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Productos Reconocidos

Ordenado por fecha de aparición en línea:

1. Fontecha, J.E.; Cano, N.A.; Velasco, N.; Muñoz, F. (2016). Optimal Sectioning of Hydrocarbon Transport Pipeline by Volume Minimization, Environmental and Social Vulnerability Assessment. Journal of Loss Prevention in the Process Industries. 44: 681-689. Doi: 10.1016/j.jlp.2016.07.017

2. Guillier, S.; Muñoz, V.; Rogan, J.; Zarama, R.; Valdivia, J.A. (2016). Optimization of Spatial Complex Networks. Physica A: Statistical Mechanics and its Applications. 467 (1): 465-473. Doi: 10.1016/j.physa.2016.09.011

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9. Abolghasem, S.; Gómez-Sarmiento, J.; Medaglia, A.L.; Sarmiento, O.L.; González, A.D.; Díaz del Castillo, A.; Rozo-Casas, J.F.; Jacoby. E. (2017). A DEA-centric Decision Support System for Evaluating Ciclovía- Recreativa Programs in the Americas. Socio-Economic Planning Sciences. 1-12: Doi: 10.1016/j.seps.2017.03.005

10. Díaz, A.; Olaya, C. (2017). An Engineering View for Social Systems: Agency as an Operational Principle for Designing Higher Education Access Policies. Systemic Practice and Action Research. 1-23. Doi: 10.1007/s11213-017-9412-0

11. Monroy-Licht, M.; Amaya, C.A. Langevin, A. (2017). Adaptive Large Neighborhood Search Algorithm for the Rural Postman Problem with Time Windows. Networks. 70(1): 44-59. Doi: 10.1002/net.21747

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Optimal Sectioning of Hydrocarbon Transport Pipeline by Volume Minimization, Environmental and Social Vulnerability Assessment

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Optimal sectioning of hydrocarbon transport pipeline by volume minimization, environmental and social vulnerability assessment

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ARTICLE INFO

ABSTRACT

Sectioning is one of the key mitigation strategies in pipeline transport of liquid hydrocarbons. The valves located along pipelines reduce the maximum volume that may be spilled decreasing economic, social and environmental losses. Defining the location and number of valves in a specific pipeline section is a challenging decision due to the countless combinations of these two design components (i.e., where and how many valves). In this work, we address the valve location problem (VLP) for sectioning using an optimization approach based on a shortest path problem, which assesses the possible location of valves to minimize environmental risk and guarantee a tolerable value of individual risk. To estimate and quantify both the environmental vulnerability and individual risk a new framework is proposed, employing the spill volume and ecological and social characteristics as inputs. We present two case studies for sectioning in Latin-American pipelines; the problem is solved using a Bellman-Ford algorithm with CPU times up to 40 s. The results show reductions on the order of 50%–85% of the maximum possible spill volume compared with the current situation, in each case respectively. The resulting valve configurations cover areas with high environmental vulnerability, reducing ecological losses and guaranteeing a level of individual risks lower than the acceptable value on all populated areas.

1. Introduction

The installation of flow cut devices (e.g., valves) to split a pipeline in segments is known as sectioning and constitutes a mitigation strategy which enables the isolation of a pipeline segment when a primary loss of containment (LOC) takes place. The main objective of isolation is to reduce the possible spill volume (British Standard, 2003). Given that the social and environmental risks related to hydrocarbon transportation are directly linked to the spill volume, sectioning is a tool that can be used to minimize those risks. The challenge faced here is to define the most suitable location/number of valves in order to reach this goal.

