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RESEARCH PAPER

Indicators and performance requirements for suppliers' evaluation in the Brazilian electricity sector

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ABSTRACT

Objective: This paper presents a conceptual model comprising performance indicators designed for evaluating suppliers in companies within the electricity sector.

Design / Methodology / Approach: The conceptual model was developed based on articles identified from Scopus and Web of Science, which provided indicators and their associated requirements, validated by both academics and practitioners. A multiple case study method was applied, and interviews were conducted with nine participants from six leading companies, which had the highest revenues in the electricity sector in Brazil. The interviews were semistructured and administered remotely. For data analysis, the authors assessed the alignment of the the indicators with the essential requirements for suppliers' evaluation. This evaluation was carried out using the Lawshe's (1975) scale, the Content Validity Ratio (CVR), and the critical CVR (Wilson et al., 2012).

Results: The conceptual model consists of tree groups of indicators: quality, logistics, and financial. In public companies, the evaluation facilitated external integration, whereas in private companies, this evaluation enabled internal integration. The findings show that some indicators were not applicable to the practice, while all requirements were applicable within the context of both academics and practitioners' reality.

Limitations of the investigation: A notable limitation of this study is the relatively small number of interviewees, particularly within the academic sample.

Practical implications: The proposal of these indicators aims to guide companies to a more precise supplier evaluation by procurement and operation departments, which manage a valuable input (spare parts).

Originality / Value: The proposal of indicators that meet the requirements, using the Lawshe's scale and the calculation of the CVR, and further validated by two different actors (academics and practitioners) was not found in the publications concerning suppliers' evaluation in the electricity sector.

Keywords: Indicators; Requirements; Evaluation; Suppliers; Electricity sector.

1 INTRODUCTION

The current competitive world has motivated the companies to identify and select suppliers of raw materials to achieve the goal of survival and excellence (Sadatian *et al.*, 2022). According to Cao and Wang (2022) and Jama and Mohamud (2024), the ability to optimize procurement processes and strategies has emerged as a central focus for organizations aiming to enhance their overall performance. Spare parts are held as inventory to support product maintenance in order to reduce downtime and extend products lifetime. Recently, spare parts inventory management has been attracting more attention due to the "right-to-repair" movement which requires that manufacturers provide the availability of adequate spare parts throughout the entire lifecycle of their

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products, thereby reducing waste and promoting sustainability (Zhang *et al.*, 2021). To avoid unscheduled interruptions, companies must strategically determine the optimal composition of spare parts inventories by analyzing assets from an operational perspective (Castro *et al.*, 2021).

Based on the purchasing requirements, decision-makers should select a set of indicators to serve as performance evaluation metrics for potential suppliers, considering that the identification of critical indicators plays a crucial role in the evaluation process (Igarashi *et al.*, 2013; Saputro *et al.*, 2022; de Oliveira *et al.*, 2023; Zhang *et al.*, 2023). The suppliers' evaluation through performance indicators is one of the main requirements for companies to remain competitive in the market and achieve service improvement, being the crucial strategic components of any supply chain management (SCM) system with a substantial economic impact and risk reduction (Galo *et al.*, 2018; Baldassin *et al.*, 2020; Zakeri *et al.*, 2023).

Indicators used in the suppliers' evaluation must meet several essential requirements, such as be quantifiable, easily measurable, broad applicability, objectivity, and operability (Shohet and Nobili, 2017; Tan *et al.*, 2023). Although this relation between indicators and requirements has been studied for some years, there is no consensus on the appropriate model to apply, considering the complexity and dynamics of the electricity sector. The choice of performance indicators for measuring the potentiality and desirability metrics of the supplier continues to pose a significant challenge for purchasing firms in local or global supply chains (Govindan *et al.*, 2023).

The central question of the research is: What conceptual model should be used, based on indicators and their requirements, to evaluate suppliers in the electricity sector?

The secondary questions are:

- What are the most used indicators for supplier' evaluation?
- What are the existing requirements that indicators must meet (to be part of the conceptual model)?
- Which indicators meet most requirements according to the interviewees (to be part of the conceptual model)?

The contribution of this article is to discuss the suppliers' evaluation within both public and private companies in the electricity sector, responding to many requirements that are not cited in the selected sample of articles. When the authors searched in the period considered in this research (2017-2024) with the query '"conceptual model" AND "key performance indicators" AND "electricity"' there were two papers in Scopus and nine in Web of Science (excluding one paper that appeared in both searches), ten in total. The papers found in Scopus do not have any alignment with the aim of this paper. In Web of Science, only two mentioned one of the keywords. Almeida *et al.* (2022) selected indicators (by theory and practitioners) for agile software development companies. Zhang *et al.* (2017) joined prisoner's dillema with performance indicators and analytic approaches in a theory building. After these searches, the authors observed that this paper fills out this gap.

Hence, this article presents and discusses the selection of indicators for the evaluation of the suppliers within the electricity sector based on performance requirements. Besides, the Lawshe's (1975) scale application for the validation of performance indicators, the analysis of indicators through the answers from interviewees, and a proposed conceptual model, in the end, constitute a contribution to the electricity sector and the academia. The conceptual model was built by a literature review (section 2) validated by the interviewees answers (academics and practitioners - interviewees from public and private companies from electrictricity sector) and analysed by Content Validity Ratio (CVR) proposed in Lawshe's (1975) and improved in Wilson *et al.* (2012) (section 4).

2 SUPPLY CHAIN MANAGEMENT AND EVALUATION OF THE SUPPLIERS

This section presents the basis for the conceptual model, outlining the requirements (Table 1) and indicators (Table 2), that will be validated by the interviewees in section 4.

2.1 Supply Chain Management

In the second part of the 1990s, the main authors who studied Logistic and Supply Chain Management (SCM) presented their findings about the concept of SCM and the differences between these two concepts. Cooper *et al.* (1997) (with 5,344 citations in Google scholar on February, 2024) and Lambert *et al.* (1998) (with 5,264 citations in Google scholar on February, 2024) published books about Logistics and SCM in the last decades.

In their efforts to establish the concept of SCM and to avoid named it as 'the new Logistic', Cooper *et al.* (1997, p.2) defined SCM as "the integration of business processes from end user through original suppliers that provides products, services and information that add value for

customers." Lambert *et al.* in 1998 added to this concept another member of supply chain (SC), the stakeholders. Mentzer (2001) added to this concept the member of a supply chain as (organizations or individuals), the two parts of SC (upstream and downstream), and the financial activities.

Lambert *et al.* (1998) considered that the SCM framework econmpassed the combination of three elements: the structure of the supply chain, the supply chain business processes, and the SCM components. The structure of the supply chain is the network of member and the links between them. When a company implements a SCM, it must identify its members, what processes need to be linked, and what kind of integration apllies to each process link. The business process links are the tiers where the suppliers are upstream, and the costumers are downstream in the supply chain. These relationships, between the focal company and their suppliers (upstream) and customers (downstream) constitute the SCM concept. Simultaneously, Council of Logistic Management (CLM) and Council of Supply Chain Management Professionals (CSCMP) discussed the concepts either.

