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CHARACTERIZATION AND NETWORK ANALYSIS OF THE STUDENT SERVICE SUPPLY CHAIN IN A HIGHER EDUCATION INSTITUTION

Caracterização e análise de redes da cadeia de suprimentos de serviços de atendimento aos alunos em uma instituição de ensino superior

Caracterización y análisis de redes de la cadena de suministro de servicios de atención al estudiante en una institución de educación superior

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ABSTRACT

This study characterizes and analyzes the Student Service Supply Chain (SSSC) of a private Higher Education Institution in Paraná, Brazil, focusing on ICT-related programs. A mixed-methods single-case study combined semi-structured interviews, on-site observations, institutional records, and Social Network Analysis using UCINET. The network comprised 15 actors and presented a density of 40.95%, indicating intermediate connectivity. The Journey Coordinator (CO) showed the highest degree-related value (25.000), the highest betweenness centrality (27.574), and the lowest reported distance value (16.000), evidencing a highly central and intermediary structural position. The findings reveal uneven relationship distribution and dependence on a limited number of actors, particularly CO. The study contributes by integrating structural, relational, and cognitive perspectives in higher education service supply chains. Managerially, the results support clearer service routing, stronger interdepartmental coordination, and better distribution of responsibilities, while digital integration technologies are suggested as future improvement opportunities.

RESUMO

Este estudo caracteriza e analisa a Cadeia de Suprimentos de Serviços de Atendimento aos Alunos (CSSA) de uma Instituição de Ensino Superior privada localizada no Paraná, Brasil, com foco em cursos relacionados às Tecnologias da Informação e Comunicação (TIC). Foi realizado um estudo de caso único, de abordagem mista, combinando entrevistas semiestruturadas, observações in loco, registros institucionais e Análise de Redes Sociais por meio do UCINET. A rede compreendeu 15 atores e apresentou densidade de 40,95%, indicando conectividade intermediária. O Coordenador de Jornada (CO) apresentou o maior valor relacionado ao grau (25,000), a maior centralidade de intermediação (27,574) e o menor valor de distância reportado (16,000), evidenciando posição estrutural altamente central e intermediadora. Os resultados revelam distribuição desigual das relações e dependência de um número limitado de atores, especialmente o CO. O estudo contribui ao integrar perspectivas estrutural, relacional e cognitiva, indicando implicações para coordenação interdepartamental, direcionamento dos atendimentos e distribuição de responsabilidades.

RESUMEN

Este estudio caracteriza y analiza la Cadena de Suministro de Servicios de Atención al Estudiante (CSSAE) de una Institución de Educación Superior privada ubicada en Paraná, Brasil, con énfasis en programas relacionados con las Tecnologías de la Información y la Comunicación (TIC). Se realizó un estudio de caso único con enfoque mixto, combinando entrevistas semiestructuradas, observaciones in situ, registros institucionales y Análisis de Redes Sociales mediante UCINET. La red estuvo compuesta por 15 actores y presentó una densidad del 40,95%, indicando una conectividad intermedia. El Coordinador de Trayectoria (CO) presentó el mayor valor relacionado con el grado (25,000), la mayor centralidad de intermediación (27,574) y el menor valor de distancia reportado (16,000), evidenciando una posición estructural altamente central e intermediaria. Los resultados revelan una distribución desigual de las relaciones y dependencia de un número limitado de actores, especialmente CO. El estudio contribuye integrando perspectivas estructurales, relacionales y cognitivas, señalando implicaciones para la coordinación interdepartamental, el direccionamiento de los servicios y la distribución de responsabilidades.

INTRODUCTION

Higher Education Institutions (HEIs) play a fundamental role in developing professionals capable of responding to increasingly dynamic and competitive labor-market demands. Their responsibilities extend beyond teaching and curriculum delivery to include a broad range of

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academic and administrative support services that influence students throughout their academic journey. The quality and efficiency of these services can affect student experience, satisfaction, retention, and, consequently, institutional reputation and sustainability (Johnson et al., 2022; Mendoza-González et al., 2022). Student support involves interconnected activities performed by areas such as the registrar's office, finance, library, course coordination, pedagogical support, and other administrative units (Bentalha, 2023). From a supply chain perspective, these interactions can be understood as a Student Service Supply Chain (SSSC), in which different actors and service channels are connected through flows of information, requests, decisions, and responses. Effective coordination of these relationships can improve information clarity, responsiveness, problem resolution, and student engagement (Chansamut, 2023).

This challenge is particularly relevant in Information and Communication Technology (ICT) programs, given their strategic role in economic and social development and in supporting digital transformation across different sectors. The increasing demand for qualified ICT professionals reinforces the importance of educational environments capable of providing not only high-quality academic training but also effective support services throughout the student journey (Bagde, Bobde & Bagde, 2021). ICT-related activities underpin essential areas such as health, education, transportation, and finance (Szymkowiak et al., 2021), making student retention and successful academic progression relevant beyond the institutional context. In this regard, efficient academic and administrative support can contribute to student satisfaction and persistence by facilitating access to information and the resolution of academic and operational demands (Afzal et al., 2023). Consequently, understanding how the actors responsible for these services interact becomes important for identifying organizational weaknesses that may compromise service efficiency.

Previous studies have emphasized the importance of service quality, student satisfaction, institutional support, and continuous assessment in higher education. Diagnostic tools, satisfaction surveys, and performance indicators can reveal student perceptions and support evidence-based improvements in service delivery (Borishade et al., 2021). Likewise, weaknesses in service visibility, communication, and contact points may negatively affect the student experience, highlighting the importance of process improvement and coordination among institutional areas (Gonzalez Aleu et al., 2021). Continuous staff development, process standardization, integration among departments, and appropriate technological support can therefore contribute to more consistent student services and stronger institutional relationships (Gardner, Hickmott & Ludvik, 2023). However, evaluating service performance only through satisfaction or operational indicators provides limited insight into how the underlying network of relationships among departments, professionals, and service channels is structured and how the position of specific actors may influence information and service flows.

Despite the relevance of these interactions, the application of the Service Supply Chain perspective to student support in HEIs remains comparatively underexplored, particularly when the structural configuration of service relationships is considered together with relational and cognitive dimensions. This represents an important research gap because service outcomes may depend not only on the individual performance of departments but

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also on how actors are connected, how information circulates, and where dependencies or potential bottlenecks emerge within the institutional network. Network analysis provides a means of addressing this gap by examining patterns of connectivity and the positions occupied by different actors through measures such as density, degree, closeness, and betweenness centrality. Applying this perspective to student support can complement traditional service assessments by revealing structural characteristics that are not directly observable through satisfaction indicators alone. This approach also enables the SSSC to be examined as an interconnected organizational system rather than as a collection of isolated service units.

