human Right to a Clean, Healthy and Sustainable Environment, 2022*). The interest engendered by this declaration has resulted in a growing number of community-facing

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Adaptive stochastic lookahead policies for dynamic multi-period purchasing and inventory routing

01 de noviembre de 2024

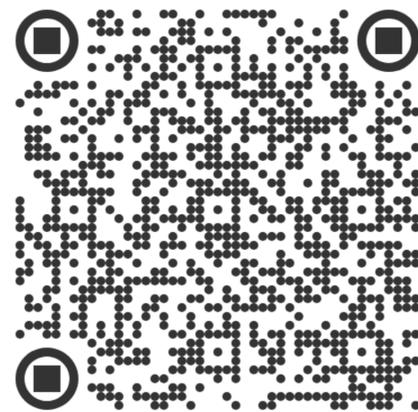
Publicado en: European Journal of Operational Research



Camilo Gómez
David Álvarez-Martínez
Daniel Cuéllar-Usaquén
Marlin W. Ulmer

Este estudio aborda la gestión integrada de compras, inventarios y ruteo en plataformas de e-commerce agroalimentario con productos perecederos y alta incertidumbre. Se propone un método estocástico lookahead que anticipa escenarios futuros y, mediante aproximaciones y aprendizaje adaptativo de costos de ruteo, logra decisiones eficientes. Los resultados muestran mejoras significativas al combinar anticipación, aproximación y aprendizaje, ofreciendo aportes prácticos y metodológicos para reducir desperdicios y satisfacer la demanda.

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Innovative applications of O.R.

Adaptive stochastic lookahead policies for dynamic multi-period purchasing and inventory routing

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ARTICLE INFO

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Routing
Agri-food supply chains
Dynamic multi-period vehicle routing
Approximate dynamic programming

ABSTRACT

We explore a problem faced by agri-food e-commerce platforms in purchasing different, perishable products and collecting them from multiple producers and delivering them to a single warehouse, aiming to maintain adequate inventory levels to meet current and future customer demand, while avoiding waste. Customer demand and suppliers' purchase prices and supply volumes are uncertain and revealed on a periodical basis. Every period, purchasing, inventory, and routing decisions are made to satisfy demand and to build inventory for future periods. For effective decisions integrating all three decision components and anticipating future developments, we propose a stochastic lookahead method that, in every period, samples future scenarios for demand, supply volumes, and prices. It then solves a two-stage stochastic program to obtain the decision for the current period. To make this approach computationally tractable, we reduce the routing decision in the two-stage program and use an approximate routing cost instead. Given the reduced decision, we then create the final decision via a conventional routing heuristic. We learn the routing cost approximation adaptively via repeated training simulations. In comprehensive experiments, we show that all three components, stochastic lookahead, routing cost approximation, and adaptive learning, are very effective individually, but especially in combination. We also provide a comprehensive analysis of the problem parameters and obtain valuable insights in problem and methodology.

1. Introduction

In recent years, there has been a growing demand for fresh, locally sourced, and high-quality food products worldwide (Fukase & Martín, 2020), as consumers are becoming more conscious of the origin and quality of their food. In addition, locally sourced food products require less transportation, refrigeration, and packing, which can significantly reduce the food system's carbon footprint. This trend, along with technological developments, has led to new business models in which local suppliers are connected to the local consumer through e-commerce platforms. These platforms allow small producers to sell their products and reach new markets, enabling easy access to fresh and locally sourced products (Gu, Archetti, Cattaruzza, Ogier, Semet, & Speranza, 2022).