Cooper *et al.* (1997, p.6) in their seminal paper added a question that still remains: "What metrics should be used to evaluate the performance of an entire supply chain?'. In this paper, the authors aim to propose a conceptual model that would support the supplier's (upstream) evaluation in the companies (focal) of electricity sector.

In a search for relevant papers (in Scopus databasis) about the applications of SCM in different sectors since 1997, when Cooper *et al.* published their paper, the authors identified a study involving teams from key suppliers and telecom partners, describing the telecommunications systems in Stockholm and Sacramento (Blazek *et al.*, 1999); the business-to-business electronic commerce (B2B EC) for enabling SCM in the clothing industry (Au and Ho, 2002); a buyer-supplier relationship is explored in a hospital and its supplier of gasses (Van Donk, 2003); the optimization of total supply chain costs, improvement in turnover, and reduction of carrying costs in a pharmaceutical company's supply chain (Choudhury *et al.*, 2004); analyis of the impact of supply-side externalities existing among downstream retailers on supply chain performance (Netessine and Zhang, 2005); optimization of decision-making in the apparel supply chain (Pan *et al.*, 2009); SCM concept's implementation in construction enterprises (Qin and Peng, 2012); an analysis and determination of supply chain structure, organization management and stakeholders demands for information systems that should enable efficient support to supply chain management processes in the automotive industry (Arsovski *et al.*, 2012); SCM practices adopted by food processing units (Dharni and Sharma, 2015); improve supply chain performance through strategic alliance between information intensive services and supply chain integration (Roy and Satpathy, 2019); the production outsourcing decisions of multinational luxury brands by formulating the trade-off between low cost and consumers' strong "country of origin" preferences (Niu *et al.*, 2020); the relation between SCM and industry 4.0 (Kunrath *et al.*, 2023).

2.2 Requirements to evaluate performance indicators

Performance indicators are selected through the analysis of criteria and metrics to follow up and monitor the management of a process or the entire organization. The selection of indicators is a challenge for managers due to the number of parameters and factors that the managers must follow to select the key performance indicators (kpi).

Indicators are not universal and vary according to the objectives of the assessment and the case study in question (Kim *et al.*, 2005; Mahmoud *et al.*, 2020). The requirements of evaluation indicators are necessary as they guide companies and their employees who are responsible to decide what indicators they will adopt to evaluate their suppliers. Establishing clear and objective indicators is essential to guarantee efficient performance supplier's evaluation (Tsai; Cheng, 2012). These indicators may vary dependending on the company, its objectives, and preferences (Marr, 2012; Dwivedi; Madaan, 2020). In the supply chain, the indicators can identify different characteristics inside it, based on their focus (Bak, 2018; Romule *et al.*, 2019). Finally, it is crucial to define a limited number of indicators, considered essential, based on their characteristics to align with the organizations management in a holistic point of view (Si *et al.*, 2017).

Thus, for an effective suppliers' evaluation and favorable outcomes in the process, it is imperative to assess the indicators used in terms of their alignment with the requirements. Therefore, indicators must generate objectivity and transparency in achieving the goals. According to Neri *et al.* (2021), the selection of indicators should have met specific requirements to guarantee the relevance of them. This paper presents the indicators' requirements identified in the literature review in Table 1.

Table 1 - Performance indicator requirements

Requirements	Aspects	Sources
Comparability	The indicator must contain elements that enable temporal and spatial comparison	Kayano and Caldas (2002); Magalhães (2004); Bayne and Wee (2019); Dočekalová *et al.* (2018); Ferreira *et al.* (2022)
Utility	Support decisions, whether at the operational, tactical, or strategic level, should be based on the needs of decision makers	Magalhães (2004); Shohet and Nobili (2017); Xing *et al.* (2023)
	Ensuring that activities are aligned with the objectives of the performance indicators	Popa (2015); Lavy *et al.* (2010)
Information availability	The basic data for its composition must be easy to obtain	Kayano and Caldas (2002); Rua (2004); Ferreira *et al.* (2022)
	The collection of information is necessary to improve activities	Popa (2015)
Control	Control and monitor the activities and people involved	Popa (2015); Kropachev *et al.* (2023)
Support for decisions	Ensure the effectiveness of the indicator and its efficiency in making managerial decisions	Rua (2004); Guirado *et al.* (2022)
	Support for stakeholder reporting	Popa (2015); Guirado *et al.* (2022)
Possibility to quantify	Scope and measurement, with adequate documentation and periodic updating	Kayano and Caldas (2002); Magalhães (2004); Fernandes *et al.* (2004); Bakhshi *et al.* (2024)
	They must be quantitative and qualitative	Ogunlana (2010); Kerzner (2017); Shohet and Nobili (2017)
Simplicity	They must be easy to obtain, build, maintain, communicate, and understand	Pfaffel *et al.* (2019); Kayano and Caldas (2002); Magalhães (2004); Rua (2004)
Economy	Obtain at low cost Represent performance in terms of money spent per unit of area, person, or product	Rua (2004); Lavy (2011); Lavy *et al.* (2010); Li *et al.* (2023)
Sensible to changes	Should have the capability to promptly reflect changes resulting from interventions implemented	Magalhães (2004); Dočekalová *et al.* (2018)
	They must be functional and measure the companie's performance, evaluating aspects related to the organization, business mission, space, employees, and other aspects	Lavy (2011)
Adaptability	Capability to adapt to changes in customer behavior and demands	Rua (2004); Hassini *et al.* (2012); Kasi *et al.* (2023)
Representativity	Define the most important and critical steps of the processes in the right place. Be sufficiently representative, comprehensive, and trustworthy. Select your measures in line with the organization's characteristics	Rua (2004); Dočekalová *et al.* (2018) Hassini *et al.* (2012); Bendoly *et al.* (2007); Ferreira *et al.* (2022)
Have reference values	Visible They should be referenced in practices that emphasize aspects such as business, business objectives and job satisfaction	Magalhães (2004) Lavy *et al.* (2010); Amaratunga and Baldry (2003); Brackertz (2006); Pacios and Martínez-Cardama (2023)
Stability	Establish stable historical series	Rua (2004)
	Observe the dynamic nature of operations	Hassini *et al.* (2012); Yang *et al.* (2023)
Traceability	Availability	Rua (2004); Gamisch and Pöhn (2023)
	Comparable to serve as a method for assessing potential enhancements in the business.	Lavy *et al.* (2010); Cable e Davis (2004)

Source: Done by authors.

The analysis of these requirements for evaluation of the indicators is a step before the performance measurement model application. This step aims to ensure that the selected indicators for evaluation are compatible with the process and activity in which they will be applied to guarantee results for the organization and support decision-making. According to the data provided in Table 1, the most frequent requirements in the literature are simplicity, usefulness, the possibility of quantification, comparability, and reference values.

2.3 Evaluation of the Suppliers

Increased competition, globalization pressure, and market developments have changed methods of supplying several items and communication with customers and suppliers. Therefore, the increased importance of procurement has highlighted the importance of purchasing decisions (Sadatian et al, 2022).

