# API MANAGEMENT QUALITY AND ISO/IEC SQUARE: A PRACTITIONERS' PERSPECTIVE

## CALIDAD EN ADMINISTRACIÓN DE APIS Y EL ESTÁNDAR ISO/IEC SQUARE: UNA PERSPECTIVA DE LA INDUSTRIA

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## Abstract

APIs have become a cornerstone in software ecosystems: organizations have been increasingly connecting software applications to share complex digital assets. Nowadays, API management has become a trending research topic: managing APIs is non-trivial and organizations have been struggling with different quality-related issues. Thus, we aim to understand how practitioners perceive quality characteristics related to API management capabilities and requirements. As a de facto standard, we adopted the ISO/IEC 25010 (SquaRE) standard as the reference model and conducted a structured survey with professional developers, system administrators and software functional analysts based in Rio Gallegos City, Argentina. Questions were based on main API management capabilities provided in current literature and their relation with the ISO/IEC 25010 model's quality characteristics. After running an statistical descriptive analysis over 125 answered topics, results show that Functional Suitability and Security were perceived as the most critical quality capabilities, which can provide a basis for future research.

**Keywords:** API Management, Software Engineering, Software Product Quality, SquaRE, Software Product Quality Model.

## Resumen

*Las APIs se han convertido en una piedra angular de los ecosistemas de software: las organizaciones conectan cada vez más aplicaciones de software para compartir activos digitales complejos. Hoy en día, la Administración de APIs se ha convertido en un tema de investigación de tendencia: la Administración de APIs no es trivial y las organizaciones han estado lidiando con diferentes problemas relacionados con la calidad. A raiz de ello, nuestro objetivo es comprender cómo los profesionales comprenden las características de calidad relacionadas con las capacidades y requisitos de Administración de APIs. Como estándar de facto, adoptamos el estándar ISO/IEC 25010 (SquaRE) como modelo de referencia y realizamos una encuesta estructurada con desarrolladores profesionales, administradores de sistemas y analistas funcionales de software con sede en la ciudad de Río Gallegos, Argentina. Las preguntas se basaron en las principales capacidades de Administración de API proporcionadas en la literatura actual y su relación con las características de calidad del modelo ISO/IEC 25010. Después de realizar un análisis estadístico descriptivo de 125 temas respondidos, los resultados muestran que la idoneidad funcional y la seguridad destacan como las capacidades de calidad más críticas, lo que puede proporcionar una base para futura investigación.*

***Palabras Clave:*** *Administración de APIs, Calidad del Producto Software, Ingeniería de Software, Modelos de Calidad del Producto Software.*

## 1. Introduction

Over the past few years, information system distribution models have been undergoing a significant transformation, shifting towards XaaS (Anything as a Service) paradigms [Geelan, 2009]. These paradigms enable organizations to offer their digital assets directly to customers [Fehling, 2014]. Among the emerging trends, microservices architectures have gained rapid popularity due to their flexibility and scalability. This architectural model [Gamez-Diaz, 2017] allows organizations to distribute their information systems as a collection of highly-scalable services.

Typically, these services are backed by APIs that adhere to REST (Representational State Transfer) principles [Fielding, 2000].

As mentioned in [Andreo, 2019], APIs encompass both a technical and a business aspect. The technical side entails providing a solution to specific business challenges by establishing a set of requirements that govern how applications interact and exchange data. On the other hand, the business side plays a crucial role as a facilitator, determining how organizations utilize their assets to deliver value not only within internal units but also to external third parties. The notion of an "API Economy" has emerged to describe the growing trend in industries, where they explore novel ways of expanding their business models. This involves conceptualizing and commercializing solutions that incorporate APIs as part of their service offerings [Brown, 2014].

The prevalence of this API Economy scenario introduced added challenges in the development, deployment, and maintenance of information systems [Bloch, 2006]. With APIs assuming a critical role, organizations must address the risks associated with their usage by implementing effective API management strategies through specialized platforms [Andreo, 2019], [De, 2017]. In this sense, API Management Platforms have emerged to offer fundamental capabilities to create, analyze, and maintain APIs in a secure and scalable environment. These platforms facilitate various essential functions, including providing comprehensive documentation, managing access to the APIs, and monitoring and analyzing their usage patterns [De, 2017], [Preibisch, 2018], [Gamez-Diaz, 2019]. Adittionaly, Recent industry reports [RapidAPI, 2023], [SmartBear, 2023] have highlighted challenges associated with API Management.

