

Work Shift Generation In The Operation Of A Bus Rapid Transit System

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Abstract

Generation of work shifts is an important issue in Bus Rapid Transit Systems, due to the impact caused by the costs of hiring drivers to carry out the routes. The generation of shifts consists of putting together work schedule blocks, in order to cover the operation of the routes specified by the transport system, in this case, the routes of the Colombian West-Center Metropolitan Area. To solve this problem, a two-phase solution methodology was proposed, based on a Column Generation Algorithm that combines the work blocks, minimizing the number of shifts. The Table 1 presents a comparison of the results obtained with the manual programming and the proposed methodology in real-world instances (Megabús, Colombia). The Table 1 also shows that the methodology reaches feasible solutions in reasonable computing times, and outperforms all the proposed solutions by skilled practitioners, decreasing the total number of shifts. Moreover, the algorithmic solution allows the coordinators to focus in the contingencies presented during the operation of the massive transit system; as shown in Table 1, a task requiring approximately 8 hours of coordinator's work (feeder and main routes), the methodology schedules the daily operation in 8 minutes. Note that the algorithm generates less work shifts than the manual programming, reducing the operational costs of the company. Additionally, the number of mixed shifts is also reduced, a scenario where drivers with the most expensive license (C3), will be scheduled for services requiring only C2 license.

	Manual Programming		Methodology	
	Feeder Routes (C2 license)	Main Routes (C3 license)	Feeder Routes (C2 license)	Main Routes (C3 license)
Number of services	3459	892	3459	892
One block shifts	0	0	1	0
Two block shifts	68	46	64	41
Three block shifts	1	3	5	8
Mixed shifts	-	4	-	0
Number of drivers	69	53	70	49
Computing time (s)	14400	14400	300	180
Total number of shifts	122		119	

Table 1. Comparison between Manual Programming and the Proposed Methodology.

Keywords

Bus Rapid Transit, Column Generation and Work shift Generation

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Biographies

Daniel Esteban Cortés has a degree in Industrial Engineering from the University of Los Andes, Bogotá, Colombia (2019) and he is currently doing his M.Sc. in Operations Research at the same university. He is currently doing applied research on Integra S.A., operator of the BRT system in Pereira Colombia. He has experience in logistics and scheduling problems.

David Álvarez-Martínez is an Associate Professor, his main scientific activity area is Operation Research and Computer Sciences. Within Operations Research David focuses on the problems modeling, solution and application related to supply chain management, manufacturing and production, logistics and transport, as well as cutting stock problem, staff recruitment, goods packaging, vehicle routing, among others. From a technical point of view, David's research focuses on specialized software development, through the use and development of accurate and approximate optimization methods. Profile: Postdoctoral Fellow, Applied Optimization Systems Group, Polytechnic University of Valencia - UPV (Spain); Ph.D. in Electrical Engineering (Automation Science), São Paulo State University - UNESP (Brazil); M.Sc. in Electrical Engineering (Computer Science), Technological University of Pereira - UTP (Colombia) and B.Sc. in Systems and Computer Engineering, Technological University of Pereira - UTP (Colombia).

César Augusto Marín-Moreno is the Manager of the R+D+i department at Integra S.A, the operator of the massive transit system in the city of Pereira, Colombia. He recently completed his Ph.D. in the Technological University of Pereira (2019), working problems oriented to Tactical and Operational Planning. He is expert in project formulation and PMP certified.

Rubén Iván Bolaños. is currently the Development Coordinator of Integra S.A. Ph.D. student at the Technological University of Pereira, working Vehicle and Crew Scheduling Problems, and Rostering for BRT (Bus Rapid Transit) operators.

Luis Miguel Escobar-Falcón has a degree in Computer Science Engineering (2007) and a M.Sc. degree in Electrical Engineering (2012) from the Technological University of Pereira, Colombia. He has a Ph.D. in Engineering (2019) in the same university, having his abroad period in the University of Bio-Bio, Chile and the University of Bologna, Italy (2016). Currently is the Research Coordinator of Integra S.A, operator of the Bus Rapid Transit System of Pereira, Colombia, and Professor in the Program of Systems Engineering of The Free University in the same city. Has experience working and implementing solutions for operations research problems such as Packing Problems, Vehicle Routing Problems and Scheduling Problems.

Kenny Cárdenas Parra has a degree in Industrial Engineering from the Technological University of Pereira, Colombia (2019) and he is currently doing his M.Sc. in Operations Research at the same university. He is currently one of the main researchers in the Group TransFÓRMATE, which belongs to Integra S.A., operator of the BRT system in Pereira Colombia. He has experience in scheduling and rostering problems for bus drivers.