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# Fuzzy linguistic approach to quality assessment model for electricity network infrastructure



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## ABSTRACT

In the modern service economy, the consumer satisfaction is one of primary objectives that a company aims at achieving. Successful companies offer high quality of products or services in order to meet the consumers' expectation, and, at the same time, they safeguard their own profits and increase market competitiveness. The consumer satisfaction is an indicator to estimate how likely a customer will make a purchase in the future and it is used as a metric very useful in managing and monitoring the company businesses. To address this issue, we present QuAM (Quality Assessment Model), a model for evaluating the overall quality and value of services supplied by a company, through the analysis of the consumer satisfaction. The quality is measured indeed, by the definition of some subjective criteria that are collected through a question form filled in by the consumers. The consumers' judgments about the supplied items/services allow evaluating the reputation as well as the success of a company. In this work, QuAM has been applied in the electricity network domain, in order to assess an electricity company. In this domain, the overall evaluation of the organization is based on measuring service quality in terms of response times and cost. The quality of service often comes at a cost, with a concern that the pursuit of profit incentives by utilities may have a negative effect on the quality of service. The role of customers is crucial to estimate a market demand curve for service quality, and maximize the customers satisfaction means increasing profitability, productivity and the corporate image. QuAM has been designed by exploiting a fuzzy linguistic approach along with the Computing with Words (CWW) paradigm: the customers feedbacks are modeled through linguistic labels, which naturally fit to describe human judgments; then a linguistic operator LOWA (Linguistic Ordered Weighted Averaging) allows aggregating all the collected judgments into a synthetic linguistic expression. Finally, heuristic measures enable a comprehensive company evaluation.

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## 1. Introduction

In the present-day business world, the main challenge a company must face is to find business opportunities and strategies that raise the market value above the cost of capital needed to finance the business choices. Then, a company must maintain a productive workflow, that is, more effective, more efficient and more capable of adapting to the changing environment; moreover it must optimally plan and dispatch the available resources [1]. Efficiency and effectiveness are two sides

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of the same coin: the balancing of this two indexes allows assessing and measuring the performance of an organization, even though the company's success is often measured in term of efficiency rather than effectiveness in a business network [15]. To achieve objectives such as Customer Satisfaction and maximum resource utilization, it is important to have adequate means of efficiently managing the company and assuring that the produced plan always gives a better choice at marketing strategy level. Particularly, the Customer Satisfaction with the service on-site, as well as on the Web, is a subjective assessment of service effectiveness, and can be considered the fulcrum of the success in today's high competitive world of business [9]. Companies should continuously assess their services quality to ensure that they are managing the customers' expectations effectively. Service quality (QoS) is the key to measure Customer Satisfaction [14]: as service effectiveness improves, the probability of Customer Satisfaction also increases [6]. Another measure that recently has been widely used in the on-line communities, is the Quality of Experience (QoE) [26,27]. It is strongly correlated to the Customer Satisfaction. It enables the service evaluation by means of objective psychological variables in addition to subjective variables of more traditional measures. QoE is frequently used in a technical context and "refer(s) to the overall acceptability of an application or service, as perceived subjectively by the end user" [26].

This paper introduces QuAM (Quality Assessment Model). It is a model for the quality assessment that is based on the assumption that "only customers judge quality; all other judgments are essentially irrelevant" [3,4]. It is inspired by an existing service quality tool, called SERVQUAL (SERVice QUALity), developed to assess customer perceptions of service quality in service and retail businesses [13]. SERVQUAL defines five factors which describe the service quality and models service quality as the gap between a customer's expectations for a service supplied and the customer's perceptions of the service received.

Similarly, our model QuAM aims at evaluating the quality of the services supplied by a company, by analyzing the consumers' judgements, in response to the provision of the services. The quality is measured by defining some subjective and specific criteria that are collected through a questionnaire, completed by the consumers. The consumers can express personal opinions about the provided item/service. QuAM evaluates the Customer Satisfaction (CS) and the Service Productivity (SP). These two measures provide a wider view of the well-being of the company, based on the quality of the services supplied. It can be considered a proficient support for the business process and the workforce management in order to increase the profits and market competitiveness of big companies, with the consequent boosting in the corporate brand and consumers' fidelity.

Our model has been applied in the electricity network domain. The complexity of the electricity network infrastructure needs constant maintenance and the asset management is cumbersome and expansive. Thus it is required a highly-productive management to deliver continuous services which meet the customer requirements and standards. For electricity providers, the nature of the product delivery can require a high level of service response time [2]. Since the electricity networks are key infrastructures of the modern life, their failure will probably paralyse a whole area. Thus, in case of the emergency, the electric power must be immediately re-established. In an idealized competitive electricity market, customers would choose a network provider offering a level of service quality that matches their expectation and mainly their willingness to pay for it. The role of customers is crucial for determining a market demand curve for service quality and maximize the customers satisfaction means increase profitability productivity and the corporate image.

To address this issue, QuAM has been used to evaluate the services productivity of the electricity company through the analysis of the customers' satisfaction; specifically, it provides the information that would allow us to evaluate:

- Customer Satisfaction: described as a gap between the perceived and desired quality. The model achieves this evaluation, by the answers provided in the questionnaire by the consumers. Due to the subjective nature of the customers evaluations, the typical cardinal scale is replaced by fuzzy linguistic variables that better represent the imprecise nature of the human language.
- Service quality and productivity: two strongly interrelated measures of good performances in service companies, respectively from the customer and provider stakeholder perspective.
- Corporate image: described by the customer global expectations and the perceived value of the supplied services.

The paper is organized as follows: Section 2 gives a brief literature review; Section 3 introduces QuAM, by describing the whole the model process; then Sections 4–6 describe each stage that compounds the comprehensive process, along with the associated theoretical background; Section 7 is devoted to show an example of scenario in the electricity network domain. Experimental results, discussion and conclusion close the paper.

## 2. Related work

The assessment of the service quality is strongly affected by two well-known variables: the expected (desired) service and the perceived service [29]. Perceived service quality is the user's evaluation of the performance of the received service and its comparison with the expected one. These evaluations are objective and not based on service attributes, because they reflect the users' perceptions and feelings [30].

Service quality has been defined by considering mainly two schools of thought [36]: one described service quality using categorical terms and divided the construct into different dimensions [31]: the technical dimension (what), the functional

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