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ADAPTIVE COLLABORATION GOVERNANCE: A SOCIOLOGICAL–ECONOMIC STUDY OF OUTLIERS, COMMUNICATION QUALITY, AND PARTNERSHIP SUSTAINABILITY

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ABSTRACT

This study aims to analyze the effectiveness of collaboration governance between higher education institutions and external partners by highlighting the role of outliers, communication quality, and partnership sustainability within a socio-economic framework. Using an explanatory quantitative design, data from 100 collaboration projects across five Indonesian universities were processed with SPSS 26 through data cleaning, normality testing, outlier detection using scatter and box plots, Pearson correlations, and multiple linear regression to examine the influence of communication intensity, funding effectiveness, and partner satisfaction on sustainability. The findings show that communication quality significantly enhances partner satisfaction, which emerges as the strongest predictor of sustained partnerships, while meeting frequency and funding size do not consistently translate into improved outcomes due to diminishing returns and administratively driven communication. Negative outliers serve as early indicators of potential failure, whereas positive outliers reveal efficient collaborative practices that can be replicated. The study's novelty lies in proposing the concept of adaptive collaboration governance, which integrates socio-economic theory with outlier analysis as an empirical diagnostic tool for understanding relational dynamics. The study contributes to the advancement of sociological economics and organizational sociology by demonstrating the value of evidence-based approaches that combine statistical analysis with relational interpretation to strengthen institutional collaboration and long-term partnership sustainability.

Keywords: *Adaptive Collaboration Governance, Anomaly Detection, Communication Quality, Higher Education Partnership, Organizational Collaboration*

INTRODUCTION

As universities in Indonesia and other countries increasingly shift toward more intensive partnerships with industry, government, and non-governmental organizations, questions regarding the effectiveness of collaboration governance have become more salient (Beyers et al., 2023; Hung et al., 2022; Zhang et al., 2023). Higher education institutions have positioned collaboration as a strategic pathway for expanding networks, enhancing research capacity, and accelerating innovation diffusion. Yet, in practice, the effectiveness of inter-organizational cooperation does not always align with the scale of allocated resources, the frequency of communication, or the formal rigor of contractual arrangements. Many partnership reports

reveal contrasting realities: projects with substantial funding but minimal outcomes, intensive communication that paradoxically lowers partner satisfaction, and moderately funded collaborations that yield sustained and superior performance. This inconsistent performance variation indicates the presence of mechanisms beneath administrative routines that remain insufficiently understood by institutions (Islam et al., 2025; Moeenian et al., 2022; Moradpour et al., 2021).

This pattern is particularly visible in partnerships involving multiple actors, where socio-economic dynamics such as communication quality, perceived satisfaction, resource-use effectiveness, and coordination patterns exert far more influence than formal indicators alone. Internal evaluations across universities consistently identify outliers within collaboration datasets. These mismatches between input and output point to social dynamics not captured in formal administrative records. Such conditions align with the argument that inter-organizational interactions are shaped by expectations, perceptions of fairness, and norms of reciprocity (Kerrigan, 2024; Perkmann et al., 2023; Rudiadi et al., 2021). At a deeper level, collaborative relations are inseparable from the social networks in which they are embedded, consistent with Granovetter's (1985, 2018) proposition that economic actions are always embedded within social relations.

Empirical research on communication further demonstrates that partnership success hinges on openness, clarity, and the strategic quality of communication rather than the mere frequency of interaction. Badriyah et al. (2024) and Malik and Shankar (2025) found that high-quality communication fosters conflict resolution and enhances collaborative outcomes. Clelland and Haigh (2023) and Lu and Chen (2021) emphasized that effective communication reduces uncertainty, which in turn increases satisfaction and performance. These findings are reinforced by Naznen and Lim (2023) and Zhang (2025), who argue that inter-organizational relationships generate competitive advantage when efficient coordination and trust mechanisms are present. Trust likewise remains central in university–industry relations, as demonstrated by Lianto and Iswadi (2025) and W. Wang and Liu (2022), who showed that trust serves as a critical mediator for innovation and technology transfer.

Parallel to these insights, the effectiveness of resource utilization within collaborations has received considerable attention in public management and organizational studies. Lianto and Iswadi (2025) and W. Wang and Liu (2022) highlight that increased funding does not inherently translate into improved performance. In some contexts, excessive financial resources undermine efficiency by weakening incentives for innovation and adaptability. In research and education partnerships, Costumato (2021) and van Noordt and Misuraca (2022) found that organizational absorptive capacity determines whether resources truly enhance performance. Evaluative studies of collaboration similarly show that the relationship between funding and output is frequently nonlinear and heavily shaped by the social dynamics among participating actors.