The evaluation of the supplier is a management decision-making process that addresses how organizations, in their procurement departments, select strategic suppliers to enhance their competitive advantage. Previous studies on supplier selection focused on identifying the criteria used to select suppliers (Karsak and Dursun, 2015). A sort of case studies on evaluation of the supplier have been published in the literature in different sectors, such as R&D services suppliers (Shao *et al.*, 2022), electric vehicle battery manufacturers (He and Chen, 2024), and cosmetic company (Ribeiro *et al.*, forthcoming).

In this way, the suppliers should be selected according to specific principles and criteria in order to minimize the risk of outsourcing activities (Sadatian *et al.*, 2022). Hence, the supplier's evaluation facilitates the reduction of contract cancellations and establish collaborative and lasting relationships within the supply chain (Morales, 2016). Thus, a set of requirements (to assess the indicators - Table 1) and indicators to evaluate suppliers will define the choice by the companies related to suppliers. Based on the literature review, Table 2 outlines the indicators identified in the literature.

Table 2 - Indicators for evaluation of the supplier

Indicators	Sources
Costs	Osiro *et al.* (2014); Liou *et al.* (2014); Omurca (2013); Calache *et al.* (2019); Karsak and Dursun (2015); Ho *et al.* (2010); Seth *et al.* (2018); Shishodia *et al.* (2019); Kusi-Sarpong *et al.* (2018); Golmohammadi and Mellat-Parast (2012); Lin *et al.* (2019); Seth *et al.* (2018)
Easy of Communication	Osiro *et al.* (2014); Liou *et al.* (2014); Lin *et al.* (2019)
Technical Capacity	Osiro *et al.* (2014); Liou *et al.* (2014); Omurca (2013); Calache *et al.* (2019); Shishodia *et al.* (2019); Wu and Olson (2008); Kusi-Sarpong *et al.* (2018); Zhu *et al.* (2022)
Financial situation	Patton III (1996); Osiro *et al.* (2014); Talluri *et al.* (2006); Wu and Olson (2008); Lee *et al.* (2009); Zhu *et al.* (2022)
Performance history	Karsak and Dursun (2015); Seth *et al.* (2018); Wu and Olson (2008)
Delivery	Osiro *et al.* (2014); Restrepo and Villegas (2019); Karsak and Dursun (2015); Ho *et al.* (2010); Kusi-Sarpong *et al.* (2018); Seth *et al.* (2018); Shishodia *et al.* (2019); Svensson (2004); Wu and Olson (2008); Golmohammadi and Mellat-Parast (2012); Lin *et al.* (2019); Zhu *et al.* (2022)
Price	Osiro *et al.* (2014); Omurca (2013); Restrepo and Villegas (2019); Ho *et al.* (2010); Kusi-Sarpong *et al.* (2018); Svensson (2004); Wu and Olson (2008); Golmohammadi and Mellat-Parast (2012); Wu and Meng (2022); Alamroshan *et al.* (2022)
Reliability	Karsak and Dursun (2015); Talluri *et al.* (2006); Kannan and Tan (2006); Alamroshan *et al.* (2022)
Quality	Osiro *et al.* (2014); Omurca (2013); Calache *et al.* (2019); Restrepo and Villegas (2019); Karsak and Dursun (2015); Ho *et al.* (2010); Kusi-Sarpong *et al.* (2018); Seth *et al.* (2018); Shishodia *et al.* (2019); Wu and Olson (2008); Golmohammadi and Mellat-Parast (2012); Zeydan *et al.* (2011); Lin *et al.* (2019); Zhu *et al.* (2022)
Efficacy of corrective action (problem solution)	Osiro *et al.* (2014); Restrepo and Villegas (2019); Karsak and Dursun (2015); Ho *et al.* (2010); Zeydan *et al.* (2011)

Flexibility in billing	Liou *et al.* (2014); Karsak and Dursun (2015)
Customer and supplier relationship	Liou *et al.* (2014); Svensson (2004); Talluri *et al.* (2006); Zhu *et al.* (2022)
On-time rate (punctuality)	Liou *et al.* (2014); Ho *et al.* (2010); Golmohammadi and Mellat-Parast (2012); Seth *et al.* (2018)
Quality Management	Omurca (2013); Calache *et al.* (2019); Karsak and Dursun (2015); Ho *et al.* (2010); Svensson (2004); Wu and Olson (2008); Zeydan *et al.* (2011); Lin *et al.* (2019); Alamroshan *et al.* (2022)
Internal Audit	Omurca (2013); Ho *et al.* (2010); Narasimhan *et al.* (2001)
Process Capacity	Omurca (2013); Restrepo and Villegas (2019); Ho *et al.* (2010); Wu and Olson (2008); Golmohammadi and Mellat-Parast (2012)
Company management	Omurca (2013); Seth *et al.* (2018); Zeydan *et al.* (2011)
Safety	Calache *et al.* (2019)
Flexibility	Restrepo and Villegas (2019); Kusi-Sarpong *et al.* (2018); Shishodia *et al.* (2019); Talluri *et al.* (2006); Golmohammadi and Mellat-Parast (2012); Alamroshan *et al.* (2022)
Product conformity	Karsak and Dursun (2015); Ho *et al.* (2010); Calache *et al.* (2019)
Customer support	Karsak and Dursun (2015); Talluri *et al.* (2006); Wu and Olson (2008); Bischoff (2023)
Geographical location	Karsak and Dursun (2015); Ho *et al.* (2010); Seth *et al.* (2018); Shishodia *et al.* (2019)
Control (and inspection)	Ho *et al.* (2010); Zeydan *et al.* (2011); Kraynova (2020)

Source: Done by authors.

The most used indicators through the survey carried out in Table 2 are quality, delivery, costs, price, and technical capacity. These indicators are the most relevant and commonly used to evaluate suppliers. After analyzing 103 authors and 151 indicators, Kant and Dalvi (2017) listed the top five most frequent indicators: quality, delivery, cost, reputation, and technical capacity. Emelianova (2023) states that the ability of public buyers to considers reputation when selecting a supplier is subject to highly regulation. Karsak and Dursun (2015), after analyzing 74 articles, identified that the most used indicators are price, delivery, quality, ease of production, and location. After a survey with experts, Tavana *et al.* (2016) identified that the most used indicators are quality, delivery, technology, price, and location. This analysis confirms the necessity for a robustness and precise selection of indicators to define the most suitable suppliers for contracting.

3 METHOD

3.1 Research design and steps

The approach applied in this research is qualitative-quantitative (or mixed method), which has four important aspects: timing, weighting, mixing, and theorizing (Creswell, 2009). In the timing aspect, the data was collected concurrently because the researcher who collected it organized her time to interview the participants (done remotely), avoid setting up additional interviews for data collection to minimize inconvenience to the interviewees. In this paper, quantitative analysis has priority (more weight) compared to qualitative analysis. Mixing means either that the qualitative and quantitative data are brought together at one end of the continuum, remain separate at the other end of the continuum, or are combined in some way between these two extremes. In this paper they are mixed, as the responses in Tables 5, 6 and 7 were analyzed as part of the qualitative theme (4.1), but they were used for the quantitative analysis to compose Table 8. According to Creswell (2009), the theories in mixed methods studies are typically found in the first sections (here in section 2) and serve as a guide that determines the type of questions asked, the participants in the study, the type of data collection, and the conclusions drawn from the study.