In countries worldwide, initiatives have been developed to distribute local agricultural products through e-commerce platforms (Halkier & James, 2022). These initiatives have created new supply chain structures composed of multiple small producers, requiring the coordination of the replenishment process with a network of participants rather than relying on a single supplier. This process involves

purchasing products, collecting them from suppliers, and managing stocks in distribution centers (*first mile*, which is the focus of this work), followed by distribution to end customers (*last mile*). These structures with high horizontal integration reduce the number of intermediaries, increase the participation of small producers, and improve the efficiency and transparency of the supply chain, in addition to reducing the gap between small and large producers in terms of competitiveness (Prajapati, Chan, Daultani, & Pratap, 2022). Despite being advantageous, the new structures pose new challenges for the supply chain management. The high expectations of local customers underline the need for an effective collection, storage, and distribution process. In addition, the volatility of demand, supply, and prices increases the difficulty of agri-food supply chain management. To address these challenges, it is necessary to develop methodologies that account for uncertainty, perishability, and manage the complexity of joint decisions in replenishment, routing, and inventory operations in a dynamic environment (Majluf-Manzur, González-Ramírez, Velasco-Paredes, & Villalobos, 2021). Failing to consider these factors can result in poor planning and inefficiencies.

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Enhancing Transparency in Public Procurement: A Data-Driven Analytics Approach

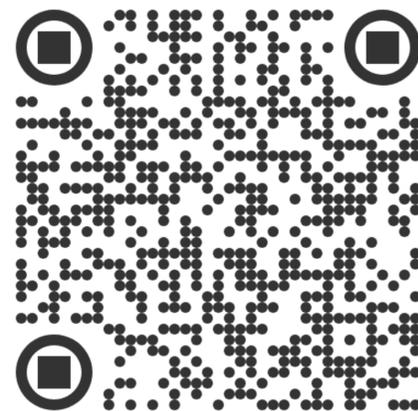
01 de noviembre de 2024
Publicado en: Information Systems



Camilo Gómez
Heriberto Felizzola
Nicolás Arrieta
Vianey Jeréz
Yilber Erazo
Geraldine Camacho

Este estudio presenta una herramienta de visual analytics que facilita el análisis de datos abiertos de contratación pública para usuarios no expertos en datos. La herramienta automatiza la extracción, limpieza y estandarización de información, genera visualizaciones claras e incorpora indicadores de riesgo de corrupción. Mediante un caso de estudio, se demuestra su utilidad para apoyar el análisis de la contratación pública y fortalecer la transparencia y la rendición de cuentas.

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Information Systems
Volume 125, November 2024, 102430

Enhancing transparency in public procurement: A data-driven analytics approach

Heriberto Felizzola ^{a b} ✉, Camilo Gomez ^b, Nicolas Arrieta ^a, Vianey Jerez ^a, Yilber Erazo ^a, Geraldine Camacho ^a

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Abstract

Open data is a strategy used by governments to promote transparency and accountability in public procurement processes. To reap the benefits of open data, exploring and analyzing the data is necessary to gain meaningful insights into procurement practices. However, accessing, processing, and analyzing open data can be challenging for non-data-savvy users with domain expertise, creating a barrier to leveraging open procurement data. To address this issue, we present the design, development, and implementation of a visual analytics tool. This tool automates data extraction from multiple sources, performs data cleansing, standardization, and database processing, and generates meaningful visualizations to streamline public procurement analysis. In addition, the tool estimates and visualizes corruption risk indicators at different levels (e.g., regions or public entities), providing valuable insights into the integrity of the procurement process. Key contributions of this work include: (1) providing a comprehensive guide to the development of an open procurement data visualization tool; (2) proposing a data pipeline to support processing, corruption risk estimator and data visualization; (3) demonstrating through a case study how visual analytics can effectively use open data to generate insights that promote and enhance transparency.

Introduction

Government open data refers to datasets produced and managed by public entities that are made freely and accessibly available using machine-readable formats. The goal of these initiatives is to provide citizens, researchers, and other stakeholders with valuable information that they can reuse and leverage to create public value [1]. Through these initiatives, governments seek to promote transparency, accountability, efficiency, and societal participation in public management [2].

