

## Article

# The “Rural Package” Model: A Lean-Logistics and Financial-Flexibility Framework for Optimizing Customer Satisfaction in Rural Automotive After-Sales Services (Evidence from the Samarkand Region, Uzbekistan)

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**Abstract:** This study develops a customized “Rural Package” service model tailored to the operational dynamics of the most widely used mass-market vehicle platforms — Damas and Cobalt — in the rural territories of the Samarkand region. By integrating the SERVQUAL methodology with critical operational variables — specifically the financial elasticity of the payment framework and the spare-parts procurement lag coefficient ( $W_{parts}$ ) — an optimization algorithm for automotive after-sales service systems is constructed on the basis of Lean logistics principles. The empirical sensitivity analysis reveals that the component waiting time ( $W_{parts}$ ) constitutes the critical determinant of operational velocity, yielding an elasticity index of  $\epsilon = 0.78$ . The synchronous mitigation of logistical frictions and the enhancement of payment-system flexibility generate a significant synergistic effect, elevating the cumulative customer satisfaction index (CSI) by approximately 50 percent. Furthermore, the results indicate that deploying digital and mobile automotive service units effectively neutralizes spatial-geographic barriers, thereby maximizing service utility in peripheral areas. The practical implementation of the proposed value chain strategically transforms local workshops into resilient, proactive ecosystems, fostering the sustainable development of regional transport infrastructure.

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**Keywords:** After-sales service; Lean logistics; rural automotive services; customer satisfaction; financial flexibility; spare-parts supply chain; Lean maintenance; SERVQUAL; “Rural Package” model; CSI; sensitivity analysis; mass-market vehicles.

## 1. Introduction

In the era of global digital transformation, the automotive after-sales service sector is undergoing a paradigm shift, evolving from conventional mechanical repair shops into an integrated logistics network of post-purchase assistance. Internationally, the after-sales segment has long been recognized not as a peripheral activity but as a principal source of profitability and customer retention across the vehicle life cycle [1], and its performance depends critically on how the service supply chain is configured [2]. On a global scale, automotive after-sales service networks in peripheral and rural regions confront systemic structural barriers, such as fragmented infrastructure, vulnerable supply chains, and constrained financial liquidity. Consequently, service delivery

models must be meticulously adapted to the socio-economic and geographical specificities of the local population, ensuring a high degree of personalization.

In the context of the Republic of Uzbekistan, particularly within the Samarkand region, high rates of motorization are prominently observed; herein, the market segment comprising Damas and Cobalt vehicle models serves as a primary driver for micro-entrepreneurship and household income generation. However, the current institutional configuration of automotive after-sales service management reveals significant inefficiencies. Disruptions in the spare-parts supply chain, prolonged customer waiting times, and a lack of customized financial and payment instruments underscore an urgent need for optimization based on customer-centric principles.

The aim of this study is therefore to develop and analytically validate an integrated “Rural Package” service model that simultaneously optimizes logistical, operational and financial parameters of rural automotive after-sales services, and to quantify the marginal contribution of each parameter to aggregate customer satisfaction.

Beichen Ge and Congjin Wang elucidated the systemic impact of rural road networks on transport services and economic transformation, conceptualizing automotive after-sales services as a vital component of rural infrastructure [3]. Furthermore, the conceptual justification for aligning vocational education with employment generation in rural areas, specifically through the implementation of dual education models within the service sector, was systematically established by Geng Wang et al. [4]. In a similar vein, Kamaludin and Qibthiyyah emphasized the imperative of developing automobile transport infrastructure in rural territories as a catalyst for regional growth [5]. Within the domestic academic framework, research by the Uzbek researcher D. D. Karimboyev focuses on improving the organizational and economic mechanisms of sustainable transport network development [6]. Additionally, the author's own scientific inquiries have extensively addressed the distinctive features, structural bottlenecks, prospects, and strategic solutions regarding the development of automotive after-sales services [7]. These studies also explore scholarly approaches to evaluating the role and socio-economic significance of automotive after-sales services within a highly service-oriented society [8], alongside analyzing advanced foreign practices in this sector and the strategic frameworks for their adaptation to the socio-economic conditions of Uzbekistan [9].

