



# SELECTED PROCEEDINGS

## METHODOLOGIES FOR QUALITY ASSESSMENT OF HIGHWAY OPERATORS BASED IN GOVERNANCE BEST PRACTICES WITH EMPHASIS ON TOLL COLLECTION ECOSYSTEM

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*Methodologies for quality assessment of highway operators based in governance best practices with emphasis on toll collection ecosystem*

# **METHODOLOGIES FOR QUALITY ASSESSMENT OF HIGHWAY OPERATORS BASED IN GOVERNANCE BEST PRACTICES WITH EMPHASIS ON TOLL COLLECTION ECOSYSTEM**

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## **ABSTRACT**

The service quality and the user fulfillment are the main targets that the highway operators need to take into account in their business plan; moreover, a healthy financial stability is critical to the harmony of this environment. In this sense, the toll collection system has a key role for the highway's operations sustainability. It is necessary to remember that the Toll Collection System is an ecosystem that involves the quality and maturity of operations, business processes, institutional aspects, and equipment maintenance and infrastructure

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management. The creation of a methodology for quality assessment of the entire Toll Collection ecosystem allows the establishment of quantitative and qualitative parameters, which may be monitored and evaluated, therefore, enabling useful tools for the operator's decision-making process and government agencies assessments.

*Keywords: ITS, Toll Collection, Governance, highway management*

## **1. INTRODUCTION**

In the last decades, investments of the Government of the State of São Paulo in its Roads and Highway Systems were not enough to keep pace with growth on traffic volumes and changing patterns of road transportation business.

To increase the speed of investments in the modernization of the State Road Infrastructure and improve the quality of services to users, the state Government initiated the transfer of management of key highways to private companies, under the terms of Bill 9.361 signed on 5<sup>th</sup> July 1996. With the transfer to the private sector of part of the public infrastructure, there was a need to set up an organization to serve not only as a watchdog, but as a mediator between the public authorities (State Government), the Highway Operators and users of the highways network in the State of São Paulo.

Therefore, the Regulatory Agency for Delegated Transportation Services in the State of São Paulo - ARTESP was created in 2002. Its primary goal is to ensure compliance with the rules governing delegated public services and ensure the implementation of clauses in contracts celebrated between the State and the private operator.

Efficiency in operation and management of highways are among the requirements of contracts for concessions. Among ARTESP's duties are the confirmation of modernization works and expansion of the road infrastructure and services, compliance with risk reduction program, and running and maintenance of highways according to international quality standards.

Quality assessment has to be based on best practices, rapid implementation and classic models so that the evaluation process costs do not compromise benefits. Studies of quality assessment of urban transportation systems [1] highlight the difficulty of running and maintaining quality programs, which may take years before its full implementation.

Furthermore, studies [2] and [3] highlight that assessment results are the first step in the decision-making processes of policy makers in the airline industry or any other regulated sector. Under scrutiny are the differences in the efficiency of governance frameworks. The

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authors emphasize the role of infrastructure managers, government agencies and researchers in developing models that examine different stakeholders' requirements.

As a consequence of the foregoing considerations, this paper presents a methodology developed to establish an assessment and governance model based on best practices, inspired on the Reference Architecture Control Objectives for Information and related Technology (COBIT) [4], guide recommended by the Information Systems Audit and Control Association (ISACA) for the Management of Information Technology (IT). Policy makers need the information to determine differences in the efficiencies of the governance structure, the performance of operations and infrastructure management, and fulfillment of different stakeholder's expectations [5].

The methodology defines business objectives and evaluation criteria, establishes metrics for analysis (Performance and target Indicators, and critical success factors), and organizes its activities around dominions, processes and activities. Special attention is given to the evaluation of management assets that, in IT case, are represented by software applications, information databases, IT infrastructure and human resources.