Optimal hybrid backup systems for substation auxiliary services during outages through stochastic programming

02 de noviembre de 2024

Publicado en: Electric Power Systems Research



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 Matheus Holzbach
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 John F. Franco

Este trabajo propone un modelo de programación estocástica para diseñar un sistema híbrido de respaldo con paneles solares y baterías para servicios auxiliares de subestaciones, considerando la incertidumbre de la irradiación solar y las fallas eléctricas. El modelo logra altos niveles de confiabilidad, reduciendo significativamente las horas de indisponibilidad, y muestra que las baterías son clave para la robustez del

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Optimal hybrid backup systems for substation auxiliary services during outages through stochastic programming

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ABSTRACT

Auxiliary services are fundamental to ensure the uninterrupted operation, control, and surveillance of critical infrastructure. Traditional dependency on diesel generators as backup power sources during service disruptions is increasingly challenged by their non-renewable nature, operational costs, and environmental impacts. Addressing these concerns, this paper introduces a novel stochastic programming method for the optimal design of a hybrid backup system (HBS), integrating photovoltaic (PV) panels, battery storage, and bidirectional inverters, specifically tailored for substation auxiliary services (SAS). The proposed model represents the uncertainties associated with solar irradiance and power outages (occurrence and duration) through a scenario-based analysis, ensuring a required level of robustness. The proposed model is applied to a case study and a sensitivity analysis of the most important parameters was executed. It was identified that the optimal investment corresponds to an HBS formed by 6 batteries and 22 PV panels (18 kWh/8.58 kWp), providing a robustness level of 99.526 %, which reduces the unavailable hours of the SAS by 61 %. The findings underscore the pivotal contribution of battery systems to support SAS under outages, facilitating the attainment of requisite reliability thresholds. Nonetheless, achieving higher levels of robustness is intrinsically linked to increased financial investment in the backup system infrastructure.

1. Introduction

Substation auxiliary services (SAS) are essential tasks for the normal distribution network operation. They perform functions associated with monitoring, measuring, communicating, and operating of numerous electrical equipment such as potential and current transformers, automatic switches, sensors, protection relays, supervisory systems, and others. Furthermore, SAS include essential loads such as lighting, heating-cooling, motors, and circuit breakers [1–3].

Due to their importance to the electric distribution system, SAS must be operated without interruption, even under outage. Generally, SAS are supplied by a low-voltage bus connected to a distribution feeder in normal operating conditions. Still, to act during an outage, substations are equipped with backup systems to provide power for SAS during the outage period in the distribution feeder.

The most common backup system is the diesel generator. However, it has some disadvantages: (i) diesel is a non-renewable and highly

polluting energy source, (ii) diesel generators have high operation and maintenance costs, and (iii) there are frequent reports of diesel generator malfunctions. Additionally, some regulations recommend the presence of more than one backup system. For instance, Brazilian regulation requires at least two independent sources to supply SAS [1,4].

Environmental concerns have become an increasingly sensitive issue in recent decades. Recently, the Secretary-General of the United Nations announced that the “era of global warming” has ended and the “era of global boiling” has arrived, marking an unprecedented level of heating in human history [5]. This fact reinforces the importance of renewable energy generation, which has emerged as a focal point in modern research, reflecting a vital and strategic investment in response to evolving environmental, social, and economic challenges. For instance, PV panels, wind turbines, and energy storage systems (ESSs) are distributed energy resources (DER) often integrated into modern power systems [6]. The large-scale inclusion of renewable DERs: (i) increases the energy sources to meet time-varying consumer demands, (ii) reduces the electrical system dependence on fossil fuels, and (iii) postpones

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Design of logistics indicators for monitoring the COVID-19 vaccination process in Colombia

13 de noviembre de 2024

Publicado en: Health Services Research



Ciro-Alberto Amaya
Nubia Velasco
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Estefanía Hernández

Este estudio desarrolla y valida un conjunto de KPIs y un tablero de control para monitorear el desempeño logístico y operativo del Plan Nacional de Vacunación contra la COVID-19 en Colombia. El dashboard permitió el seguimiento en tiempo real y apoyó la toma de decisiones, mejorando la planificación y ejecución de la cadena de suministro de vacunas a nivel nacional y regional.