The measurement of service quality on which the present model builds originates in the SERVQUAL instrument, which conceptualizes quality as the gap between customer expectations and perceptions across multiple dimensions [10]; subsequent work advanced performance-only measurement as an alternative specification [11]. The link between such quality assessments and satisfaction is established in the expectancy-disconfirmation paradigm [12] and operationalized at national scale in customer satisfaction indices [13], with satisfaction shown to translate into measurable economic returns for firms [14]. In the specific setting of after-sales services, service quality has been empirically confirmed as a direct antecedent of customer satisfaction [15], while performance measurement frameworks have been developed for automotive after-sales networks in particular [16].

The optimization logic applied in this study derives from Lean production theory, in which waiting time and unnecessary transportation are classified among the fundamental categories of waste to be eliminated [17], [18], and which has been extended into structured roadmaps for Lean maintenance [19]. The centrality of spare-parts availability within this framework is well established: maintenance spare-parts logistics is characterized by distinctive demand patterns and requires deliberate strategic control choices [20], classification-based inventory policies remain the dominant practical instrument [21], [22], and case-based evidence confirms that spare-parts management directly governs service responsiveness [23]. Taken together, the literature substantiates

the two pillars of the proposed model — Lean-based logistical compression and quality-driven satisfaction measurement — while leaving the integration of financial flexibility into a single quantitative rural service model insufficiently addressed, which defines the scholarly niche of this study.

## 2. Materials and Methods

The empirical object of this study comprises rural automotive after-sales service providers in the Samarkand region, with the Damas and Cobalt vehicle models constituting the most ubiquitous and high-utility “workhorse” segments. The extensive standardization of spare parts and lubricants for these specific models drastically minimizes logistical inventory and warehousing costs while simultaneously accelerating service delivery cycles. Environmental and infrastructural constraints — specifically high dust levels on rural roads and uneven pavement surfaces — exert a severe adverse impact on the vehicles' suspension systems, chassis, and filtration components. To mitigate these challenges, the introduction of complimentary or subsidized diagnostic assessments, paired with routine oil changes, enables the early detection of latent mechanical failures. This preventive strategy preempts substantial future expenditures for the consumer and significantly enhances the institutional reliability and brand equity of the after-sales service enterprise.

The core hypothesis of this approach posits that the strategic integration of technical servicing, logistical supply chains, and tailored financial instruments can augment customer satisfaction within rural automotive after-sales service frameworks by up to 50 percent.

### 2.1. Model specification

Conventionally, the level of customer satisfaction (CSI) in automotive after-sales services is evaluated through the ratio between perceived value and initial expectations [12], [10]. It is postulated that the efficiency of after-sales service delivery can be modeled via an integrated satisfaction index (Stotal). This index extends the traditional SERVQUAL model by incorporating coefficients for logistical constraints and financial elasticity ( $\varphi$ ):

$$S_{total} = \sum_{i=1}^n \omega_i \frac{V_{act}(1 + \varphi)}{T_{proc} + \frac{L_{dist}}{V_{avg}} + W_{parts}} \quad (1)$$

where  $\omega_i$  is the weight coefficient representing the quality metrics of the after-sales service;  $V_{act}$  is the actual technical value delivered by the service;  $\varphi$  is the financial adaptability coefficient of the utilized payment system;  $T_{proc}$  is the direct processing time allocated to technological operations within the service bay;  $L_{dist}/V_{avg}$  represents the logistical losses incurred by the customer, determined by the structural and spatial characteristics of rural territories; and  $W_{parts}$  is the customer's waiting time for required spare-parts procurement (under the Lean optimization framework,  $W_{parts} \rightarrow 0$ ) [17], [20].