The application of this architecture for the transport business, more specifically the governance of Toll Collection Systems of conceded highways in the State of São Paulo, was carried out by a multidisciplinary team with experts from research institutes, Transportation Regulatory Agency, and consultants working in strategic areas of the road transportation business.

The methodology presented here may help in catching control weaknesses that are undesirable in toll collection systems. It is useful to assess the user's satisfaction of conceded roads as it will affect citizen's perceptions of public authorities' performance.

This paper is organized in five sections. The following section describes the reference model for the assessment of quality of services provided by toll collection systems of highway operators. Section three describes how the evaluation process is conducted using a bottom up approach, starting analyzing how effective the basic activities are performed, clustering activities into processes, processes into domains, and, finally, assessing the overall operation. Section four presents the results from the application of the proposed model in twelve Highway Operators from the São Paulo state highway system, from 2008 to 2012. Section five presents the conclusions and future works.

## 2. REFERENCE MODEL

The methodology was designed following the same principles and guidelines sponsored by CobIT, assimilating the method of aggregating Activities into Processes, Processes into Domains, and Domains into the overall evaluation. Balanced scorecard techniques were used to quantify the scores for all assessments made in the evaluation process. The application of the proposed method in all 12 private operators of the state of São Paulo allowed benchmarking their performance against each other and with a reference level of quality defined by ARTESP.

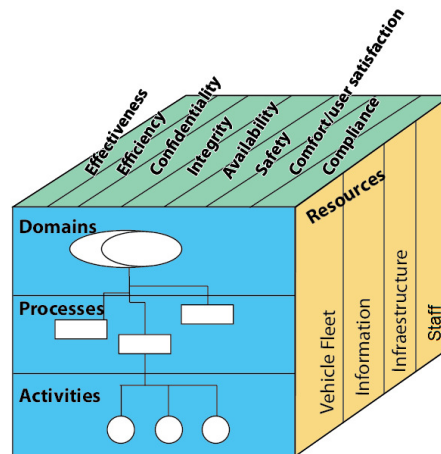


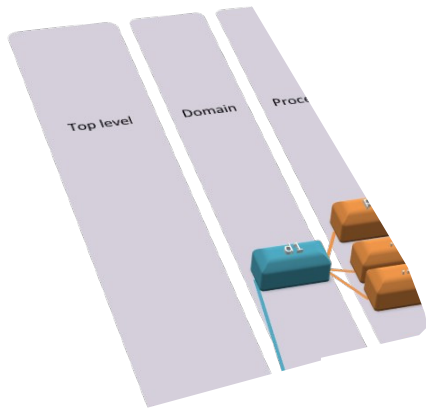
Figure 1 –Reference Model. Source: Adapted from [4]

As shown in Figure 1 –Reference Model. Source: Adapted from [4], all the activities are clustered in business processes using the same technique used by CobIT. Similarly, those business processes are gathered in domains as presented in the frontal face of the cube. On the upper side of the cube are the Criteria by which the activities are evaluated, which were imported from CobIT and adapted to the transportation sector: Effectiveness, Efficiency, Confidentiality, Integrity/ Authenticity, Availability, Safety, Comfort/user satisfaction, and Compliance. Finally, the other face of the cube presents "Resources" used for activities within the toll collection system.

This structure encompasses, horizontally, five higher orders of analysis called Domains. A domain is a cluster of process control variables, each of which comprises a group of discrete activities. Thus, we selected five (5) Domains to cover all the processes that provide support to the Toll Collection System: Institutional, Operational, Toll Collection, Maintenance and Infrastructure (Table 1). The frontal face of Figure 21 presents the hierarchical structure from

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this model. Processes are aggregations of key activities for Toll Collection Systems; a total of 86 activities have been defined. The preview from hierarquical as shown in Figure 2.