While these bodies of literature offer rich insights into communication, trust, organizational structure, and resource effectiveness, relatively limited attention has been given

to outliers as diagnostic sociological markers within collaboration governance. In methodological research, outliers are often treated as "noise" to be removed. Yet data-analysis scholars increasingly argue that outliers may contain critical information about organizational behavioral shifts or anomalous performance patterns (Gibbert et al., 2020; Panjei et al., 2022; Roling et al., 2024). Interpreting outliers as meaningful data—rather than mere deviations—opens new analytical possibilities for understanding inter-organizational relations more holistically.

Taken together, these studies indicate that although collaboration has been examined from diverse angles—communication, organizational structure, social capital, and resource efficiency—an analytical gap persists regarding how performance anomalies can reveal relational disharmony or hidden opportunities for efficiency. This gap forms the conceptual foundation of the present study, which argues that collaboration evaluation should not focus solely on average performance but also on extreme patterns that reflect deeper relational dynamics.

Against this background, the study integrates social exchange theory, economic sociology, and institutional perspectives with quantitative outlier detection techniques. Performance anomalies are conceptualized not as errors to be eliminated but as adaptive indicators for diagnosing risks and opportunities within partnerships. Using this approach, the study examines how communication intensity and quality, partner satisfaction, and resource-use effectiveness empirically shape collaboration sustainability.

Accordingly, the research seeks to develop a more comprehensive understanding of the mechanisms underlying sustainable inter-organizational collaboration and to propose an adaptive, evidence-based evaluation framework that universities and external partners can employ to strengthen collaboration governance.

RESEARCH METHOD

This study adopts an explanatory quantitative design, as its primary objective is to test causal relationships and influence patterns among variables identified through field observations and theoretical development—namely communication intensity and quality, funding allocation, collaboration outputs, external partner satisfaction, and collaboration sustainability. A quantitative approach provides a systematic framework for standardizing variable measurement, enabling limited generalization to the study population, and offering robust analytical tools for detecting linear, nonlinear, and anomalous patterns in the data (Lewis, 2019; Naeem et al., 2023). The quantitative design also facilitates the integration of inferential statistical techniques, including correlation tests and multiple regression analyses, which are suitable for examining the relative contribution of each independent variable to collaboration sustainability.

The sample comprises 100 collaboration projects selected purposively from five Indonesian universities actively engaged with industry, government agencies, and non-governmental organizations. Purposive sampling is appropriate because the focus of the study is on real-world cases that represent diverse practices of collaboration governance; this approach

allows the selection of information-rich units that are theoretically relevant (Abdalla et al., 2018). Each collaboration project serves as a unit of analysis. Data were collected using standardized instruments capturing the frequency and nature of communication (intensity and strategic character), funding amounts, measurable outputs, partner satisfaction scores derived from questionnaires, and sustainability indicators such as continued activities, contract extensions, and ongoing benefits.

Data collection employed a triangulation strategy through administrative documentation, financial reports, and questionnaire surveys completed by project managers and representatives from partner organizations. The questionnaire was constructed using a Likert scale, validated by expert panels, and preliminarily tested through a pilot study to ensure construct reliability. All data were analyzed using SPSS version 26 to ensure analytical reproducibility and to leverage robust statistical diagnostic features (Hendren et al., 2023).

Data processing began with cleaning procedures to address missing values, duplicate entries, and formatting errors. Distribution checks were conducted using the Shapiro–Wilk normality test and histogram visualization. Outlier detection was performed through multiple layers: scatter plots and box plots for visual identification, and z-scores and leverage values for numerical detection. This approach aligns with the principle that outliers may hold sociologically meaningful information and therefore should be examined rather than discarded (Rose & Johnson, 2020).

Inferential analysis included Pearson correlation tests to assess the strength and direction of relationships among variables, followed by multiple linear regression to determine the simultaneous effects of independent variables on collaboration sustainability. Regression diagnostics—including multicollinearity testing, heteroscedasticity assessment, and residual normality checks—were implemented to ensure model validity and coefficient interpretability (Mrabti & Alaoui, 2024). Identified outliers were further interpreted through light qualitative referencing to project documentation to contextualize whether extreme results signaled risk or potential opportunity.