However, despite the advancements mentioned earlier, API management activities present a myriad of challenges within both internal [Andreo, 2019], [Schultis, 2014] and decentralized [Wilde, 2019] software ecosystems. To address these challenges effectively, software quality models encompass a comprehensive set of characteristics and sub-characteristics, forming a foundation for assessing the quality of software components. This critical step enables the development of pragmatic solutions readily adopted by software practitioners in the industry.

Moreover, quality models facilitate continuous monitoring of an organization's software components, enabling swift intervention when deviations occur. Given the significance of API management platforms, it becomes essential to investigate how software industry practitioners perceive quality characteristics related to common functions and capabilities. Such inquiry aims to establish benchmarks and offer insights into emerging trends throughout the software product's lifecycle. In this regard, this paper presents the findings of the inaugural survey conducted among a group of professionals based in Río Gallegos City, Argentina. This initial exploratory study was specifically designed to identify the correlation between the quality characteristics outlined in the ISO/IEC 25010 standard and the main functions/capabilities of API management.

This paper is structured as follows: Section 2 outlines the methodology employed in the design and execution of the survey, serving as a preliminary study laying the foundation for future more specific investigations. Section 3 presents a comprehensive account of the survey results. In Section 4, we delve into a concise discussion encompassing API surveys, an analysis of the results, potential threats to validity, identified limitations, reflections on the impact and significance of this work, and concluding remarks along with proposed future directions.

## 2. Methods

In this section, we present the methodology utilized to conduct the survey, which serves as a preliminary study laying the groundwork for more targeted investigations in the future. The survey adopts an exploratory approach, building upon the classification proposed by [Wohlin, 2012]. Its primary objective is to gain valuable insights into API management practices and evaluate the quality characteristics of API management platforms. The results obtained from this initial study will form the basis for future research endeavors, enabling in-depth exploration of specific aspects related to API management.

Sampling Technique: The survey employed a non-probabilistic sampling method, more specifically, convenience sampling, following recommendations from [Wohlin, 2012], [Fowler Jr, 2013], [Kasunic, 2005]. Convenience sampling entails selecting

participants based on their accessibility and availability. For this study, the subjects were drawn from professionals residing in the city of Río Gallegos, Argentina, possessing an academic background in computer science, and actively working in the field, both in the public and private sectors. This particular sample was deliberately chosen for their expertise and relevance to the study's primary focus.

Data Collection: The survey was administered and data collected through an online survey platform, chosen for its accessibility and efficiency in capturing responses.

Survey Design: The survey questions were meticulously crafted, encompassing the eight main quality characteristics specified in ISO/IEC 25010, along with a set of 15 capabilities commonly supported by API management platforms, as outlined in the existing literature [De, 2017], [Preibisch, 2018], [Mathijssen, 2020]. The survey was structured into two main groups of prompts, outlined as follows.

The first group consisted of five open-ended questions specifically designed to gather demographic data and obtain information about the professional trajectories of the respondents. The aim of these questions was to collect comprehensive census data and gain insights into the respondents' backgrounds, with a particular focus on their experiences within the API management domain.

The second group consisted of 15 closed-ended multiple-choice grid questions, with each question aligned with one of the primary API management capabilities identified in [De, 2017], [Preibisch, 2018], [Mathijssen, 2020]. The selected capabilities were as follows: 1. Authentication; 2. Authorization (Access Control); 3. Identity mediation; 4. Data privacy through encryption; 5. Data privacy through masking; 6. Key and certificate management; 7. DoS protection; 8. Threat detection; 9. Consumption quota; 10. Spike arrest; 11. Usage throttling; 12. Traffic prioritization; 13. Format translation; 14. Protocol translation; and 15. Service and data mapping.

