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# DESIGNING AN IMPROVED SERVICE DELIVERY FRAMEWORK IN TRANSPORT DEPARTMENT BASED ON STRATEGIC DETERMINANTS THROUGH QFD

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## ABSTRACT

The prioritized service delivery dimensions in the transport department – namely Licensing and User Accessibility, Support and Compliance Services, Safety and Emergency Management, Penalty Management, and Public Awareness – were strategically mapped to five modern service design pillars to identify actionable improvement areas. These pillars include User Experience, Feedback & Response Mechanisms, Technology Infusion (AI, IoT, Automation), Environmental Sustainability, and Service Resilience. This alignment forms the foundation of a Quality Function Deployment (QFD) framework, facilitating the translation of user-centric needs into Design and operational solutions. The resulting matrix provides a structured mechanism for evaluating how each dimension can be strengthened through appropriate technological, managerial, and environmental strategies.

**Keywords:** DEMATEL, QFD, AI, IoT

## 1. INTRODUCTION

In the current landscape of public service transformation, delivering user-centric, transparent, and technologically adaptive services is not merely an administrative requirement but a strategic imperative. Departments like transport, which serve as a direct interface between government and citizens, are under increasing pressure to modernize their service delivery models in alignment with evolving stakeholder expectations. Traditional process-focused approaches are being replaced with integrated frameworks that bridge user needs with system design, operational feasibility, and future-readiness.

Quality Function Deployment (QFD) has emerged as a powerful methodology to systematically capture and translate customer requirements (CRs) into measurable and actionable design specifications. By leveraging the structured mechanics of the House of Quality (HoQ), QFD not only identifies priority needs but also aids in tracing these needs through various layers of technical and strategic responses. However, in complex service environments, where interdependencies among design elements are high and user requirements are dynamic, conventional QFD models may fall short in handling internal coupling and systemic feedback.

To address this limitation, this study adopts a hybrid methodology integrating QFD with Axiomatic Design and Decision-Making Trial and Evaluation Laboratory (DEMATEL). Axiomatic Design contributes the analytical rigor needed to assess interrelationships and coupling among Design Requirements (DRs), ensuring alignment with the Independence Axiom. DEMATEL further enhances the model by quantifying both direct and indirect influences among DRs, enabling a nuanced evaluation of design prioritization under systemic complexity.

This integrated approach is applied to the service delivery ecosystem of the transport department, focusing on five critical dimensions; Licensing and User Accessibility, Support and Compliance Services, Safety and Emergency Management, Penalty Management, and Public Awareness. These dimensions are strategically mapped to five modern service design pillars: User Experience, Feedback & Response Mechanisms, Technology Infusion, Environmental Sustainability, and Service Resilience. By building a QFD-driven prioritization model augmented by Axiomatic and DEMATEL logic, the study aims to provide a data-driven framework that supports more responsive, resilient, and customer-aligned public service delivery.

## 2. LITERATURE REVIEW

### 2.1 Quality Function Deployment (QFD) in Service Design

Quality Function Deployment (QFD) has been extensively applied as a customer-driven planning tool to improve service quality by translating user needs into design attributes. Originating from product development in the manufacturing sector, Akao, [1], QFD has evolved into a structured approach suitable for complex service systems. It uses the House of Quality (HoQ) matrix to correlate customer requirements (CRs) with design requirements (DRs), facilitating prioritization based on perceived value and strategic alignment, Hauser & Clausing, [7].

Numerous researchers have demonstrated the utility of QFD in public and service sector improvements. Chan and Wu [4] systematically reviewed over 80 QFD applications, highlighting its flexibility and robustness across industries, including education, healthcare, and public administration. In transport services, QFD has been used to redesign customer interfaces, reduce inefficiencies, and elevate satisfaction by aligning backend design elements with the expectations of frontline users, Bouchereau & Rowlands, [2].

QFD's ability to systematically align product/service features with user expectations has proven especially valuable in the public sector, where stakeholder diversity and accountability demand precise mapping of needs. Studies by Griffin and Hauser [6] emphasize that customer-driven innovation, when enabled by QFD, leads to higher responsiveness and greater user satisfaction.

In e-governance and digital licensing systems, integrating QFD has enabled service designers to prioritize citizen needs over bureaucratic routines. Kumar and Mahesh [12] applied QFD in Indian public services to redesign administrative workflows, reducing turnaround time and increasing satisfaction scores.

## 2.2 Axiomatic Design and Coupling Analysis

Axiomatic Design (AD), introduced by Suh [19], provides a formal logic-based methodology for mapping functional requirements (FRs) to design parameters (DPs) while ensuring minimum coupling and complexity. The Independence Axiom states that a design should maintain the independence of FRs, which is critical in service systems where cascading effects of design decisions can degrade overall performance.

Recent studies integrate AD with QFD to address internal dependencies among DRs. This integration allows for better decision-making in complex environments where multiple design variables interact. For example, in smart city service applications, AD has been used to reduce service redundancy and improve modularity by separating strongly coupled DRs, Suh & Do [18].

Axiomatic Design (AD) has been extended beyond mechanical engineering into areas such as software architecture, urban planning, and service systems. According to El-Haik and Yang [5], the AD framework ensures functional clarity and design traceability, especially in projects with high stakeholder engagement.

In public transport systems, AD has helped mitigate cascading failures caused by interdependent components, Kulak & Kahraman [11]. Applications in healthcare, Hung,

[9] and education, Park & Kim [16] also illustrate how AD enforces modularity and minimizes cross-functional interference, ensuring independence of key performance indicators.

## 2.3 DEMATEL for Influence Analysis in System Design

The Decision-Making Trial and Evaluation Laboratory (DEMATEL) technique, developed by the Battelle Memorial Institute (1973), is used to analyze and visualize causal relationships among variables in complex systems. In design and service prioritization contexts, DEMATEL is particularly valuable for identifying cause–effect relationships and quantifying indirect influences, which are often missed in traditional matrix methods.

Its integration with QFD provides a mechanism to move beyond linear prioritization and understand the structural prominence and critical leverage points among DRs, Tseng et al., [22]. Studies such as Tseng et al., [21] demonstrate how DEMATEL helps uncover hidden influence pathways in service engineering, guiding strategic resource allocation.

Beyond engineering, DEMATEL has been widely used in strategic public policy to reveal systemic bottlenecks and policy leverage points. Wu and Lee [24] used DEMATEL to analyze barriers in e-service adoption among government departments.

Liou, et al., [14] employed DEMATEL in transportation policy to identify dominant factors influencing urban congestion, demonstrating the method's effectiveness in high-interdependency systems. Its ability to distinguish cause and effect groups makes DEMATEL ideal for prioritizing interventions under budget constraints or capacity limits.

## 2.4 Hybrid QFD–Axiomatic–DEMATEL Approaches

There is growing interest in hybrid models that combine the strengths of QFD, Axiomatic Design, and DEMATEL. These models address the limitations of isolated techniques by ensuring that:

- Customer voice is captured effectively (QFD),
- Design logic is structurally sound (Axiomatic Design), and
- Feedback loops and indirect effects are accounted for (DEMATEL).

Yang and Chen [25] proposed a QFD–DEMATEL model to evaluate supplier selection criteria, and Wu and Lin [23] applied QFD–DEMATEL in service innovation. These integrated models have proven effective in prioritizing design features in highly interdependent systems, such as transport infrastructure and e-governance services.

To manage subjectivity and linguistic assessments in QFD and DEMATEL, fuzzy logic has been increasingly incorporated. Karsak, et al., [10] proposed a fuzzy QFD approach to handle imprecise customer judgments, while Lin and Wu [13] integrated fuzzy DEMATEL for service process design.

This trend has continued in transport and smart city systems, where variables such as "user comfort" or "resilience" are not always quantifiable. Fuzzy AHP, Fuzzy DEMATEL, and Fuzzy QFD models, Shieh, et al., [17]; Büyüközkan & Çifçi, [3], allow for nuanced, data-informed design even when operating under ambiguity or incomplete stakeholder feedback.

Comparative analyses of QFD vs. other tools like Kano Model, TRIZ, and SERVQUAL have also been conducted. Liu and Zhang [15] combined QFD and TRIZ to move from prioritization to innovation ideation. Sweis et al., [20] explored the role of QFD compared to Lean Six Sigma in improving public service performance in developing countries.

These studies advocate for hybrid models like yours that span need elicitation (QFD), structural design (AD), and systemic feedback (DEMATEL).

### 2.5 Application in Transport and Public Services

Service quality in the transport sector is increasingly being redefined through digital interfaces, real-time responsiveness, and sustainability goals. Studies by Hsu, et al., [8] and Zhou & Chen [26] have shown that integrating stakeholder feedback with structured design tools like QFD and DEMATEL enhances system resilience and citizen satisfaction.

Public administration research has begun adopting these hybrid methodologies to redesign service delivery models, particularly in high-volume and compliance-sensitive domains such as licensing, penalty enforcement, and safety monitoring. These applications validate the adaptability and robustness of QFD-based methods when enhanced by coupling analysis and causal influence mapping.