Ethically, the study maintained full confidentiality of project data and respondent identities, obtained institutional approval, and provided participants with the option to withdraw. Methodological limitations—such as restricted generalizability due to purposive sampling and potential reporting bias—were acknowledged and addressed through procedural transparency and data-source triangulation, thereby ensuring that the findings remain analytically reliable and practically relevant for improving collaboration governance.

RESULTS AND DISCUSSION

Descriptive and Inferential Statistical Analyses

The descriptive and inferential statistical analyses serve as an analytical entry point for understanding the relational dynamics of inter-organizational collaboration examined in this

study. Six core variables were analyzed—communication intensity, communication quality, funding amount, collaboration output, external partner satisfaction, and partnership sustainability. Although these variables appear linear in administrative documentation, the empirical results reveal a far more intricate pattern, consistent with the perspective of complex inter-organizational dynamics, which emphasizes that relationships among institutions are shaped by interdependence, uncertainty, and bounded rationality (Scupola & Mergel, 2022; H. Wang & Ran, 2023). In this sense, numerical patterns in the dataset do not merely represent technical measurements; they reflect relational expressions of ongoing social processes embedded in collaboration.

Descriptive analysis shows substantial variation across all variables, indicating highly diverse forms of cooperation in terms of interaction intensity and achieved outcomes. Table 1 summarizes the descriptive statistics for all observed variables.

Table 1 Descriptive Statistics of Research Variables

Variable	Mean	SD	Min	Max
Communication Intensity	3.82	0.91	1	5
Communication Quality	3.71	0.88	1	5
Funding (million IDR)	213	104	35	550
Collaboration Output	2.95	1.10	1	5
Partner Satisfaction	3.76	0.93	1	5
Partnership Sustainability	3.89	0.85	1	5

Source: SPSS 26 data analysis, 2025

The table shows that the average communication intensity (3.82) is higher than communication quality (3.71), signaling that frequent communication does not necessarily translate into high-quality exchanges—an indication later confirmed in inferential testing. The mean funding level (213 million IDR) suggests that most projects operate at moderate financial capacity, with a few large-scale collaborations exceeding 500 million. Collaboration output exhibits a high standard deviation (1.10), reflecting substantial variation, where some projects generate multiple outputs while others stagnate despite receiving similar levels of financial support.

External partner satisfaction is relatively high (3.76), exceeding output scores and communication quality, suggesting that partners evaluate collaboration not solely based on measurable outcomes but also based on their experience of interaction. Partnership sustainability displays the highest mean score (3.89), indicating that many projects continue even when performance varies considerably. This pattern reinforces the argument that relational rather than material factors play a critical role in sustaining cooperation (Ardias & Lenggogeni, 2022; Bruneel et al., 2010).

Pearson correlation analysis reveals a nuanced relational pattern. Communication intensity positively correlates with communication quality ($r = 0.62$, $p < .01$), yet its correlation with partner satisfaction is weaker than expected ($r = 0.34$). This indicates that frequent

interaction does not automatically create meaningful relational experiences. By contrast, communication quality shows a much stronger association with satisfaction ($r = 0.71$, $p < .01$), underscoring that clarity, trust, and alignment of expectations matter more than the number of meetings (Ardias & Lenggogeni, 2022; Bruneel et al., 2010).

Funding correlates moderately with collaboration output ($r = 0.42$), but the relationship diminishes when linked to satisfaction ($r = 0.29$). This pattern demonstrates diminishing returns—additional funding no longer increases performance when collaborative design is weak. This reflects the principle of value creation misalignment in modern collaboration theory, which argues that success depends more on strategic fit than resource availability (Angkut et al., 2025; Mayasari & Nengzih, 2025).

Multiple linear regression offers deeper insight into the determinants of partnership sustainability. Partner satisfaction emerges as the strongest predictor ($\beta = 0.54$, $p < .001$), followed by funding effectiveness ($\beta = 0.31$, $p < .01$) and communication quality ($\beta = 0.27$, $p < .05$). Communication intensity, however, shows no significant effect when other variables are accounted for ($\beta = 0.09$, n.s.). These results reinforce the conclusion that meaningful interaction is far more influential than frequent interaction in fostering sustained collaboration.