Commonly, the installation of flow cut devices is subject to legislation, international standards, and recommended practices (RP) such as US DOT CFR 195.260–195.179 (US DOT, 2011; US DOT, 1998), ANSI/ASME B31.4 (ASME/ANSI, 2012), CSA Z662 (CSA, 2011) and BS 1416 (British Standard, 2003). The above are prescriptive

approaches that assess sectioning based on general criteria (mostly related to the social characteristics of an area such as population type -urban, suburban- and density) and that define a maximum distance between valves. These prescriptive approaches do not consider the particularities of the system, environmentally vulnerable areas and the operating conditions of each pipeline. Because of this new methodologies are being developed. The resultant approaches are usually based on the performance of the system, potential spill volume, risk calculations, and, in some cases, they are coupled with optimization models as presented by Weir et al. (2006), Weir and Li (2008); Grigorieva and Grigoriev, (2007); Grigoriev and Grigorieva (2009); Li and Weir (2012); Rout (2012). For example Weir et al. (2006) which consider risk reduction instead of the often used rule-of-thumbs and regulatory requirements.

Weir et al. (2006) developed the Intelligent Valve Placement (IVP) approach in order to identify optimum valve locations on existing pipelines in the United States. Weir's approach incorporates risk evaluation in order to attempt to reduce negative consequences of potential spill volumes and their impact on sensitive areas in an iterative manner. In recent years, the author has

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Optimization of Spatial Complex Networks

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Physica A: Statistical Mechanics and its Applications

Optimization of spatial complex networks

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HIGHLIGHTS

- Growth model for spatial network subject to optimization criterion.
- Scaling exponent depends on optimization criterion.
- Transition from exponential to scale-free behavior studied.
- Discussion of network size effects.

ARTICLE INFO

ABSTRACT

First, we estimate the connectivity properties of a predefined (fixed node locations) spatial network which optimizes a connectivity functional that balances construction and transportation costs. In this case we obtain a Gaussian distribution for the connectivity. However, when we consider these spatial networks in a growing process, we obtain a power law distribution for the connectivity. If the transportation costs in the functional involve the shortest geometrical path, we obtain a scaling exponent $\gamma = 2.5$. However, if the transportation costs in the functional involve just the shortest path, we obtain $\gamma = 2.2$. Both cases may be useful to analyze in some real networks.

1. Introduction

Complex networks have received substantial attention in recent years, because they provide a useful representation for many technological, biological and social systems [1–4]. Many of the networks in nature have common features, such as the connectivity distribution $P(k)$, which often results to behave as a power law $P(k) \sim k^{-\gamma}$ for large degree k [5–14]. Several authors have developed network models that seek to replicate these distributions. One of the most emblematic cases was proposed by Barabási–Albert [1,15,16], in which a weighted random growth model is used to generate a power law distribution with $\gamma = 3.0$. In this model in each step a new vertex appears and it is connected randomly with a vertex of the network with a probability proportional to its connectivity degree. Empirical networks show similar characteristic exponent γ, such as citation networks [5] and electronic circuits [6]. However there are other important sets of systems which exhibit a network structure with a different exponent, for example: telephone calls [7,8], World Wide Web [9], metabolic [10],

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The Rescheduling Arc Routing Problem

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The rescheduling arc routing problem

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Abstract

In this paper, the *rescheduling arc routing problem* is introduced. This is a dynamic routing and scheduling problem that considers adjustments to an initial routing itinerary when one or more vehicle failures occur during the execution stage and the original plan must be modified. We minimize the operational and schedule disruption costs. Formulations based on mixed-integer programming are presented to compare different policies in the rerouting phase. A solution strategy is developed when both costs are evaluated and it is necessary to find a solution quickly. Computational tests on a large set of instances compare the different decision-maker policies.

Keywords: rescheduling; disruption schedule costs; mixed-integer programming; arc routing problem

1. Introduction

Arc routing problems arise in applications where streets require maintenance or customers located along roads must be serviced. Most of the real applications deal with the capacitated case where the vehicle capacities must not be exceeded, for instance in waste collection or in salt-spreading vehicles have a load capacity to consider. Other applications, such as snow plowing, belong to multivehicle rural postman problems where vehicles do not have a load capacity; they serve the streets but do not load or unload materials.