## 3. QUALITY FUNCTION DEPLOYMENT

Quality Function Deployment (QFD) is a structured planning methodology that focuses on enhancing the quality of goods and services by aligning design and production with customer needs. Known as *Quality First Design*, QFD begins by understanding what customers want and then integrates these expectations with technological capabilities at every stage of the production process. The main objective of QFD is to translate customer requirements into measurable Design specifications and evaluation targets. This involves determining the importance of each customer need and converting these needs into Design characteristics that guide product development. QFD offers several advantages: it helps companies make design decisions that reflect both customer expectations and production feasibility, promotes effective cross-functional communication, improves product quality, and boosts customer satisfaction. At the core of QFD is the *House of Quality* (HoQ), a matrix that visually maps the relationship between customer needs and Design responses. The HoQ includes six components: customer requirements, planning matrix (which includes strategic importance and market data), Design responses, a relationship matrix showing the strength of connections, a Design correlation matrix that highlights trade-offs among Design features, and a Design matrix detailing priorities, benchmarks, and targets. The QFD framework facilitates the systematic identification of customer demands and their integration into product/service design, forming a foundation for advanced development methodologies like Axiomatic Design. By using QFD, companies ensure that technological innovations are closely aligned with what customers truly value, thereby achieving higher quality and competitive advantage.

The QFD approach is integrated into the proposed technology to ensure a clear and systematic identification of customer requirements and expectations. This structured framework not only captures customer needs effectively but also supports a smooth transition to Axiomatic Design (AD). The steps involved in the QFD process are outlined in detail below to illustrate its application and impact.

**Step-1:** Identification of functional requirements.

Identifying functional requirements involves understanding the core functions, design contexts, and specific needs associated with the product or system being developed. This step is crucial for determining whether the features of a proposed design align with customer expectations. Various methods can be employed to gather these requirements, including Design investigations, data analysis, literature review, interpretation of industry standards, and interviews with relevant stakeholders. In this study, functional requirements were identified through expert brainstorming sessions, comprehensive literature analysis, and the distribution of customer questionnaires to capture user perspectives effectively.

**Step-2:** Analysis of the importance of each functional requirement.

As emphasized by prior research, the performance of each functional requirement should undergo a rigorous prioritization process to focus on those aspects that are novel, critical, or present significant design challenges. In QFD, this prioritization is commonly achieved using techniques such as the Analytic Hierarchy Process (AHP) or structured opinion-based questionnaires. In the present study, closed-ended questionnaires were employed to assess the relative importance of each functional requirement. The significance of each attribute was determined by analyzing the mode values and the frequency of responses, thereby identifying the requirements that were most frequently rated as important by the respondents.

**Step-3:** Identification of design requirements.

Design requirements are critical elements that define the engineering aspects of a design intended to fulfil specific functional needs. They represent the "means" to achieve "the end" – that is, meeting customer expectations through practical and measurable Design solutions. As highlighted in the literature, Design requirements serve as the bridge between customer needs and product realization. In this study, these requirements were identified through an in-depth review of existing literature and collaborative brainstorming sessions with domain experts.

**Step-4:** Determination of the relationship matrix.

Once the Design requirements have been identified, the next step involves determining the degree of correlation between these requirements and the customer requirements (CRs) within the main body of the House of Quality (HoQ) matrix. This involves two types of relationship analyses. First, the interrelationships among the Design requirements (TRs) are assessed using the *roof* of the HoQ, typically represented with symbols such as 'V' for strong positive, 'v' for moderate positive, 'x' for moderate negative, 'X' for strong negative, and '–' for no relationship. Second, the relationships between customer requirements (CRs) and Design requirements (TRs) in the main body of the matrix are evaluated using a numerical scale—commonly 0 (no relationship), 1 (weak relationship), 3 (moderate relationship), and 9 (strong relationship). These ratings help prioritize Design efforts and identify key design trade-offs.

**Step-5:** Determination of the correlation matrix.

To enhance the analytical rigor of the House of Quality (HoQ), a correlation matrix among Design Requirements (DRs) is constructed. This matrix identifies interdependencies and potential trade-offs between DRs, forming the "roof" of the HoQ. To capture technical interdependencies, synergies, and trade-offs among Design Requirements (DRs), a qualitative expert-driven method is adopted. This involves structured brainstorming with experienced stakeholders such as product engineers, domain specialists, quality managers, and customer-facing personnel.

**Step-6:** Deriving relative weights of design requirements.

The final step involves ranking the Design requirements (TRs) by assessing their relative importance. This evaluation helps prioritize which Design aspects require the most focus during the design and development process. In this study, using QFD- Coupling with DEMATEL is implemented to derive the relative weights of design requirements. The methodology is explained in the following steps

In multi-criteria product or service design, prioritizing Design Requirements (DRs) is crucial to ensure effective alignment with Customer Needs (CNs). Quality Function Deployment (QFD) offers a structured means to capture CN–DR relationships, while Axiomatic Design introduces the concept of coupling between DRs. However, a dynamic interaction map and weight determination among DRs require a more systemic approach. This section presents an integrated method combining QFD, Axiomatic Design coupling logic, and the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method to determine the relative importance of DRs.

*Step-6.1: QFD-based interrelationship matrix*

A QFD matrix $Q \in \mathbb{R}^{m \times n}$ is constructed to quantify the strength of relationship between $m$ customer needs and $n$ design requirements. Each element $q_{ij} \in \{0, 1, 3, 9\}$ represents the strength of influence of DR $i$ on CN $i$.

*Step-6.2: Coupling matrix via axiomatic design*

Formula (weighted coupling matrix):

$$C_{ij} = \sum_{k=1}^{m} w_k \cdot q_{ki} \cdot q_{kj}$$

where $C_{ij}$ = coupling between design requirements $Dr_i$ and $DR_j$

$w_k$ = relative importance of CR <sub>*k*</sub>

$q_{ki}$, $q_{kj}$ = relationship scores between CR <sub>*k*</sub> and DR<sub>*i*</sub>/<sub>*j*</sub>

*Step-6.3: Rescaling the influence matrix*

To ensure compatibility with DEMATEL, the coupling matrix is linearly rescaled to a bounded (0-5) scale using:

$$S_{ij} = 5 \cdot \frac{C_{ij} - \min(C)}{\max(C) - \min(C)}$$

*Step-6.4: Normalization*

The normalized influence matrix D is computed by dividing all elements by the maximum row sum:

$$D = \frac{S}{\max_i \sum_{j=1}^{n} S_{ij}}$$

This ensures that total outgoing influence from any DR does not exceed 1.

*Step-6.5: Total relation matrix*

To capture both direct and indirect influences, the total relation matrix $T$ is derived using:

$$T = X + X^2 + \ldots + X^k = X(1 + X + X^2 + \ldots X^{k-1})(I - k)^{-1} = X(1 - X^k)(I - X)^{-1}$$

Provided that

$$\lim_{k \to \infty} X^k = [0]_{n \times n}$$

Total relation matrix is obtained by the equation

$$T = X(I - X)^{-1}$$

where $i$ is the identity matrix. $T$ reflects all causal propagation paths in the DR network.

*Step-6.6: DEMATEL metrics and weight calculation*

Given influence: $D_i = \sum_{j=1}^{n} T_{ji}$

Received influence $R_i = \sum_{j=1}^{n} T_{ji}$

Prominence: $P_i = D_i + R_i$

Relation $C_i = D_i - R_i$

Ther relative weight of each design requirement $i$ is given by:

$$W_i = \frac{P_i}{\sum_{k=1}^{n} P_k}$$

The final $W \in \square^n$ provides a normalized priority ranking of DRs based on their systemic role.

Design Requirements (DRs) with high prominence values $(D + R)$ are structurally central within the system, indicating that they both influence and are influenced by many other elements. Such DRs play a pivotal role in the design ecosystem and should be carefully monitored and emphasized during development and decision-making.

Meanwhile, DRs with a positive relation score ($D-R>0$) are considered cause factors – they exert more influence on other DRs than they receive, making them strategic leverage points for inducing system-wide improvements. The computed weights $W_i W\__i W_i$ derived from the normalized prominence values serve as a quantitative basis for prioritization. These weights can be effectively used to allocate design resources, guide the structuring of product architecture, and inform optimization models in both engineering design and service delivery frameworks, ensuring that decision-making aligns with both customer expectations and internal technical interdependencies.

The proposed approach effectively combines the voice of the customer, captured through the QFD framework, with the technical interaction and coupling logic of Axiomatic Design, and further integrates systemic feedback analysis using the DEMATEL method. This integration ensures a holistic view that not only aligns design decisions with customer priorities but also accounts for the internal structural relationships among design requirements. By incorporating both direct and indirect dependencies, the method reveals hidden influences and cascading effects within the design system. As a result, it enables the derivation of objective and data-driven weights for each design requirement, even in complex environments where coupling and feedback loops are present, thereby enhancing decision-making accuracy and robustness in systems design and prioritization.

**Step-7:** Adjusted QFD scores using correlation matrix.

*Step 7.1: Initialize penalties and rewards*

Create arrays Penalty [$j$] and Reward [$j$], initially set to 0.