This study aims to characterize and analyze the Student Service Supply Chain of a private HEI, with a specific focus on ICT-related programs, by examining the relationships among the actors and channels involved in student support. The study maps the service network and analyzes its structural characteristics using network indicators to identify critical actors, patterns of connectivity, dependencies, and potential bottlenecks in information and service flows. The study contributes to the literature by extending the Service Supply Chain perspective to the higher education context and integrating structural network analysis with relational and cognitive interpretations of student support interactions. From a managerial perspective, the findings provide evidence that can support the diagnosis of service structures, the identification of critical relationships, and the formulation of initiatives aimed at improving interdepartmental coordination and service efficiency. Importantly, student satisfaction indicators are treated as contextual information rather than as outcomes statistically explained by the network measures, since the study does not directly test causal or statistical relationships between network structure and student satisfaction.

LITERATURE REVIEW

Supply chain management has evolved from a predominantly operational perspective, traditionally associated with logistics, transportation, and material flows, toward a strategic and systemic approach to managing interconnected organizations, resources, information, and processes. This evolution has been driven by increasing market complexity, technological development, internationalization, product and service diversification, and the expansion of digital commerce, which have intensified interdependencies among organizations and their stakeholders (Karimi et al., 2022; Guntuka, Corsi, & Canto, 2024). Consequently, supply chains are increasingly understood as networks in which the performance of one actor may influence the efficiency, reliability, and responsiveness of the entire system.

Recent research also indicates that supply chain management has progressively moved from a predominantly operational and cost-oriented approach toward a strategic model characterized by integration, digitalization, sustainability, and data-supported decision-making (Garcia, Barbosa, & Cotrim, 2026).

Within this network perspective, effective supply chain management requires coordination and control of material, informational, financial, and service flows while simultaneously addressing risks and adapting to changing market conditions (Al-Rawashdeh, Jawabreh, & Ali, 2023). The growing use of outsourcing has further expanded organizational boundaries by incorporating external partners, suppliers, and service providers into value-creation processes. As a result, organizational performance increasingly depends on the quality of relationships and the capacity to coordinate actors both within and outside organizational

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boundaries (Taghipour et al., 2022). Integration and collaboration therefore become central mechanisms for reducing fragmentation and supporting the continuity and reliability of supply chain operations.

This development has also expanded the strategic scope of supply chain management. Contemporary supply chains are expected not only to improve operational efficiency and reduce costs but also to support innovation, sustainability, customer experience, and data-driven decision-making (Chowdhury, 2024). Organizations capable of integrating internal processes and responding effectively to environmental changes can achieve higher levels of flexibility and performance (Espino-Rodríguez & Taha, 2022; Khanuja & Jain, 2022). Supply chain management can thus be understood as a broader mechanism of coordination and governance through which organizations manage interdependencies, create value, and strengthen their competitive position (Liao, Hu, & Chen, 2022). This broader interpretation provides the conceptual foundation for extending supply chain principles beyond manufacturing environments and into service-oriented systems.

Service Supply Chain

The growing economic relevance of services has stimulated the application of supply chain principles to contexts in which value is predominantly generated through activities, interactions, information, and experiences rather than through the physical transformation of products (Emon, Khan, & Siam, 2024). In this context, the Service Supply Chain (SSC) encompasses the interconnected processes and actors involved in planning, delivering, supporting, and continuously improving services to meet customer requirements (Jaboob et al., 2024; Fang et al., 2023). Unlike a conventional manufacturing supply chain, the SSC is particularly dependent on information flows, human interactions, coordination among service providers, and direct participation of customers in the service process.

The characteristics of services create specific management challenges. Intangibility makes quality more difficult to assess before service delivery and increases the relevance of customer perceptions (Liu et al., 2019; Wang et al., 2015). The simultaneous production and consumption of many services require coordination and communication among actors during service delivery (Christopher, 2018; Espino-Rodríguez & Taha, 2022). Heterogeneity can produce variability in customer experiences, reinforcing the importance of process consistency and staff development (Gonzalez Aleu et al., 2021). In addition, service capacity is perishable because unused resources cannot necessarily be stored for future demand, making capacity planning and resource allocation particularly relevant (Liu et al., 2019; Fang et al., 2023). These characteristics reinforce the central role of customer interaction and perceived service quality in SSC management (Baehre et al., 2022).

The management of an SSC involves both operational and behavioral dimensions. From an operational perspective, it requires demand management, resource allocation, process integration, coordination, and the management of information flows (Karimi et al., 2022; Liao et al., 2022; Guntuka et al., 2024). From a behavioral perspective, perceptions, expectations, trust, satisfaction, and interactions among the participants can influence perceived service value and the effectiveness of relationships throughout the chain (Taghipour et al., 2022). Adaptable process design, monitoring mechanisms, information technologies, and performance indicators can support organizations in responding to demand variability and

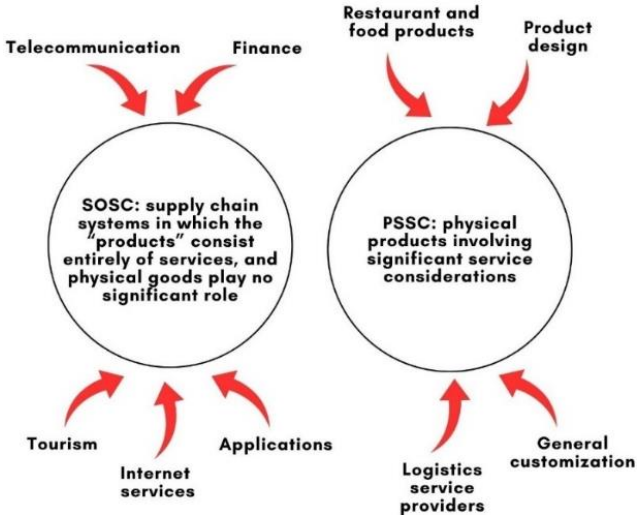
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identifying opportunities for service improvement (Bentalha, 2023; Chansamut, 2023; Afzal et al., 2023; Chowdhury, 2024). In this sense, SSC management integrates processes, people, information, and relationships in the pursuit of operational efficiency and value creation (Liu et al., 2019; Fang et al., 2023; Christopher, 2018).

Types of Service Supply Chains

The literature distinguishes service supply chains according to the nature of the value delivered to the customer. Two major configurations are the Service-Only Supply Chain (SOSC) and the Product–Service Supply Chain (PSSC) (Nagariya, Kumar, & Kumar, 2021; Peng et al., 2023). This distinction is relevant because the presence or absence of physical products changes the flows that must be coordinated, the resources involved, and the managerial challenges faced by the chain (Figure 1).