Each grid was designed with eight rows, presenting boolean (Related/Not related) options to assess the alignment of each API management function with the ISO/IEC 25010 quality characteristics. To ensure response accuracy, mandatory radio buttons were utilized.

In total, each respondent was required to answer 125 questions, comprising a combination of open-ended and closed-ended questions. To ensure a satisfactory

response rate and obtain a representative sample, the survey was accessible for a two-week period. This duration allowed professionals to access the survey and complete the questionnaire at their convenience.

## 3. Results

In relation with labor sphere, It is important to note that some participants provided multiple answers for both the labor sphere and role questions, indicating their involvement in various domains or responsibilities within the IT-related industry. Results are detailed as follows:

- Private Companies (28.57%), Government Departments: (71.43%).
- Role (self-described): Developer (coding, full stack: 50.00%), Help and Support: (25.00%), Functional Analyst: (8.33%), Project Management: (8.33%), Research and Development (8.33%).

The survey was conducted as a pilot experiment, involving a small sample of professionals from the IT-related industry. A total of six participants took part in the study. The participants' demographic and professional characteristics are summarized below:

- Age: The age range of the participants varied from 27 to 42, with an average age of 31 years.
- Experience: The professional experience of the participants ranged from 4 to 20 years, with an average experience of 9 years.

Regarding the labor sphere, it is essential to note that some participants provided multiple answers for both the labor sphere and role questions, indicating their involvement in various domains or responsibilities within the IT-related industry. The results are as follows:

- Employment. Private Companies: 28.57%; Government Departments: 71.43%
- Self-described Roles. Developer (coding, full stack): 50.00%. Help and Support: 25.00%. Functional Analyst: 8.33%. Project Management: 8.33%. Research and Development: 8.33%

Findings: As this study served as a pilot experiment to gather preliminary insights, the emerging findings from the collected data are presented in figures 1 to 15. These figures represent the responses concerning the capabilities used in the survey, as described in the Methods section. For example, figure 1 displays the survey responses for the "Authentication" capability, figure 2 shows the survey responses for the "Authorization" capability, and so on. The responses are presented as tabular counts (% of total responses), and a corresponding 3D bar graph accompanies each table. The horizontal axis of the graph represents the quality characteristics described in the ISO 25010 standard, while the bars depict the responses. Additionally, error bars are incorporated into the graph.
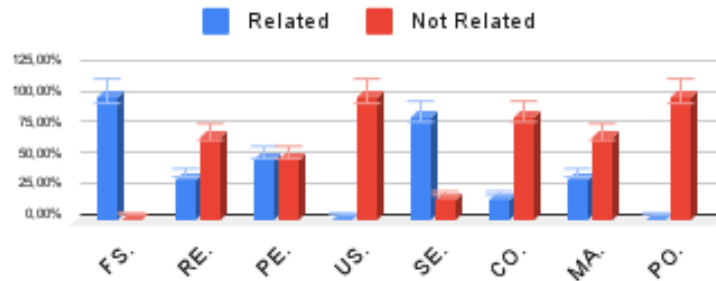


*Source: self made*

Figure 1 Capability "Authentication" relation with ISO/IEC 25010 quality characteristics.
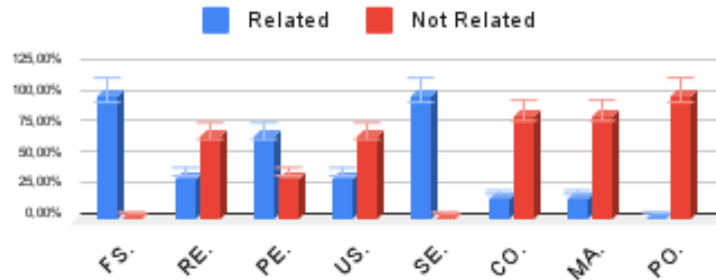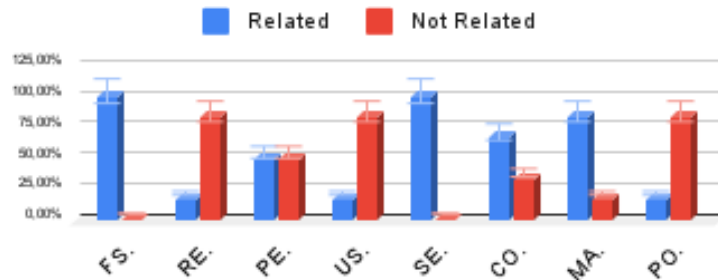


*Source: self made*

Figure 2 Capability "Authorization" relation with ISO/IEC 25010 quality characteristics.