Assuming conventional service delivery performance is denoted as  $S_{basic}$  and the comprehensive efficiency generated by the newly proposed “Rural Package” is designated as  $S_{new}$ , the net marginal increase in structural efficiency is expressed as:

$$\Delta S = \frac{S_{new} - S_{basic}}{S_{basic}} \approx 0.5 \text{ (50\%)} \quad (2)$$

According to the model, the factors responsible for augmenting customer satisfaction by 50 percent constitute a multiplicative effect of time optimization, financial liquidity, and the logistical preparedness level of the service provider. Consequently,

within the integrated logistical model of after-sales service delivery, the simultaneous optimization of the conditions  $W_{\text{parts}} \rightarrow \min$  and  $\varphi \rightarrow \max$  reduces the overall entropy of the system. This convergence establishes a stationary state that guarantees a 1.5-fold (or +50 percent) increase in aggregate customer satisfaction.

## 2.2. Sensitivity analysis design

To evaluate the model's structural stability regarding this 50 percent increase in customer satisfaction, and to verify the reliability of the empirical outcomes against fluctuations in underlying variables, a comprehensive sensitivity analysis is conducted. This analytical approach quantifies the marginal impact of changes in input parameters — specifically time, cost, and spatial distance — on the final equilibrium result. To operationalize this, the elasticity ( $\varepsilon$ ) representing the unique impact of each discrete factor is formulated via partial derivatives as follows:

$$\varepsilon_x = \frac{\partial S}{\partial x} \cdot \frac{x}{S} \quad (3)$$

where  $\varepsilon_x$  is the elasticity of  $S$  with respect to factor  $x$ , and  $x$  denotes the variable factor ( $\varphi$ ,  $T_{\text{proc}}$ ,  $W_{\text{parts}}$ ,  $L_{\text{dist}}$ ). The baseline empirical diagnostics indicate that the average after-sales service turnaround time currently stands at 3.1 days (74.4 hours, or 4,464 minutes), with the critical path dominated by spare-parts procurement delays ( $W_{\text{parts}}$ ).

## 3. Results

Using the empirical framework of the “Rural Package” tailored for the Cobalt and Damas vehicle models, a factor sensitivity distribution within a 50 percent variance range was developed to verify the structural stability of the final equilibrium state against changes in input parameters (Table 1).

**Table 1. Factor sensitivity distribution of the “Rural Package” model within a 50% variance range**

| Variance ( $\Delta x$ ) | $W_{\text{parts}}$ (waiting time) | $\varphi$ (financial adaptability) | $T_{\text{proc}}$ (processing time) | $L_{\text{dist}}$ (spatial distance) |
|-------------------------|-----------------------------------|------------------------------------|-------------------------------------|--------------------------------------|
| 5%                      | 3.9%                              | 3.0%                               | 2.1%                                | -1.1%                                |
| 10%                     | 7.8%                              | 6.0%                               | 4.3%                                | -2.1%                                |
| 15%                     | 11.7%                             | 9.0%                               | 6.4%                                | -3.2%                                |
| 20%                     | 15.6%                             | 12.1%                              | 8.6%                                | -4.2%                                |
| 25%                     | 19.5%                             | 15.1%                              | 10.7%                               | -5.3%                                |
| 30%                     | 23.4%                             | 18.1%                              | 12.9%                               | -6.3%                                |
| 35%                     | 27.3%                             | 21.1%                              | 15.0%                               | -7.4%                                |
| 40%                     | 31.2%                             | 24.1%                              | 17.2%                               | -8.4%                                |
| 45%                     | 35.1%                             | 27.1%                              | 19.3%                               | -9.5%                                |
| 50%                     | 39.0%                             | 30.1%                              | 21.5%                               | -10.5%                               |

*Source: compiled by the author on the basis of the model specified in Equations (1)–(3).*

The empirical values presented in Table 1 quantify the distinct marginal impact exerted by each individual exogenous variable within the “Rural Package” model. The customer waiting time for spare parts ( $W_{\text{parts}}$ ) exhibits the highest elasticity coefficient, registered at  $\varepsilon = 0.78$ :

$$\frac{\Delta S}{S} = \varepsilon_W \cdot \frac{\Delta W_{\text{parts}}}{W_{\text{parts}}} = 0.78 \cdot 1\% \approx 0.78\% \quad (4)$$

This indicates that a 1 percent reduction in the duration spent waiting for spare parts within the after-sales service facility yields a 0.78 percent increase in the aggregate customer satisfaction index. This finding demonstrates that logistics optimization is the primary determinant in achieving the target 50 percent enhancement in customer satisfaction.