Figure 1. Service Supply Chain: distinction between SOSC and PSSC. Reviews the conceptual distinction between these configurations



Source: Authors, 2025.

Service-Only Supply Chains (SOSCs) are centered on the delivery of predominantly intangible value and emphasize the coordination of service capacity, people, information, activities, quality, and responsiveness. Because no physical product constitutes the core of the offering, effective coordination among service actors becomes particularly important for providing consistent customer experiences (Liu et al., 2019; Nagariya et al., 2021; Wang et al., 2015; Espino-Rodríguez & Taha, 2022). By contrast, Product–Service Supply Chains (PSSCs) combine tangible products and associated services, requiring simultaneous management of physical and service flows, including procurement, transportation, storage, warranties, returns, support, and disruption risks (Zhou et al., 2024; Fang et al., 2023). This hybrid configuration requires coordination among multiple departments and partners to align operational performance with service quality and customer expectations (Taghipour et al., 2022; Christopher, 2018).

Despite their differences, both configurations face challenges related to outsourcing, competition, capacity, continuity, and alignment of expectations. Effective management requires mechanisms capable of coordinating service provision and mitigating the effects of disruptions or insufficient capacity (Jaboob et al., 2024; Karimi et al., 2022; Peng et al., 2023). PSSCs generally add the complexity of coordinating tangible and intangible components, whereas SOSCs concentrate managerial attention on service interactions and information

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flows (Bentalha, 2023; Liao et al., 2022). In both cases, value creation depends on the capacity to align operations with customer requirements and maintain effective relationships throughout the chain (Khanuja & Jain, 2022; Nagariya et al., 2022) (Table 1).

Table 1. Key supply chain management issues in service supply chains (SOSCs and PSSCs)

Scope	Issues
SOSC	Outsourcing; Mobile-related service sector; IT services; Service competition; Service capacity; Public electricity utilities.
PSSC	Service franchise rate; Service fee contract; Performance-based contract; Product package with warranty/after-sales service; Supply management with service disruption risk; Outsourcing; Service competition; Customer service; Logistics service; Commitment and service strategy; Service capacity; Bonus contract.

Source: Adapted from WANG et al. (2015).

The comparison demonstrates that SOSCs and PSSCs share concerns related to outsourcing, competition, and capacity, while PSSCs incorporate additional mechanisms associated with products, contracts, logistics, warranties, and after-sales activities (Wang et al., 2015). For the context investigated in this study, the SOSC perspective is particularly relevant because student support is predominantly based on intangible service delivery, information exchange, interaction among institutional actors, and the resolution of student demands rather than on the movement of physical products.

Customer Focus and Behavioral Management in the SSC

The characteristics of service supply chains place the customer in a central position in value creation. Customer satisfaction, loyalty, perceived value, and experience influence decisions concerning service design, delivery, resource allocation, priorities, and process improvement (Baehre et al., 2022; Borishade et al., 2021). Effective SSC management requires the integration of internal processes with an understanding of customer expectations and interactions throughout the service journey (Gardner et al., 2023).

Behavioral aspects add complexity to this process because service evaluation is influenced not only by operational performance but also by perceptions of risk, trust, expectations, and subjective assessments of the service received (Szymkowiak et al., 2021). Interactions occurring at different stages of service provision can therefore shape customers' perceptions of quality and value (Gonzalez Aleu et al., 2021). Capacity planning, prioritization, and resource allocation should consequently consider both operational requirements and their implications for customer experience (Mendoza-González et al., 2022).

The combination of operational and behavioral perspectives provides a more comprehensive understanding of service performance. Efficient processes can increase consistency and responsiveness, while knowledge of customer behavior and expectations can support

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adaptation and relationship development. The interaction between these dimensions can contribute to satisfaction, retention, and value creation in service environments (Al-Rawashdeh et al., 2023; Emon et al., 2024; Bentalha, 2023; Liao et al., 2022). This customer-centered perspective is particularly relevant in higher education, where students interact continuously with multiple academic and administrative services throughout their institutional journey.

Service Supply Chain in Higher Education Institutions

Applying the SSC perspective to Higher Education Institutions (HEIs) requires recognizing that the student experience results from multiple interconnected academic and administrative services rather than exclusively from classroom activities. Student support may involve academic offices, finance departments, course coordination, libraries, laboratories, pedagogical support, information technology, and other institutional units. Together, these actors and processes constitute what this study defines as the Student Service Supply Chain (SSSC), a service network through which information, requests, decisions, and responses circulate throughout the student journey (Bagde, Bobde, & Bagde, 2021; Gonzalez Aleu et al., 2021).

The SSSC can be characterized as a predominantly service-only configuration because the central value delivered through student support is intangible and highly dependent on interactions, information accessibility, response quality, and coordination among institutional actors. Its effectiveness therefore depends not only on the performance of individual departments but also on their capacity to communicate and coordinate activities across organizational boundaries. Process mapping and bottleneck identification can contribute to understanding these interactions and aligning human and technological resources (Christopher, 2018). At the same time, student diversity and the complexity of academic trajectories require service structures capable of adapting to different demands and maintaining consistent support (Capioto et al., 2019; Espino-Rodríguez & Taha, 2022).

Service assessment in HEIs commonly incorporates indicators such as response time, accessibility, problem resolution, communication quality, and student perceptions. Such measures are valuable for identifying service weaknesses and supporting improvement initiatives (Nagariya, Kumar, & Kumar, 2022). However, evaluating departments or satisfaction indicators individually may provide only a partial understanding of the system because student requests frequently cross organizational boundaries. A problem initiated in one service channel may require information or action from several other actors before resolution. Consequently, fragmented communication or weak relationships among departments may produce delays, rework, inconsistencies, and difficulties in directing requests to the appropriate service channel (Khanuja & Jain, 2022; Espino-Rodríguez & Taha, 2022; Bentalha, 2023).

Positioning students as central recipients of value reinforces the need to coordinate these interactions throughout the academic journey. Integrated processes, effective resource coordination, and systematic monitoring of service performance can support trust, engagement, and the quality of the institutional experience (Taghipour et al., 2022; Gonzalez Aleu et al., 2021). Digital technologies and analytical resources may also support information management and institutional learning, although their effectiveness depends on how they are

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incorporated into organizational processes and relationships (Bagde et al., 2021; Chansamut, 2023; Fang et al., 2023; Szymkowiak et al., 2021). Therefore, the SSSC should be understood not merely as a set of service channels but as an interconnected organizational network whose performance depends on the configuration and quality of relationships among its actors.