Arc routing operations are planned normally for several vehicles that start and finish at the same depot and cover all or part of a network in order to provide services. Several works have been devoted to produce optimal or near-optimal solutions for arc routing problems (Corberán and Laporte, 2014). A solution describes a routing schedule, that is, the sequence of roads to be traversed by every vehicle. Once a solution is presented as an initial schedule, drivers should follow the planned routes if no unexpected events happen.

However, various disruptions may occur during the execution of the plan; they include traffic jams, vehicle breakdowns, and traffic accidents. It may also be necessary to include new services.

Economic Evaluation of Kangaroo Mother Care: Cost Utility Analysis of Results from a Randomized Controlled Trial Conducted in Bogotá

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Latin American Clinical Epidemiology Network Series — Paper 4: Economic evaluation of Kangaroo Mother Care: cost utility analysis of results from a randomized controlled trial conducted in Bogotá

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Abstract

Background and Objective: Although kangaroo mother care (KMC) has been shown to be safe and effective in randomized controlled trials (RCTs), there are no published complete economic evaluations including the three components of the full intervention.

Methods: A cost utility analysis performed on the results of an RCT conducted in Bogotá, Colombia between 1993 and 1996. Hospital and ambulatory costs were estimated by microcosting in a sample of preterm infants from a University Hospital in Bogotá in 2011 and at a KMC clinic in the same period. Utility scores were assigned by experts by means of (1) direct ordering and scoring discrete health states and (2) constructing a multi-attribute utility function. Ninety-five percent confidence intervals (CIs) for the incremental cost—utility ratios (ICURs) were computed by the Fiellers theorem method. One-way sensitivity analysis on price estimates for valuing costs was performed.

Results: ICUR at 1 year of corrected age was \$ −1,546 per extra quality-adjusted life year gained using the KMC method (95% CI \$ −7,963 to \$ 4,910).

Conclusion: In Bogotá, the use of KMC is dominant: more effective and cost-saving. Although results from an economic analysis should not be extrapolated to different systems and communities, this dominant result suggests that KMC could be cost-effective in similar low and middle income countries settings.   © 2016 Elsevier Inc. All rights reserved.

Keywords: Kangaroo mother care method; Cost-effectiveness analysis; Quality-adjusted life years; Randomized controlled trial; Colombia; Cost comparison; Infant; Premature

1. Introduction

Low birth weight (LBW) is a major public health problem, particularly in developing countries [1]. Currently in Colombia, about 12% of all live newborn infants are under 2,500 g at birth [2]. The economic burden related to neonatal care of LBW infants is very high, and this is a cause for concern both in developed [3—7] and in developing countries where the problem is even greater [8—10]. Cost-effective alternatives are badly needed.

Kangaroo mother care (KMC) is a human-based technology of well-established effectiveness and safety that could improve the affordability and efficiency of LBW infants care. It is based on the kangaroo position: continuous skin-to-skin contact between the mother and her baby that allows appropriate thermal regulation among other benefits. Other components are breastfeeding-based nutrition and timely (early) discharge with close follow-up [11—13]. KMC does not substitute for proper neonatal care [10] but complements it. KMC was originally developed in

Time Series Analysis of the Bacillus Subtilis Sporulation Network Reveals Low Dimensional Chaotic Dynamics

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Time Series Analysis of the *Bacillus subtilis* Sporulation Network Reveals Low Dimensional Chaotic Dynamics

