Journal of Operations Management 44 (2016) 1–12

Contents lists available at ScienceDirect

Journal of Operations Management

journal homepage: www.elsevier.com/locate/jom

Fleet management policies for humanitarian organizations: Beyond the utilization–residual value trade-off

Mahyar Eftekhar [a], Luk N. Van Wassenhove [b, *]

[a] Supply Chain Management, W.P. Carey School of Business, ASU, PO Box 874706, Tempe, AZ 85287-4706, USA
[b] Technology and Operations Management, INSEAD, Boulevard de Constance, Fontainebleau, 77305, France

ARTICLE INFO

Article history:
Received 20 September 2013
Received in revised form
3 February 2016
Accepted 17 March 2016
Available online 24 May 2016

Keywords:
Fleet management
Humanitarian development programs
Empirical analysis
Trade-off

ABSTRACT

Four-wheel drive vehicles play a pivotal role in securing the last-mile distribution of goods and services in humanitarian development programs. To optimize the use of their fleets, humanitarian organizations recommend policies aimed at enhancing the utilization of vehicles while preserving residual value. Although these decisions have a significant impact on cost, there is limited empirical evidence to show that the recommended policies are actually implemented and that they produce the expected benefits. This paper theoretically and empirically examines the complex and inter-related effects of vehicle-to-mission allocation decisions and of alternative vehicle usage patterns on vehicle utilization and residual value in humanitarian development programs. The results suggest that humanitarian organizations could break the utilization–residual value trade-off by adopting different policies than the ones currently in place. They also reveal that organizations need to realize that what seems logical from the headquarters' perspective may be illogical or inconvenient for the field, and as a result, the field may do the opposite of what is recommended or even instructed. Therefore, they either need better data and analysis combined with audits or they need to improve mechanisms that incentivize field delegations to follow standards recommended by the headquarters.

1. Introduction

In humanitarian development programs, the delivery of humanitarian services to beneficiaries, known as last-mile distribution (LMD), is one of the most critical operations (Balcik et al., 2008). The centerpiece of LMD is the vehicle, which is used to transport food, materials, and humanitarian workers. LMD typically requires large and expensive fleets (Apte, 2009) whose management presents several operational challenges: Purchasing the right quantity of vehicles with features appropriate to the typically substandard road networks, allocating them to different types of missions, and reselling used vehicles before they become too old are all important decisions that affect both LMD performance and cost.

These challenges are further amplified by the difficult environmental conditions in which humanitarian organizations (HOs) operate and by their distinct decision-making processes. In most HOs, fleet management policies are set centrally by the headquarters (HQ) but are implemented locally by sub-delegations (i.e., operating units located close to beneficiaries that are directly confronted by local problems such as civil conflicts, rugged terrain, or a lack of infrastructure). Because HQs often have limited visibility related to local operations, policies and vehicle allocation rules are often set with little understanding of field issues, and may not be followed in practice. Therefore, information asymmetries and incentive misalignment problems induce sub-delegations to deviate from the HQ's recommendations and policies.

HOs have an obvious interest in utilizing their vehicles as much as possible to maximize demand coverage and the number of missions they perform. However, as HOs resell vehicles at the end of their operational life, overutilizing these vehicles may reduce their recovery value and consequently reduce the budget available for future operations, thereby indirectly affecting future service levels. Therefore, the trade-off between utilization and residual value is clear. The following three decisions at the core of any fleet management policy affect the utilization–residual value trade-off: (1) how to assign vehicles to different types of missions, (2) how to modify a vehicle's utilization over its operational life (i.e., how to identify a vehicle's optimal usage trend), and (3) when to replace a used vehicle with a new one.

* Corresponding author.
E-mail addresses: eftekhar@asu.edu (M. Eftekhar), luk.van-wassenhove@insead.edu (L.N. Van Wassenhove).

http://dx.doi.org/10.1016/j.jom.2016.03.008
0272-6963/

HQs typically recommend policies based on their a priori estimate of the presumed effect of the different operational decisions on vehicle utilization and residual value, often under the assumption that these objectives cannot be attained together. However, to implement policies that enable HOs to achieve both goals, they need to understand the causes of the loss of vehicles' resale value and the parameters that affect the utilization of vehicles during their life cycle. To the best of our knowledge, there is a surprising lack of empirical research that examines the mechanisms through which operational decisions affect the utilization and the residual value of vehicles and validates these policies. Moreover, there is insufficient evidence to show that the policies are actually implemented. The present paper, which is one of the first attempts to conduct a rigorous empirical analysis of fleet management processes at the field level, aims to fill this research void.

In this paper, we quantify the specific impact of operational decisions on utilization and residual value to identify why and where trade-offs originate. We address these questions empirically by analyzing the fleet management operations from 2000 to 2014 of one of the largest international HOs in four countries representative of its operational environment. We first examine the allocation rules used to assign vehicles to missions and analyze the impact of different types of missions on residual value. In addition, we consider the impact of different usage trends on vehicle utilization, accident rate, and residual value. Furthermore, we analyze whether the standard vehicle replacement policy recommended by most HOs is effective and comprehensive. Finally, our analysis clarifies the nature of utilization–residual value trade-off and examines its root causes.