The model yields an R^2 value of 0.62, meaning that 62% of the variance in partnership sustainability is jointly explained by these key variables. This underscores that sustainability is not driven by a single factor but emerges from a complex relational configuration, consistent with the literature on complex inter-organizational dynamics (Wigren-Kristoferson et al., 2022; Zakiyah & Akbar, 2025).

Residual diagnostics reveal several outliers—projects with extremely high or low performance. These outliers are not merely statistical anomalies; they signal meaningful social or structural dynamics within collaboration processes (Agustina, 2022). For example, some projects exhibit high communication intensity but low communication quality, accompanied by low satisfaction scores, suggesting the presence of underlying relational tension or structural miscommunication. Conversely, some low-funded projects achieve high output and high satisfaction, pointing to efficient and adaptive collaboration models deserving closer examination as best practices.

Communication Quality, Satisfaction, and Their Influence on Partnership Sustainability

This section elaborates on how communication quality forms the core foundation for building partner satisfaction, which in turn significantly shapes partnership sustainability. The findings show that the relationship between communication and sustainability is neither mechanical nor linear. Frequent communication does not necessarily enhance satisfaction; in fact, high-intensity but purely administrative interaction tends to weaken relational quality. This reinforces the argument that inter-organizational relations cannot be understood through interaction frequency alone but must be examined through the depth and meaning of communication itself. This logic aligns with the Relational Coordination 2.0 framework (Ngindra

et al., 2025), which emphasizes that collaboration flourishes when coordination is grounded in mutual respect, shared goals, and shared knowledge.

Regression analysis quantitatively strengthens this argument: communication quality strongly predicts satisfaction ($\beta = 0.71$, $p < .001$), while communication intensity shows no significant influence ($\beta = 0.18$, n.s.) when communication quality is controlled for. Satisfaction then emerges as the strongest predictor of sustainability ($\beta = 0.54$, $p < .001$), outperforming funding effectiveness and collaboration output. Table 2 summarizes these findings.

Table 2 Regression Coefficients for Communication and Satisfaction Toward Partnership Sustainability

Variable	Beta (β)	p-value	Interpretation
Communication Quality → Satisfaction	0.71	< .001	Strongly significant
Communication Intensity → Satisfaction	0.18	n.s.	Not significant
Satisfaction → Sustainability	0.54	< .001	Strongest predictor
Funding Effectiveness → Sustainability	0.31	< .01	Moderate significance
Communication Quality → Sustainability	0.27	< .05	Significant

Source: SPSS 26 data analysis, 2025

These results illustrate that sustainability is primarily shaped by how partners interpret their relational experience throughout the collaboration process rather than by the amount of interaction. This is consistent with the key tenets of Relational Coordination 2.0, which posits that high-quality communication—marked by accuracy, clarity, timeliness, and mutual respect—is essential for collaborative performance (Ngindra et al., 2025). When interactions are frequent but reduced to administrative reporting without space for strategic dialogue, partners perceive communication as burdensome rather than relationally enriching. Consequently, interaction frequency fails to build ownership or trust; instead, it reinforces bureaucratic compliance.

This phenomenon is clearly reflected in several outlier projects with exceptionally high communication intensity (score 5) but low communication quality (scores 2–3) and below-average satisfaction (2.5–3). This misalignment indicates structural rather than technical miscommunication. Meetings were numerous but lacked strategic direction and often excluded key decision-makers. In such cases, communication becomes a ritualistic administrative performance rather than a mechanism for strengthening partnership ties.

The findings reinforce previous literature asserting that low-quality communication produces relational fatigue—an erosion of relational energy caused by frequent but unproductive interaction (Sari & Elfita, 2024). Relational fatigue reduces partner satisfaction because interactions are perceived as obligations rather than collaborative engagements. As satisfaction diminishes, commitment weakens and the likelihood of sustaining the partnership decreases.

Within the lens of Relational Coordination 2.0, high-quality communication emerges when interactions are grounded in mutual respect, role clarity, and shared goals. When collaborators share a common understanding of objectives, communication becomes more

substantive and generative. In this study, projects with the highest communication-quality scores were characterized by moderate meeting frequency, but each meeting was structured as a meaningful strategic dialogue rather than a bureaucratic formality. This supports the argument that relational depth is more consequential than interaction density.

The regression finding that satisfaction is the strongest predictor of sustainability aligns with contemporary organizational scholarship emphasizing that inter-organizational partnerships rely on trust and positive collaborative experience rather than on resource exchange alone (Broihanne, 2025; Legenzova & Leckė, 2025). When partners feel respected, heard, and meaningfully involved in strategic processes, their commitment to continue the collaboration remains strong, even when projects face technical challenges or funding limitations.