<b>Domains</b>
d1. Institutional
d2. Operational
d3. Maintenance
d4. Toll Collection
d5. Infrastructure
<b>Processes</b>
...
p6. Structure of Customer Services
...
p13. Structure of Maintenance Service
....
p16. Analysis of Tier 1
p17. Analysis of Tier 2
p18. Analysis of Tier 3
...
<b>Activities</b>
...
a21. Equipment and procedures, opening and closing of lanes
a22 Log and tracking of incidents
a23 Toll booth operators scheduling
a24 Quality of customer service
...
a40. Equipment and procedures
a41.Maintenance Tracking
a42. Management and revenue model
....

Table 1 – Domains, quantity of Process and Activities

Figure 2. Hierarchical structure for governance

**Quantity of Processes**

5  
6  
4  
4  
4

The definition of the activities and how they should be analyzed represent the core knowledge of the proposed model. They were defined based on the regulations and rules described on contracts and agreements between operators and ARTESP, and on International Standards [6]. Additionally, they embody the expertise accrued from previous works [7] done during the period from 2002 to 2008.

For demonstration purpose, this paper discusses the leading Domains, some of its constituent processes and their main activities.

In the ***Institutional Domain*** are examined the company Policies and Procedures registered in the Quality Management System. For this domain, the investigation is centered on the organizational structure adopted for the management of operation, maintenance and toll collection at the toll plazas. Also considered are the tools used in the development of controls and services mentioned above, as well as the qualification of the personnel. The governance model and the organizational culture, which support and interact with the Toll Collection Systems, are essential to guarantee effectiveness and quality in services provided. It also should address user needs for comfort and safety and commitments made to the conceding authority.

In the ***Infrastructure Domain***, the investigation is centered on the infrastructure (resources contemplated only within the toll plaza system) since it is considered a public good and should be managed by the operator within quality standards to guarantee perfect performance of services on toll collection plaza. The perception of quality of service by the user is closely linked to the quality of infrastructure, e.g. toll facilities, signaling system and plaza cleanliness. Special attention is dedicated to the communication antennas used on the Tolling Systems since its position is affected by installation conditions and traffic vibration. All antennas are subject to measurements regarding its position and its radiation lobe. This is crucial in order to obtain a secure communication with the vehicle transponder.

In the ***Operation Domain***, the investigation is centered on the evaluation of actions, procedures and operational strategies to support Toll Collection operation and a smooth flow of traffic, guaranteeing user comfort and security at the toll plazas. The proper operation of the plazas is one of the cornerstones in management of traffic flow on the highway, where operational model aims at meeting demand - at different traffic volumes - and be ready to assist contingency processes, always taking into account the best practices and better customer care.

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In the ***Maintenance Domain***, the analysis is centered on the evaluation of the efficacy of the management and maintenance of the service structure at the toll plazas. As required by contract, all equipment must be kept in proper operational status, taking into account the operation standards and the revitalization policies for updating and incorporating new technologies into installed park.

Technical maintenance services effectiveness is regarded as a key factor in Highway Concession Program of the State of São Paulo since all infrastructure managed by the operator are considered public property and should be returned in perfect conditions at the end of the concession period. The assessment of the management of maintenance services signals the obsolescence of electronic resources, as well as any deviations from the obligation to maintain and update the public patrimony.

In the ***Toll Collection Domain***, the analysis is centered on the Toll Collection business processes adopted by the Highway Operator, which also includes systems and the *modus operandis* at the toll plazas. Also, is concerned with the generation of revenues to cover operational and maintenance costs, as well as ensure the financial health of the Highway Operator.

### **3. EVALUATION MODEL**

The proposed model is implemented with a bottom-up approach (Figure 3). The evaluation process starts with activities, then goes up to processes, domains and the whole entity.