As mentioned above, figure 1 showcases the survey outcomes regarding Authentication capability and its correlation with the quality characteristics specified in ISO/IEC 25010. According to such outcomes, 100% of participants consider its related with Functional Suitability and 83.33% with Security. 50% of participants

consider the capability is related with Performance Efficiency, 33.33% with Reliability and Maintanability, and 16.67% with Compatibility. Finally, all responses consider Authentication is not related with Usability and Portability.

Regarding to figures 2 to 15, the survey data in figure 2 illustrates the findings concerning Authorization and its association with the ISO/IEC 25010 quality characteristics. Presented in figure 3 are the survey results for Identity mediation, and its alignment with the quality characteristics from ISO/IEC 25010.
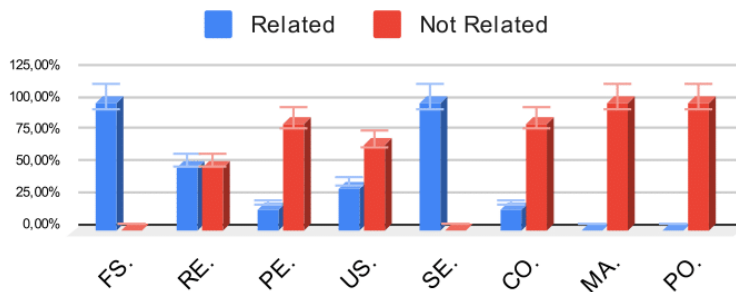


*Source: self made*

Figure 3 "Identity mediation" relation with ISO/IEC 25010 quality characteristics.
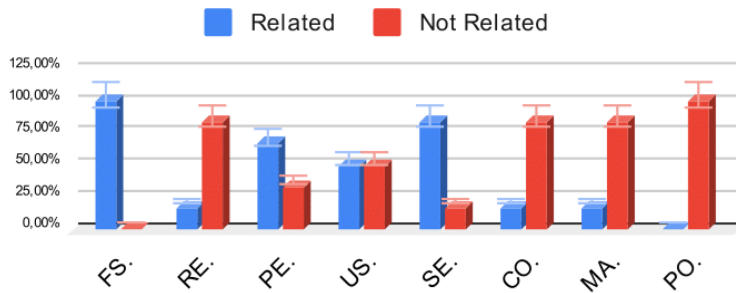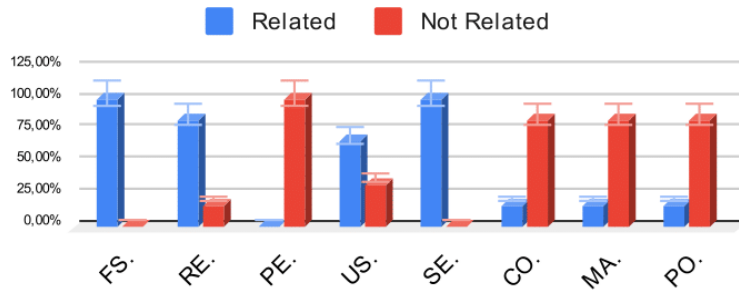


*Source: self made*

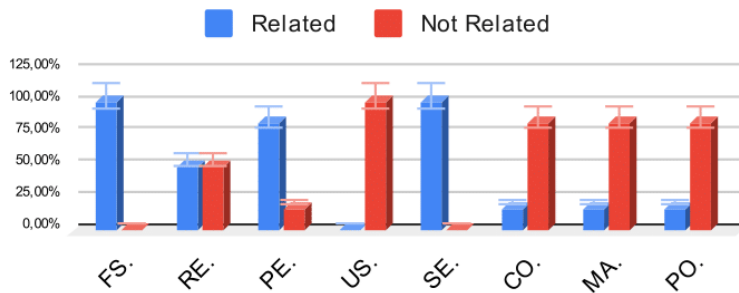Figure 4 "Encryption" relation with ISO/IEC 25010 quality characteristics.