The research method employed in this paper is a multiple case study, following the five stages outlined by Eisenhardt (1989). The initial stage involved defining the research objective and formulating the research question. In the second step, a bibliometric analysis was conducted to search for relevant articles, and the cases (companies) were then carefully selected. The third step involved conducting a comprehensive literature review, which served to construct the research protocol for data collection and provided the theoretical foundation for the conceptual model. Moving on to the fourth step, the researcher entered the field to collect data. The fifth step encompassed data analysis, culminating in the formulation of the conceptual model (Figure 1). This

final step, the sixth one, integrated insights from the literature review, where requirements and indicators were extracted from the analyzed and reviewed articles, and the findings derived from the data analysis. Following this, interviewees from procurement and operations departments of electricity companies selected the most suitable indicators for supplier evaluation, utilizing the Lawshe's scale (1975) alongside the identified requirements. The data gathered underwent analysis using the CVR (Wilson *et al.*, 2012), critical CVR, and median techniques. Ultimately, the paper will conclude by presenting the proposed conceptual model outlining the indicators for supplier evaluation (Figure 1).

3.2 Articles selection and literature review

After defining the primary objective and central research question, the second stage involved searching for articles in the Scopus and Web of Science databases, following the methodology outlined by Gomes *et al.* (2018). These articles served as the foundation for developing the conceptual model. The selected search filters included articles published in journals ('articles') from 2017 to 2020. The Boolean operator 'AND' was employed to connect the terms Supply Chain Procurement, Evaluation, Supplier, Management, and Key Performance Indicator. The bibliometric analysis started with a total of 3,109 articles. These data were refined, removing the repeated ones between the bases, considering as inclusion criteria: articles published in Journals; articles published from 2017 to 2020; language (English). The search criteria were refined to include journals with an Impact Factor greater than 1, thereby reducing the number of articles, as many journals had an impact factor below 1. Additionally, authors with a minimum of three published articles on the topic were included. Furthermore, only papers with titles and abstracts aligned with the topics discussed in this research were considered. The exclusion criteria encompassed duplicate papers, papers in languages other than English, articles published before 2017, conference papers, reviews, and chapters. Additionally, papers that were not directly related to the research topic, such as those concerning supplier development and selection, were excluded. To update the sources, the authors conducted searches in both databases from 2021 to 2024 using the same queries and filters.

Following the analysis of publications, the third stage (literature review), presented in Section 2, involved the selection of 59 articles. From these articles, the requirements presented in Table 1 and the indicators in Table 2 were raised and validated in the field in the next step.

3.3 Data collection

In the fourth stage, data collection and the study of multiple cases were conducted as part of the research method. This approach was inspired by the methodology presented by Carvalho *et al.* (2019), which involved analyzing indicators through the agents involved in productive activities. The case studies selected for the research were homogeneous based on their Net Revenues, with the first six in the ranking considered in terms of this economic variable (Eisenhardt, 1989; Yin, 2009; Brazil, 2020; Valor 1000, 2020). Semi-structured interviews were applied as the method for data collection, employing a research instrument with closed questions.

The departments selected for the study were procurement and operations, representing the "supplier" and "client" departments within the companies, respectively. In total, 17 employees from the electricity sector were contacted as part of the supplier-client chain. However, only nine answered the emails and agreed to participate in the study. These included six employees from companies that were public at the time of the interviews and three employees from private companies. The research protocol with the indicators and requirements was sent to 23 academics and obtained three responses (Tables 5 to 7). Tables 3 and 4 present the profiles of the interviewees.

Table 3 - Interviewees from companies (practitioners)

Interviewees	Formation	Time in the Company	Position	Time in the position
Public Companies				
I1	Business	16 years	Supply Analyst	1 year
I2	Electric Engineering	6 years	Eletric Engineer	6 years
I3	Business	10 years	Contracts and Suppliers Manager	10 years
I4	Electric Engineering	17 years	Operations Manager	4 years

I5	Civil Engineering	14 years	Supply Technician	11 years
I6	Business	14 years	Contracts and Suppliers Manager	9 years
Private Companies				
Interviewees	**Formation**	**Time in Company**	**Position**	**Time in the position**
I7	Business	3 years	Procurement Manager	3 years
I8	Economist	3 years	Senior Commercial Analyst	3 years
I9	International Relations	1 year	Supply Coordinator	1 year

Table 4 - Academic Interviewees

Interviewees	Formation	Position	Stream of research
A1	Economy and Managament	Adjunct Professor	Supply Chain Management and Operational Research
A2	Production Engineering	Associate Professor	Operations Management
A3	Production Engineering	Ph.D. alumni	Supply Chain Management

3.4 Data analysis

In the quantitative analysis, the Content Validity Ratio (CVR), initially proposed by Lawshe's (1975) and further refined by Wilson *et al.* (2012), was utilized to determine the essential importance of indicators. Lawshe's work holds significant prominence, evidenced by its citation in 3,293 other documents indexed in Scopus as of February 2024. The CVR employs a specific scale designed to measure importance, distinct from Likert scales commonly used to gauge attitudes and performance. Furthermore, it is important to note that in the CVR scale, also known as the Lawshe's scale, interviewees assessed indicators using the following options: "essential" (E), "useful, but not essential" (U), and "unnecessary" (UN). This scale was instrumental in reflecting each interviewee's perception of the assessment. According to Yang (2019), in evaluating components applied in this sector, companies should identify and assess suppliers from various perspectives to safeguard mutual interests and establish robust and enduring partnerships. The application of Lawshe's scale (1975) in academic research aims to classify what is considered "essential" and "unnecessary." This validation process was conducted through the Content Validity Ratio (CVR), as illustrated in equation 1.

$$CVR = \frac{Ne-(\frac{N}{2})}{\frac{N}{2}} \quad (1)$$

Being:
Ne = number of interviewees who indicate that the item is "essential"
N = total number of interviewees in the survey

Lawshe's (1975) scale has the following assessment: if all interviewees rate the indicator as being "Essential," the CVR value should be equal to one; when more than half of interviewees rate it as "Essential," the CVR value is between zero and one; when half of the interviewees classify the indicators as "Essential" and the other half as "Unnecessary" or "Useful," the CVR value is equal to zero; when less than half classify the indicators as "Essential," the CVR value is less than zero.

This formula proposed by Lawshe's (1975) was revised by Wilson *et al.* (2012). These authors proposed a table with the correction of the values presented by Lawshe's (1975), considering the calculation of the critical CVR with a probability of 5% significance. In this work, the number of interviewees (N) equals 12, as shown in Tables 3, 4, and 5. Thus, the value of critical CVR proposed by Wilson *et al.* (2012) in the research is defined at 0.566.

After calculating the CVR presented in Equation 1, the result was compared to the critical CVR value. If the CVR were higher than the critical CVR, the indicator would be classified as "essential." Otherwise, it would be evaluated as "unnecessary." In this multiple case study, there was a necessity to thoroughly evaluate indicators. This involved collecting data through interviews with the participants and subsequently analyzing the gathered information. With this objective in mind, the CVR was calculated from the perspective of "essential" and "unnecessary" indicators. Therefore, Ne will be considered the score of "essential" indicators in the first evaluation, and in the second

evaluation, Ne will be considered the score of "unnecessary" indicators.