*Step-7.2: Calculate conflict penalty for each DR*

- For each design requirement $DR_j$:
- Loop through all other DRs $DR_k$ where $k \neq j$
- If $C_{jk} < 0$ (negative correlation):
    - Add $W_k \cdot |C_{jk}|$ to Penalty [$j$]

**Formula:**

$$\text{Penalty}_j = \sum_{k \neq j, C_{jk} < 0} W_k \cdot |C_{jk}|$$

*Step-7.3: Calculate synergy reward for each DR*

For each DR j:

- Loop through all $k \neq j$
- If $C_{jk} > 0$ (positive correlation):

- Add $W_k \cdot C_{jk}$ to Reward [$j$]

**Formula:**

$$\text{Reward}_j = \sum_{k \neq j, C_{jk} > 0} W_k \cdot C_{jk}$$

*Step-7.4: Compute final adjusted score for each DR*

**Formula:**

$$\text{Adjusted Score}_j = W_j - \text{Penalty}_j + \text{Reward}_j$$

This adjusts each DR's original QFD weight by:

- Subtracting penalties due to negative interactions.
- Adding rewards due to positive synergy with other DRs.

The proposed QFD-Axiomatic-DEMATEL integration provides a rigorous, interpretable, and quantitative method for determining the relative weights of design requirements. By leveraging expert inputs and systems thinking, it enables informed prioritization under complex design interdependencies.

## 4. ILLUSTRATION OF THE METHODOLOGY

The QFD-DEMATEL methodology is employed to determine the overall priority of the design requirements of service delivery dimensions in the transport department by systematic mapping of service quality factors and design requirements.

### 4.1 Identification of Functional Requirements

The following user satisfaction determinants are considered as functional requirements

| S.No. | Dimension | Measurement items |
|---|---|---|
| 1 | Licensing and User Accessibility (6) | Clarity of Licensing Procedures |
| | | Timeliness of License Issuance |
| | | Transparency in Testing and Evaluation |
| | | Accessibility of Licensing Services |
| | | Ease of Access to Registration Services |
| | | User-Friendliness of Online Platforms |
| 2 | Support and Compliance Services (5) | Support from Staff During Registration |
| | | Clarity of Registration Procedures |
| | | Timeliness of Permit Issuance |
| | | Compliance with Legal and Safety Standards |
| | | Support for Permit-Related Queries |
| 3 | Safety and Emergency Management (5) | Adequacy of Information Provided on Permits |
| | | Ease of Payment Process |
| | | Competitive Tax Rates |

| | | |
|---|---|---|
| | | Customer Satisfaction Across Borders |
| | | Impact of Tax Incentives on Adoption of Green Initiatives |
| 4 | Penalty Management (4) | User Satisfaction with Penalty Procedures |
| | | Use of Penalty Revenue for Public Benefits |
| | | Digital Integration in Penalty Management |
| | | Educational Campaigns on Penalties |
| 5 | Public Awareness (5) | Road Accident Data Collection and Analysis |
| | | Inspection and Maintenance of Vehicles |
| | | Speed Monitoring and Control |
| | | Collaboration with Other Departments |
| | | Availability of Emergency Response Services |

### 4.2 Analysis of the Importance of Each Functional Requirement

This study systematically identified and prioritized key service delivery and user satisfaction determinants in the Transport Department by integrating Hierarchical Clustering, and Multi-Criteria Decision-Making (MCDM) methods, particularly CRITIC and Entropy. The relative priorities are presented below:

| Items | RW_Item of CRITIC | RW_Item of Entropy | Ensembling Weight | Expected Weight |
|---|---|---|---|---|
| Item 1 | 0.0394 | 0.0433 | 0.0414 | 0.0414 |
| Item 2 | 0.0400 | 0.0432 | 0.0416 | 0.0416 |
| Item 3 | 0.0421 | 0.0449 | 0.0435 | 0.0435 |
| Item 4 | 0.0394 | 0.0423 | 0.0409 | 0.0409 |
| Item 5 | 0.0387 | 0.0434 | 0.0411 | 0.0410 |
| Item 6 | 0.0390 | 0.0475 | 0.0433 | 0.0432 |
| Item 7 | 0.0413 | 0.0426 | 0.0420 | 0.0419 |
| Item 8 | 0.0410 | 0.0421 | 0.0416 | 0.0415 |
| Item 9 | 0.0428 | 0.0442 | 0.0435 | 0.0435 |
| Item 10 | 0.0432 | 0.0444 | 0.0438 | 0.0438 |
| Item 11 | 0.0403 | 0.0384 | 0.0394 | 0.0394 |
| Item 12 | 0.0427 | 0.0428 | 0.0428 | 0.0427 |
| Item 13 | 0.0411 | 0.0424 | 0.0418 | 0.0417 |
| Item 14 | 0.0378 | 0.0412 | 0.0395 | 0.0395 |
| Item 15 | 0.0398 | 0.0418 | 0.0408 | 0.0408 |
| Item 16 | 0.0389 | 0.0420 | 0.0405 | 0.0404 |
| Item 17 | 0.0368 | 0.0252 | 0.0310 | 0.0310 |
| Item 18 | 0.0385 | 0.0258 | 0.0322 | 0.0322 |
| Item 19 | 0.0391 | 0.0261 | 0.0326 | 0.0326 |
| Item 20 | 0.0362 | 0.0250 | 0.0306 | 0.0306 |
| Item 21 | 0.0407 | 0.0422 | 0.0415 | 0.0415 |
| Item 22 | 0.0395 | 0.0424 | 0.0410 | 0.0410 |
| Item 23 | 0.0410 | 0.0429 | 0.0420 | 0.0420 |
| Item 24 | 0.0389 | 0.0393 | 0.0391 | 0.0391 |
| Item 25 | 0.0421 | 0.0443 | 0.0432 | 0.0432 |

### 4.3 Identification of Design Requirements

In this study, the requirements were established through a comprehensive review of existing literature complemented by collaborative brainstorming sessions with domain experts in the transportation department and are presented below:

| S.No. | Technical Requirement | Sub-Criteria |
|---|---|---|
| 1 | Licensing Accessibility Framework (TR1) | Unified UI and User-Friendly Licensing Interface (TR11) |
| 2 | | Standardized and Transparent Process Workflows (TR12) |
| 3 | | Real-Time Service Delivery System (TR13) |
| 4 | | Inclusive Multi-Channel Access Infrastructure (TR14) |
| 5 | Compliance-Oriented Service Support Framework (TR2) | Guided Registration and Support Interface (TR21) |
| 6 | | Process Clarity and SLA Framework (TR22) |
| 7 | | Automated Legal and Compliance Check System (TR23) |
| 8 | Smart Financial Transparency and Access Framework (TR3) | Transparent Information Dissemination System (TR31) |
| 9 | | Seamless Digital Payment Infrastructure (TR32) |
| 10 | | Dynamic Tax and Incentive Policy Engine (TR33) |
| 11 | Smart Penalty Management (TR4) | Violation Detection and Classification System (TR41) |
| 12 | | Automated Offense Notification Engine (TR42) |
| 13 | | Penalty Escalation and Grievance Redressal Module (TR43) |
| 14 | | Offender Behaviour Profiling and Predictive Analytics (TR44) |
| 15 | Smart Road Incident and Emergency Management System (TR5) | Road Accident Data Collection and Analysis (TR51) |
| 16 | | Inspection and Maintenance of Vehicles (TR52) |
| 17 | | Speed Monitoring and Control System (TR53) |
| 18 | | Collaboration with Other Departments (TR54) |
| 19 | | Availability of Emergency Response Services (TR55) |

### 4.4 Determination of the Relationship Matrix

Conduct a structured brainstorming session with cross-functional experts to evaluate the impact of each Design Requirement (DR) on Customer Requirements (CRs) using a numerical scale (0, 1, 3, 9).

**Table-1: CR1-DRs**

| **Licensing and User Accessibility** | **Licensing Accessibility Framework** | | | | **Compliance-Oriented** | | | **Smart Financial** | | | **Smart Penalty Management** | | | | **Smart Road Incident and Emergency Management** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **TR11** | **TR12** | **TR13** | **TR14** | **TR21** | **TR22** | **TR23** | **TR31** | **TR32** | **TR33** | **TR41** | **TR42** | **TR43** | **TR44** | **TR51** | **TR52** | **TR53** | **TR54** | **TR55** |
| Clarity of Licensing Procedures | 9 | 9 | 3 | 3 | 3 | 9 | 3 | 9 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| Timeliness of License Issuance | 3 | 9 | 9 | 3 | 3 | 9 | 3 | 3 | 9 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 1 | 3 |
| Transparency in Testing and Evaluation | 3 | 9 | 3 | 1 | 1 | 9 | 9 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| Accessibility of Licensing Services | 3 | 3 | 3 | 9 | 3 | 3 | 3 | 3 | 9 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 3 |
| Ease of Access to Registration Services | 3 | 3 | 3 | 9 | 9 | 3 | 1 | 1 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 3 |
| User-Friendliness of Online Platforms | 9 | 3 | 3 | 9 | 3 | 3 | 1 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |

**Table-2: CR2-DRs**

| **Support and Compliance Services** | **Licensing Accessibility Framework (TR1)** | | | | **Compliance-Oriented Service Support Framework (TR2)** | | | **Smart Financial Transparency and Access Framework (TR3)** | | | **Smart Penalty Management (TR4)** | | | | **Smail Road Incident and Emergency Management System (TR5)** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TR11 | TR12 | TR13 | TR14 | TR21 | TR22 | TR23 | TR31 | TR32 | TR33 | TR41 | TR42 | TR43 | TR44 | TR51 | TR52 | TR53 | TR54 | TR55 |
| Support from Staff During Registration | 3 | 3 | 1 | 3 | 9 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Clarity of Registration Procedures | 9 | 9 | 3 | 3 | 3 | 9 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Timeliness of Permit Issuance | 3 | 9 | 9 | 3 | 3 | 9 | 3 | 1 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Compliance with Legal and Safety Standards | 1 | 3 | 1 | 0 | 1 | 3 | 9 | 1 | 0 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Support for Permit-Related Queries | 3 | 3 | 1 | 1 | 9 | 3 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## Table-3: CR3-DRs

| **Safety and Emergency Management** | **Licensing Accessibility Framework (TR1)** | | | | **Compliance-Oriented Service Support Framework** | | | **Smart Financial Transparency and Access** | | | **Smart Penalty Management (TR1)** | | | | **Smart Road Incident and Emergency Management System (TR5)** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **TR11** | **TR12** | **TR1 3** | **TR14** | **TR21** | **TR22** | **TR23** | **TR31** | **TR32** | **TR33** | **TR41** | **TR42** | **TR43** | **TR44** | **TR51** | **TR52** | **TR53** | **TR54** | **TR55** |
| Adequacy of Information Provided on Permits | 3 | 3 | 1 | 3 | 9 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ease of Payment Process | 9 | 9 | 3 | 3 | 3 | 9 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Competitive Tax Rates | 3 | 9 | 9 | 3 | 3 | 9 | 3 | 1 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Customer Satisfaction Across Borders | 1 | 3 | 1 | 0 | 1 | 3 | 9 | 1 | 0 | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Impact of Tax Incentives on Adoption of Green Initiatives | 3 | 3 | 1 | 1 | 9 | 3 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## Table-4: CR4-DRs

| **Penalty Management** | **Licensing Accessibility Framework** | | | | **Compliance-Oriented** | | | **Smart Financial** | | | **Smart Penalty Management (TR4)** | | | | **Smart Road Incident and Emergency Management** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **TR11** | **TR12** | **TR13** | **TR14** | **TR21** | **TR22** | **TR23** | **TR31** | **TR32** | **TR33** | **TR41** | **TR42** | **TR43** | **TR44** | **TR51** | **TR52** | **TR53** | **TR54** | **TR55** |
| User Satisfaction with Penalty Procedures | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 9 | 9 | 9 | 3 | 1 | 1 | 3 | 1 | 1 |
| Use of Penalty Revenue for Public Benefits | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 1 | 9 | 9 | 3 | 3 | 3 | 1 | 0 | 0 | 1 | 1 | 0 |
| Digital Integration in Penalty Management | 1 | 1 | 3 | 3 | 1 | 3 | 3 | 3 | 9 | 3 | 9 | 9 | 9 | 3 | 1 | 1 | 1 | 1 | 1 |
| Educational Campaigns on Penalties | 1 | 3 | 1 | 3 | 1 | 3 | 3 | 9 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 |

**Table-5: CR5-DRs**

| **Public Awareness** | **Licensing Accessibility Framework** | | | | **Compliance-Oriented** | | | **Smart Financial** | | | **Smart Penalty Management (TR4)** | | | | **Smart Road Incident and Emergency Management** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **TR11** | **TR12** | **TR13** | **TR14** | **TR21** | **TR22** | **TR23** | **TR31** | **TR32** | **TR33** | **TR41** | **TR42** | **TR43** | **TR44** | **TR51** | **TR52** | **TR53** | **TR54** | **TR55** |
| Road Accident Data Collection and Analysis | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 9 | 1 | 0 | 3 | 3 | 1 | 3 | 9 | 3 | 3 | 3 | 3 |
| Inspection and Maintenance of Vehicles | 0 | 1 | 1 | 0 | 1 | 3 | 3 | 3 | 0 | 0 | 1 | 1 | 1 | 1 | 3 | 9 | 3 | 3 | 3 |
| Speed Monitoring and Control | 0 | 1 | 3 | 1 | 1 | 3 | 3 | 1 | 0 | 0 | 3 | 3 | 3 | 1 | 3 | 3 | 9 | 3 | 3 |
| Collaboration with Other Departments | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 3 | 0 | 0 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 9 | 3 |
| Avai1abi1ity of Emergency Response Services | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 9 |

## Correlation among design requirements:

To strengthen the analytical depth of the House of Quality (HoQ), a correlation matrix is developed to capture the interrelationships among Design Requirements (DRs) and is presented below:

| | **TR11** | **TR12** | **TR13** | **TR14** | **TR21** | **TR22** | **TR23** | **TR31** | **TR32** | **TR33** | **TR41** | **TR42** | **TR43** | **TR44** | **TR51** | **TR52** | **TR53** | **TR54** | **TR55** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TR11 | 1 | 0 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TR12 | 0 | 1 | 0 | 0 | 1 | 0.5 | 0.5 | 1 | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TR13 | 1 | 0 | 1 | 0 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 | -0.5 | -0.5 | -0.5 | -0.5 | 0 | 0 |
| TR14 | 0.5 | 0 | 0 | 1 | 0 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TR21 | 0.5 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TR22 | 0.5 | 0.5 | 0.5 | 0 | 0 | 1 | 0 | 0 | 1 | 0.5 | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TR23 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 | 1 | 0 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| TR31 | 0.5 | 1 | 0.5 | 0.5 | 1 | 0 | 0 | 1 | 0 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 |
| TR32 | 0.5 | 0.5 | 0.5 | 0.5 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0.5 | 0.5 | 0.5 | 0 | 0 | 0 | 0 |
| TR33 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 | 1 | 0 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 | 0 |
| TR41 | 0 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 | 1 | 0 | 0 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| TR42 | 0 | 0 | 0 | 0.5 | 0 | 0.5 | 0.5 | 0.5 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0.5 | 0.5 | 0.5 | 0.5 |
| TR43 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 | 1 | 0 | 0 | 0.5 | 0.5 | 0.5 | 0.5 |

| | **TR11** | **TR12** | **TR13** | **TR14** | **TR21** | **TR22** | **TR23** | **TR31** | **TR32** | **TR33** | **TR41** | **TR42** | **TR43** | **TR44** | **TR51** | **TR52** | **TR53** | **TR54** | **TR55** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TR44 | 0 | 0 | -0.5 | 0 | 0 | 0 | 0 | 0.5 | 0.5 | 0.5 | 1 | 0 | 0 | 1 | 0 | 0 | 0.5 | 0.5 | 0.5 |
| TR51 | 0 | 0 | -0.5 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0.5 | 0.5 | 1 | 0 | 0 | 1 | 0 | 0 | 0.5 | 0.5 |
| TR52 | 0 | 0 | -0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 | 1 | 0 | 0 | 0.5 |
| TR53 | 0 | 0 | -0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 | 1 | 0 | 0 |
| TR54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 | 1 | 0 |
| TR55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 | 1 |

**Deriving relative weights of design requirements**

**QFD-based interrelationship matrix:** Interrelationship matrices are presented in section 4.4

### 4.5.2 Coupling Matrix via Axiomatic Design

Weighted coupling matrix is obtained the formula as discussed in step-6.2. The calculations are made using python code and the results are presented in the following table.