This study makes several contributions to the humanitarian operations literature. First, it challenges the validity of the policies currently in place in many organizations. The results provide evidence of counterintuitive allocation rules and demonstrate that the vehicle usage policy recommended by HQs is not properly followed by sub-delegations. Moreover, they reveal that organizations need to realize that what seems logical from the HQ's perspective may be illogical or inconvenient for the field, and as a result, the field may do the opposite of what is recommended or even instructed. Therefore, they either need better data and analysis combined with audits or they need to improve mechanisms that incentivize field delegations to follow standards recommended by the HQ. Finally, the paper brings the trade-off perspective into the humanitarian context. While trade-offs between competitive priorities have been extensively analyzed for manufacturing and service operations, their role in the humanitarian framework is still not fully understood. This paper reveals that humanitarian vehicles are also subject to the utilization–residual value trade-off, but only when they are kept in the fleet for a long time, regardless of their cumulative mileage. This implies that well-designed fleet management policies that intensively utilize new vehicles can help HOs to avoid trade-offs, whereas the common practice of adopting a decreasing usage trend as the vehicle ages does not have a positive impact on utilization, nor does it preserve residual value.

The rest of the paper is organized as follows: In §2, we review the relevant literature on humanitarian fleet management. In §3, we develop testable hypotheses, while in §4, we describe the methodology, including the data collection process and the econometric model employed. Furthermore, §5 presents the results and some managerial insights, and finally, §6 explains the limitations of this study and suggests avenues for further research.

2. Literature review

In recent years, humanitarian logistics has generated considerable interest in the MS/OR research community. Many humanitarian scholars have focused on LMD in particular due to its complexity and potential impact on beneficiaries (Whiting and Ayala-Ostrom, 2009). Attention has been dedicated to questions at the strategic level, for example, by studying facility location and resource allocation problems (Barbarosoglu et al., 2002; Balcik and Beamon, 2008); at the tactical level, for example, by addressing delivery and distribution questions (Tzeng et al., 2007; Balcik et al., 2008; Kula et al., 2012; McCoy and Lee, 2014); and at the operational level, for example, by focusing on emergency response and operations scheduling (Simpson, 2006; Ingolfsson et al., 2008). The literature, however, has predominantly emphasized on relief operations (Malini et al., 2009).

Specifically considering the nascent, but steadily growing, literature on development programs, fleet management problems have received comparatively less attention. In this domain, decisions involve two general areas, as follows: "procurement" (e.g., determining fleet size) and "fleet management at the field level" (e.g., optimizing the use of vehicles after they have been purchased). Procurement problems have attracted a few recent studies. For example, Besiou et al. (2014) examine the relationship between the HOs' mandate and different fleet management structures (i.e., centralized, hybrid, and decentralized) to identify the structure that maximizes procurement effectiveness. Fleet sizing decisions for development programs have been considered both at the macro- and micro-level. At a macro-level and focusing on a centralized procurement model, Eftekhar et al. (2014) propose an optimal fleet vehicle procurement policy. Combining empirical analysis and analytical modeling, they study how to efficiently build fleet capacity over time for different demand requirements in the absence of detailed data. At a micro-level, Pedraza Martinez and Van Wassenhove (2013) determine an optimal vehicle replacement policy that minimizes HOs' fleet costs. In the first stage, they conduct an empirical study to identify the main drivers of vehicles' maintenance cost and residual value. Accordingly, they develop a dynamic programing model to determine the optimal policy. Pedraza Martinez et al. (2011) use a case-based approach to study field vehicle fleet management in four large HOs. They explain how HOs manage their vehicle fleets and depict the key elements that affect the objectives of HOs' field fleet management.

Although fleet management at the field level contributes to 50% of total fleet costs (Pedraza Martinez et al., 2011), the academic literature has so far offered limited guidance to HOs willing to optimize their fleet management at this level. By the same token, most research articles in humanitarian operations have taken a modeling approach, whereas empirical research is still scant (Altay and Green, 2006; Simpson and Hancock, 2009), primarily because of the difficulty in gathering reliable field data from sub-delegations; thus, it should be further developed, at least to validate the normative prescriptions from analytical models.

The contributions of this paper are twofold. First, it considers vehicle-to-mission assignment policy, vehicle usage patterns, and vehicle utilization–residual value trade-off, which have not been studied in the context of humanitarian logistics. Second, it provides a comprehensive empirical analysis of fleet performance, producing robust estimates of the variables influencing vehicle utilization and residual value. As most of the modeling papers in this area assume ad hoc values for critical variables, the results of this study can be successfully used to prime and validate these models. In addition, given the need for standardization in the humanitarian sector, the results of this study can shed further light on how vehicles should be effectively and efficiently utilized in the field.

It is worth noting that in transportation and economic literature, there are empirical studies that consider vehicle utilization and residual value. The drivers of vehicle utilization–often defined as "total miles driven"–are considered in Dargay (1997), Golob (1998),