In another step of data analysis, after calculating the CVR for these two perspectives, the median was calculated for each Table of results, according to Tables 8 and 9. In Table 8, the indicators with a Ne value higher than the median value would be considered "essential" for the evaluation of the suppliers. For indicators scored as unnecessary, as those below the median was considered less "unnecessary." Table 10 shows the result of this validation of the medians. Although some indicators are above or below the median in both analyses, they were not eliminated from the evaluation. Thus, the indicators in common in the two Tables (8 and 9), as shown in Table 10, were considered helpful to evaluate suppliers and the indicators that were not included in the two analyses (Tables 8, 9, and 10) were disregarded for the proposition, called "Unclassified" in Table 11.

In order to propose indicators that match the requirements, in the second part of the interviews, the interviewees evaluated whether the performance indicators were aligned with the requirements presented in Table 1. There was a sum of requirements for each indicator. After this, as a result, the median was calculated to verify which performance indicators to evaluate suppliers meet the most requirements. These indicators were compared to the indicators previously defined as "useful" and "essential" (analysis using the Lawshe's scale).

After comparing and validating the indicators identified in two analyses, the indicators in common were considered. Then, the proposal of performance indicators for the suppliers' evaluation in companies in the electricity sector was carried out, resulting in the conceptual model (Figure 1) achieving the research objective.

The conceptual model took into account both sources of knowledge in this theme—theoretical foundations presented in Section 2 and insights from specialists. The specialists included academics engaged in research on supplier evaluation and practitioners actively working in departments related to buyer-supplier relationships (procuremente and operations). These specialists played a key role in selecting the indicators, as detailed in the results presentation and data analysis in Section 4.

4. RESULTS AND DATA ANALYSIS

This section will present the answers to the closed questions related to the indicators and their requirements. In the initial organization, the academics were separated from the companies' respondents (practitioners). As informed in the Methodology, the legend for the Lawshe's (1975) scale used was E – "essential"; U – "useful but not essential"; UN – "Unnecessary." The analysis was divided into qualitative (4.1) and quantitative (4.2).

4.1 Qualitative analysis

The analysis conducted by academics, as detailed in Appendix A (Table 5), revealed that the essential indicators were delivery, reliability, quality, and customer support. Additionally, the indicator unanimously considered "useful" by all respondents is Geographical Location. Moving on to the responses from public companies, as presented in Table 6 of Appendix B, the sum of their choices per option regarding indicators is provided. Remarkably, it is observed that the indicators deemed "essential" by all respondents align precisely with those identified in the responses of academics, namely delivery, quality, reliability, and customer support. This alignment underscores the significance of these indicators in academic research and their practical application within organizations.

In both the operational and procurement departments, ensuring high-quality spare parts delivered within the specified timeframe is crucial for maintaining excellent reliability within the electricity sector. These spare parts are utilized in equipment with extended useful lifespans, emphasizing the necessity for suppliers to provide technical support to facilitate repairs and replacements, if required. Moreover, respondents from the procurement department emphasized the importance of two indicators deemed "essential": performance history and technical capacity. These indicators serve as fundamental prerequisites for supplier selection in public companies.

The interviewees working in the company's operation department unanimously rated the "Efficacy of corrective action" (problem solution) as "essential." This outcome underscores the critical importance of a supplier's ability to address and resolve problems during material supply. In the context of companies in the electrical sector, any disruptions in equipment operation can lead to significant losses for the organization and may result in the imposition of fines by regulatory bodies overseeing the electrical system.

Table 7 in Appendix C displays the responses from respondents representing private companies, along with the total tally of their choices per indicator option. Notably, all interviewees from private companies rated the following indicators as "essential": costs, Financial Capabilities,

product quality, and conformity. The interviewees of these companies evaluate the academics and public companies in the same way only regarding the "quality" indicator. Reducing administrative costs is imperative for enhancing the profitability of these companies. This is particularly crucial as these companies maintain a robust supplier selection system and must demonstrate that potential suppliers possess the financial stability necessary to mitigate operational risks within the supply chain. Consequently, effective risk management is directly correlated with product quality. Moreover, the indicator for product quality is closely linked to product conformity, ensuring satisfaction for the customer.

4.2 Quantitative analysis

After analyzing Tables 5, 6, and 7, the data from three groups of interviewees were consolidated by summing the scores for each indicator provided by the interviewees for each element of Lawshe's (1975) scale. The Lawshe's scale was employed to determine which indicators should be retained as "essential".

In Table 8, the column "N" represents the total number of respondents in the survey, and "Ne" means the total number of respondents who answered that the indicator is "essential." For the purpose of comparing indicators, those initially categorized as "unnecessary" based on the initial calculation were positioned below the "essential" indicators.

Table 8 – Interviewees' score according to the Lawshe's (1975) scale and CVR - essential

Indicators	N	Ne	CVR	Critical CVR	Decision
Quality	**12**	**12**	**1.000**	**0.566**	**Essential**
Delivery	**12**	**11**	**0.833**	**0.566**	**Essential**
Reliability	**12**	**11**	**0.833**	**0.566**	**Essential**
Customer support	**12**	**10**	**0.667**	**0.566**	**Essential**
Technical Capacity	12	9	0.500	0.566	Unnecessary
Product conformity	12	9	0.500	0.566	Unnecessary
Safety	12	8	0.333	0.566	Unnecessary
Costs	12	7	0.167	0.566	Unnecessary
Ease of Communication	12	7	0.167	0.566	Unnecessary
Efficacy of corrective action	12	7	0.167	0.566	Unnecessary
On-time rate	12	7	0.167	0.566	Unnecessary
Financial situation	12	6	0.000	0.566	Unnecessary
Price	12	6	0.000	0.566	Unnecessary
Performance history	12	5	-0.167	0.566	Unnecessary
Customer and supplier relationship	12	5	-0.167	0.566	Unnecessary
Company management	12	5	-0.167	0.566	Unnecessary
Control and inspection	12	5	-0.167	0.566	Unnecessary
Quality management	12	4	-0.333	0.566	Unnecessary
Flexibility	12	3	-0.500	0.566	Unnecessary
Internal Audit	12	2	-0.667	0.566	Unnecessary
Flexibility in billing	12	1	-0.833	0.566	Unnecessary
Process Capacity	12	1	-0.833	0.566	Unnecessary
Geographical location	12	0	-1.000	0.566	Unnecessary

Source: Done by authors.

Based on the CVR calculation (Equation 1) outlined in Table 8, the essential indicators for supplier evaluation are quality, delivery, reliability, and customer support. These indicators were validated through the analysis of the critical CVR (determined for this research as 0.566) and CVR, which classified these four indicators as "essential". This happens because their CVR are above than critical CVR. The indicators that had CVR below than critical CVR, were considered "unnecessary". However, qualitative analysis of the data found in interviews and research on companies must be considered. It appears that only these four indicators do not represent the reality of the supply chain of the organizations where the field research was carried out and, mainly, of the purchasing sector. Other indicators such as performance history, costs, on-time rate, and price can also serve as decisive factors in approving a specific supplier within the company.