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Velasco et al. *BMC Health Services Research* (2024) 24:1397
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BMC Health Services Research

RESEARCH

Open Access



Design of logistics indicators for monitoring the COVID-19 vaccination process in Colombia

Logistic indicators for vaccination process

Nubia Velasco^{1*}, Andrea Herrera², Johanna Trujillo-Díaz^{3,4}, [Ciro-Alberto Amaya²](#), [Catalina González-Uribe³](#) and [Estefanía Hernández¹](#)

Abstract

Background The vaccine supply chain (VSC) integrates all activities from production to dispensing, characterized by complexity and low responsiveness. This study aims to define key performance indicators (KPIs) to evaluate the logistic and operational performance during the COVID-19 National Vaccination Plan in Colombia.

Methods This study employed the design science research (DSR) methodology to develop a dashboard for monitoring COVID-19 vaccination progress. DSR is a problem-solving paradigm focused on conceiving, testing, and evaluating artifacts to tackle specific challenges. The dashboard integrated a set of Key Performance Indicators (KPIs) that incorporated three dimensions: epidemiological, humanitarian, and logistical. Both, the dashboard and the KPIs underwent validation through three iterative DSR cycles, in collaboration with both private and public health stakeholders.

Results A set of 38 validated KPIs, grouped into eight categories, was consolidated into an online dashboard. This tool enabled real-time tracking of the National Vaccination Plan at both national and departmental levels, providing stakeholders with a comprehensive view of the vaccine supply chain. It also allowed for the assessment and comparison of the execution and effectiveness of public policies.

Conclusions These KPIs supported decision-making from a logistical standpoint, enhancing the planning, preparation, and continuous improvement of mass vaccination processes, thereby increasing their potential impact even further.

Keywords Key logistics performance indicators, Vaccine supply chain, Design science research, Mass vaccination, COVID-19 vaccination

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A Matheuristic Approach Based on Variable Neighborhood Search for the Static Repositioning Problem in Station-Based Bike-Sharing Systems

15 de noviembre de 2024

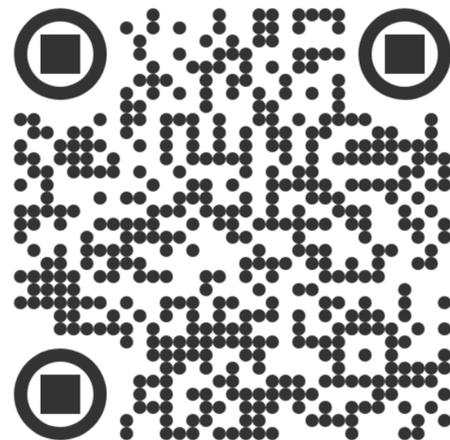
Publicado en: Mathematics



David Álvarez-Martínez
Julio Mario Daza-Escorcía

Este trabajo aborda un nuevo problema de redistribución estática en sistemas de bicicletas compartidas, considerando bicicletas operativas, dañadas y espacios disponibles en las estaciones. Se propone una matheurística que combina Variable Neighborhood Search con un modelo de programación lineal entera para optimizar rutas y cargas de bicicletas. Probada con datos reales, la metodología logra reducir desviaciones respecto a la demanda objetivo, retirar bicicletas dañadas y minimizar el tiempo de operación, obteniendo soluciones de alta calidad en tiempos computacionales razonables.

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Article

A Matheuristic Approach Based on Variable Neighborhood Search for the Static Repositioning Problem in Station-Based Bike-Sharing Systems

Julio Mario Daza-Escorcía ^{*,†} and David Álvarez-Martínez [†]

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Abstract: In this paper, we study a novel *static bike-sharing repositioning problem*. There is a set of stations spread over a given area, each containing a number of operative bikes, damaged bikes, and free slots. The customers may pick up an operative bike from a station, use it, and return it to another station. Each station should have a target number of operative bikes to make it likely to meet customer demands. Furthermore, the damaged bikes should be removed from the stations. Given a fleet of available vehicles, the *repositioning problem* consists of designing the vehicles' routes and calculating the number of operative (usable) and damaged (unusable) bikes that will be moved (loading instructions/loading policy) between stations and/or the depot. The objective is to minimize the weighted sum of the deviation from the target number of bikes for each station, the number of damaged bikes not removed, and the total time used by vehicles. To solve this problem, we propose a *matheuristic* based on a *variable neighborhood search* combined with several improving algorithms, including an *integer linear programming model* to optimize loading instructions. The algorithm was tested in instances based on real-world data and could find good solutions in reasonable computing times.