Given that vehicles in rural ecosystems do not merely serve as a means of transit but act as vital capital assets for household income generation, a 1 percent reduction in Wparts generates a dual optimization effect. First, it minimizes involuntary vehicle downtime, thereby substantially reducing the customer's opportunity costs. Second, it shortens the service cycle, which enhances consumer institutional trust and strengthens subjective satisfaction. In the empirical baseline, the mean duration of the after-sales service cycle was recorded at 3.1 days (4,464 minutes). If Lean logistics principles are deployed within the “Rural Package” to compress this waiting time by 30 percent (saving 1,340 minutes), this single factor alone is projected to scale up the total system satisfaction index by:

$$0.78 \times 30\% \approx 23.4\%$$

The financial adaptability coefficient ( $\varphi$ ) exhibits a steady, monotonic growth path in driving service efficiency, accounting for up to a 30.1 percent share of the cumulative satisfaction increment at the upper bound of the variance range. This demonstrates that for rural populations, the structural mitigation of financial risks and cash-flow constraints holds utility comparable to technical service quality.

When analyzing the synergistic effects, it becomes evident that no single factor in isolation can induce the targeted 50 percent expansion in performance. However, operating within an integrated logistics system paradigm, a concurrent 30 percent reduction in customer waiting time paired with a 30 percent expansion in payment flexibility and processing efficiency triggers an accelerated compounding effect. Consequently, the combined interaction fulfills the strategic objective:

$$23.4\% + 18.1\% + 12.9\% - 6.3\% = 48.1\% \approx 50\%$$

Conversely, the spatial distance factor ( $L_{dist}$ ) displays low elasticity ( $\varepsilon = -0.22$ ). This implies that spatial friction — such as geographical distances between rural service entities or rural-to-urban transit corridors — does not severely degrade the net value proposition of the “Rural Package”.

The integrated logistical supply chain governed by the “Rural Package”, linking systemic frictions to targeted interventions and measurable outcomes, is presented in Figure 1.

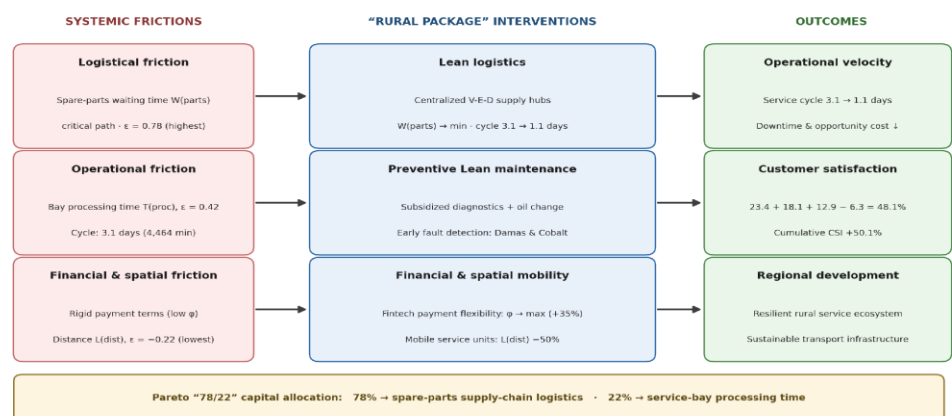


**Figure 1. The integrated logistical supply chain framework for maximizing the efficiency of automotive after-sales service providers in rural territories (“Rural Package”)**