*Source: self made*

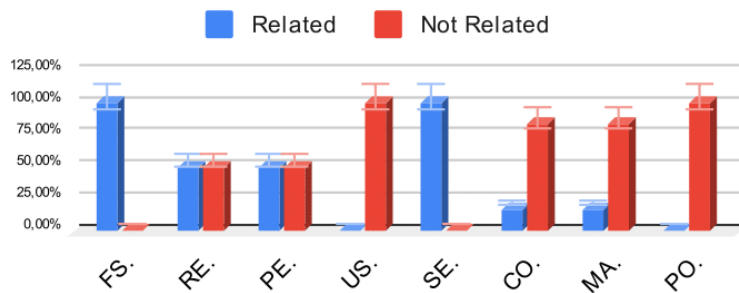Figure 5 "Masking" relation with ISO/IEC 25010 quality characteristics.

*Source: self made*

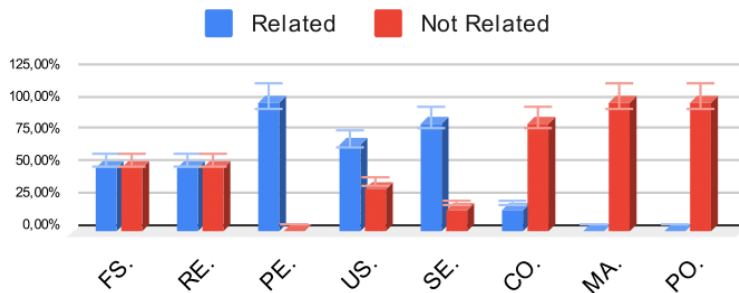Figure 6 "Keys and Certificates" relation with ISO/IEC 25010 quality characteristics.



*Source: self made*

Figure 7 "DoS Protection" relation with ISO/IEC 25010 quality characteristics.
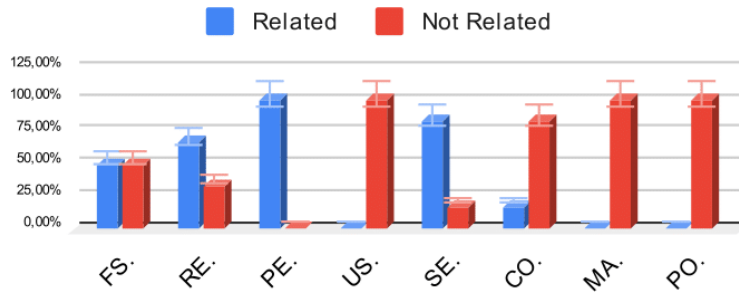


*Source: self made*

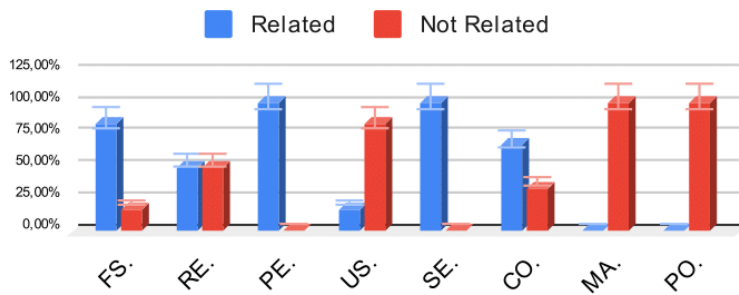Figure 8 "Threat Detection" relation with ISO/IEC 25010 quality characteristics.



*Source: self made*

Figure 9 "Consumption quota" relation with ISO/IEC 25010 quality characteristics.