Efficiency and Optimization of the Student Service Supply Chain (SSSC)

The efficiency of the SSSC depends on the coordination of processes, actors, information, and resources around student demands. Mapping processes and information flows can reveal redundancies, potential bottlenecks, unnecessary steps, and opportunities for improving responsiveness and reducing non-value-adding activities (Christopher, 2018; Liao, Hu, & Chen, 2022). Interdepartmental integration is particularly important because insufficient coordination between academic, administrative, financial, and support areas may result in delays, rework, inconsistent information, and fragmented student experiences. Standardized processes and integrated management practices can contribute to aligning these departments around shared objectives (Khanuja & Jain, 2022; Espino-Rodríguez & Taha, 2022; Bentalha, 2023).

Human and technological capabilities complement this integration. Continuous staff development can strengthen the ability of service teams to interpret demands and respond effectively to student needs (Johnson et al., 2022). Information technologies and analytical tools can support monitoring and decision-making by organizing information concerning institutional interactions and service performance (Bagde, Bobde, & Bagde, 2021; Chansamut, 2023). In this context, Rodrigues et al. (2026) emphasize that higher levels of organizational and digital maturity are associated with greater integration of processes, information, and decision-support mechanisms within supply chains.

A network perspective complements traditional service assessment by examining the SSSC as a system of interconnected nodes and ties. Structural characteristics can reveal the overall level of connectivity and identify actors occupying strategically relevant positions in information and service flows. In this context, network density provides an indication of the extent to which actors are interconnected; degree centrality reflects the extent of a node's direct connectivity; closeness centrality concerns its relative accessibility to other actors in the network; and betweenness centrality indicates the extent to which an actor occupies intermediary positions along network paths. These measures are conceptually useful for identifying concentration of relationships, dependencies, potential intermediaries, and possible structural bottlenecks in a service network. Their mathematical definitions, operationalization, matrix characteristics, and calculation procedures are presented in the Methodology section, as their interpretation depends on how nodes and ties are defined in the empirical network.

This structural perspective can be complemented by relational and cognitive dimensions. The relational dimension concerns the nature and quality of interactions among actors, including cooperation, trust, communication, and information sharing, whereas the cognitive dimension concerns the creation, interpretation, sharing, and application of knowledge within the network. Considering these dimensions alongside structural indicators provides a broader basis for understanding how the SSSC operates and where opportunities for organizational improvement may exist. Analyzing student support as a network makes it possible to move

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from an isolated view of departments toward a systemic understanding of how institutional actors interact to deliver services and respond to student demands. This theoretical perspective provides the foundation for the empirical network analysis developed in this study.

Supply Chain Analysis: Structural, Relational, and Cognitive Dimensions

Supply chain analysis provides a systemic perspective for understanding the structures, relationships, and organizational behaviors that sustain the flow of materials, information, services, and decisions within organizational networks. Rather than examining actors or departments as isolated units, this perspective considers their interdependencies and the way in which patterns of interaction influence coordination, responsiveness, and overall network performance. In this context, supply chain analysis can be organized into three complementary dimensions: structural, relational, and cognitive (Nureen et al., 2022). Together, these dimensions enable the investigation of how the network is configured, how actors interact, and how organizational knowledge is created, shared, interpreted, and applied (Wiedmer & Griffis, 2021).

The structural dimension concerns the configuration of the network and the pattern of connections among its actors. Each participant, department, or service channel can be represented as a node, while the relationships among them constitute ties through which information, decisions, and services circulate (Joshi, 2022). Structural analysis enables the identification of highly connected or relatively peripheral actors, concentrations of interactions, dependencies, and potential bottlenecks. Among the most widely used measures are network density and centrality. Density indicates the overall level of connectivity of a network by comparing observed relationships with the number of relationships that could theoretically exist. Greater density may facilitate communication and coordination, although excessive concentration of relationships can also generate redundancy, whereas lower density may indicate limited integration among actors (Wallmann & Gerschberger, 2021).

Centrality measures complement density by examining the structural position occupied by individual actors. Actors positioned more centrally may have greater access to information or play important coordination and intermediary roles within organizational flows (Alinaghian, Qiu, & Razmdoost, 2021). Degree centrality reflects the extent of an actor's direct connectivity with other members of the network (Rivera-Gonzalez, Holguin-Veras, & Calderon, 2023). Betweenness centrality indicates the extent to which an actor lies on shortest paths connecting other nodes, providing evidence of potential intermediary or brokerage positions (Tokito, Kagawa, & Hanaka, 2022). Closeness centrality concerns the relative structural accessibility of an actor in relation to the remaining nodes and is related to the geodesic distances separating network members (Lavassani & Movahedi, 2021). Because the calculation and interpretation of these measures depend directly on how nodes, ties, and matrices are operationalized, their mathematical formulations and analytical procedures are presented in the Methodology section.

Recent empirical applications have demonstrated the usefulness of Social Network Analysis for identifying structural dependencies in supply chains. Soares et al. (2026), for example, integrated network analysis with supply chain management and showed that degree,

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closeness, and betweenness indicators can reveal critical central actors, excessive dependence on specific nodes, and limited connectivity among peripheral actors.

The relational dimension concerns the nature, intensity, and quality of interactions among supply chain members. Relationships influence information sharing, communication, stability, coordination, and the ability of actors to respond collectively to operational problems (Liao, Hu, & Chen, 2022; Khanuja & Jain, 2022; Emon, Khan, & Siam, 2024). Such relationships may range from predominantly transactional interactions, characterized by limited integration and short-term exchanges, to cooperative and collaborative arrangements involving stronger information sharing, trust, coordination, and common objectives (Christopher, 2018; Capioto et al., 2019). Conceptually, transactional relationships represent lower levels of integration, cooperative relationships involve intermediate coordination, and collaborative relationships reflect greater trust, operational integration, and alignment of objectives (Christopher, 2018; Liao et al., 2022; Taghipour et al., 2022; Karimi, Haghighat Monfared, & Keramati, 2022).

This relational perspective is particularly relevant in-service environments because fragmented relationships may contribute to communication failures, delays, rework, and inconsistent customer experiences. Conversely, stronger relational integration may improve information exchange, adaptability, coordination, and the use of organizational resources (Fang et al., 2023; Emon et al., 2024; Espino-Rodríguez & Taha, 2022; Nagariya, Kumar, & Kumar, 2022). Structural indicators should therefore be interpreted together with evidence concerning the characteristics of the relationships represented by the network.