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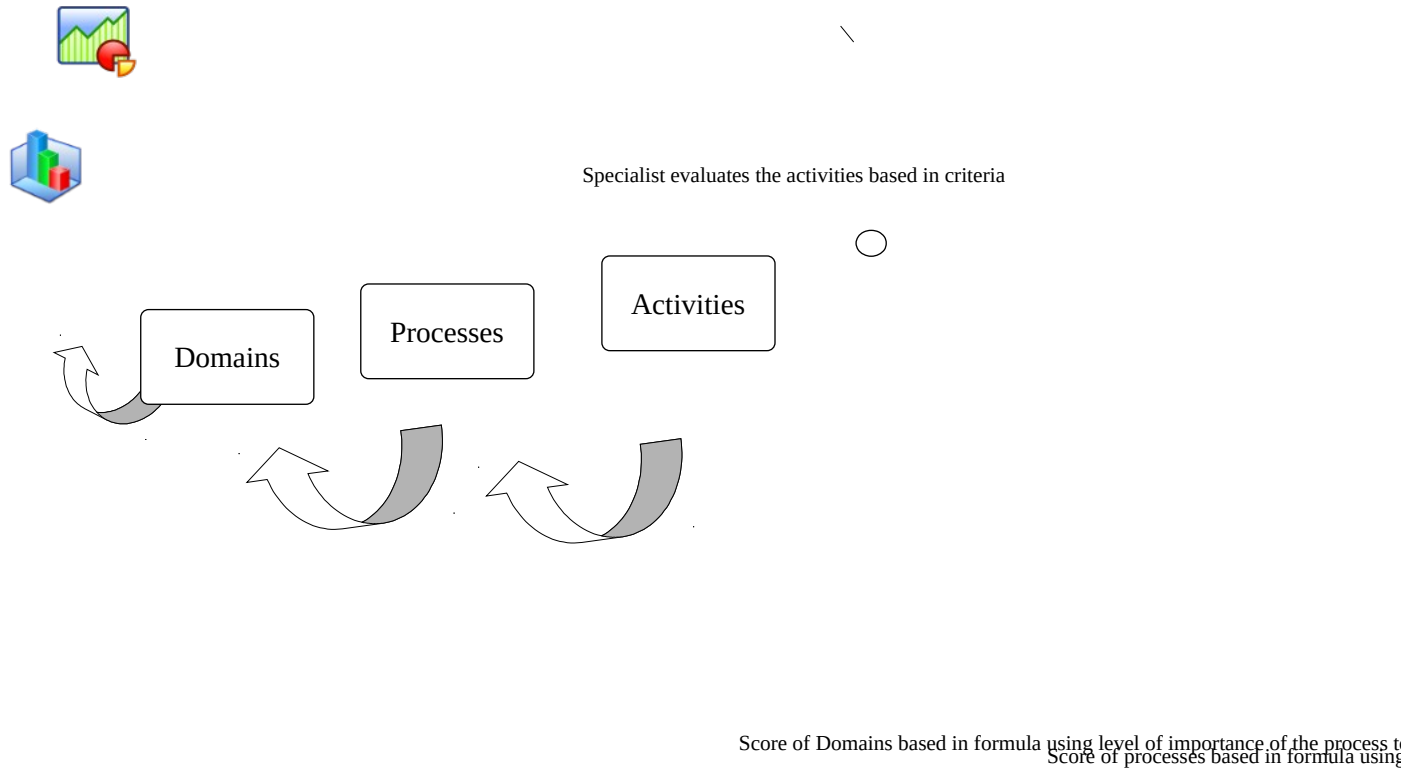


Figure 3 – Evaluation process diagram

Each activity is evaluated according to an appropriate sub set of the criteria defined for the model. The evaluation process is based in four "quality levels". These levels reflect the quality of execution of the activity by the service operator: "c" (critical – score: zero); "i" (insufficient - score: three); "s" (suitable – score: seven) and "b" (better than expected – score: ten). At the time of the evaluation of a given activity, the analyst will pay attention only to the criteria under which it should be evaluated. Any deviation from the middle score, in the sense of excess (b) or deficiency of quality (c or i) is annotated and commented upon, in order to characterize the score deviation in relation to the expected value. The analyst may add photos to illustrate his comments. Once all the activities are evaluated, the process goes one-step further, to the level of processes.