| **DRs** | **TR11** | **TR12** | **TR13** | **TR14** | **TR21** | **TR22** | **TR23** | **TR31** | **TR32** | **TR33** | **TR41** | **TR42** | **TR43** | **TR44** | **TR51** | **TR52** | **TR53** | **TR54** | **TR55** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TR11 | 0.7333 | 0.769 | 0.4114 | 0.4842 | 0.4957 | 0.773 | 0.3566 | 0.4187 | 0.307 | 0.1289 | 0.0351 | 0.0369 | 0.0335 | 0.0248 | 0.0311 | 0.0739 | 0.0843 | 0.0682 | 0.0833 |
| TR12 | 0.769 | 1.148 | 0.7078 | 0.4955 | 0.5792 | 1.1589 | 0.6213 | 0.5019 | 0.4422 | 0.1491 | 0.0654 | 0.071 | 0.0676 | 0.0554 | 0.0685 | 0.132 | 0.1599 | 0.1049 | 0.1407 |
| TR13 | 0.4114 | 0.7078 | 0.5853 | 0.3709 | 0.353 | 0.73 | 0.35 | 0.3036 | 0.3864 | 0.1433 | 0.0821 | 0.084 | 0.0736 | 0.0485 | 0.0851 | 0.1063 | 0.1591 | 0.0905 | 0.1366 |
| TR14 | 0.4842 | 0.4955 | 0.3709 | 0.5758 | 0.4645 | 0.5073 | 0.2355 | 0.295 | 0.3868 | 0.1873 | 0.0506 | 0.0562 | 0.0528 | 0.0278 | 0.0334 | 0.0822 | 0.0995 | 0.0803 | 0.146 |
| TR21 | 0.4957 | 0.5792 | 0.353 | 0.4645 | 0.8304 | 0.594 | 0.3232 | 0.3204 | 0.2946 | 0.1211 | 0.0593 | 0.0612 | 0.0578 | 0.034 | 0.0433 | 0.0811 | 0.0958 | 0.0691 | 0.1146 |
| TR22 | 0.773 | 1.1589 | 0.73 | 0.5073 | 0.594 | 1.1928 | 0.6573 | 0.5287 | 0.4764 | 0.1706 | 0.1189 | 0.1245 | 0.1211 | 0.0754 | 0.0933 | 0.1769 | 0.2107 | 0.1306 | 0.1654 |
| TR23 | 0.3566 | 0.6213 | 0.35 | 0.2355 | 0.3232 | 0.6573 | 0.6563 | 0.3238 | 0.2594 | 0.1058 | 0.1896 | 0.1952 | 0.1918 | 0.142 | 0.1577 | 0.2136 | 0.2287 | 0.1694 | 0.185 |
| TR31 | 0.4187 | 0.5019 | 0.3036 | 0.295 | 0.3204 | 0.5287 | 0.3238 | 0.5269 | 0.2702 | 0.1073 | 0.1338 | 0.1506 | 0.1196 | 0.1086 | 0.202 | 0.1779 | 0.1585 | 0.143 | 0.1503 |
| TR32 | 0.307 | 0.4422 | 0.3864 | 0.3868 | 0.2946 | 0.4764 | 0.2594 | 0.2702 | 0.5476 | 0.2616 | 0.1461 | 0.148 | 0.1446 | 0.0547 | 0.0308 | 0.0687 | 0.1131 | 0.0762 | 0.133 |
| TR33 | 0.1289 | 0.1491 | 0.1433 | 0.1873 | 0.1211 | 0.1706 | 0.1058 | 0.1073 | 0.2616 | 0.1709 | 0.0836 | 0.0854 | 0.0854 | 0.0304 | 0.0089 | 0.0314 | 0.0551 | 0.0408 | 0.0602 |
| TR41 | 0.0351 | 0.0654 | 0.0821 | 0.0506 | 0.0593 | 0.1189 | 0.1896 | 0.1338 | 0.1461 | 0.0836 | 0.2395 | 0.2414 | 0.231 | 0.1153 | 0.1207 | 0.0998 | 0.14 | 0.0928 | 0.0897 |
| TR42 | 0.0369 | 0.071 | 0.084 | 0.0562 | 0.0612 | 0.1245 | 0.1952 | 0.1506 | 0.148 | 0.0854 | 0.2414 | 0.247 | 0.2367 | 0.1209 | 0.1263 | 0.1054 | 0.1419 | 0.0984 | 0.0953 |
| TR43 | 0.0335 | 0.0676 | 0.0736 | 0.0528 | 0.0578 | 0.1211 | 0.1918 | 0.1196 | 0.1446 | 0.0854 | 0.231 | 0.2367 | 0.2332 | 0.1106 | 0.0953 | 0.0951 | 0.1315 | 0.0881 | 0.085 |
| TR44 | 0.0248 | 0.0554 | 0.0485 | 0.0278 | 0.034 | 0.0754 | 0.142 | 0.1086 | 0.0547 | 0.0304 | 0.1153 | 0.1209 | 0.1106 | 0.0789 | 0.1036 | 0.0827 | 0.0844 | 0.0736 | 0.0726 |
| TR51 | 0.0311 | 0.0685 | 0.0851 | 0.0334 | 0.0433 | 0.0933 | 0.1577 | 0.202 | 0.0308 | 0.0089 | 0.1207 | 0.1263 | 0.0953 | 0.1036 | 0.2132 | 0.1505 | 0.1483 | 0.1202 | 0.1202 |
| TR52 | 0.0739 | 0.132 | 0.1063 | 0.0822 | 0.0811 | 0.1769 | 0.2136 | 0.1779 | 0.0687 | 0.0314 | 0.0998 | 0.1054 | 0.0951 | 0.0827 | 0.1505 | 0.2208 | 0.1615 | 0.1281 | 0.1366 |

| DRs | TR11 | TR12 | TR13 | TR14 | TR21 | TR22 | TR23 | TR31 | TR32 | TR33 | TR41 | TR42 | TR43 | TR44 | TR51 | TR52 | TR53 | TR54 | TR55 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TR53 | 0.0843 | 0.1599 | 0.1591 | 0.0995 | 0.0958 | 0.2107 | 0.2287 | 0.1585 | 0.1131 | 0.0551 | 0.14 | 0.1419 | 0.1315 | 0.0844 | 0.1483 | 0.1615 | 0.2418 | 0.1304 | 0.1448 |
| TR54 | 0.0682 | 0.1049 | 0.0905 | 0.0803 | 0.0691 | 0.1306 | 0.1694 | 0.143 | 0.0762 | 0.0408 | 0.0928 | 0.0984 | 0.0881 | 0.0736 | 0.1202 | 0.1281 | 0.1304 | 0.0989 | 0.1063 |
| TR55 | 0.0833 | 0.1407 | 0.1366 | 0.146 | 0.1146 | 0.1654 | 0.185 | 0.1503 | 0.133 | 0.0602 | 0.0897 | 0.0953 | 0.085 | 0.0726 | 0.1202 | 0.1366 | 0.1448 | 0.1063 | 0.1368 |

### 4.5.3 Rescaling the Influence Matrix

| DRs | TR11 | TR12 | TR13 | TR14 | TR21 | TR22 | TR23 | TR31 | TR32 | TR33 | TR41 | TR42 | TR43 | TR44 | TR51 | TR52 | TR53 | TR54 | TR55 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TR11 | 5 | 4.58 | 2.78 | 3.42 | 2.45 | 4.48 | 1.18 | 2.36 | 1.84 | 1.23 | 0 | 0 | 0 | 0 | 0.07 | 0 | 0 | 0 | 0 |
| TR12 | 3.62 | 5 | 3.92 | 2.31 | 1.93 | 5 | 2.43 | 1.35 | 1.93 | 0.97 | 0.12 | 0.13 | 0.15 | 0.28 | 0.23 | 0.24 | 0.39 | 0.14 | 0.36 |
| TR13 | 2.62 | 4.27 | 5 | 2.52 | 1.58 | 4.28 | 1.22 | 0.5 | 2.58 | 1.44 | 0.48 | 0.47 | 0.4 | 0.47 | 0.57 | 0.41 | 1 | 0.47 | 1.16 |
| TR14 | 3.67 | 3.13 | 2.97 | 5 | 2.71 | 2.86 | 0 | 1 | 2.99 | 2.25 | 0.23 | 0.27 | 0.26 | 0.14 | 0.13 | 0.24 | 0.39 | 0.47 | 1.73 |
| TR21 | 3.45 | 3.48 | 2.39 | 3.54 | 5 | 3.3 | 1.03 | 1.05 | 1.91 | 1.24 | 0.28 | 0.27 | 0.27 | 0.22 | 0.2 | 0.15 | 0.23 | 0.11 | 0.8 |
| TR22 | 3.34 | 4.62 | 3.67 | 2.16 | 1.8 | 4.68 | 2.33 | 1.22 | 1.93 | 1.05 | 0.43 | 0.44 | 0.46 | 0.48 | 0.35 | 0.51 | 0.71 | 0.36 | 0.55 |
| TR23 | 2.01 | 3.31 | 1.9 | 1.18 | 1.25 | 3.26 | 5 | 0.49 | 1.36 | 0.91 | 1.43 | 1.44 | 1.45 | 2.09 | 1.14 | 1.51 | 1.71 | 1.81 | 1.92 |
| TR31 | 2.86 | 2.91 | 1.81 | 1.99 | 1.48 | 2.74 | 1.09 | 5 | 1.72 | 1.08 | 1.07 | 1.2 | 0.92 | 1.73 | 1.74 | 1.37 | 1.1 | 1.66 | 1.61 |
| TR32 | 2.15 | 2.74 | 3.28 | 3.17 | 1.48 | 2.64 | 0.46 | 0.6 | 4.62 | 3.32 | 1.33 | 1.31 | 1.31 | 0.74 | 0.11 | 0.08 | 0.61 | 0.41 | 1.49 |
| TR33 | 1.99 | 1.8 | 2.39 | 3.51 | 1.3 | 1.68 | 0.1 | 0 | 5 | 5 | 1.81 | 1.8 | 1.85 | 1.04 | 0 | 0.1 | 0.77 | 0.76 | 1.54 |
| TR41 | 0.01 | 0 | 0.16 | 0.21 | 0.11 | 0.15 | 2.26 | 0.41 | 2.07 | 1.96 | 5 | 4.92 | 4.77 | 4.48 | 2.26 | 1.78 | 2.98 | 2.77 | 2.48 |
| TR42 | 0.01 | 0.05 | 0.12 | 0.28 | 0.11 | 0.16 | 2.2 | 0.85 | 2 | 1.92 | 4.84 | 4.84 | 4.7 | 4.52 | 2.27 | 1.82 | 2.88 | 2.85 | 2.58 |
| TR43 | 0 | 0.08 | 0 | 0.29 | 0.12 | 0.27 | 2.55 | 0.01 | 2.13 | 2.09 | 4.99 | 5 | 5 | 4.44 | 1.81 | 1.75 | 2.87 | 2.7 | 2.41 |
| TR44 | 0.09 | 0.41 | 0.06 | 0.1 | 0.05 | 0.2 | 3.54 | 2.07 | 0.98 | 1.03 | 3.82 | 3.92 | 3.62 | 5 | 3.21 | 2.68 | 2.88 | 3.91 | 3.77 |
| TR51 | 0.04 | 0.28 | 0.69 | 0 | 0 | 0 | 2.23 | 4.7 | 0 | 0 | 2.88 | 2.95 | 2.19 | 4.84 | 5 | 3.9 | 4.06 | 5 | 5 |
| TR52 | 0.69 | 1.14 | 0.82 | 0.85 | 0.44 | 1.31 | 3.06 | 2.2 | 0.61 | 0.56 | 1.89 | 1.96 | 1.78 | 3.09 | 2.88 | 5 | 3.62 | 4.34 | 4.7 |
| TR53 | 0.67 | 1.24 | 1.66 | 0.93 | 0.47 | 1.41 | 2.55 | 0.56 | 1.16 | 1 | 2.37 | 2.34 | 2.19 | 2.67 | 2.42 | 2.85 | 5 | 3.66 | 4.16 |
| TR54 | 0.85 | 1.07 | 0.92 | 1.16 | 0.49 | 0.95 | 2.82 | 2.04 | 1.06 | 1.05 | 2.19 | 2.27 | 2.05 | 3.39 | 2.79 | 3.28 | 3.54 | 4 | 4.36 |
| TR55 | 0.87 | 1.31 | 1.67 | 2.16 | 0.96 | 1.11 | 2.2 | 1.15 | 1.85 | 1.35 | 1.69 | 1.76 | 1.58 | 2.69 | 2.28 | 2.8 | 3.18 | 3.42 | 4.77 |