Keywords: vehicle routing problem; static bike-sharing repositioning problem; matheuristic based on variable neighborhood search

MSC: 90B06



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1. Introduction

public bike-sharing systems (PBSs) have become a sustainable mobility model that has attracted significant interest worldwide. These were first introduced in Amsterdam in 1965 [1], and the number of cities with PBSs has grown rapidly since then due to the reduction of the users' environmental impact and the lower usage costs compared to other means of transportation. According to the consultancy PBSC Urban Solutions [2], as of August 2021, there were nearly 10 million shared bikes and 3000 bike-sharing systems worldwide.

There are two primary categories within PBSs. The first category is the *station-based bike-sharing system* (SBBS), allowing users to rent bicycles at fixed stations and return them to the same station or any other designated station after usage [1]. SBBSs were first introduced in Denmark in 1991 [3]. The second category is the *free-floating bike-sharing systems* (FFBSs), where bicycles can be conveniently picked up and returned anywhere according to the users' preferences [4]. In these systems, there may be no fixed stations. The FFBSs were first introduced in China in 2016 [5]. This study focuses on the *station-based bike-sharing system*.

In the SBBS category, a user takes a bike from one fixed station, uses it, and returns it to another station from the system. Each station has a number of bike parking slots, some of which may be empty or occupied by operational or damaged bikes. During the day, some stations may not have operative bikes or free slots to park, preventing the correct service

Human behavior-driven epidemic surveillance in urban landscapes

04 de diciembre de 2024
Publicado en: Complexity



Felipe Montes
Pablo Valgañón
Andrés Felipe Useche
Alex Arenas
David Soriano-Paños
Jesús Gómez-Gardeñes

Se presenta una estrategia de vigilancia urbana que usa datos de movilidad y residencia para identificar rutas clave de transmisión y focalizar pruebas en puntos críticos. Este enfoque mejora la detección temprana y la eficiencia del control de brotes frente a estrategias no dirigidas.

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<https://doi.org/10.1038/s44260-024-00021-z>

Human behavior-driven epidemic surveillance in urban landscapes

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P. Valgañón^{1,2}, A. F. Useche^{3,4}, F. Montes⁴, A. Arenas⁵✉, D. Soriano-Paños^{2,5,6}✉ & J. Gómez-Gardeñes^{1,2,7}✉

We introduce a surveillance strategy specifically designed for urban areas to enhance preparedness and response to disease outbreaks by leveraging the unique characteristics of human behavior within urban contexts. By integrating data on individual residences and travel patterns, we construct a Mixing matrix that facilitates the identification of critical pathways that ease pathogen transmission across urban landscapes enabling targeted testing strategies. Our approach not only enhances public health systems' ability to provide early epidemiological alerts but also underscores the variability in strategy effectiveness based on urban layout. We prove the feasibility of our mobility-informed policies by mapping essential mobility links to major transit stations, showing that few resources focused on specific stations yields a more effective surveillance than non-targeted approaches. This study emphasizes the critical role of integrating human behavioral patterns into epidemic management strategies to improve the preparedness and resilience of major cities against future outbreaks.

Throughout history, the interplay between epidemics and human societies has been profound, each significantly influencing and shaping the course of the other¹⁻³. This interplay, already present during our early hunter-gatherer days, was notably boosted by the establishment of agrarian societies around 10,000 years ago, when the creation of communities provided fertile breeding grounds for diseases to thrive. It was during this transformative period that humanity first encountered diseases such as malaria, tuberculosis, leprosy, influenza, and smallpox, which have since significantly altered the course of human history⁴.