*Source: self made*

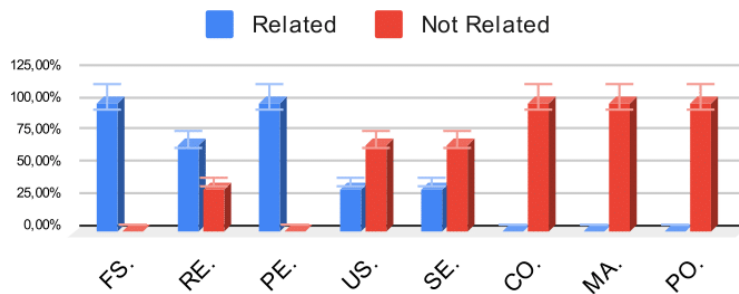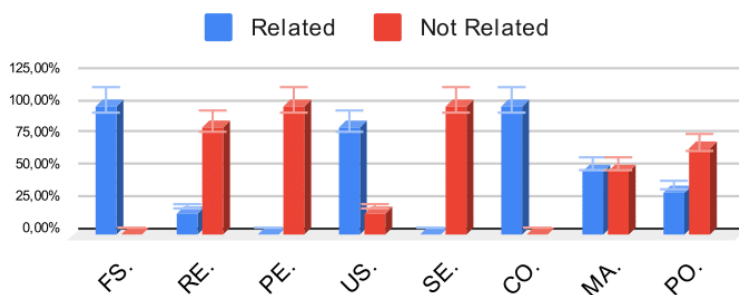Figure 10 "Spike arrest" relation with ISO/IEC 25010 quality characteristics.



*Source: self made*

Figure 11 "Usage throttling" relation with ISO/IEC 25010 quality characteristics.
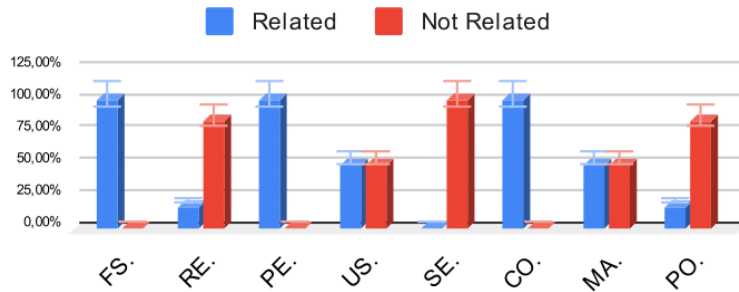


*Source: self made*

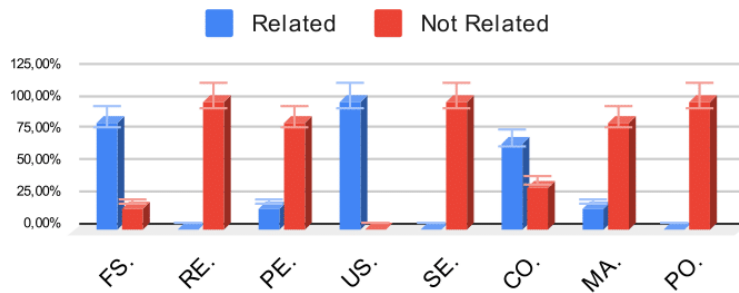Figure 12 "Traffic priorization" relation with ISO/IEC 25010 quality characteristics.



*Source: self made*

Figure 13 "Format translation" relation with ISO/IEC 25010 quality characteristics.

*Source: self made*

Figure 14 "Protocol translation" relation with ISO/IEC 25010 quality characteristics.



*Source: self made*

Figure 15 "Service and data mapping" relation with ISO/IEC 25010 quality characteristics.

Figure 4 demonstrates the survey responses pertaining to capability (Data privacy through) Encryption, and its connection to the quality characteristics outlined in ISO/IEC 25010. figure 5 provides a visual representation of the survey outcomes for (Data privacy through) Masking, and its relationship with the quality characteristics defined in ISO/IEC 25010. The correlation between Keys and Certificates capability and the quality characteristics identified in ISO/IEC 25010 is illustrated in figure 6, along with the survey results. figure 7 presents the survey data concerning DoS Protection and its relevance to the ISO/IEC 25010 quality characteristics. figure 8 exhibits the survey findings for Threat Detection, and how it relates to the quality characteristics specified in ISO/IEC 25010. The results depicting the relationship between Consumption quota administration and the ISO/IEC 25010 quality characteristics are shown in figure 9. Figure 10 depicts the survey responses for Spike arrest capability, and its association with the quality characteristics outlined in ISO/IEC 25010. The survey results for Usage throttling capability and its alignment with the ISO/IEC 25010 quality characteristics are visually represented in figure 11.