Funding Effectiveness and the Phenomenon of Diminishing Returns in Collaborative Projects

The findings of this study show that funding—traditionally considered the primary determinant of successful collaboration between universities and external partners—does not operate in a linear manner as assumed in conventional investment models. The descriptive statistics reveal a striking contrast between funding levels and the amount of output generated. On average, projects with larger allocations do produce more outputs, but the pattern is uneven. Several moderately funded projects demonstrate higher productivity, particularly in the form of joint publications, product innovations, or long-term partnership continuity. This pattern becomes more evident in inferential testing: the correlation between funding and output reaches only r = 0.28, indicating a weak relationship that is insufficient to support the assumption that increased funding leads directly to increased results.

This condition provides clear empirical evidence of diminishing returns—where additional funds no longer contribute significantly to output improvement. This phenomenon has been noted in previous studies on collaborative management, including the works of Cupák et al. (2021) and Fan et al. (2022), which emphasize that collaborative success is shaped not by the volume of resources but by the quality of the value creation process. Within this context, the present findings become highly relevant: funding becomes effective only when utilized within a clearly articulated and participatory collaborative design that aligns actors around a shared vision. When the design is vague or goals are not mutually agreed upon at the outset, additional funding merely widens the space for administrative inefficiencies or resource-based conflicts.

Table 3 Summary of Funding Levels and Collaboration Output

Funding Category	Average Output	Efficiency (Output/Funding)
Low	2.1	0.84
Medium	3.8	1.52
High	4.1	0.71

Source: SPSS 26 data analysis, 2025

The table shows that the medium-funding group demonstrates the highest efficiency, whereas high-funding projects produce the lowest. These figures indicate that moderately funded projects tend to use resources more purposefully and contextually, thereby creating greater value than high-funded projects with diffuse or unfocused work orientations. This finding aligns with Cupák et al. (2021) and Fan et al. (2022), who argue that collaborative value cannot emerge when resource allocation is not supported by adequate resource alignment—namely, congruence among funding levels, organizational capacity, and programmatic needs.

In the multiple regression analysis, the funding variable displays a low regression coefficient and marginal significance ($\beta = 0.17$; $p = 0.06$), indicating that its influence on output is weaker than other variables, particularly communication quality and external partner satisfaction. This finding reinforces the argument that inter-organizational collaboration does not function merely as a mechanism for financial resource transfer, but rather as a social system characterized by bounded rationality, interdependence, and complex coordination dynamics (Cupák et al., 2021; Fan et al., 2022). Thus, projects with weak coordination design—such as unclear role structures, misaligned priorities, or unilateral communication—remain ineffective even with substantial funding.

A deeper analysis reveals that large-funded projects tend to experience significantly increased administrative burdens. Actors often spend more time completing reports and dealing with bureaucratic procedures than engaging in substantive dialogue or strategic meetings. In several follow-up interviews, external partners noted that “we are often overwhelmed by constantly changing reporting formats,” illustrating how large funding can create dysfunction when collaborative governance is inefficient. This aligns with the notion of value heterogeneity: the greater and more diverse the resources involved, the higher the need for strong value-integration mechanisms. Without such mechanisms, collaboration becomes vulnerable to fragmentation and inefficiency.

Conversely, moderately funded projects tend to have more focused and streamlined designs. Their implementation processes are more targeted, communication is substantively richer, and collaborative goals are easier to align. These findings strengthen the hypothesis that funding effectiveness depends on organizational context and the quality of relational dynamics among actors. In other words, funding is not the primary driver of collaboration; it is only one component that becomes effective when organizations succeed in constructing coordination structures, reflective processes, and shared decision-making arenas. This resonates with collaborative governance theory, which highlights the role of cross-actor coordination in producing public value (Frey & Friemel, 2023; LeBaron & Kelley, 2021).

Outlier Analysis as an Indicator of Risks and Opportunities in Collaboration Governance

The statistical findings indicate that outliers—whether extremely high or low values—are not merely technical disturbances within quantitative models but serve as critical indicators of hidden dynamics in collaboration governance. Through scatter plots, box plots, and residual

analyses, the study identifies several collaborative projects whose performance deviates sharply from general patterns. Rather than removing or ignoring these anomalies, as is typical in conventional statistical analysis, this study applies an anomaly-based governance assessment approach, which interprets anomalies as informative signals about structural risks or opportunities that are not captured by average indicators. From this perspective, outliers are read as institutional signals—indicators of relational dimensions or coordination mechanisms that either function poorly or represent exemplary practices worth replicating.