As human settlements transformed into nowadays vast urban centers, they also introduced new challenges for contemporary epidemiology^{5,6}. Urban environments, characterized by dense populations, complex social interactions, and socioeconomic disparities, create ideal conditions for the spread of communicable diseases⁷⁻⁹. Moreover, the rapid movement of people and goods within and across cities sweeps out national and continental boundaries, thus facilitating the global dissemination of pathogens between major city centers¹⁰.

The advent of big data and advanced modeling techniques offers new avenues for understanding and managing this cocktail of epidemic boosters, emphasizing the importance of integrating mobility data and demographic insights into urban epidemic management strategies¹¹. In this line, data

analytics have significantly advanced epidemic modeling^{12,13}, enabling the mathematical formalization of complexities associated with demographic segregation, mobility patterns, and heterogeneous contacts-key factors in disease propagation¹⁴.

Utilizing metapopulation frameworks, epidemic models effectively manage the interaction among the above ingredients by coupling contact-driven transmission with mobility-related dispersal¹⁵⁻²². In recent decades, such behaviorally informed metapopulation models have become indispensable for mechanistic forecasting, enabling precise predictions of epidemic trajectories across diverse scales-from local communities^{23,24} through national²⁵⁻²⁷ to global levels²⁸⁻³⁰. Moreover, contemporary epidemic models extend beyond mapping the spatio-temporal spread of diseases, but also facilitate the development of data-informed containment strategies with maximal resource efficiency and minimal socioeconomic disruption³¹⁻³⁴.

These efforts highlight the critical role that incorporating social dynamics into epidemic models has on our capacity to respond to infectious disease threats, an aspect that has recently materialized in research agendas³⁵⁻³⁷ aimed at advancing this endeavor. These agendas, among other problems, specifically highlight the challenge of employing realistic human contact structures to explore localization behavior in *key subpopulations* for epidemic control policies. Addressing this precise challenge, here we

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VigIA: Prioritizing public procurement oversight with machine learning models and risk indices

20 de diciembre de 2024
Publicado en: Data & Policy



Juan F. Pérez
Andrés Salazar
Jorge Gallego

Se presenta VigIA, una herramienta basada en datos para apoyar la supervisión de la contratación pública. Combina modelos de machine learning para detectar sobre costos y retrasos con índices de riesgo que identifican irregularidades, usando solo datos abiertos. El sistema ayuda a priorizar investigaciones y asignar recursos de forma más eficiente.

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RESEARCH ARTICLE

VigIA: prioritizing public procurement oversight with machine learning models and risk indices

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Keywords: GovTech solutions; machine Learning; Public procurement

Abstract

Public procurement is a fundamental aspect of public administration. Its vast size makes its oversight and control very challenging, especially in countries where resources for these activities are limited. To support decisions and operations at public procurement oversight agencies, we developed and delivered VigIA, a data-based tool with two main components: (i) machine learning models to detect inefficiencies measured as cost overruns and delivery delays, and (ii) risk indices to detect irregularities in the procurement process. These two components cover complementary aspects of the procurement process, considering both active and passive waste, and help the oversight agencies to prioritize investigations and allocate resources. We show how the models developed shed light on specific features of the contracts to be considered and how their values signal red flags. We also highlight how these values change when the analysis focuses on specific contract types or on information available for early detection. Moreover, the models and indices developed only make use of open data and target variables generated by the procurement processes themselves, making them ideal to support continuous decisions at overseeing agencies.

Policy Significance Statement

Overseeing agencies are tasked with the key but very challenging task of preventing inefficient and irregular practices in public procurement. Here we describe the development of tools to support these entities in the early detection of these practices. The tools are designed and developed with the user in mind, prioritizing explainability and easy access to the data required, especially making use of open data sources. The results reveal which operational variables associated with the procurement process are key for the early detection of inefficiencies. The tools can further support decisions regarding the prioritization of investigations and resource allocation in overseeing agencies.

This research article was awarded Open Data and Open Materials badges for transparent practices. See the Data Availability Statement for details.