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Each process is attached to a sub set of activities. The score of the process is calculated adding the scores of each related activity multiplied by an importance weight. The sum of importance weights for the process should equal one.

$$\text{Score of Process (k)} = \frac{\sum_{i=1}^j \text{Activity importance weight (i)} * \text{Activity score (i)}}{\sum_{i=1}^j \text{Activity importance weight (i)}} \quad (1)$$

*j represents the quantity of activities in process (k)*

In a similar way, the score of one domain is calculated from the scores of processes attached to it:

$$\text{Score of Domain (k)} = \frac{\sum_{i=1}^j \text{Process importance weight (i)} * \text{Process score (i)}}{\sum_{i=1}^j \text{Process importance weight (i)}} \quad (2)$$

*j represents the quantity of processes in Domain(k)*

Finally, the score of transport Highway Operator is derived from the scores of all domains:

$$\frac{\sum_{i=1}^j \text{Domain importance weight (i)} * \text{Domain score (i)}}{\sum_{i=1}^j \text{Domain importance weight (i)}} \quad (3) \quad j = 5(\text{domains}).$$

The methodology presented allows the assessment of Highway Operators based on a single model. The result of the evaluation provides an operational overview of the quality offered by the Highway Operators, which will serve as a basis for decision-making by Government Agencies, as well as a valuable input for quality improvement programs in areas with critical or insufficient scores. The approach to present results certainly helps decision makers to understand the value and different points of view of the quality of services (Figure 4).

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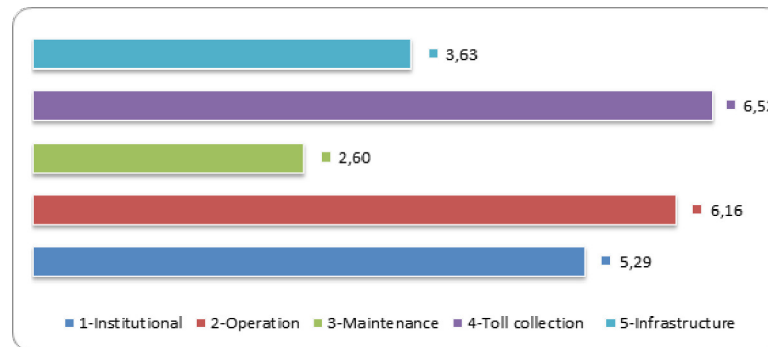


Figure 4. Results by Domains

The Highway Operators, like any services provider in the current competitive environment, must constantly seek improvements in all domains.

## 4. DEPLOYMENT AND RESULTS

With the program of road concessions in the State of São Paulo, Brazil, almost 5,400 kilometers of highways began to be managed, operated and economically exploited by the private initiative. These concessions are responsible for a large percentage of the Average Daily Volume (ADV) and consequently of fundamental importance in the movement of goods and people in the State of São Paulo.

The methodology was applied in 12 Highway Operators in the State of São Paulo during the period from February 2008 to January 2012, considering continuous two weeks visit in each operator to the premises of toll plazas. The evaluation process included face-to-face interviews with managers and operators of the toll collection system, assessment of operational actions and events, and assessment of other systems that interact with it. The Figure 5 presents the final scores of assessment received by the twelve operators.