Figure 12 displays the survey outcomes concerning 12 capability and its connection to the quality characteristics described in ISO/IEC 25010. Shown in figure 13 are the survey findings for capability and its relevance to the ISO/IEC 25010 quality characteristics. Figure 14 presents the survey data regarding capability and its correlation with the quality characteristics from ISO/IEC 25010. Finally, figure 15 exhibits the survey responses for capability and how it corresponds with the quality characteristics defined in ISO/IEC 25010.

## 4. Discussion

Several surveys and reports, including "The Rapid Developer Survey" [RapidAPI, 2023] and the "State of Software Qualit – API" [SmartBear 2023] reports, highlight API Management issues as a prominent trend in the global industry. Additionaly, the utilization of surveys targeting API practitioners is a widely adopted approach by leading organizations within the industry. These surveys yield influential guiding documents that benefit both the web API production and consumption sectors. In our study, we have integrated specific elements from the RapidAPI survey to enhance our analysis.

On a global scale, [RapidAIP, 2023] obtained 850 responses from over 100 different countries. A significant majority of respondents identified as professional developers, with more than 85% reporting active programming as part of their vocation or educational pursuits. The survey participants represented a diverse spectrum of organizational sizes, experience levels, and industries. Additionally, [Smartbear, 2023] published the annual report titled "State of Software Quality - API" with the aim of "Identifying the latest benchmarks and gaining insights into the trajectory of the API industry." This report compiles information on "the latest methodologies, practices, and tools used by software teams across the world." The survey responses involved more than 1,100 API practitioners and customers, spanning various industries and ranging from startups to large enterprises in terms of company size. Furthermore, within an Argentinean perspective, [Constanzo, 2022] presented the outcomes of the first-ever survey specifically targeting developers in Argentina. The primary objective of this investigation was to comprehend the usage patterns

and challenges faced by software developers when consuming web APIs within the Argentinean context.

Despite previous surveys, there remains a scarcity of evidence regarding research that specifically targets stakeholders' perceived quality in the industry, as proposed in our current work and ongoing research agenda. Our emphasis lies in characterizing quality aspects related to API management requirements, capabilities, and best practices, utilizing the ISO 25010 / SQuaRE standard as our quality reference model.

Due to the extensive nature of the survey, which covered 15 capabilities, the data from all positive responses has been synthesized and presented in table 1. To enhance the visualization and understanding of the results, a color scale was adopted, with the midpoint set at the 20th percentile. The table includes the average and median values for reference.

Table 1 Positive results summary – API Management capabilities and ISO 25010.

| | Functional Suitability | Reliability | Performance Efficiency | Usability | Security | Compatibility | Maintainability | Portability |
|---|---|---|---|---|---|---|---|---|
| Average | 91.07% | 40.07% | 58.93% | 36.67% | 71.00% | 36.93% | 21.20% | 6.73% |
| Mean | 100.00% | 50.00% | 67.00% | 33.00% | 83.00% | 17.00% | 17.00% | 0.00% |

*Source: self made*

The survey results demonstrate the alignment between API Management capabilities and various quality characteristics. Functional Suitability received the highest average percentage of related responses at 91.07%, indicating strong compatibility between capabilities and intended functionality.  This can support a hypothesis that API Management capabilities serve as functional requirements of API Management software products, which would exhibit a high rate of functional suitability. Security obtained a relatively high average percentage at 71%, ensuring security aspects within the platforms. Reliability and Performance Efficiency received moderate scores of 40.07% and 58.93%, respectively, signifying their contribution to reliable and efficient performance. Usability and Compatibility received lower scores of 36.67% and 36.93%, suggesting associations with user-friendliness and compatibility with external systems. Maintainability garnered a

21.2% average, indicating some relevance to ease of maintenance. However, Portability received the lowest average percentage at 6.73%, suggesting limited alignment with portability quality. These findings provide valuable insights into the perceived associations between API Management capabilities and the ISO 25010 quality characteristics. It is essential to consider these results when designing, developing, and enhancing API management platforms to better meet user needs and ensure high-quality software products.

