M&SOM MANUFACTURING & SERVICE OPERATIONS MANAGEMENT
Vol. 15, No. 1, Winter 2013, pp. 159–162
ISSN 1523-4614 (print) | ISSN 1526-5498 (online)

informs

http://dx.doi.org/10.1287/msom.1120.0427

MSOM Society Student Paper Competition: Abstracts of 2012 Winners

The journal is pleased to publish the abstracts of the six finalists of the 2012 Manufacturing and Service Operations Management Society's student paper competition.

The 2012 prize committee was chaired by Gad Allon (Kellogg School of Management, Northwestern University), Omar Besbes (Graduate School of Business, Columbia University), and Gabriel Weintraub[1] (Graduate School of Business, Columbia University). The other committee members were Philipp Afèche, Aydın Alptekinoğlu, Atalay Atasu, Göker Aydın, Opher Baron, Damian Beil, Kostas Bimpikis, Metin Çakanyıldırım, Felipe Caro, Carri Chan, Li Chen, Ying-Ju Chen, Xin Chen, Soo-Haeng Cho, Laurens Debo, Nicole DeHoratius, Sarang Deo, Karen Donohue, Cheryl Druehl, Qi Feng, Noah Gans, Vishal Gaur, Manu Goyal, Xinxin Hu, Ming Hu, Tim Huh, Dan Iancu, Özge İşlegen, Srikanth Jagathabula, Ganesh Janakiraman, Elena Katok, Diwas KC, Eda Kemahlioğlu-Ziya, Saravanan Kesavan, Sang Kim, Harish Krishnan, Qian Liu, Ilan Lobel, Ruben Lobel, Lauren Lu, Victor Martínez-de-Albéniz, Adam Mersereau, Toni Moreno-Garcia, Alp Muharremoglu, Hamid Nazerzadeh, Rodney Parker, Ali Parlakturk, Margaret Pierson, Ramandeep Randhawa, Justin Ren, Guillaume Roels, Paat Rusmevichientong, Amar Sapra, Denis Saure, Glen Schmidt, Kevin Shang, Enno Siemsen, Melvyn Sim, Amitabh Sinha, Greys Sošić, Xuanming Su, Ravi Subramanian, Robert Swinney, Alireza Tahbaz-Salehi, Brian Tomlin, Senthil Veeraraghavan, Owen Wu, Wenqiang Xiao, Xiaowei Xu, Nan Yang, Fuqiang Zhang, Jiawei Zhang, Yao Zhao, Karen Zheng, Shaohui Zheng, and Leon Zhu.

The 2012 prize winners are as follows:

Two First Prizes

Yina Lu, Columbia University
"Measuring the Effect of Queues on Customer Purchases"

Soroush Saghafian, Arizona State University
"Complexity-Based Triage: A Tool for Improving Patient Safety and Operational Efficiency"

Finalists

Buket Avci, INSEAD
"Electric Vehicles with a Battery Switching Station: Adoption and Environmental Impact"

Bar Ifrach, Stanford University
"Monopoly Pricing in the Presence of Social Learning"

Sang Won Kim, Columbia University
"Measuring the Performance of Large-Scale Combinatorial Auctions: A Structural Estimation Approach"

Emre Nadar, Bilkent University
"New Functional Characterizations and Optimal Structural Results for Assemble-to-Order *M*-Systems"

[1] Gabriel Weintraub withdrew from the process after the first round due to a conflict of interest.

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Measuring the Effect of Queues on Customer Purchases

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Capacity decisions in service operations often involve a trade-off between the operating cost and the service level offered to customers. Although the cost of attaining a prespecified service level has been well studied, there is not much research studying how customer service levels affect revenue and profit. This paper conducts an empirical study to analyze how waiting in queue in the context of a retail store affects customer purchasing behavior. Our methodology uses a novel technology based on digital imaging to record periodic information about the queuing system. Our econometric method uses queuing theory combining these data with point-of-sales information to estimate the effect of queues on purchases. We find that waiting in queue has a nonlinear impact on purchase incidence and that customers appear to focus mostly on the length of the queue, without adjusting enough for the speed at which the line moves. We also find that customers' sensitivity to waiting is heterogeneous and negatively correlated with price sensitivity. These empirical findings have important implications for service design, staffing, and pricing. First, pooling multiple queues into a single queue may increase the length of the queue observed by customers and thereby lead to an increase in lost sales. Second, the model can be used to make staffing decisions, balancing labor costs with revenues. Third, we show that the relationship between price and waiting sensitivity is an important factor for pricing decisions in a multiproduct category when congestion effects are present.

Complexity-Based Triage: A Tool for Improving Patient Safety and Operational Efficiency

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Most hospital emergency departments (EDs) use urgency-based triage systems that classify and prioritize the majority of patients almost exclusively in terms of their need for timely care. We demonstrate that this is less effective than an augmented ED triage system that adds an up-front estimate of patient complexity to the conventional urgency-based classification. Using a combination of analytic and simulation models calibrated with hospital data, we show that complexity-based triage can substantially improve both patient safety (by reducing the risk of adverse events) and operational efficiency (by shortening the average length of stay). We also investigate the priority rules that can harness the complexity information. We show how triage misclassification error rates can be taken into account to provide effective priority guidelines that resemble extensions of the $c\mu$ rule. Moreover, we find that EDs with high resource (physician and/or examination room) utilization, high heterogeneity between the average treatment time of simple and complex patients, and a relatively equal split between simple and complex patients benefit most from the proposed complexity-based triage system. Finally, we draw some insights about implementation of complexity-based triage: (1) While misclassification of a complex patient as simple is slightly more harmful than vice versa, complexity-based triage is robust to misclassification error rates as high as 25%. (2) Streaming patients based on complexity information and prioritizing them based on urgency is better than doing the reverse. (3) Separating simple and complex patients via streaming facilitates the application of lean methods that can further amplify the benefit of complexity-based triage information.