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Chaotic behavior refers to a behavior which, albeit irregular, is generated by an underlying deterministic process. Therefore, a chaotic behavior is potentially controllable. This possibility becomes practically amenable especially when chaos is shown to be low-dimensional, i.e., to be attributable to a small fraction of the total systems components. In this case, indeed, including the major drivers of chaos in a system into the modeling approach allows us to improve predictability of the systems dynamics. Here, we analyzed the numerical simulations of an accurate ordinary differential equation model of the gene network regulating sporulation initiation in *Bacillus subtilis* to explore whether the non-linearity underlying time series data is due to low-dimensional chaos. Low-dimensional chaos is expectedly common in systems with few degrees of freedom, but rare in systems with many degrees of freedom such as the *B. subtilis* sporulation network. The estimation of a number of indices, which reflect the chaotic nature of a system, indicates that the dynamics of this network is affected by deterministic chaos. The neat separation between the indices obtained from the time series simulated from the model and those obtained from time series generated by Gaussian white and colored noise confirmed that the *B. subtilis* sporulation network dynamics is affected by low dimensional chaos rather than by noise. Furthermore, our analysis identifies the principal driver of the networks chaotic dynamics to be sporulation initiation phosphotransferase B (Spo0B). We then analyzed the parameters and the phase space of the system to characterize the instability points of the network dynamics, and, in turn, to identify the ranges of values of Spo0B and of the other drivers of the chaotic dynamics, for which the whole system is highly sensitive to minimal perturbation. In summary, we described an unappreciated source of complexity in the *B. subtilis* sporulation network by gathering evidence for the chaotic behavior of the system, and by suggesting candidate molecules driving chaos in the system. The results of our chaos analysis can increase our understanding of the intricacies of the regulatory network under analysis, and suggest experimental work to refine our behavior of the mechanisms underlying *B. subtilis* sporulation initiation control.

Keywords: systems biology, computational modeling, sensitivity analysis, low dimensional chaos, signal transduction, sporulation, *Bacillus subtilis*

An Integrative Approach to Computational Modelling of the Gene Regulatory Network Controlling Clostridium botulinum Type A1 Toxin Production

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PLoS Computational Biology

An Integrative Approach to Computational Modelling of the Gene Regulatory Network Controlling *Clostridium botulinum* Type A1 Toxin Production

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Abstract

Clostridium botulinum produces botulinum neurotoxins (BoNTs), highly potent substances responsible for botulism. Currently, mathematical models of *C. botulinum* growth and toxigenesis are largely aimed at risk assessment and do not include explicit genetic information beyond group level but integrate many component processes, such as signalling, membrane permeability and metabolic activity. In this paper we present a scheme for modelling neurotoxin production in *C. botulinum* Group I type A1, based on the integration of diverse information coming from experimental results available in the literature. Experiments show that production of BoNTs depends on the growth-phase and is under the control of positive and negative regulatory elements at the intracellular level. Toxins are released as large protein complexes and are associated with non-toxic components. Here, we systematically review and integrate those regulatory elements previously described in the literature for *C. botulinum* Group I type A1 into a population dynamics model, to build the very first computational model of toxin production at the molecular level. We conduct a validation of our model against several items of published experimental data for different wild type and mutant strains of *C. botulinum* Group I type A1. The result of this process underscores the potential of mathematical modelling at the cellular level, as a means of creating opportunities in developing new strategies that could be used to prevent botulism; and potentially contribute to improved methods for the production of toxin that is used for therapeutics.

Author Summary

Clostridium botulinum produces botulinum neurotoxins (BoNTs), highly potent substances responsible for botulism. Currently, mathematical models of *C. botulinum* growth and toxigenesis are largely aimed at risk assessment and do not include explicit genetic

Self-Organized Societies: on the Sakoda Model of Social Interactions

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Complexity

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Research Article

Self-Organized Societies: On the Sakoda Model of Social Interactions

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We characterize the behavior and the social structures appearing from a model of general social interaction proposed by Sakoda. The model consists of two interacting populations in a two-dimensional periodic lattice with empty sites. It contemplates a set of simple rules that combine attitudes, ranges of interactions, and movement decisions. We analyze the evolution of the 45 different interaction rules via a Potts-like energy function which drives the system irreversibly to an equilibrium or a steady state. We discuss the robustness of the social structures, dynamical behaviors, and the existence of spatial long range order in terms of the social interactions and the equilibrium energy.