The cognitive dimension addresses the creation, interpretation, sharing, and application of knowledge within organizational networks. It incorporates learning, adaptation, innovation, continuous improvement, and the use of information to support decision-making (Szymkowiak et al., 2021). Learning generated through interactions can support process adaptation and responses to emerging demands (Gardner, Hickmott, & Ludvik, 2023), while knowledge sharing can foster innovation and organizational improvement (Joshi, 2022; Zhou, Gao, & Zhang, 2024). Analytical and digital technologies may also contribute to information processing and decision support when appropriately integrated into organizational processes (Afzal et al., 2023).

The integration of structural, relational, and cognitive perspectives provides a multidimensional framework for examining service supply chains. Structural analysis indicates how actors are connected, relational analysis investigates the characteristics and intensity of these connections, and cognitive analysis considers how knowledge arising from interactions contributes to learning and decision-making. Together, these dimensions provide the theoretical basis for analyzing the Student Service Supply Chain (SSSC) investigated in this study (Liu, Wang, Long, Shen, & Shi, 2019; Wang, Wallace, Shen, & Chojet, 2015; Alinaghian et al., 2021).

METODOLOGY

Research Design and Case Context

This study investigated the Student Service Supply Chain (SSSC) of a private Higher Education Institution located in Paraná, Brazil, focusing on Information and Communication Technology (ICT)-related programs. The empirical context comprised academic and administrative

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services associated with the student journey and the interactions established among students, service channels, academic units, administrative departments, and institutional managers.

The study was characterized as applied, exploratory, and descriptive and adopted a mixed-methods approach integrating qualitative and quantitative procedures (Creswell & Clark, 2018). The qualitative component was used to understand service processes, communication patterns, organizational relationships, perceived integration, and difficulties associated with student support. The quantitative component consisted of Social Network Analysis (SNA), through which relational information was represented and analyzed using network indicators generated with UCINET software (Han et al., 2020).

A single-case study strategy was adopted because the research examined service relationships within a specific organizational context. Field and documentary procedures were combined. Primary evidence was obtained through semi-structured interviews and on-site observations, whereas institutional records and operational indicators were used as complementary secondary information. This methodological combination enabled the organizational context and the structural configuration of the service network to be examined jointly.

Participants and Data Sources

Data collection was conducted between October 19 and November 9, 2023. Participants were actors directly associated with student support and with academic and administrative activities involving ICT-related programs. The groups represented in the investigation included managers, coordinators, service staff, and students.

Participants were considered relevant to the study because they were directly involved in institutional service flows or had direct experience with the service channels investigated. Their contributions were used to identify functional and informational relationships among the actors involved in student support.

The original research record available for this manuscript does not report the exact number of interview participants or their numerical distribution among the four participant categories. Consequently, no participant count is introduced in the revised manuscript without documentary evidence. This information should be added if it can be recovered from the original research records.

Data Collection Procedures

Data were collected through semi-structured interviews, on-site observations, and institutional records. The interviews examined student service flows, communication among academic and administrative areas, perceived process efficiency, difficulties encountered in resolving student requests, and the level of integration among departments.

On-site observations complemented the interviews by enabling the researchers to examine communication flows, interactions among institutional units, service-routing practices, and situations in which the resolution of a student request depended on more than one organizational actor. Institutional documents and operational indicators were used to contextualize the service environment and support the interpretation of the evidence collected in the field.

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The available manuscript does not document the exact duration of the interviews, whether they were audio-recorded, or the complete interview protocol. Therefore, these characteristics are not specified unless the corresponding original research records can be recovered.

Identification of Network Actors and Relationships

The construction of the relational network followed the principles of the Roster Recall Method proposed by Morrison and Rabellotti (2009). Through this procedure, participants identified the institutional actors and service units with which functional or informational interactions occurred during student support activities.

A node was operationally defined as an actor, department, or service channel involved in the SSSC. The final empirical network consisted of 15 nodes, subsequently represented and analyzed in UCINET.

The actors represented in the network included the student and several frontline and back-office service units. Among the nodes identified in the empirical model were the Student (A), Student Success and Retention Center (MS), Multi-Service Department (MA), virtual service environment (ST), coordination e-mail (EM), coordination WhatsApp (WT), Coordination Secretariat (SC), Journey Coordinator (CO), Multi-Service Manager (GM), Academic Support Center (NA), Administrative Manager (GA), Financial Department (FI), professors (PF), and other institutional actors represented in the complete network.

A tie represented the existence of a functional or informational relationship between two network actors. In addition to identifying the existence of a relationship, the research characterized its level of interaction using an ordinal scale.

Operationalization of Relationship Intensity

Relationships among institutional actors were classified using a three-level ordinal scale. Level 1 represented basic functional relationships characterized by low interaction and limited coordination. Level 2 represented intermediate relationships involving occasional cooperation and moderate communication. Level 3 represented highly integrated relationships characterized by recurrent collaboration and more intensive information sharing.

The scale enabled qualitative assessments of organizational interactions to be transformed into relational values suitable for network representation and subsequent analysis using UCINET.

Accordingly, the relational database preserved information concerning both the existence and the reported intensity of interactions. This distinction is particularly relevant when interpreting connectivity values because a valued relationship measure may differ from the simple count of distinct neighboring actors.

Construction of the Relational Matrix

The identified relationships were organized into a relational adjacency matrix containing the 15 nodes of the Student Service Supply Chain. Rows and columns represented network actors, whereas matrix cells represented the relationship identified between pairs of actors according to the ordinal interaction scale.

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The original manuscript confirms the use of a relational matrix and the three-level scale but does not explicitly report whether the UCINET input was processed as a directed or undirected matrix, whether the original valued data were retained in every centrality routine, or whether the matrix was symmetrized or dichotomized before particular calculations. These characteristics are analytically relevant and should be verified against the original UCINET dataset if it remains available.

Consequently, measures derived from the matrix are interpreted according to their empirical meaning and with caution regarding the specific UCINET output. Degree values greater than the theoretical number of distinct neighbors in a 15-node simple network should not automatically be described as numbers of direct contacts. Such values may reflect valued connectivity, combined directional connectivity, or another UCINET degree specification.

Qualitative Data Processing

Qualitative evidence obtained through interviews and observations was systematized according to thematic similarity and recurrence of organizational behaviors. The main analytical categories included service flows, communication among departments, service-routing difficulties, level of integration, information-sharing practices, and perceived bottlenecks. The qualitative evidence was used for two complementary purposes. First, it supported the characterization and interpretation of relationships among the actors included in the network. Second, it provided contextual information for interpreting the structural indicators generated through Social Network Analysis.