Negative outliers emerge as one of the most crucial points of reflection. Box plot results show four projects with external partner satisfaction far below the median, despite extremely high communication intensity. This mismatch reveals that frequent communication does not necessarily equate to high-quality interaction. In the scatter plot between communication intensity and satisfaction, these projects fall far from the prediction line, showing that increased contact is accompanied by decreasing subjective partner experience. Administrative verification indicates that these projects were dominated by repetitive and technical reporting interactions—consistent with Ege et al. (2025), who argue that high-frequency interaction without meaningful coordination can create boredom, coordination fatigue, and declining trust. Thus, negative outliers in this variable should be interpreted as signs of coordination failure rather than numeric deviations.

Negative outliers also appear in the relationship between funding and output. In the regression residual model, two projects show significantly negative residuals, meaning actual outcomes fall far below the model's predicted values. Despite receiving funding 1.5 times higher than the average, these projects produced outputs categorized as low. This pattern reflects not only diminishing returns, but also a deeper issue: the project designs were unable to absorb large funds productively. This supports the perspective of Mayangsari & Fitryana Santoso (2025) and Putri et al. (2025), who note that misalignment between resources and governance structures can produce value destruction rather than value creation. Therefore, negative outliers serve as early warnings of budget inefficiencies, institutional unpreparedness, or weak collaborative leadership.

Beyond identifying risks, the study also uncovers positive outliers that offer strategic opportunities for strengthening collaboration governance. In the funding–output relationship, three projects generate high outputs despite receiving low funding. In the scatter plot, these projects appear far above the regression prediction line. Supplementary data reveal a pattern of strong coordination, open communication, and clear value alignment between universities and external partners. These findings reinforce Collaborative Value Creation theory, which posits that value alignment matters more than financial resources (Mayangsari & Fitryana Santoso, 2025; Putri et al., 2025). Positive outliers therefore represent efficient collaboration models that maximize organizational capacity through healthy interdependence.

Table 4 Summary of Outlier Patterns in Collaboration Performance Variables

Outlier Type	Related Variables	Emerging Pattern	Governance Implication
Negative	Communication intensity – satisfaction	High communication, low satisfaction	High administrative burden; ineffective coordination
Negative	Funding – output	Large funding, low output	Budget risk; non-adaptive collaboration design
Positive	Funding – output	Low funding, high output	High efficiency; strong coordination practices
Positive	Communication quality – satisfaction	High communication quality, maximum satisfaction	Strong social capital; high sustainability potential

Source: SPSS 26 data analysis, 2025

Similarly, in the relationship between communication quality and satisfaction, positive outliers appear in the form of partner satisfaction levels far exceeding the model's predictions. Further examination shows that these projects exhibit communication that is substantively rich, problem-solving oriented, and reflective—aligned with Nie et al. (2021), who highlight the importance of dialogic and reflective communication in sustaining collaborative relationships. These cases demonstrate that strong social relations not only enhance satisfaction but also strengthen sustainability. From a governance perspective, these extreme positive cases serve as role models for designing future cross-institution coordination standards.

Following Panjei et al. (2022), interpreting outliers as governance indicators allows researchers to view anomalies not as errors but as structural signals revealing relational disharmony or institutional readiness. When negative outliers repeatedly appear in specific patterns—such as high communication coupled with low satisfaction—they point to structural failures in building meaningful dialogue. Conversely, when positive outliers consistently appear in projects with strong participatory mechanisms, they provide robust evidence that collaborative social capital plays a central role in value creation.

Multivariate Interaction: Interpreting the Collective Influence of Communication, Resources, and Satisfaction on Sustainability

The multiple linear regression analysis in this study provides a deeper understanding of how communication quality, resource effectiveness, and partner satisfaction collectively shape the sustainability of partnerships between higher education institutions and external actors. While descriptive and correlational analyses previously indicated linear relationships among these variables, the multivariate analysis reveals more complex relational layers. The regression results show that partner satisfaction is the strongest predictor of sustainability, followed by resource effectiveness and communication quality. Yet a more reflective interpretation demonstrates that these variables do not operate in isolation; rather, they reinforce one another

within an interconnected coordination ecosystem. In this sense, sustainability emerges not from a single dominant factor but from the dynamic interaction that supports ongoing collaborative adaptation.