Based on these interviews review and the qualitative data analysis and to have a complete choice, the CVR was also calculated considering the study of the indicators evaluated as "unnecessary" (UN) by the interviewees. In this second analysis, the authors used the Lawshe scale

(1975) inverted, seeking for the worse indicators ("unnecessary" – UN). It means that to be "unnnecessary", the indicator had CRV above critical CVR. Because the number of interviewees did not change, the ciritcal CVR was the same (0.566). Table 9 presents these results.

Table 9 - Interviewees' score according to the Lawshe's (1975) scale and CVR - unnecessary

Indicators	N	Ne	CVR	Critical CVR	Decision
Geographical location	**12**	**12**	**1,000**	**0,566**	**Unnecessary**
Flexibility in billing	**12**	**11**	**0,833**	**0,566**	**Unnecessary**
Process Capacity	**12**	**11**	**0,833**	**0,566**	**Unnecessary**
Flexibility	**12**	**10**	**0,667**	**0,566**	**Unnecessary**
Quality management	12	9	0,500	0,566	Essential
Internal Audit	12	9	0,500	0,566	Essential
Company management	12	9	0,500	0,566	Essential
Financial situation	12	7	0,167	0,566	Essential
Efficacy of corrective action	12	7	0,167	0,566	Essential
Customer and supplier relationship	12	7	0,167	0,566	Essential
Product conformity	12	7	0,167	0,566	Essential
Control and inspection	12	7	0,167	0,566	Essential
Costs	12	6	0,000	0,566	Essential
Ease of Communication	12	6	0,000	0,566	Essential
Technical Capacity	12	6	0,000	0,566	Essential
Performance history	12	6	0,000	0,566	Essential
Delivery	12	6	0,000	0,566	Essential
Price	12	6	0,000	0,566	Essential
Reliability	12	6	0,000	0,566	Essential
Quality	12	6	0,000	0,566	Essential
On-time rate	12	6	0,000	0,566	Essential
Safety	12	6	0,000	0,566	Essential
Customer support	12	6	0,000	0,566	Essential

Source: Done by authors.

The calculation of the CVR for indicators classified as "Unnecessary" (UN) by the interviewees revealed that four indicators are deemed unnecessary for evaluating suppliers in companies within the electricity sector. Upon comparison with the results presented in Table 8, it becomes apparent that these four indicators, along with the "Internal Audit" indicator, received the lowest scores based on Lawshe's (1975) scale. Furthermore, the indicators deemed "Essential" for evaluating suppliers in the studied companies are listed towards the end of Table 9.

Therefore, several indicators were not classified by the Lawshe's (1975) scale as "Essential" (Table 8) and as "Unnecessary" (Table 9), as they were not at the 'extremes' (above the Critical CVR on the Scale). After these Tables (8 and 9), and analyzing the the interviewees' responses, more analysis are required, considering that more indicators must be proposed to evaluate suppliers.

To finalize the selection of indicators considering Lawshe's (1975) scale applied to the "Essential" and "Unnecessary" categories, the median of the scores Ne was calculated for Tables 8 and 9. In Table 8, the median of the column "Ne" was found to be six, while in Table 9, it was seven. For Table 8, the analysis was conducted from the perspective of "Essential" scores. Indicators above the median were selected. Conversely, for Table 9, the analysis of the median for the indicators was carried out inversely, as indicators below the median are considered less "unnecessary." Therefore, those above the median are firmly deemed unnecessary. Table 10 displays the results obtained, with all indicators in Table 8 above the median (strongly 'essential') and all indicators below the median in Table 9 (less 'unnecessary'):

Table 10 – Median analysis

Analysis Table 5 – Essentials	Analysis Table 6 - Unnecessary
Indicators above the Median – Strongly Essential	Indicators below the Median – Less Unnecessary
Quality	Costs
Delivery	Ease of Communication
Reliability	Process Capacity
Customer support	Performance history
Process Capacity	Delivery
Product conformity	Price
Safety	Reliability
Costs	Quality
Ease of Communication	On-time rate
Efficacy of corrective action	Safety
On-time rate	Customer support

Source: Done by authors.

The indicators common to the two Tables (8 and 9) with the analysis of the medians are quality, delivery, reliability, customer support, process capacity, safety, costs, communication, and on-time rate (punctuality). These indicators are "more essential" and "less unnecessary", which mmeans that they are the best. The indicators that can be considered "useful but not essential," as they are not in both analysis (Table 10), were: performance history, price, product conformity, and efficacy of corrective action (problem solution). To consolidate the analyses using Lawshe's (1975) scale and validation through qualitative research conducted via interviews, Table 11 was constructed.

The Table has the following legend: "essentials" – dark grey; "useful" – medium grey scale; and "Unnecessary" – light grey. Indicators that did not stand out in any of the median analyses after applying Lawshe's (1975) scale were categorized as "Unrated" (without any color) in Table 11.

Table 11 - Classification of items using Lawshe's (1975) scale analysis and median

Indicators	Classification
Quality	Essential
Delivery	Essential
Reability	Essential
Customer support	Essential
Process Capacity	Useful
Product conformity	Useful
Safety	Useful
Costs	Useful
Ease of Communication	Useful
Efficacy of corrective action	Useful
On-time rate	Useful
Financial situation	Unrated
Price	Useful
Performance history	Useful
Customer and supplier relationship	Unrated
Company management	Unrated
Control and inspection	Unrated
Quality Management/Process Management	Unrated
Flexibility	Unnecessary
Internal Audit	Unnecessary
Flexibility in billing	Unnecessary
Process Capacity /Technology	Unnecessary
Geographical location	Unnecessary

Source: Done by authors.

Table 11 expands the horizon of indicators for evaluating suppliers, increasing the possibility of proposing from four to eleven indicators. This analysis, using Lawshe's (1975) scale, made it possible, as presented by Eisenhardt (1989), to triangulate the data (review of the literature, academics, and practitioners). The final proposition of indicators was made by analyzing the indicator requirements.

In the final stage of the indicator analysis for the work's final proposal, each indicator was evaluated by the interviewees with an "x" indicating which requirements the indicator met. Subsequently, the summation of each indicator's conditions was performed according to each of the interviewees (academics and practitioners), as presented in Table 12 (Appendix D).

To propose indicators for suplliers' evaluation of companies in the electricity sector, the median of the indicators that match the most requirements was used. The result found was 57, so the indicators above this result were: quality, delivery, product conformity, price, costs, reliability, performance history, customer support, internal audit, the efficacy of corrective action, on-time rate, and safety. These indicators are the ones that most match the requirements for evaluating suppliers in the electricity sector. After, it was considered the result found for indicators classified as "essential" and "useful" after the results found in Table 11. After that, the indicators that were common from the Lawshe scale (1975), CVR nad critical CVR (Wilson *et al.*, 2012) and median, were proposed for the conceptual model. As a result, the indicators for suppliers' evaluation of companies in the electricity sector in this conceptual model are quality, delivery, performance history product conformity, reliability, delivery, on-time rate (punctuality), customer support, efficacy of corrective action (problem solution), safety, costs, and price.

It was decided to divide them into areas such as Quality Management, Logistics, and Finance. According to Radej *et al.* (2017), product quality is directly related to Product conformity in industrial sectors. The quality, reliability, and product conformity can be classified in Quality Management.