1. Introduction

Throughout the history, the society has self-organized in a myriad of social structures and behaviors which appears as a response to the attitudes, decisions, and expectations among individuals, that is to say, from local (usually simple) rules to global behavior [1]. This capacity appears in animals [2], insects [3, 4], among others, and it flourishes in human beings since the early life [5]. The basic underlying mechanism of this self-organization lies on the evaluation of the expectations resulting from the attitudes among individuals inducing, or not, a mobility decision.

Interestingly, despite the complex nature of social interactions, the social behavior shares many common features with a variety of physical systems. Segregation, inclusion, and aggregation are examples of a collective order arising from simple and local individual rules based on attitudes, decisions, and expectations among individuals [6–9].

In the late forties, Sakoda introduced in his Ph.D. thesis [10] a first general discrete dynamical model for social interactions and published later [11], at the same time of the well-known Schelling's social segregation model [12, 13], which is, as we will show, only a special class already included in the original Sakoda model. The particular case of the Schelling segregation model and its variations have been studied widely through agent based models [9, 14–23]. However, the Sakoda dynamics and its underlying richness, which explain other different social phenomena far from segregation, are mostly unknown; thus they have not been, to the best of our knowledge, studied previously in a deeper manner.

The original Sakoda model roughly consists of social interactions among two groups of individuals evolving in a network according to specific attitudes of attraction, repulsion, and neutrality. An individual evaluates its social expectative at all possible available locations, preferring those near individuals associated with attractive (positive) attitudes and avoiding locations near individuals associated with repulsive (negative) ones. This procedure is repeated randomly among all possible individuals; henceforth Sakoda's algorithm is iterated recursively driving the system, under some conditions, to a well-organized spatial pattern.

The dynamics is quite rich because of three aspects: (1) the large number of combinations of the possible attitudes, (2) the effect of the separation distance among individuals (i.e., the interaction could be of short or long range), and (3) the

Cochlear Implants Versus Hearing Aids in a Middle-Income Country: Costs, Productivity, and Quality of Life

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Otology & Neurotology

Cochlear Implants Versus Hearing Aids in a Middle-Income Country: Costs, Productivity, and Quality of Life

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Objective: In Colombia there are three main treatment approaches for bilateral profound sensorineural hearing loss, also known as profound deafness (PD): cochlear implants (CI), hearing aids (HA), and no treatment (NT). The objective of this study is to determine the optimal treatment approach for PD in terms of productivity and cost-effectiveness.
Study Design: Hearing levels and SES data were obtained from audiometric tests conducted on 100 patients with CI. For each treatment approach, productivity and cost-effectiveness assessments were estimated using influence diagrams and Monte Carlo simulations. Productivity was calculated as the net present value of a patient's lifetime income divided by total health-related and educational costs. For the CI and HA, the cost-effectiveness indicator was calculated as quality-adjusted life-years (QALYs) gained in comparison with the NT approach divided by the total cost of the treatment option.

Results: The results for the CI, the HA, and NT in terms of productivity ratio were 1.53, 0.94, and 1.47, respectively. Patients using CI had a gain of 5.7 QALYs, whereas patients using HA had a gain of 4.6 QALYs. The results for the CI and the HA in terms of cost-effectiveness were $15,169 and $15,430 per QALY, respectively.
Conclusion: The CI was found to be the optimal treatment for PD, as it was the most efficient and cost-effective in terms of improving patients' productivity and quality of life. We observed that children who had received CI developed hearing and speech abilities that contributed to their productivity and quality of life to a greater extent than those with HA. **Key Words:** Cochlear implants—Cost-effectiveness—Cost-productivity—Profound sensorineural hearing loss—Stochastic decision analysis.