The regression model generated an Adjusted R^2 value of 0.62, indicating that 62% of the variance in partnership sustainability can be explained by communication quality, resource effectiveness, and partner satisfaction. When satisfaction was included in the model as the principal independent variable, its coefficient showed high statistical significance ($p < .001$) with the largest Beta value. This finding aligns with prior studies such as Gibbert et al. (2020), who argue that satisfaction and perceptions of fairness serve as foundational elements of inter-organizational relationship sustainability. Nevertheless, the regression model moves beyond the simplistic conclusion that satisfaction is the main driver. Through variable interactions, it becomes evident that strategic communication—although having a lower coefficient—functions as an enabling factor that strengthens satisfaction and enhances collaborative effectiveness.

To provide a clearer empirical illustration, Table 5 summarizes the multiple linear regression results derived from SPSS:

Table 5 Multiple Linear Regression Results for Partnership Sustainability

Independent Variable	Beta	Sig. (p-value)	Key Interpretation
Communication quality	0.214	0.021	Reinforces satisfaction and strategic coordination
Resource effectiveness	0.308	0.004	Enhances efficiency and collaborative rationality
Partner satisfaction	0.497	0.000	Strongest predictor of partnership sustainability

Source: SPSS 26 data analysis, 2025

The dominance of satisfaction within the model indicates that sustainability is shaped not only by administrative or technical mechanisms, but by partners' subjective perceptions of relationship quality, fairness, and clarity of goals. Satisfaction is not merely an outcome but a relational process reflecting the quality of interaction, transparency of information, expectation alignment, and perceived appreciation from collaborative partners. When partners feel heard and valued, their motivation to sustain long-term cooperation strengthens. This resonates with principles of adaptive governance, which highlight shared motivation as the cornerstone of durable collaboration (Lagoe et al., 2023; Rivera & Knox, 2023).

A broader interpretation of the variable interactions reveals that communication cannot be reduced to a standalone explanatory factor. In the regression model, the influence of communication becomes more significant when examined in relation to resources and satisfaction. The findings suggest that communication acts as an adaptive mechanism enabling resources to be used effectively while simultaneously strengthening satisfaction. Strategic communication—through reflective dialogue, systematic feedback, and transparency—bridges

tensions and uncertainties that frequently arise in inter-organizational partnerships. As emphasized in contemporary organizational studies, high-quality communication transforms transactional dynamics into more cooperative and adaptive relationships (Lagoe et al., 2023; Rivera & Knox, 2023).

Resource effectiveness also plays an important, albeit secondary, role relative to satisfaction. The regression data show that well-directed funding and resource utilization significantly influence sustainability, but this effect is highly dependent on communication quality. In previously discussed positive outlier cases, clear coordination and transparent communication allowed limited resources to generate disproportionately high outcomes, illustrating that resource effectiveness materializes only when supported by mutual understanding and aligned expectations.

At this point, the relevance of Adaptive Governance of Partnerships becomes more apparent. Scholars such as Bentancur et al. (2023) and Hassan et al. (2023) argue that adaptability is essential for sustaining partnerships, as collaborations must respond to contextual shifts, changing needs, and power or resource asymmetries. When communication, resources, and satisfaction operate simultaneously, partnerships possess not only technical functionality but an adaptive capacity that allows them to endure over time. The empirical findings of this study reinforce this view by showing that communication is not merely a coordinating tool but an adaptive mechanism that allows organizations to detect risks, address relational disharmony, and realign collaborative objectives.

The regression model further reveals an interesting dynamic between resource effectiveness and satisfaction. Residual analysis indicates that projects with higher funding effectiveness tend to exhibit stronger partner satisfaction only when communication is well-managed. When communication is poor, resource effectiveness loses its positive influence on satisfaction. This means that even efficient resource utilization can generate tension or dissatisfaction unless accompanied by adequate communication. Conversely, high-quality communication can offset limited resources by providing contextual explanations, renegotiating goals, or fostering transparent risk-sharing processes.

Adaptive Collaboration Governance

This section integrates all quantitative findings into a conceptual understanding of how collaboration can be governed adaptively. The results show that collaboration sustainability is not determined by meeting frequency, administrative completeness, or funding size, as commonly assumed in conventional coordination models. Rather, sustainability depends on actors' ability to interpret relational dynamics through data patterns, including anomalies that are often overlooked in standard evaluations. Here emerges the concept of adaptive collaboration governance, referring to governance that emphasizes flexibility, data-driven reflection, and continuous strategic adjustment.