The integration of qualitative evidence and network indicators was interpretative rather than causal. Therefore, statements concerning communication problems, integration, or organizational dependencies were supported by the joint examination of structural measures and qualitative evidence rather than being treated as direct statistical consequences of individual network indicators.

Social Network Analysis and UCINET Procedures

The relational matrix was analyzed using UCINET, a software package widely applied in Social Network Analysis. Four principal structural measures were considered: network density, degree, betweenness, and closeness-related measures (Han et al., 2020).

Network density was used to characterize the overall connectivity of the SSSC. The empirical analysis reported a density of 40.95%, indicating that the observed network contained a substantial but incomplete proportion of the relationships that could potentially exist among the investigated actors.

Degree was used to assess the extent of connectivity associated with each actor. Because the empirical table reports values such as 25.000 for the Journey Coordinator (CO) in a network containing 15 nodes, this result should not be interpreted automatically as 25 distinct direct connections. Rather, the value reflects the degree measure produced from the relational structure processed in UCINET and must be interpreted according to the matrix configuration used in the original analysis.

Betweenness centrality was used to identify actors occupying intermediary positions in the network. The CO node presented a betweenness value of 27.574, the highest value reported

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in the empirical network, indicating a structurally important intermediary position in the connections among other actors.

The table also reported values identified as closeness, including 16.000 for CO, 19.000 for GM and GA, and 26.000 for EM and WT. Because the ordering of these values is consistent with a distance-based or fairness-type output, their interpretation requires attention. When the reported measure corresponds to the sum of geodesic distances, lower values indicate greater structural proximity. Thus, the original interpretation that larger values necessarily represent greater closeness should not be maintained without verification of the UCINET output.

The version and specific menu routines of UCINET used in the original analysis are not reported in the available manuscript and should be added only if they can be recovered from the original analytical records.

Network Measures and Mathematical Formulation

The mathematical expressions used in the Social Network Analysis were included in the Methodology because they describe the analytical procedures applied to the empirical relational data. The indicators considered were network density, degree centrality, weighted degree, betweenness centrality, closeness centrality, and geodesic distance. Their interpretation depends on the configuration of the relational matrix processed in UCINET.

Network density represents the proportion of observed relationships relative to the total number of relationships that could potentially exist among the actors in the network. For an undirected network, density is calculated according to Equation (1):

$$D = \frac{2m}{n(n-1)} \tag{1}$$

where D is the network density, $m$is the number of observed ties, and $n$is the total number of nodes in the network.

In the analyzed Student Service Supply Chain, the network consisted of 15 nodes. Therefore, in an undirected configuration, the maximum number of possible relationships is given by:

$$\frac{n(n-1)}{2} = \frac{15(15-1)}{2} = 105$$

The empirical network presented a density of 40.95%, indicating that approximately 41% of the possible relationships among the network actors were effectively represented. This measure describes the overall level of connectivity of the network and does not, by itself, indicate whether individual relationships are strong, efficient, or collaborative.

Degree centrality measures the direct connectivity of an actor with the other members of the network. For a binary relational matrix, the degree centrality of node vi s calculated according to Equation (2):

$$C_D(v) = \sum_{u \neq v} a_{vu} \tag{2}$$

where $C_D(v)$ is the degree centrality of node v; a_{vu} represents the existence of a direct relationship between nodes v and u; and u represents the other nodes in the network.

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In a binary matrix, $a_{vu} = 1$ indicates the existence of a relationship and $a_{vu} = 0$ indicates its absence. Thus, the resulting value corresponds to the number of directly connected actors.

However, when relational data include different levels of interaction intensity, as in the three-level ordinal scale adopted in this study, the connectivity of an actor may also be represented through weighted degree, or node strength. This measure is expressed by Equation (3):

$$s(v) = \sum_{u \neq v} w_{vu} \tag{3}$$

where $s(v)$ is the weighted degree of node v; and w_{vu} represents the weight assigned to the relationship between nodes v and u.

In the present study, relationship intensity was classified into three ordinal levels, representing low, intermediate, and high levels of interaction. If these weights were retained in the UCINET calculation, degree values represent accumulated relational intensity rather than the simple number of distinct neighboring actors. This distinction is particularly important for interpreting the value of 25.000 observed for the Journey Coordinator (CO), since a 15-node undirected, binary network would allow a maximum of 14 distinct direct neighbors.

Betweenness centrality evaluates the extent to which an actor occupies intermediary positions along the shortest paths connecting other actors in the network. It is calculated according to Equation (4):

$$C_B(v) = \sum_{\substack{s \neq v \neq t \\ s<t}} \frac{\sigma_{st}(v)}{\sigma_{st}} \tag{4}$$

where $C_B(v)$ is the betweenness centrality of node v; σ_{st} is the total number of shortest paths between nodes s and t; and $\sigma_{st}(v)$ is the number of these shortest paths that pass-through node v.

A higher betweenness value indicates that an actor occupies more intermediary positions in the network and may play an important role in connecting otherwise less directly connected actors. In organizational terms, such a position may indicate brokerage or coordination potential, but it may also reveal structural dependence on a particular actor. In the empirical network analyzed in this study, the Journey Coordinator (CO) presented the highest reported betweenness value, 27.574.

Closeness centrality measures the structural accessibility of an actor relative to the remaining nodes in the network. It is based on the geodesic distance, that is, the length of the shortest path between two actors. Normalized closeness centrality is expressed by Equation (5):

$$C_C(v) = \frac{n-1}{\sum_{u \neq v} d\,(v,u)} \tag{5}$$

where $C_C(v)$ is the closeness centrality of node v, n is the total number of nodes, and $d(v,u)$ is the geodesic distance between node v and node u.

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Under this formulation, actors with higher closeness values are structurally closer to the other members of the network because the total distance required to reach them is lower.

However, some Social Network Analysis outputs report the sum of geodesic distances directly rather than its inverse. This measure is commonly referred to as farness and can be expressed according to Equation (6):

$$F(v) = \sum_{u \neq v} d\,(v,u) \tag{6}$$

where $F(v)$ represents the total geodesic distance from node v to all other reachable nodes.

The interpretation of farness is the opposite of normalized closeness. Lower $F(v)$ values indicate greater structural proximity, whereas higher values indicate that the actor is more distant from the remaining network members.

This distinction is relevant to the present study because the values reported in the empirical table, such as 16.000 for CO, 19.000 for GM and GA, and 26.000 for EM and WT, are consistent with a distance-based measure. Thus, if the UCINET output corresponds to farness, CO would occupy the most structurally accessible position among these actors, whereas EM and WT would be relatively more distant. The original UCINET output should therefore be verified before the final column heading and interpretation are established.