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Bilateral profound sensorineural hearing loss, also known as profound deafness (PD), is defined as hearing loss caused by abnormalities of the inner ear (1). Individuals with severe loss of hearing cannot detect tones at a level below 70 to 94 decibels hearing level (dB HL) on average in their better-hearing ear, whereas those with profound hearing loss cannot detect tones below 95 dB HL in their better-hearing ear (2). Risk factors associated with hearing loss include congenital infections, toxoplasmosis, bacterial meningitis, syphilis, rubella, cytomegalovirus, herpes, and a family history of hereditary

childhood sensorineural hearing loss (3). Children with severe to profound hearing loss experience increased difficulty with verbal and nonverbal communication skills, greater problems with their behavior, and a lower psychosocial well-being than children with normal hearing (3). They tend to feel excluded from society, experience greater difficulties in social interaction, and have more adjustment problems than hearing children (4). It is estimated that 50% of deaf children are not able to establish standard social interactions, compared with 16% of hearing children (5). Therefore, in order for children to develop their hearing and their perception of spoken language, it is important to ensure early screening and provide appropriate treatment to affected newborns at the youngest age compatible with a confirmed diagnosis of permanent loss of hearing (6).

According to the 2005 census carried out by the National Bureau of Statistics (DANE), in Colombia, there are approximately 440,000 people suffering from hearing difficulties (7). An estimated number of 1 in 1,000 newborns in the country suffer from PD (8). In 2013, the total population of Colombia was 47,121,089

A DEA-Centric Decision Support System for Evaluating Ciclovía- Recreativa Programs in the Americas

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Socio-Economic Planning Sciences

A DEA-centric decision support system for evaluating Ciclovía-Recreativa programs in the Americas

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ABSTRACT

Ciclovía-Recreativa (CR) is a community-based program with health and social benefits including physical activity promotion, social capital development, improvement in the population's quality of life, and reduction of air pollution and street noise. It is critical that these programs are evaluated through their operational performance and efficient use of resources. In this paper, we develop a DEA methodology that measures each CR efficiency relative to its peer programs, compares its performance to a benchmark system, identifies its sources of inefficiencies and offers recommendations for improvement. We examine the proposed methodology on programs in the region of the Americas as a case study and demonstrate the results and the recommendations. Finally, we present a spreadsheet-based DEA-centric Decision Support System (DSS) that facilitates the evaluation of the CR programs. Based on this study, an award called "*Bicis de Calidad*" (in English "Bikes of Quality") was created to be granted to the best CR programs reaching full efficiency according to the DEA outcomes.

1. Introduction

Ciclovía-Recreativa (CR) programs are multi-sectorial community-based programs, in which streets are temporarily open exclusively for people so that they can enjoy safe and free space in their city for cycling, skating, walking, jogging, or cultural activities [1,2]. In the U.S. these programs are called Open Street programs [3]. By encouraging the use of public space for recreation, the CR has multiple benefits including physical activity promotion, social capital development, improvement in the population's quality of life, and reduction in air pollution and street noise [2].

Since the first CR began in the 1960s, these programs have gradually spread across the world with the highest growth taking place after the year 2000 [2,4]. Currently, CRs are implemented in at least 490 cities of 24 countries in all continents where the fastest expansion takes place in the region of the Americas [4].

Given the multiple benefits of the CR programs and their rapid growth, representatives of the CR Network of the Americas (CRA) and the Pan American Health Organization (PAHO) have highlighted the necessity of a model for classifying these programs according to their quality and efficiency. Measuring indicators that allow for the classification of these programs according to their quality and efficiency is a crucial element for strengthening CR programs.

In this context, this study proposes a methodology based on Data Envelopment Analysis (DEA) to measure the programs' relative efficiencies. Based on this methodology, it is possible to continuously evaluate different programs and compare them within their benchmark peers [5]. Furthermore, this tool will be useful for the members of the CRA, and program coordinators to understand the sources of good practices in order to set the goals to improve the CR programs. Finally, the study proposes a Decision Support System (DSS) design based on the developed models through an interface platform, which provides tailored services to the evaluator to assess the CR programs.