Customer satisfaction includes the need to improve the support offered to the customer, such as on-time rate and delivery time (Dörnhöfer *et al.*, 2016). According to Seth *et al.* (2018), the supplier's performance history is related to its capacity to deliver and meet the commitments defined by its customer. Therefore, it is possible to classify the indicators of on-time rate, delivery, customer support, and performance history as Logistics Management.

For Calache *et al.* (2019), wrongly selecting a supplier in the industrial area directly influences production problems, increased costs, and the security of the organization and the supply chain. Wu and Olson (2008), after literature review analysis, considered the indicators "costs" and "price" as belonging to the same evaluation class. Because of this, these indicators can be in the same group with security, efficacy of corrective action (problem solution), the Financial Management.

Figure 1 presents this conceptual model, considering the results found in the closed questions by the interviewees, according to Lawshe's (1975) scale, the CVR, critical CVR, and the median.

The proposed conceptual model shows (Figure 1) its adherence to the most relevant indicators of the suppliers' evaluation process analyzing the answers from the practitioners in the electricity sector and academics in this research area. The indicators were grouped in Quality, Logistic and Financial themes. This conceptual model presents the indicators from the literature review (Table 2) that match most requirements (Table 1), according to the interviewees, and the techniques (Lawshe scale, CVR and critical CVR) applied to their answers. The indicators were grouped to bring a clearer view of the companies' supply chain, which they can choose to use to evaluate their suppliers according to the department (Quality, Logistics, or Financial). This division leads the companies to focus the suppliers' evaluation where (department and indicators) these suppliers should enhance their performance.

Based on the data presented in Table 1, the most frequent requirements in the literature are simplicity, usefulness (as "utility"), the possibility of quantification, comparability, and reference values. All of them were considered in the field research. According to the literature review (Table 2) the most used indicators for supplier evaluation are quality, delivery, costs, price, technical capacity, ease of production, technology, and location (Kant and Dalvi, 2017; Karsak and Dursun, 2015; Tavana *et al.*, 2016). However, after the validation by the interviewees and using the data analysis techniques, the field findings show that some indicators (technical capacity, ease of production, technology, and location) are not applicable to the practice as presented in Figure 1.

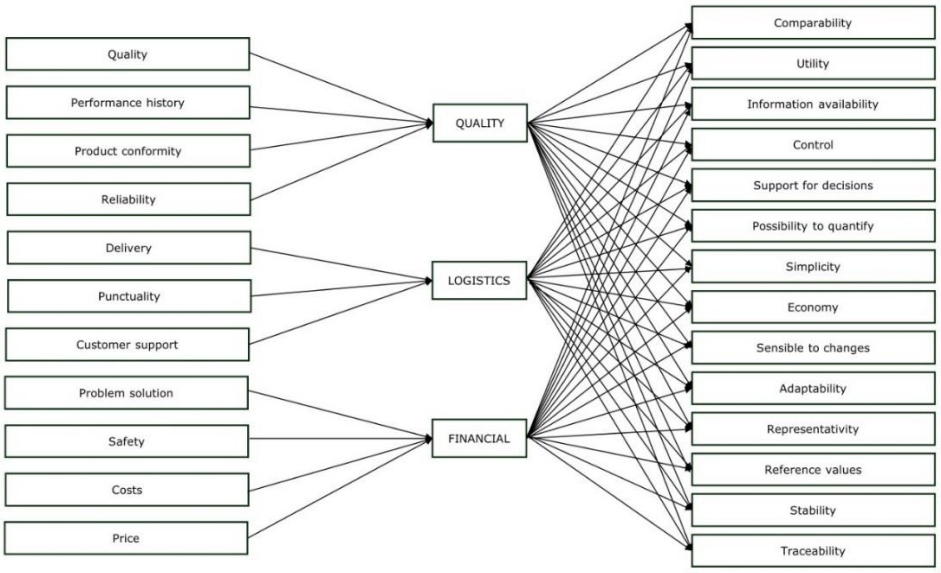

Figure 1 – Conceptual model
Source: Done by authors

5 CONCLUSION

Focusing on electricity generation and transmission companies, it is necessary to align the buyer-supplier chain. The materials stored in the companies selected for the case study are spare parts for high-voltage equipment. The suppliers are specific, with a high manufacturing cost, because they imported parts with high added value, depending on the time. These factors show the difference between the inventory of companies in the electricity sector and other organizations that operate with just-in-time logistics and high inventory turnover.

Among the companies surveyed, the public organizations, the quality of the material delivered, and the supplier's reliability are directly related to the procurement objective of the public company, which is to meet the country's interests. It is evident that meeting quality and reliability indicators serves as an essential premise for evaluating the service provided. Particularly in private companies, the evaluation of suppliers is geared towards supporting the supplier while ensuring continuous improvements. Productivity and deliverability emerge as paramount indicators for evaluating suppliers in these organizations. The procurement process is strategically aimed at enhancing the company's profitability and competitiveness. Therefore, ensuring efficiency within the supply chain is crucial for achieving these goals.

After the analysis, eleven indicators were proposed from the total of the twenty-three identified in the literature review, organizing them into three groups in a conceptual model. In public companies, it was observed that the evaluation would allow the integration of companies with the other agents in their supply chain (external). In contrast, in private companies, the assessment will enable integration between the sectors of the companies (internal). Some findings from the field research differed from the analysis conducted in the literature review, particularly regarding the most commonly used indicators. Since the validation of the indicator proposal relies on the responses of the interviewees and their analysis to align closely with the realities of companies, the conceptual model considered the findings from the field.

Considering the corporate perspective of companies in the electricity sector, this paper proposes essential and valuable performance indicators for electricity sector suppliers' evaluation that match the requirements of academics and practitioners. In addition, the analysis and validation of the indicators through the requirements and Lawshe's (1975) scale allowed a non-rigid set of indicators to be proposed. The mapping of indicators and requirements carried out during the research can support other researchers and professionals to construct their models for evaluating suppliers based on requirements, which was not found in the researched literature, mainly in the electricity sector.

The authors propose the evaluation of spare parts suppliers by procurement departments using the conceptual model. Simultaneously, the operations departments are recommended to employ the same set of indicators for evaluating the performance of the procurement department. This approach fosters a closer relationship between external suppliers and the procurement departments, even within private companies, with the aim of establishing cooperative relationships in these supply chains. This approach will result in a win-win outcome for both sides of this relationship, benefiting logistics, procurement, marketing, quality, and financial departments alike.

The connections between the departments within the company would facilitate aligned planning for purchases and logistics activities, ultimately reducing resource wastage and enhancing productivity Companies should contemplate collaborating with academics to facilitate training and develop conceptual models tailored to their specific realities, similar to the approach presented in this paper for the six companies. Furthermore, it is imperative to implement sustainability initiatives that consider environmental, social, and governance dimensions in the companies' activities.

The limitation of this research lies in the low number of responses from academics, respondents from private companies, and the presence of partial responses from two respondents. Additionally, the fact that responses were solely obtained from the procurement department hinders obtaining insights from other departments within these companies. Therefore, for future studies, it is recommended to conduct a survey involving a larger number of academics who specialize in supply chain research, indicator requirements, and key performance indicators. Hence, it will be possible to increase the research contribution for implementation in companies and greater depth of the theme in academia adding sustainable indicators to the conceptual model. A survey with more practitioners who work in other companies in procurement and operations departments could be done to give a broader point of view, and give the contribution to other companies, including abroad.