All mathematical expressions are presented as editable equations and numbered sequentially. Variables are represented in italic type, whereas mathematical operators and functions are presented in roman type. This notation was standardized throughout the manuscript to ensure consistency between the methodological definitions, the network indicators, and the subsequent interpretation of results.

Integration of Qualitative and Quantitative Evidence

The methodological strategy combined structural network indicators with evidence obtained from interviews, observations, and institutional information. Network measures were used to characterize connectivity and structural positions, whereas qualitative evidence provided information concerning the organizational meaning of those relationships.

This integration enabled structural results to be interpreted within the institutional service context. For example, a structurally central position was not automatically interpreted as evidence of service quality or organizational effectiveness; instead, its meaning was examined together with the observed functions, responsibilities, communication practices, and service flows associated with that actor.

The study did not conduct statistical tests establishing causal or associative relationships between density or centrality measures and student satisfaction indicators. The institutional Net Promoter Score (NPS) of 17%, reported for the analyzed context, was treated exclusively as contextual evidence concerning student perceptions and not as an outcome statistically explained by the structure of the service network.

Research Stages

The methodological development was organized into four sequential stages.

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1. **Situational diagnosis:** identification of existing student service practices, service channels, institutional actors, and communication flows through interviews, observations, and institutional information.
2. **Construction of the relational network:** identification of nodes and ties using the Roster Recall Method, classification of relationships according to the three-level ordinal scale, and organization of the relational information into the matrix analyzed in UCINET.
3. **Structural, relational, and cognitive analysis:** examination of network density and actor-level structural indicators together with qualitative evidence concerning communication, relationship intensity, information sharing, organizational learning, and service integration.
4. **Synthesis and interpretation of findings:** integration of qualitative and quantitative evidence to identify structural characteristics, central actors, possible dependencies, relational weaknesses, and managerial implications for the Student Service Supply Chain.

This sequence established a direct methodological connection between data collection, relational representation, Social Network Analysis, qualitative interpretation, and synthesis of the findings.

Methodological Scope and Replicability

The adopted methodology enabled an empirical representation of the Student Service Supply Chain within the investigated Higher Education Institution. The integration of qualitative evidence and Social Network Analysis made it possible to examine both the organizational meaning of service relationships and their structural configuration.

The network should nevertheless be understood as a representation of the investigated case rather than as a universally generalizable model of student service supply chains. The study is based on a single private HEI, focuses specifically on ICT-related programs, and relies partly on relational information derived from interviews and observations. These characteristics should be considered when interpreting and transferring the findings to other institutional contexts.

Methodological transparency was strengthened in the revised study by explicitly defining the network actors, relational criteria, three-level interaction scale, data sources, analytical dimensions, and network measures. However, the exact number of participants, UCINET version and routines, interview duration and recording procedures, and the precise preprocessing configuration of the original relational matrix should only be reported if they can be recovered from the original study records.

RESULTS AND DISCUSSION

Characterization of the Student Service Supply Chain

The empirical analysis showed that student support in the investigated Higher Education Institution is organized through a set of interconnected academic, administrative, managerial, and digital service channels. Rather than following a single standardized pathway, student demands can enter the service system through different points, including face-to-face services, digital platforms, e-mail, WhatsApp, professors, coordination, and specialized support units. The resulting configuration is therefore consistent with a Student Service Supply Chain (SSSC) predominantly characterized as a Service-Only Supply Chain, since the value delivered is essentially intangible and depends on information exchange, problem resolution, interaction quality, and coordination among institutional actors.

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The service structure presents a decentralized configuration. Students may interact with several service channels depending on the nature of their request, while the resolution of some demands requires communication between frontline and back-office actors. The empirical evidence indicates that this multiplicity of channels is not necessarily accompanied by equally clear routing mechanisms. Consequently, students may need to contact more than one organizational unit before identifying the appropriate pathway for their request, creating opportunities for repeated contacts, information duplication, and rework. The original case description identifies these difficulties particularly in relation to the fragmentation of service channels and the limited clarity regarding which unit should address each type of student demand.

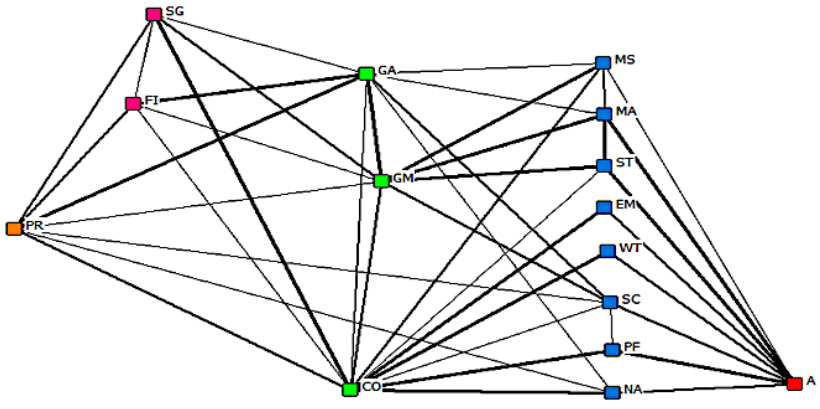
From a service supply chain perspective, this configuration demonstrates that student support performance depends not only on the individual efficiency of each department but also on the quality of coordination among them. This finding is consistent with the conceptual understanding of service supply chains as systems in which information and customer interactions are central to value creation. In the investigated institution, the student occupies the demand side of the network, whereas multiple service actors participate in processing, redirecting, and resolving requests.

The institution reported an NPS of 17% for the contextual period considered in the original study. However, this indicator should be interpreted only as contextual evidence of student perceptions. The present analysis did not statistically test whether density, centrality, betweenness, or any other network measure explains variations in NPS. Thus, the NPS cannot be used as empirical confirmation that a specific structural characteristic of the network caused lower student satisfaction.

Network Configuration of the Student Service Supply Chain

The network contains a combination of student-facing channels, intermediary academic actors, and back-office managerial units. The Student node (A) represents the main recipient of the services and is connected to several frontline channels. These include the Student Success and Retention Center (MS), Multi-Service Department (MA), virtual service environment (ST), coordination e-mail (EM), coordination WhatsApp (WT), Coordination Secretariat (SC), professors (PF), and Academic Support Center (NA). The institutional roles assigned to these actors indicate that student demands may enter the network through both physical and digital channels (Figure 2).

Figure 2 - Configuration of the Student Service Supply Chain and illustrates the connections among the 15 actors included in the network



Source: Authors (2025).