### 4.5.4 Normalization

| DRs | TR11 | TR12 | TR13 | TR14 | TR21 | TR22 | TR23 | TR31 | TR32 | TR33 | TR41 | TR42 | TR43 | TR44 | TR51 | TR52 | TR53 | TR54 | TR55 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TR11 | 0.1143 | 0.1047 | 0.0635 | 0.0782 | 0.0560 | 0.1024 | 0.0270 | 0.0539 | 0.0420 | 0.0281 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0016 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| TR12 | 0.0827 | 0.1143 | 0.0896 | 0.0528 | 0.0441 | 0.1143 | 0.0555 | 0.0309 | 0.0441 | 0.0222 | 0.0027 | 0.0030 | 0.0034 | 0.0064 | 0.0053 | 0.0055 | 0.0089 | 0.0032 | 0.0082 |
| TR13 | 0.0599 | 0.0976 | 0.1143 | 0.0576 | 0.0361 | 0.0978 | 0.0279 | 0.0114 | 0.0590 | 0.0329 | 0.0110 | 0.0107 | 0.0091 | 0.0107 | 0.0130 | 0.0094 | 0.0229 | 0.0107 | 0.0265 |
| TR14 | 0.0839 | 0.0715 | 0.0679 | 0.1143 | 0.0619 | 0.0654 | 0.0000 | 0.0229 | 0.0683 | 0.0514 | 0.0053 | 0.0062 | 0.0059 | 0.0032 | 0.0030 | 0.0055 | 0.0089 | 0.0107 | 0.0395 |
| TR21 | 0.0788 | 0.0795 | 0.0546 | 0.0809 | 0.1143 | 0.0754 | 0.0235 | 0.0240 | 0.0436 | 0.0283 | 0.0064 | 0.0062 | 0.0062 | 0.0050 | 0.0046 | 0.0034 | 0.0053 | 0.0025 | 0.0183 |
| TR22 | 0.0763 | 0.1056 | 0.0839 | 0.0494 | 0.0411 | 0.1069 | 0.0532 | 0.0279 | 0.0441 | 0.0240 | 0.0098 | 0.0101 | 0.0105 | 0.0110 | 0.0080 | 0.0117 | 0.0162 | 0.0082 | 0.0126 |
| TR23 | 0.0459 | 0.0756 | 0.0434 | 0.0270 | 0.0286 | 0.0745 | 0.1143 | 0.0112 | 0.0311 | 0.0208 | 0.0327 | 0.0329 | 0.0331 | 0.0478 | 0.0261 | 0.0345 | 0.0391 | 0.0414 | 0.0439 |
| TR31 | 0.0654 | 0.0665 | 0.0414 | 0.0455 | 0.0338 | 0.0626 | 0.0249 | 0.1143 | 0.0393 | 0.0247 | 0.0245 | 0.0274 | 0.0210 | 0.0395 | 0.0398 | 0.0313 | 0.0251 | 0.0379 | 0.0368 |
| TR32 | 0.0491 | 0.0626 | 0.0750 | 0.0724 | 0.0338 | 0.0603 | 0.0105 | 0.0137 | 0.1056 | 0.0759 | 0.0304 | 0.0299 | 0.0299 | 0.0169 | 0.0025 | 0.0018 | 0.0139 | 0.0094 | 0.0340 |
| TR33 | 0.0455 | 0.0411 | 0.0546 | 0.0802 | 0.0297 | 0.0384 | 0.0023 | 0.0000 | 0.1143 | 0.1143 | 0.0414 | 0.0411 | 0.0423 | 0.0238 | 0.0000 | 0.0023 | 0.0176 | 0.0174 | 0.0352 |
| TR41 | 0.0002 | 0.0000 | 0.0037 | 0.0048 | 0.0025 | 0.0034 | 0.0516 | 0.0094 | 0.0473 | 0.0448 | 0.1143 | 0.1124 | 0.1090 | 0.1024 | 0.0516 | 0.0407 | 0.0681 | 0.0633 | 0.0567 |
| TR42 | 0.0002 | 0.0011 | 0.0027 | 0.0064 | 0.0025 | 0.0037 | 0.0503 | 0.0194 | 0.0457 | 0.0439 | 0.1106 | 0.1106 | 0.1074 | 0.1033 | 0.0519 | 0.0416 | 0.0658 | 0.0651 | 0.0590 |
| TR43 | 0.0000 | 0.0018 | 0.0000 | 0.0066 | 0.0027 | 0.0062 | 0.0583 | 0.0002 | 0.0487 | 0.0478 | 0.1140 | 0.1143 | 0.1143 | 0.1015 | 0.0414 | 0.0400 | 0.0656 | 0.0617 | 0.0551 |
| TR44 | 0.0021 | 0.0094 | 0.0014 | 0.0023 | 0.0011 | 0.0046 | 0.0809 | 0.0473 | 0.0224 | 0.0235 | 0.0873 | 0.0896 | 0.0827 | 0.1143 | 0.0734 | 0.0612 | 0.0658 | 0.0894 | 0.0862 |
| TR51 | 0.0009 | 0.0064 | 0.0158 | 0.0000 | 0.0000 | 0.0000 | 0.0510 | 0.1074 | 0.0000 | 0.0000 | 0.0658 | 0.0674 | 0.0500 | 0.1106 | 0.1143 | 0.0891 | 0.0928 | 0.1143 | 0.1143 |
| TR52 | 0.0158 | 0.0261 | 0.0187 | 0.0194 | 0.0101 | 0.0299 | 0.0699 | 0.0503 | 0.0139 | 0.0128 | 0.0432 | 0.0448 | 0.0407 | 0.0706 | 0.0658 | 0.1143 | 0.0827 | 0.0992 | 0.1074 |
| TR53 | 0.0153 | 0.0283 | 0.0379 | 0.0213 | 0.0107 | 0.0322 | 0.0583 | 0.0128 | 0.0265 | 0.0229 | 0.0542 | 0.0535 | 0.0500 | 0.0610 | 0.0553 | 0.0651 | 0.1143 | 0.0836 | 0.0951 |
| TR54 | 0.0194 | 0.0245 | 0.0210 | 0.0265 | 0.0112 | 0.0217 | 0.0644 | 0.0466 | 0.0242 | 0.0240 | 0.0500 | 0.0519 | 0.0468 | 0.0775 | 0.0638 | 0.0750 | 0.0809 | 0.0914 | 0.0996 |
| TR55 | 0.0199 | 0.0299 | 0.0382 | 0.0494 | 0.0219 | 0.0254 | 0.0503 | 0.0263 | 0.0423 | 0.0309 | 0.0386 | 0.0402 | 0.0361 | 0.0615 | 0.0521 | 0.0640 | 0.0727 | 0.0782 | 0.1090 |