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Flavor Wheel Development from a Machine Learning Perspective

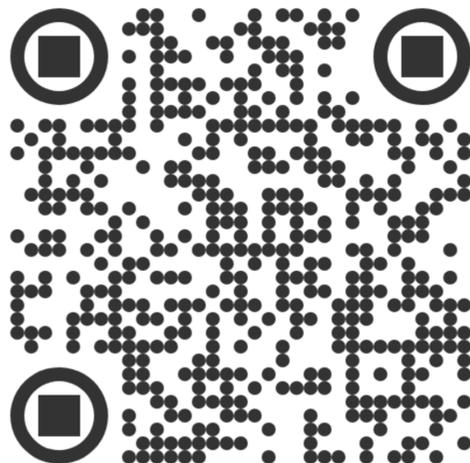
20 de diciembre de 2024
Publicado en: Foods



Rafael Amaya-Gómez
Anggie V. Rodríguez-Mendoza
Santiago Arbeláez-Parra
Nicolás Ratkovich

Este estudio explora la relación entre compuestos químicos y aromas en siete tipos de bebidas destiladas mediante técnicas de machine learning. A partir del análisis de más de 3.000 compuestos, se identifican patrones aromáticos característicos usando PCA y modelos de clustering. Como resultado, se propone una rueda de aromas que facilita la comprensión y apreciación sensorial de los destilados para productores, expertos y consumidores.

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Article

Flavor Wheel Development from a Machine Learning Perspective

Anggie V. Rodríguez-Mendoza ¹, Santiago Arbeláez-Parra ¹, Rafael Amaya-Gómez ^{2,*} and Nicolás Ratkovich ^{1,*}

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Abstract: The intricate relationships between chemical compounds and sensory descriptors in distilled spirits have long intrigued distillers, sensory experts, and consumers alike. The importance and complexity of this relation affect the production, quality, and appreciation of spirits, and the success of a product. Because of that, profoundly investigating the different flavor and aroma combinations that the chemical compounds can give to a desired beverage takes an essential place in the industry. This study aims to study these relationships by employing machine learning techniques to analyze a comprehensive dataset with 3051 chemical compounds and their associated aroma descriptors for seven distilled spirit categories: Baijiu, cachaça, gin, mezcal, rum, tequila, and whisk(e)y. The study uses principal component analysis (PCA) to reduce the dimensionality of the dataset and a clustering machine learning model to identify distinct clusters of aroma descriptors associated with each beverage category. Based on these results, an aroma wheel that encapsulates the diverse olfactory landscapes of various distilled spirits was developed. This flavor wheel is a valuable tool for distillers, sensory experts, and consumers, providing a comprehensive reference for understanding and appreciating the complexities of distilled spirits.

Keywords: flavor wheel; machine learning; PCA; distilled spirit; chemical compounds



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1. Introduction

Spirits and alcoholic beverages encompass various elixirs that have been distilled and often aged to attain unique and complex flavor profiles. These beverages, ranging from cachaça and brandy to rum and cognac, are cherished not only for their alcoholic content but also for the richness and depth of their flavor notes and aromas. The sensory diversity of spirits originates from an intricate interplay of multiple factors [1,2]. The grains, fruits, or vegetables used in fermentation and distillation contribute fundamental nuances, while the aging process in oak casks adds additional layers of complexity. The duration of aging, climatic conditions, and the type of wood used in the cask construction significantly influence the final profile. These beverages contain a variety of compounds such as esters, aldehydes, and phenols, among others, which are fundamental to the flavor and aroma profiles, directly influencing consumer preferences depending on the distribution and traces [3,4]. For instance, esters typically enhance the flavor profile with fruity notes. Understanding these chemical components allows producers to refine their fermentation and distillation processes, optimizing flavor extraction and product quality.

Each alcoholic spirit possesses a distinctive sensory signature. From the smoky and earthy notes of single malt whisk(e)y to the subtle fruity and vanilla hints of brandy, these beverages celebrate sensory diversity [2,5,6]. Sensory descriptors provide a language for consumers to articulate their tasting experiences, enhancing their enjoyment and guiding their preferences. They serve as benchmarks, allowing for comparisons across products and



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