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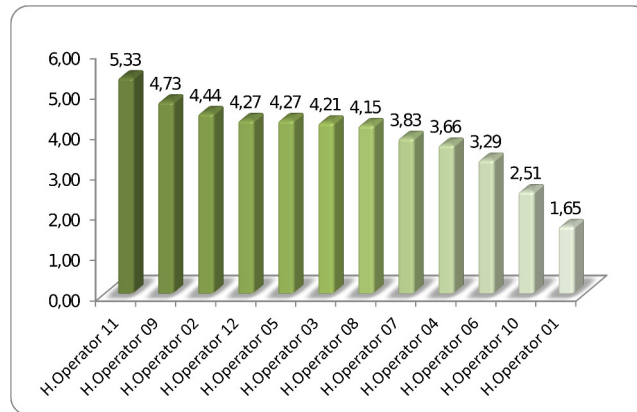


Figure 5. Benchmark of Highway Operators

During the evaluation, it was realized the need to return to the inspection site, after a period of at least one year, to monitor the results of the measures taken after the improvements identified by the initial application of the model. On this occasion, besides allowing the Highway Operators show the measures adopted in solving the problems pointed out in the First Phase of the Project, it was reassessed the effectiveness of all activities through new field interviews, personal observation and document analysis. In the "Action plan for problem resolution", the Highway Operators list the steps taken to solve the deficiencies found in the previous phase. Each activity was scored according to the effectiveness of the action taken as: Problem Solved, Problem Partly Solved, No Providence and Degraded (Figure 6). The critical and insufficient activities in the first study, 38% were solved and 37% partially solved, demonstrating the usefulness of taking corrective actions. These numbers demonstrate the usefulness of the quality assessment programs to improve quality of services offered by highway operators in the state of São Paulo.

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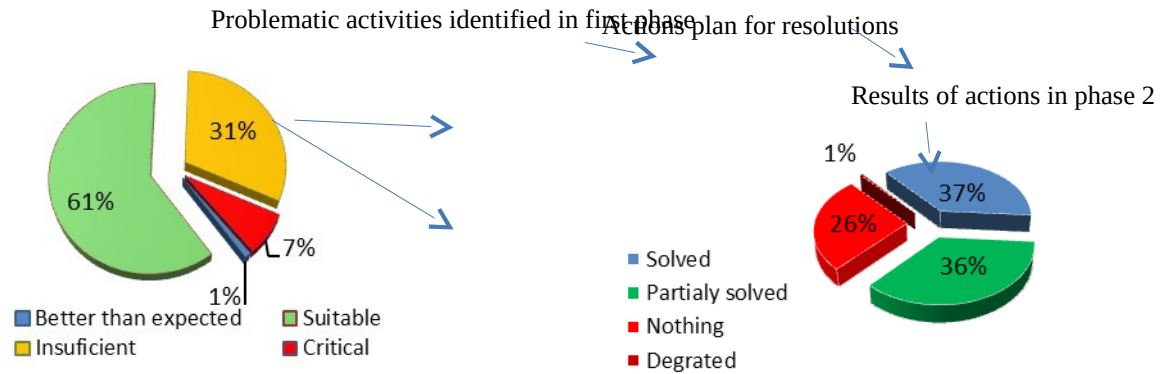


Figure 6 – Results from the approach between Phase 1 (critical and insufficient) and Phase 2

## 5. CONCLUSION

This paper presents a methodology for the evaluation of the effectiveness of toll collection systems as implemented by Highway Operators under concession contracts with the Government of the state of São Paulo.

The application of the model to 12 Highway Operators gives to government authorities and regulatory agencies such as ARTESP, a benchmark of the quality of services actually offered to the user population.

Given the goals for quality levels established by ARTESP, the assessment results give a clear picture of areas of attention for each operator in the continuous improvement program they should adopt to reach their own-targeted goal.

This methodology also enables the Highway Operator to evaluate their own business model. Consequently, they can identify, improve and/or modify any weaknesses in the various areas, not only to be in accordance with regulation constraints.

It is expected, from carrying out periodic evaluations, not only improvements in the effectiveness of activities performed, but also a significant increase in process maturity, which results in a gain not only for utilities. Another byproduct is the possibility of the improvement of regulations requirements of Highway concessions.

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This model was developed for ARTESP, but had the secondary effect of helping highway operator managers to improve the quality of service.

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