**Threats to validity and LImitations**

It is important to note that these findings should be interpreted with caution due to the small sample size and the exploratory nature of the pilot experiment. When conducting surveys, it is crucial to address potential threats to the validity of the results. In this regard, sample and population size become significant considerations as potential threats to survey results' validity. Specifically, two types of threats related to sample and population size are worth mentioning: a) Sampling Bias [Cochran, 1977], [Kish, 1965]: This bias can restrict the generalizability of the findings and lead to inaccurate conclusions about the broader population. b) Limited Statistical Power [Cohen, 1988], [Rosenthal, 2008]: Inadequate statistical power may impede the study's ability to detect meaningful relationships or differences, thereby increasing the likelihood of Type II errors (false negatives) and limiting the capacity to draw accurate conclusions from the data.

To mitigate this threat, we have implemented various strategies as described in [Ghazi, 2019]. While the study makes valuable contributions, it is essential to acknowledge its limitations, given its pilot nature. The inherent limitations in the study design include:

a) Small sample size: With only six participants, the study's findings may have limited generalizability.

b) Lack of diversity: The sample size was small and may not be representative of the broader population of professionals in the IT-related industry.

c) Preliminary nature: As the study sought to gather preliminary insights, it may not provide definitive conclusions.

**Impact and significance**

The findings of this study carry significant implications for the field of API management and software development. Understanding the relationships between API Management capabilities and ISO 25010 quality characteristics provides valuable insights into the design, development, and enhancement of API management platforms as software products. The study's insights on the associations between capabilities and ISO 25010's quality characteristics can serve as guidance for platform providers to make informed decisions, leading to improvements in specific aspects of their API management offerings. Addressing the identified gaps and weaknesses empowers developers to create more robust, efficient, and user-friendly API management platforms that meet users' expectations and align with industry standards.

Moreover, the study's results can greatly assist API management platform users, developers, and decision-makers in making informed choices when selecting or customizing platforms to meet their specific needs and quality requirements. Understanding which capabilities significantly contribute to each quality characteristic empowers stakeholders to make data-driven decisions during their platform evaluation and adoption processes. Confirming the identified high rate of functional suitability and security among capabilities through wider surveys may further indicate that developers and organizations can prioritize and invest in functionalities that align well with user needs and overall system functionality.

# 5. Conclusions

This study successfully identified the quality characteristics perceived as related to API Management capabilities by industry practitioners. The high rate of functional suitability among capabilities suggests a strong alignment with meeting functional needs and user requirements, providing a foundation for future surveys with a higher number of participants to confirm this hypothesis further. The findings also contribute valuable insights to the existing knowledge in API management and software development. Despite the study's limitations, such as the relatively small sample size, it lays the groundwork for future research in this domain as a trend to be proven.

The study revealed moderate associations between capabilities and other ISO 25010 quality characteristics, presenting opportunities for improvement. Addressing the identified gaps could lead to enhanced API Management functional suitability, reliability, performance efficiency, usability, security, compatibility, maintainability, and portability.

We recommend that future studies explore these associations with larger and more diverse samples to enhance the generalizability of the results. Additionally, considering other factors that may influence participants' perceptions, such as their experience with API management platforms, could provide further insights into quality characteristic prioritization.

In conclusion, the insights gained from this study offer valuable guidance to API management platform providers, developers, and users, promoting the continuous improvement and adoption of high-quality API management software products that meet the evolving needs of the software industry.

Based on the preliminary findings and the identified limitations, future research in this area should consider the following directions: i. Increase sample size: Carefully considering the sample size and ensuring its appropriateness for the research objectives and the target population is crucial in addressing potential threats. Conducting the study with a larger and more diverse sample would allow for a more robust establishment of the hypothesis for future surveys. ii. Explore additional variables: Investigating other factors or variables that may influence the observed patterns will provide a more comprehensive understanding. iii. Perform additional statistical analyses, such as multivariate analysis and other techniques, to deepen the insights gained from the data.

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