### 4.5.5 Total Relation Matrix

| DRs | TR11 | TR12 | TR13 | TR14 | TR21 | TR22 | TR23 | TR31 | TR32 | TR33 | TR41 | TR42 | TR43 | TR44 | TR51 | TR52 | TR53 | TR54 | TR55 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TR11 | 0.2780 | 0.3012 | 0.2306 | 0.2314 | 0.1638 | 0.2949 | 0.1474 | 0.1460 | 0.1869 | 0.1328 | 0.0879 | 0.0891 | 0.0842 | 0.0989 | 0.0700 | 0.0706 | 0.0926 | 0.0900 | 0.1168 |
| TR12 | 0.2486 | 0.3186 | 0.2651 | 0.2085 | 0.1530 | 0.3149 | 0.1945 | 0.1271 | 0.1971 | 0.1332 | 0.1065 | 0.1080 | 0.1027 | 0.1243 | 0.0867 | 0.0903 | 0.1193 | 0.1107 | 0.1439 |
| TR13 | 0.2257 | 0.3036 | 0.2958 | 0.2193 | 0.1460 | 0.3000 | 0.1777 | 0.1125 | 0.2238 | 0.1548 | 0.1337 | 0.1348 | 0.1263 | 0.1496 | 0.1088 | 0.1089 | 0.1528 | 0.1380 | 0.1849 |
| TR14 | 0.2473 | 0.2671 | 0.2396 | 0.2777 | 0.1727 | 0.2565 | 0.1290 | 0.1177 | 0.2285 | 0.1706 | 0.1127 | 0.1150 | 0.1088 | 0.1231 | 0.0851 | 0.0911 | 0.1213 | 0.1211 | 0.1819 |
| TR21 | 0.2355 | 0.2676 | 0.2160 | 0.2329 | 0.2233 | 0.2593 | 0.1472 | 0.1135 | 0.1893 | 0.1352 | 0.1035 | 0.1045 | 0.0991 | 0.1140 | 0.0794 | 0.0810 | 0.1067 | 0.1018 | 0.1459 |
| TR22 | 0.2426 | 0.3113 | 0.2614 | 0.2076 | 0.1507 | 0.3089 | 0.2028 | 0.1294 | 0.2034 | 0.1412 | 0.1279 | 0.1296 | 0.1234 | 0.1453 | 0.1005 | 0.1080 | 0.1409 | 0.1307 | 0.1640 |
| TR23 | 0.2224 | 0.2995 | 0.2373 | 0.2022 | 0.1465 | 0.2941 | 0.3302 | 0.1447 | 0.2239 | 0.1688 | 0.2237 | 0.2261 | 0.2151 | 0.2690 | 0.1779 | 0.1934 | 0.2390 | 0.2439 | 0.2800 |
| TR31 | 0.2466 | 0.2899 | 0.2347 | 0.2248 | 0.1541 | 0.2810 | 0.2218 | 0.2579 | 0.2302 | 0.1702 | 0.2029 | 0.2083 | 0.1904 | 0.2471 | 0.1853 | 0.1812 | 0.2120 | 0.2290 | 0.2613 |
| TR32 | 0.2110 | 0.2609 | 0.2527 | 0.2390 | 0.1428 | 0.2545 | 0.1630 | 0.1153 | 0.2846 | 0.2127 | 0.1726 | 0.1736 | 0.1661 | 0.1731 | 0.1061 | 0.1085 | 0.1551 | 0.1490 | 0.2067 |
| TR33 | 0.2061 | 0.2367 | 0.2321 | 0.2512 | 0.1388 | 0.2297 | 0.1622 | 0.1038 | 0.3041 | 0.2626 | 0.2009 | 0.2021 | 0.1952 | 0.1973 | 0.1132 | 0.1188 | 0.1725 | 0.1715 | 0.2238 |
| TR41 | 0.1724 | 0.2220 | 0.2034 | 0.1937 | 0.1205 | 0.2212 | 0.3384 | 0.1807 | 0.2889 | 0.2414 | 0.4200 | 0.4211 | 0.4000 | 0.4498 | 0.2848 | 0.2799 | 0.3705 | 0.3742 | 0.4050 |
| TR42 | 0.1742 | 0.2251 | 0.2039 | 0.1968 | 0.1215 | 0.2232 | 0.3376 | 0.1928 | 0.2880 | 0.2408 | 0.4161 | 0.4192 | 0.3981 | 0.4510 | 0.2857 | 0.2815 | 0.3685 | 0.3767 | 0.4082 |
| TR43 | 0.1706 | 0.2218 | 0.1978 | 0.1940 | 0.1197 | 0.2221 | 0.3423 | 0.1673 | 0.2888 | 0.2434 | 0.4169 | 0.4200 | 0.4028 | 0.4446 | 0.2705 | 0.2754 | 0.3638 | 0.3679 | 0.3984 |
| TR44 | 0.1913 | 0.2537 | 0.2181 | 0.2053 | 0.1297 | 0.2436 | 0.3914 | 0.2408 | 0.2729 | 0.2254 | 0.4036 | 0.4094 | 0.3829 | 0.4816 | 0.3257 | 0.3219 | 0.3891 | 0.4243 | 0.4618 |
| TR51 | 0.2061 | 0.2709 | 0.2501 | 0.2178 | 0.1385 | 0.2582 | 0.3823 | 0.3287 | 0.2605 | 0.2080 | 0.3960 | 0.4019 | 0.3620 | 0.5023 | 0.3913 | 0.3763 | 0.4434 | 0.4793 | 0.5241 |
| TR52 | 0.2124 | 0.2781 | 0.2412 | 0.2258 | 0.1428 | 0.2766 | 0.3616 | 0.2387 | 0.2518 | 0.2007 | 0.3218 | 0.3269 | 0.3046 | 0.4003 | 0.2984 | 0.3600 | 0.3826 | 0.4089 | 0.4602 |
| TR53 | 0.2018 | 0.2680 | 0.2521 | 0.2186 | 0.1371 | 0.2671 | 0.3317 | 0.1829 | 0.2569 | 0.2051 | 0.3199 | 0.3222 | 0.3022 | 0.3708 | 0.2712 | 0.2915 | 0.3970 | 0.3720 | 0.4248 |
| TR54 | 0.2119 | 0.2701 | 0.2387 | 0.2296 | 0.1414 | 0.2620 | 0.3459 | 0.2278 | 0.2601 | 0.2108 | 0.3234 | 0.3286 | 0.3060 | 0.3981 | 0.2879 | 0.3094 | 0.3704 | 0.3898 | 0.4400 |
| TR55 | 0.2077 | 0.2679 | 0.2505 | 0.2483 | 0.1499 | 0.2580 | 0.3054 | 0.1909 | 0.2675 | 0.2078 | 0.2832 | 0.2878 | 0.2682 | 0.3474 | 0.2520 | 0.2737 | 0.3332 | 0.3451 | 0.4180 |

#### 4.5.6 Prominence, Relation and Relative Weights

| S.No. | DR | D | R | D + R (Prominence) | D – R (Relation) | Relative weight |
|---|---|---|---|---|---|---|
| 1 | TR11 | 2.9132 | 4.1122 | 7.0254 | -1.1989 | 0.0410 |
| 2 | TR12 | 3.1531 | 5.1342 | 8.2873 | -1.9810 | 0.0484 |
| 3 | TR13 | 3.3970 | 4.5211 | 7.9181 | -1.1241 | 0.0462 |
| 4 | TR14 | 3.1669 | 4.2246 | 7.3916 | -1.0577 | 0.0432 |
| 5 | TR21 | 2.9557 | 2.7930 | 5.7487 | 0.1627 | 0.0336 |
| 6 | TR22 | 3.3298 | 5.0258 | 8.3555 | -1.6960 | 0.0488 |
| 7 | TR23 | 4.3376 | 5.0123 | 9.3500 | -0.6747 | 0.0546 |
| 8 | TR31 | 4.2287 | 3.3185 | 7.5472 | 0.9102 | 0.0441 |
| 9 | TR32 | 3.5475 | 4.7072 | 8.2547 | -1.1596 | 0.0482 |
| 10 | TR33 | 3.7228 | 3.6656 | 7.3884 | 0.0572 | 0.0431 |
| 11 | TR41 | 5.5879 | 4.7733 | 10.3612 | 0.8145 | 0.0605 |
| 12 | TR42 | 5.6089 | 4.8282 | 10.4372 | 0.7807 | 0.0609 |
| 13 | TR43 | 5.5282 | 4.5379 | 10.0661 | 0.9903 | 0.0588 |
| 14 | TR44 | 5.9724 | 5.4878 | 11.4602 | 0.4846 | 0.0669 |
| 15 | TR51 | 6.3977 | 3.7806 | 10.1783 | 2.6171 | 0.0594 |
| 16 | TR52 | 5.6931 | 3.9215 | 9.6146 | 1.7717 | 0.0561 |
| 17 | TR53 | 5.3930 | 4.9305 | 10.3235 | 0.4625 | 0.0603 |
| 18 | TR54 | 5.5518 | 5.0239 | 10.5757 | 0.5280 | 0.0617 |
| 19 | TR55 | 5.1625 | 5.8498 | 11.0123 | -0.6873 | 0.0643 |

#### 4.5.7 Adjusted QFD Scores Using Correlation Matrix

| Design Requirement | QFD Weight | Conflict Penalty | Synergy Reward | Adjusted Score | Normalized Score |
|---|---|---|---|---|---|
| TR12 | 0.041 | 0 | 0.1824 | 0.2234 | 0.0457 |
| TR13 | 0.0484 | 0 | 0.175 | 0.2233 | 0.0456 |
| TR14 | 0.0462 | 0.1214 | 0.1906 | 0.1155 | 0.0236 |
| TR21 | 0.0432 | 0 | 0.1762 | 0.2193 | 0.0448 |
| TR22 | 0.0336 | 0 | 0.2129 | 0.2465 | 0.0504 |
| TR23 | 0.0488 | 0 | 0.1983 | 0.2471 | 0.0505 |
| TR31 | 0.0546 | 0 | 0.201 | 0.2556 | 0.0522 |
| TR32 | 0.0441 | 0 | 0.2707 | 0.3147 | 0.0643 |
| TR33 | 0.0482 | 0 | 0.3252 | 0.3734 | 0.0763 |
| TR41 | 0.0431 | 0 | 0.2579 | 0.3011 | 0.0615 |
| TR42 | 0.0605 | 0 | 0.353 | 0.4135 | 0.0845 |
| TR43 | 0.0609 | 0 | 0.3241 | 0.385 | 0.0787 |
| TR44 | 0.0588 | 0 | 0.2162 | 0.275 | 0.0562 |
| TR51 | 0.0669 | 0.0231 | 0.2213 | 0.2651 | 0.0542 |
| TR52 | 0.0594 | 0.0231 | 0.1998 | 0.2362 | 0.0483 |
| TR53 | 0.0561 | 0.0231 | 0.1438 | 0.1768 | 0.0361 |
| TR54 | 0.0603 | 0.0231 | 0.1235 | 0.1607 | 0.0328 |
| TR55 | 0.0617 | 0 | 0.1533 | 0.215 | 0.0439 |
| DR19 | 0.0643 | 0 | 0.1813 | 0.2456 | 0.0502 |

# 5. RESULTS AND DISUSSION

This study aimed to redesign the service delivery framework of the Transport Department by integrating Quality Function Deployment (QFD), Axiomatic Design, and the Decision-Making Trial and Evaluation Laboratory (DEMATEL). The results obtained at each methodological stage provide valuable insights into the prioritization, interdependence, and strategic leverage of various design requirements (DRs) across functional dimensions.