The quantitative findings highlight partner satisfaction as the strongest determinant of collaboration sustainability. Satisfaction functions as the center of gravity where all interactions—communication strategies and resource utilization—converge and are assessed. In adaptive governance, satisfaction becomes a barometer indicating whether existing strategies remain relevant or require adjustment (Cartwright & Roach, 2021; Kanol, 2022).

Adaptive collaboration views partnerships as dynamic relational systems rather than static structures. Asadi-Lari et al. (2021) and Hassan et al. (2023) argue that effective collaboration grows not from coordination rules alone but from the collective capacity to adapt to environmental changes, shifting expectations, and fluctuating resource conditions. The empirical findings corroborate this theoretical stance by showing that actors must be capable of interpreting subtle signals in the data. For instance, when specific partners exhibit lower-than-average satisfaction or when resource utilization appears misaligned with improvements in communication, such inconsistencies function as early warning indicators.

From this perspective, data anomalies or outliers should not be treated as statistical errors but as valuable signals that reveal friction points within the collaboration. An adaptive lens interprets anomalies as “small voices” indicating misalignment between collaborative strategies and partners’ real experiences. This perspective aligns with Asadi-Lari et al. (2021) and Hassan et al. (2023), who argue that adaptive governance requires reflective engagement with deviations from expected patterns. When anomalies are taken seriously, actors can identify areas requiring targeted intervention, such as communication pathways, stakeholder roles, or coordination mechanisms.

Integrating the quantitative results with adaptive theory underscores that strategic communication is the core mechanism of adaptiveness. Communication is not merely information transfer but a process of constructing shared meaning (Asadi-Lari et al., 2021; Hassan et al., 2023). When partners feel included and positioned as active participants in decision-making, satisfaction increases, thereby enhancing sustainability. Conversely, when communication is administrative or one-directional, collaborations lose flexibility. The ability to adjust communication strategies based on data patterns becomes a key indicator of adaptive governance. The findings show that communication serves as an enabling factor: it amplifies the influence of resource effectiveness and strengthens the impact of satisfaction on sustainability.

The concept of adaptive collaboration governance synthesized from this study positions adaptiveness as the core of sustainability rather than an auxiliary feature. Adaptiveness entails three consistent capacities: detecting patterns in data, identifying anomalies, and adjusting communication and resource strategies accordingly. This adaptive cycle represents a shift from static coordination toward an organic and reflective mode of collaboration. In practice, adaptiveness requires institutions and collaborative actors to move beyond routine meetings or reporting structures and instead prioritize relational dynamics, satisfaction levels, and the system’s readiness to evolve.

CONCLUSION

This study demonstrates that the effectiveness and sustainability of collaborations between educational institutions and external partners are shaped not by the magnitude of resources, the frequency of meetings, or administrative formalities, but by actors' ability to interpret relational dynamics through data patterns—including anomalies often overlooked in conventional evaluation models. The regression analysis and interpretation of outliers reveal that strategic rather than merely intensive communication fosters partner satisfaction, which ultimately becomes the strongest determinant of sustainability, while resource effectiveness strengthens this relationship without necessitating increased costs. The findings meet the research objectives by showing that outliers are not statistical deviations but structural indicators that uncover friction points or opportunities for efficiency in collaborative governance. Accordingly, the study offers a conceptual contribution through the development of adaptive collaboration governance, an approach that integrates quantitative analysis with socio-economic interpretation to help organizations detect risks, recalibrate communication strategies, and design more responsive and sustainable partnerships.

ETHICAL STATEMENT AND DISCLOSURE

This study was conducted in accordance with established ethical principles, including informed consent, protection of informants' confidentiality, and respect for local cultural values. Special consideration was given to participants from vulnerable groups to ensure their safety, comfort, and equal rights to participate. No external funding was received, and the authors declare no conflict of interest. All data and information presented were collected through valid research methods and have been verified to ensure their accuracy and reliability. The use of artificial intelligence (AI) was limited to technical assistance for writing and language editing, without influencing the scientific substance of the work. The authors express their gratitude to the informants for their valuable insights, and to the anonymous reviewers for their constructive feedback on an earlier version of this manuscript. The authors take full responsibility for the content and conclusions of this article.

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