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Appendix A

Table 5 - Responses from academics - indicators

Indicators	A1			A2			A3			Sum of scores		
	E	U	Un	E	U	Un	E	U	Un	E	U	Un
Costs		✓		✓				✓		1	2	0
Easy of Communication		✓		✓			✓			2	1	0
Financial situation	✓			✓				✓		2	1	0
Tecnhical Capacity	✓			✓				✓		2	1	0
Performance history	✓				✓			✓		1	2	0
Delivery	✓			✓			✓			3	0	0
Price	✓			✓				✓		2	1	0
Reliability	✓			✓			✓			3	0	0
Quality	✓			✓			✓			3	0	0
Efficacy of corrective action	✓				✓			✓		1	2	0
Flexibility in billing			✓		✓			✓		0	2	1
Customer and supplier relationship					✓			✓		0	2	0
On-time rate		✓		✓			✓			2	1	0
Quality Management			✓	✓				✓		1	1	1
Intern Audit	✓				✓			✓		1	2	0
Process Capacity			✓		✓			✓		0	2	1
Company management		✓			✓		✓			1	2	0
Safety	✓				✓		✓			2	1	0

Flexibility			✓		✓		✓	0	2	1
Product conformity			✓	✓		✓		2	0	1
Customer support	✓			✓		✓		3	0	0
Geographical location		✓			✓		✓	0	3	0
Control and inspection			✓	✓			✓	1	1	1

Appendix B

Table 6 - Responses from public companies' employees – indicators

Indicators	I1			I2			I3			I4			I5			I6			Sum		
	E	U	Un	E	U	Un	E	U	Un	E	U	Un	E	U	Un	E	U	Un	E	U	Un
Costs		✓			✓		✓				✓		✓			✓			3	3	0
Easy of Communication	✓				✓		✓			✓			✓				✓		4	2	0
Financial situation	✓					✓		✓			✓			✓			✓		1	4	1
Technical Capacity	✓			✓			✓			✓				✓		✓			5	1	0
Performance history	✓				✓		✓			✓				✓		✓			4	2	0
Delivery	✓			✓			✓			✓			✓			✓			6	0	0
Price	✓				✓		✓				✓		✓				✓		3	3	0
Reliability	✓			✓			✓			✓			✓			✓			6	0	0
Quality	✓			✓			✓			✓			✓			✓			6	0	0
Efficacy of corrective action		✓		✓			✓			✓			✓					✓	4	1	1
Flexibility in billing		✓			✓				✓		✓		✓					✓	1	3	2
Customer and supplier relationship	✓			✓				✓			✓		✓			✓			4	2	0
On-time rate		✓			✓		✓				✓		✓			✓			3	3	0
Quality Management		✓				✓	✓				✓		✓				✓		2	3	1
Intern Audit		✓				✓		✓			✓			✓				✓	0	4	2
Process Capacity			✓		✓		✓				✓				✓			✓	1	2	3
Company management	✓					✓	✓				✓		✓					✓	3	1	2
Safety	✓				✓			✓		✓			✓			✓			4	2	0
Flexibility			✓		✓			✓		✓			✓			✓			3	2	1
Product conformity		✓		✓			✓				✓		✓			✓			4	2	0
Customer support	✓			✓			✓			✓			✓			✓			6	0	0
Geographical location			✓			✓			✓		✓			✓				✓	0	2	4
Control and inspection			✓	✓				✓											1	1	1

Appendix C

Table 7 - Responses from private companies' employees – indicators

Interviewees	I1			I2			I3			Sum		
	E	U	Un	E	U	Un	E	U	Un	E	U	Un
Costs	✓			✓			✓			3	0	0
Easy of Communication		✓		✓				✓		1	2	0
Financial situation	✓			✓			✓			3	0	0
Technical Capacity	✓				✓		✓			2	1	0
Performance history		✓			✓			✓		0	3	0
Delivery	✓			✓				✓		2	1	0
Price		✓			✓		✓			1	2	0
Reliability	✓			✓				✓		2	1	0
Quality	✓			✓			✓			3	0	0
Efficacy of corrective action	✓			✓				✓		2	1	0
Flexibility in billing			✓			✓		✓		0	1	2
Customer and supplier relationship	✓				✓			✓		1	2	0
On-time rate	✓			✓				✓		2	1	0
Quality Management			✓	✓				✓		1	1	1
Intern Audit			✓	✓				✓		1	1	1
Process Capacity			✓		✓			✓		0	2	1
Company management			✓	✓				✓		1	1	1
Safety	✓			✓				✓		2	1	0
Flexibility			✓			✓		✓		0	1	2
Product conformity	✓			✓			✓			3	0	0
Customer support		✓		✓				✓		1	2	0
Geographical location			✓			✓		✓		0	1	2
Control and inspection	✓				✓			✓		1	2	0

Appendix D

Table 12 – Indicators' evaluation by requirements – all interviewees

Indicators	Requirements scores												
	A1	A2	A3	I1	I2	I3	I4	I5	I6	I7	I8	I9	Total
Costs	12	12	6	5	5	12	5	2	NR	2	1	2	64
Easy of Communication	1	7	5	8	3	9	10	0	NR	4	1	0	48
Financial situation	5	9	8	9	0	11	7	0	NR	2	1	3	55
Technical Capacity	3	9	6	9	5	11	8	2	NR	3	1	0	57
Performance history	5	9	4	8	6	11	12	1	NR	3	2	1	62
Delivery	11	13	10	11	4	12	4	1	NR	1	3	3	73
Price	0	13	8	10	6	10	7	3	NR	2	1	7	67
Reliability	1	11	9	8	6	11	9	1	NR	2	3	2	63
Quality	10	12	11	9	7	13	6	2	NR	2	1	2	75
Efficacy of corrective action	3	9	12	8	3	11	2	2	NR	4	2	2	58
Flexibility in billing	0	12	10	7	5	0	11	0	NR	0	0	2	47
Customer and supplier relationship	0	9	5	6	4	12	7	3	NR	3	3	4	56
On-time rate	0	13	10	7	1	13	5	2	NR	5	0	2	58
Quality Management	0	9	5	8	0	12	11	2	NR	0	3	4	54
Intern Audit	13	8	7	4	0	11	7	1	NR	0	2	5	58
Process Capacity	2	10	9	0	8	10	8	1	NR	0	1	1	50
Company management	4	8	7	8	0	10	8	1	NR	0	1	4	51
Safety	10	6	10	8	2	11	5	1	NR	2	1	2	58
Flexibility	0	8	7	0	4	6	3	1	NR	0	0	3	32
Product conformity	0	13	12	7	6	12	6	1	NR	5	1	5	68
Customer support	3	11	10	7	3	13	9	1	NR	0	1	4	62
Geographical location	3	11	10	0	0	0	6	1	NR	0	0	2	33
Control and inspection	0	12	10	7	4	0	2	1	NR	3	1	3	43

Legend: NR – not response