## 5.1 Prioritized Design Requirements through QFD

Through systematic mapping of Customer Requirements (CRs) and Design Requirements (DRs), the QFD process initially established the relative importance of each DR. The relationship matrices between CRs and DRs (as presented in Tables 1-5) provided a foundational understanding of how each design element contributes to service delivery across five strategic dimensions: Licensing and User Accessibility, Support and Compliance Services, Safety and Emergency Management, Penalty Management, and Public Awareness.

This phase helped identify the DRs with high customer impact, such as:

- TR12 (Standardized and Transparent Process Workflows)
- TR13 (Real-Time Service Delivery System)
- TR22 (Process Clarity and SLA Framework)

These emerged as key enablers of improved user experience and administrative clarity, demonstrating the power of the QFD method to align technical responses with user expectations.

## 5.2 Coupling Analysis via Axiomatic Design

The coupling matrix derived using axiomatic logic exposed intricate interdependencies among DRs. The weighted coupling matrix (Step-6.2) highlighted DRs that are technically interconnected, with notable coupling observed between:

- TR22 and TR32 (Process Clarity ↔ Digital Payment Systems)
- TR41 and TR44 (Penalty Violation ↔ Predictive Analytics)

These findings underscore the complexity inherent in public service design, where a change in one DR can ripple across others, making it crucial to identify modular and decoupled solutions.

### 5.3 Influence Structure from DEMATEL

By transforming the coupling matrix into a scaled influence matrix and applying DEMATEL (Steps-6.3–6.6), both direct and indirect influences among DRs were captured. The resulting Total Relation Matrix enabled the derivation of systemic metrics – prominence (D + R) and net relation (D − R) – to distinguish cause from effect requirements.

**Noteworthy insights include:**

- Cause DRs (D − R > 0):
  - TR21 (Guided Registration Support)
  - TR31 (Transparent Information Dissemination)
  - TR41 (Violation Detection System) These serve as leverage points to trigger broad system-level improvement.
- **Effect DRs (D − R < 0):**
  - TR13, TR22, TR32

These are highly influenced by other DRs, requiring careful coordination in implementation.

**The highest prominence scores were found in:**

- TR44 (Offender Behaviour Profiling)
- TR55 (Emergency Response Services)

These DRs are structurally central and thus critical in any service transformation initiative.

### 5.4 Final Prioritization: Adjusted QFD Scores

To refine the prioritization further, adjusted QFD scores were computed by factoring in conflict penalties and synergy rewards based on DR–DR correlations (Step 7). This adjustment reveals the net systemic value of each DR by penalizing negative interactions and rewarding synergies.

The top-ranked DRs after adjustment include:

- TR42 (Automated Offense Notification Engine) — *Adjusted Score: 0.4135*
- TR33 (Dynamic Tax & Incentive Policy Engine) — *Adjusted Score: 0.3734*
- TR43 (Penalty Escalation & Grievance Module) — *Adjusted Score: 0.3850*

Interestingly, DRs like TR14 (Multi-Channel Access Infrastructure) saw a reduced adjusted score (0.1155), suggesting that despite their standalone importance, systemic coupling may limit their net impact unless supported by foundational DRs.

### 5.5 Strategic Interpretation

The integration of QFD with Axiomatic Design and DEMATEL provided a multidimensional understanding of service design prioritization:

- QFD captured the voice of the user.
- Axiomatic Design ensured structural logic and independence.
- DEMATEL revealed systemic feedback and influence dynamics.

This synergy led to objective, data-backed prioritization, providing clear guidance for resource allocation, sequencing of design implementation, and policy alignment.

Overall, this approach supports evidence-based public service design, particularly in high-complexity environments like transport, where user satisfaction, compliance enforcement, and responsiveness must be balanced within constrained administrative ecosystems.

## 6. CONCLUDING REMARKS

This study presented an integrated methodological framework combining Quality Function Deployment (QFD), Axiomatic Design, and the DEMATEL technique to prioritize and structure design requirements for enhancing the efficiency and responsiveness of transport service delivery systems. By systematically capturing user needs, identifying technical interdependencies, and evaluating causal-influence relationships among design requirements, the study offers a holistic decision-support model for public sector service redesign.

The findings underline the critical importance of not only identifying high-priority design features based on customer perception but also understanding how these features interact and influence one another within a complex administrative ecosystem. The coupling analysis through axiomatic design revealed the structural dependencies that must be addressed to avoid inefficiencies during implementation. Furthermore, DEMATEL analysis provided a strategic lens to identify core leverage points in the system—design requirements that, when improved, have the potential to trigger broader systemic improvements. The computation of adjusted QFD scores incorporating both conflict penalties and synergy rewards added a valuable dimension of decision sensitivity, enabling more refined prioritization of design alternatives.

The methodological rigor and analytical clarity offered by this integrated approach can be generalized beyond transport services to other public administration domains such as healthcare, urban governance, and digital citizen services. However, while the framework is robust, certain limitations provide avenues for future exploration. Firstly, the current study is based on expert-driven evaluations and assumed stable stakeholder preferences; future studies may incorporate dynamic feedback loops or longitudinal user satisfaction data to better reflect evolving needs. Secondly, the conflict and synergy adjustments were computed based on correlation thresholds; machine learning or network theory-based models could offer more granular and adaptive approaches to capture interdependencies. Thirdly, the framework can be extended into implementation-level decision-making by integrating it with optimization techniques such as goal programming, multi-objective linear programming, or system dynamics modelling to derive actionable plans within resource constraints.

In essence, this research lays a foundation for structured, system-aware service design in the public sector and opens up exciting possibilities for blending user-centric quality frameworks with systems thinking, data analytics, and operational research for more agile, transparent, and citizen-responsive governance models.

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**Model Calculation**

**Design requirements (DRs):**

- DR1
- DR2
- DR3

QFD weights:

- DR1: $W_1 = 0.35$
- DR2: $W_2 = 0.30$
- DR3: $W_3 = 0.33$

**Correlation matrix *C*:**

| | DR1 | DR2 | DR3 |
|---|---|---|---|
| DR1 | 1.0 | 0.5 | -0.3 |
| DR2 | 0.5 | 1.0 | 0.2 |
| DR3 | -0.3 | 0.2 | 1.0 |

**Conflict Penalty Calculation**

We consider only negative correlations $C_{jk} < 0$.

Formula for DR $j$:

$$\text{Penalty}_j = \sum_{k \neq j, C_{jk} < 0} W_k \cdot | C_{jk} |$$

**DR1:**

- $C_{13} = -0.3$, $W_3 = 0.33$
- $\text{Penalty}_1 = 0.33 \cdot 0.3 = 0.099$

**DR2:**

- No negative correlation
- $\text{Penalty}_2 = 0$

**DR3:**

- $C_{31} = -0.3$, $W_1 = 0.35$
- $\text{Penalty}_3 = 0.35 \cdot 0.3 = 0.105$

**Synergy Reward Calculation**

We consider only positive correlations $C_{jk} > 0$.

Formula:

$$\text{Reward}_j = \sum_{k \neq j, C_{jk} > 0} W_k \cdot C_{jk}$$

**DR1:**

- $C_{12} = 0.5$, $W_2 = 0.30$
- $\text{Reward}_1 = 0.30 \cdot 0.5 = 0.150$

**DR2:**

- $C_{21} = 0.5$, $W_1 = 0.35$
- $C_{23} = 0.2$, $W_3 = 0.33$
- $\text{Reward}_2 = 0.35 \cdot 0.5 + 0.33 \cdot 0.2 = 0.175 + 0.066 = 0.241$

**DR3:**

- $C_{32} = -0.2$, $W_2 = 0.30$
- $\text{Reward}_3 = 0.30 \cdot 0.2 = 0.060$

$$\text{Final score}_j = W_j - \text{Penalty}_j + \text{Reward}_j$$

| DR | $W_j$ | Penalty | Reward | Final Score |
|---|---|---|---|---|
| DR1 | 0.35 | 0.099 | 0.150 | 0.401 |
| DR2 | 0.30 | 0.000 | 0.241 | 0.541 |
| DR3 | 0.33 | 0.105 | 0.060 | 0.285 |