Electric Vehicles with a Battery Switching Station: Adoption and Environmental Impact

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Widespread adoption of electric vehicles can limit the environmental impact of transportation and reduce oil dependence. However, limited range and high upfront battery costs have limited consumer adoption. A novel switching-station-based solution is extensively touted as a promising remedy that resolves range anxiety. Vehicles use standardized batteries that when depleted can be switched for fully charged batteries at switching stations. Further, instead of purchasing a battery, motorists pay for miles driven. We develop a stylized analytical model that captures the key trade-offs in the adoption of electric vehicles to assess the effectiveness of this remedy. Our model uses a classical repairable item inven-

tory model to capture switching-station operation; we combine it with a principal–agent construct to capture customer adoption and usage. We find that electric vehicles with switching stations can indeed incent adoption and reduce oil dependence, but, paradoxically, this increased adoption may not necessarily benefit the environment. A profit-maximizing operator increases adoption by limiting range anxiety and marginal costs of driving, which leads motorists to increase their driving, and hence increase electricity consumption. Depending on the source of electricity, this can be more harmful to the environment than the nonadoption of electric vehicles. Further, we show that switching-station electric-vehicle adoption and driving are strategic complements; thus, any policy intervention that increases adoption will also increase driving. Using real data, we show numerically that with the current generation mix in the United States, switching-station electric vehicles would reduce oil dependence and environmental impact, but in 10 years they would be harmful to the environment. Further, well-intended policy interventions such as battery purchase subsidies, and seemingly helpful battery technology advances, can actually be harmful to the environment.

Monopoly Pricing in the Presence of Social Learning

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A monopolist offers a product to a market of consumers with heterogeneous quality preferences. Although initially uninformed about the product quality, they learn by observing past purchase decisions and reviews of other consumers. Our goal is to analyze the social learning mechanism and its effect on the seller's pricing decision. Consumers follow an intuitive non-Bayesian decision rule and, under some conditions, eventually learn the product's quality. We show how the learning trajectory can be approximated in settings with high demand intensity via a mean-field approximation that highlights the dynamics of this learning process, its dependence on the price, and the market heterogeneity with respect to quality preferences. Two pricing policies are studied: a static price and one with a single price change. Finally, numerical experiments suggest that pricing policies that account for social learning may increase revenues considerably relative to policies that do not.

Measuring the Performance of Large-Scale Combinatorial Auctions: A Structural Estimation Approach

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Advisors: Marcelo Olivares, Columbia University; Gabriel Weintraub, Columbia University

The main advantage of a procurement combinatorial auction (CA) is that it allows suppliers to express cost synergies through package bids. However, bidders can also strategically take advantage of this flexibility, reducing the performance of the auction. In this paper, we develop a structural estimation approach for large-scale first-price CAs. We use bidding data to estimate the firms' cost structure and evaluate the performance of the auction in terms of the cost efficiency of the allocation and payments to the bidders. To overcome the computational difficulties arising from the large number of bids observed in large-scale CAs, we propose a novel simplified model of bidders' behavior where markups of each package bid are chosen based on a reduced set of package characteristics. We apply our method to the Chilean school meals auction, in which the government procures half a billion dollars worth of meal services every year and bidders submit thousands of package bids. Our estimates suggest that bidders' cost synergies are economically significant in this application, and the current CA mechanism achieves high allocative efficiency and a reasonable procurement cost. We also perform counterfactuals to compare the performance of the current CA with alternative mechanisms such as VCG (Vickrey-Clarke-Groves).

New Functional Characterizations and Optimal Structural Results for Assemble-to-Order *M*-Systems

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We consider an assemble-to-order *M*-system with multiple components and multiple products. An *M*-system involves a single "master" product that uses multiple units from each component, and "individual" products that each consume multiple units from one component. Each component is produced in a make-to-stock fashion in batches of fixed size, determined by individual product sizes. Production

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times are independent and exponentially distributed. Demand for each product arrives as an independent Poisson process. If not satisfied immediately upon arrival, demands are lost. We model the system as an infinite-horizon Markov decision process and seek an optimal policy that specifies when a batch of components should be produced (i.e., inventory replenishment) and whether an arriving demand for each product should be satisfied (i.e., inventory allocation). We introduce new functional characterizations for convexity and submodularity with respect to certain nonunitary directions. These help us characterize optimal inventory replenishment and allocation policies: We define a new type of policy, *lattice-dependent base-stock and lattice-dependent rationing* (LBLR), and show it is optimal for both the discounted and average cost cases. An LBLR policy is also optimal when (i) some components are not demanded individually and their replenishment batch sizes are chosen arbitrarily, and/or (ii) each product is requested by multiple demand classes. We also have some restricted results: A lattice-dependent *base-stock* policy remains optimal when customer orders for any product are independent compound Poisson process; and a lattice-dependent *rationing* policy remains optimal when the possible replenishment quantities for any component are integral multiples of the size of the corresponding individual product.