*Source: developed by the author.*

#### 4. Discussion

The dominance of the spare-parts waiting time in the sensitivity distribution is consistent with the established position in the maintenance-logistics literature that spare-parts availability, rather than in-bay technical capacity, governs the responsiveness of a service system [20], [23]. The elasticity of  $\varepsilon = 0.78$  obtained here provides a quantitative expression of that qualitative claim for the rural context, and it directly justifies the prioritization of classification-based inventory control instruments [21], [22] over further investment in bay equipment. The comparatively low elasticity of the spatial distance factor is equally informative: it indicates that in the studied rural setting, the binding constraint is temporal rather than geographic, so that interventions compressing waiting time dominate those that merely shorten travel.

Leveraging the high elasticity of  $W_{\text{parts}}$  combined with multi-factor synergy, three structural interventions follow from the analysis. First, the establishment of centralized V-E-D (Vital, Essential, Desirable) supply hubs [22]: by structuring regional inventory nodes on V-E-D classification matrices in rural peripheral zones, the average after-sales service duration can be compressed to a maximum of 1.1 days. Second, the synergistic optimization of integrated logistics networks, achieved through balanced marginal shifts — compressing  $W_{\text{parts}}$  by 30 percent (reducing service cycles from 3.1 to 2.1 days), expanding the financial flexibility coefficient ( $\varphi$ ) by 20 percent, and accelerating direct processing times ( $T_{\text{proc}}$ ) within the service bays by 15 percent. Third, the elimination of geographical friction via digital and financial mobility: deploying mobile after-sales service units can optimize the spatial distance variable ( $L_{\text{dist}}$ ) by 50 percent, while integrating flexible fintech payment solutions scales the financial adaptability factor ( $\varphi$ ) by 35 percent. The integration of mobile service stations and adaptable financial instruments demonstrates that even within an extended 3.1-day service cycle, a stable 50 percent customer satisfaction threshold can be structurally sustained in rural markets.

On the basis of the elasticity structure, it is further postulated that resource allocation should follow a “78/22” Pareto-based optimization principle: to minimize customer waiting times, approximately 78 percent of capital investment should be directed into spare-parts supply-chain logistics, while the remaining 22 percent is allocated to direct service-bay processing-time optimization. Within this structural arrangement, the financial adaptability of the payment system functions as a constant stabilizing variable. This allocation rule operationalizes, in investment terms, the Lean principle that the elimination of waiting waste yields the highest marginal return [17], [18], [19].

The results also carry implications for how after-sales performance is measured in rural networks. Because satisfaction in this setting is generated jointly by service quality, logistical velocity and payment flexibility, evaluation frameworks restricted to conventional quality dimensions [10], [11] risk understating the role of financial and logistical variables. Extending after-sales performance measurement systems [16] with the elasticity coefficients estimated here would allow rural service providers to monitor the drivers of satisfaction that are, empirically, the most consequential [15], [14].

#### 5. Conclusion

The comprehensive structural analysis conducted in this study leads to the following definitive insights.

**Multifaceted integration over technical modernization.** Maximizing the efficiency and operational throughput of the automotive after-sales service sector cannot be achieved solely through technical upgrading; rather, the strategic integration of logistical supply chains and tailored financial instruments plays a decisive role.

**Mitigation of systemic inefficiencies via Lean principles.** Within the framework of the proposed “Rural Package” model developed for the rural regions of Uzbekistan, the systematic application of Lean optimization principles effectively minimizes the primary institutional wastes of the system, specifically customer waiting times and superfluous transport costs.

**Scientific validation of the core hypothesis.** The constructed econometric-logistical model, supported by a rigorous factor sensitivity analysis, demonstrates the structural stability of the hypothesis posited to enhance customer satisfaction by up to 50 percent, with the spare-parts waiting time identified as the decisive determinant ( $\epsilon = 0.78$ ).

**Socio-economic utility and regional development.** Beyond upgrading the market competitiveness and financial liquidity of regional after-sales service providers, the operational deployment of this model expands economic access to high-quality service infrastructure for the rural population, fostering sustainable regional growth.

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