The remainder of this paper is organized as follows. In Section 2,

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An Engineering View for Social Systems: Agency as an Operational Principle for Designing Higher Education Access Policies

Adriana Díaz;
Camilo Olaya;

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ORIGINAL PAPER

An Engineering View for Social Systems: Agency as an Operational Principle for Designing Higher Education Access Policies

Adriana Díaz[1] (iD) · Camilo Olaya[1]

Abstract Access to higher education (HE) has been a persistent concern for governments, practitioners and researchers. Access to HE has been widely studied from scientific perspectives that have focussed on the factors that contribute to the problem; however, authors have highlighted the need for systemic and design perspectives on education systems. The need to connect research with policy remains one of the most challenging issues for education researchers. In view of this gap, this paper argues that engineering thinking and methods represent an opportunity for the design of HE access policies because engineering rationality (distinct from scientific rationalities) matches the concerns and goals of any policymaking attempt. Engineers design artefacts to meet particular goals. These artefacts are artificial systems, tangible or intangible, such as hammers, bridges or whole organizations, which are designed in particular contexts to meet precise goals. Policies for access to HE are good examples of artefacts that seek to fulfil specific needs under concrete constraints inherent to a country or region. More specifically, HE systems are *social systems*; in other words, they are created and recreated by the interactions and decisions of diverse actors. Hence, to change, redesign or improve such types of systems involves engineering their very interactions that are the outcomes of institutional and human actions. In particular, engineering design requires operational principles. Thus, we propose *agency* as a fundamental design concept for the improvement of HE systems, which opens new possibilities for a distinct type of policy-making that takes excellent advantage of what engineering can offer, while at the same time expanding on traditional expectations for engineering.

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Adaptive Large Neighborhood Search Algorithm for the Rural Postman Problem with Time Windows

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Networks

Adaptive Large Neighborhood Search Algorithm for the Rural Postman Problem with Time Windows

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The *rural postman problem with time windows* is the problem of serving some required edges with one vehicle; the vehicle must visit these edges during established time windows. This article presents a competitive *adaptive large neighborhood search algorithm* to solve the problem. Computational experiments are performed on a large set of instances with up to 104 required edges. The results show that this approach is efficient, significantly reducing the computational time on large instances and achieving good solutions: the algorithm is able to solve to optimality 224 of 232 instances. © 2017 Wiley Periodicals, Inc. NETWORKS, Vol. 000(00), 000–000 2017

1. INTRODUCTION

Winter road maintenance includes all the operations that aim at the removal or reduction of snow and ice on roadways providing safe winter driving conditions and safe sidewalks for pedestrians. Spreading chemicals and abrasives, plowing roadways and sidewalks, loading snow into trucks, and ice control are some examples of operations to maintaining the safety and the mobility in cities and rural areas. The complex operations, the infrastructure constraints, especially in urban areas, and the dynamic nature of the operating conditions make the winter road maintenance a challenge and costly work for many governments and transportation agencies in North America. For example, in Ontario, the total expenditures in highway winter maintenance reached $171 million in the 2013 fiscal year [15]. The New Jersey Department of Transportation reported that it spent a record $138 million to keep state roadways clear of snow and ice for 2013 [29]. The Pennsylvania Department of Transportation, which had $189.2 million budgeted for the 2013–2014 winter, spent $284 million [29].

Winter maintenance authorities are constantly seeking for technology-based solutions such as advanced road weather information systems for monitoring localized weather and road surface conditions, automated vehicle location and Global Positioning System for tracking fleet operations and performance [7]. However, to obtain a great benefit from these technologies, the integration with algorithms that support the decisions and plans in operational, strategic and tactical level is necessary.

Perrier et al. [18–21] present a comprehensive review of models and algorithms developed for the variety of winter road maintenance operations. This work is divided into four surveys. The first one focuses on optimization models and solution algorithms for the design for spreading and plowing. The second one discusses system design problems for snow disposal operations. The last two address vehicle routing, depot location, and fleet sizing models for winter road maintenance.

Later, Perrier et al. [17] provide a survey of recent optimization models and solution methodologies for the routing of spreading operations. They present a detailed classification scheme for spreader routing models developed over the past 40 years. They emphasize that the new models

Market-Level Effects of Firm-Level Adaptation and Intermediation in Networked Markets of Fresh Foods: A Case Study in Colombia

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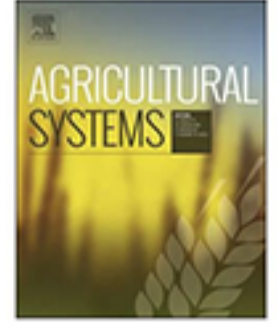
Market-level effects of firm-level adaptation and intermediation in networked markets of fresh foods: A case study in Colombia

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ABSTRACT

This paper presents a multi-agent simulation that studies market competition in a multi-stage negotiation with both direct sales and intermediation, in the presence of cost heterogeneity at the agent (i.e., producer) level. Producers sell their products according to an adaptive reinforcement strategy. Product is sold to clients (small shops and consumers) according to two types of marketplaces, which are characterized by whether they obtain the product from intermediaries or directly from producers. The model is applied to the case of a networked market of potato (*Solanum tuberosum*) producers in Bogotá, Colombia, and calibrated to real data. The results reveal that, contingent upon the number of producers, number of intermediaries, unit transportation cost and producers' culture, intermediation might lead to greater traded quantities than sales through farmers' (local) markets. Also, we found that increasing the intensity of competition among intermediaries is at odds with the increase of producers' long run profit. Thus, we conclude that intermediation still plays an important role to maintain the supply ecosystem, especially when transportation costs are important in a network of isolated and fragmented network of producers.

1. Introduction

In recent years, worldwide interest in food security has grown given its importance for the urban population. In developing countries, food security depends greatly on the supply chain of fresh foods having distinct characteristics from other supply chains (Aragrande and Argenti, 2001; Poulton et al., 2010): (1) A large number of small and fragmented producers rely on intermediation for market access: (2) In many cases, the product cannot be inventoried because refrigeration is expensive and not suitable for all products. (3) Information on real-time market prices does not exist. (4) Quality and prices vary from source to source. (5) A variety of trading channels exists, namely direct sales, auctions, intermediation, and contracts complicating aggregation and economies of scale. And (6) supply and demand are highly seasonal.

Intermediation distinguishes the supply of fresh foods in first world countries from developing countries. This has always seemed as "evil" and for a good reason: intermediation raises the prices without adding value to the product, significant losses occur due to handling/transport (Balaji and Arshinder, 2016), traceability disappears, and some intermediaries monopolize the trade with obvious consequences (Aysoy et al., 2015). However, several authors disagree with that belief: Gabre-Madhin (1999) claims that intermediation is critical to market performance as it circumvents the issue of long distance trade with unfamiliar partners; Abebe et al. (2016) point out that middlemen play an important role by linking farmers to traders in fragmented supply chains consisting of several stages. Rodríguez and Neira (2008) reached a similar conclusion studying the trade and transport of milk and rice in Peru.

Intermediation, in general, has received great attention from theoretical perspectives. Influential papers, such as those of Rubinstein and Wolinsky (1987), Biglaiser and Friedman (1999), Spulber (1996) and Hendershott and Zhang (2006), have shown that despite its dubious role, intermediation helps shorten negotiation times, matches customers with vendors, and reduces transaction costs. Major differences exist between intermediation (brokerage) as studied in the above papers and intermediation in the fresh food supply chain in developing countries. First, most brokers act as trade facilitators who charge a transaction fee but they do not own the product; intermediaries in the fresh food trade, purchase the product and re-sell it. Second, brokers match customers with vendors, not the case in the fresh food trade. And third, the brokerage has little to do with the social network, as opposed to the fresh food trade in developing countries.

Several empirical works have studied intermediation in food supply chains in developing countries in regard to competition effects and

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