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The graphical structure also shows the importance of managerial actors in connecting frontline services with other organizational areas. The Journey Coordinator (CO), Multi-Service Manager (GM), and Administrative Manager (GA) occupy visually and quantitatively relevant positions in the network. Rather than functioning as isolated departments, these actors connect different service pathways and therefore contribute to the movement of information and requests between the student-facing and administrative portions of the SSSC.

A relevant characteristic of the network is the concentration of multiple relationships around CO, GM, GA, and the Student node. This concentration suggests that the institutional service system does not distribute all interactions homogeneously across the 15 actors. Instead, some actors occupy more structurally important positions than others. Such concentration can facilitate coordination when central actors operate effectively, but it may also create organizational dependence if a considerable proportion of information and service flows relies on a small number of nodes.

This interpretation is consistent with the network perspective discussed in the literature: central actors may facilitate coordination and information access, but excessive dependence on them can create vulnerability, especially when responsibilities and communication flows are concentrated in a limited number of organizational positions.

Structural Analysis: Network Density

The network presented a density of 40.95%, indicating that approximately 41% of the possible relationships among the analyzed actors were present in the empirical configuration. This result indicates an intermediate level of structural connectivity: the network is neither sparsely connected nor close to complete interconnection.

The density value is important because it provides a global view of the SSSC. A density of 40.95% suggests that information and service relationships are sufficiently developed to connect the system, but a considerable proportion of potential interdepartmental relationships is absent. However, density alone does not demonstrate that additional connections would necessarily improve service performance. Greater density may facilitate communication, but indiscriminately increasing the number of relationships could also create redundancy and coordination costs.

The result should not be interpreted simply as evidence that the institution “needs more connections.” Instead, the more relevant managerial issue is whether the existing and potentially missing relationships correspond to the interactions needed to resolve student demands efficiently. The structural evidence should consequently be evaluated together with the observed service-routing difficulties and the positions occupied by specific actors.

The combination of moderate density and high centralization around a limited number of nodes indicates that the network is connected but unevenly organized. This pattern is consistent with the qualitative evidence showing that several student requests depend on intermediaries and that some service channels have limited autonomy to resolve demands without involving other institutional units.

Actor-Level Centrality and Structural Dependence

The values originally reported as closeness are interpreted here cautiously as distance/farness-type values because lower scores correspond to structurally more central

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actors. Confirmation against the original UCINET output is recommended before final publication. The numerical values correspond to the original centrality of Table 2.

Table 2. The actor-level structural indicators generated from the relational network

Centrality Measures				
		1	2	3
		Degree	Distance/Farness*	Betweenness
1	A	18.000	22.000	12.750
2	MS	8.000	23.000	1.246
3	MA	11.000	23.000	1.319
4	ST	10.000	24.000	0.878
5	EM	5.000	26.000	0.261
6	WT	5.000	26.000	0.261
7	SC	9.000	22.000	3.113
8	CO	25.000	16.000	27.574
9	GM	20.000	19.000	6.721
10	SG	9.000	24.000	0.000
11	FI	8.000	24.000	0.000
12	PR	12.000	21.000	1.985
13	NA	7.000	24.000	1.246
14	GA	16.000	19.000	6.387
15	PF	7.000	25.000	0.261
15 rows, 3 columns, 1 levels				

Source: Authors (2025), based on UCINET analysis.

The first relevant finding concerns the Journey Coordinator (CO). CO presents the highest degree-related value in the network, 25.000, followed by GM with 20.000, the Student node with 18.000, and GA with 16.000. Because the empirical network contains only 15 nodes, the value of 25 cannot represent 25 distinct neighboring actors in a simple binary undirected network. It should therefore be interpreted as a connectivity value resulting from the relational matrix processed in UCINET rather than as “25 direct connections.”

This distinction substantially changes the interpretation of the result. The CO node is clearly characterized by high relational intensity/connectivity, but the evidence does not justify stating that it has 25 separate direct relationships. Its high value nevertheless supports the conclusion that the Journey Coordinator occupies a highly connected position within the student support network.

The Student node (A) also presents a relatively high value of 18.000, which is consistent with its role as the recipient of multiple institutional services. This result provides structural support for the empirical observation that students interact with several channels rather than following a single service route.

GM and GA also occupy highly connected positions, with degree-related values of 20.000 and 16.000, respectively. Their position reinforces the importance of managerial areas in coordinating institutional service flows. By contrast, EM and WT both present values of 5.000, indicating substantially lower structural connectivity compared with CO, GM, and GA.

Structural Accessibility and the Interpretation of Closeness

The second structural indicator reflects the relative accessibility of each actor within the network. The reported values show that CO presents the lowest distance value (16.000), followed by GM and GA (19.000), PR (21.000), and A and SC (22.000). In contrast, EM and WT present the highest values (26.000), indicating greater accumulated geodesic distance from the remaining actors.

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When interpreted as a distance-based measure, lower values indicate greater structural accessibility within the network. CO occupies the most accessible position, followed by GM and GA. This result is consistent with the broader structural pattern observed in the network, in which managerial and coordination actors occupy positions that facilitate access to multiple service channels and institutional areas.

The comparatively higher distance values observed for EM and WT indicate that, although these channels may provide direct contact with students and coordination, they are not structurally the most accessible nodes in the overall network. Their relevance should be interpreted considering their specific communication function rather than as evidence of high global centrality.

The position of CO is particularly noteworthy because it combines the lowest distance value with the highest degree-related value and the highest betweenness centrality. This convergence across structural indicators reinforces the interpretation of the Journey Coordinator as the main integrative node of the Student Service Supply Chain. Such a position may facilitate coordination and information access, but it may also increase organizational dependence on this actor when multiple service flows converge through the same node.

From a managerial perspective, the result suggests that the network could benefit from a more balanced distribution of accessibility and coordination capacity among institutional actors. Strengthening direct relationships among other service units may reduce dependence on CO and improve the resilience and responsiveness of the service network.

Betweenness Centrality and Potential Brokerage

Betweenness centrality provides the clearest evidence of structural concentration in the investigated SSSC. CO presents a value of 27.574, substantially higher than all other actors. The next highest values are observed for the Student node (12.750), GM (6.721), GA (6.387), and SC (3.113).

The high betweenness of CO indicates that this actor frequently occupies shortest paths connecting other actors. In organizational terms, CO performs a potential brokerage and coordination role within the SSSC. Information or requests moving between different portions of the institutional network may depend disproportionately on this position.

However, high betweenness should not automatically be interpreted as evidence of superior performance. While an intermediary position can facilitate coordination, excessive dependence on one actor can create a structural vulnerability. If requests, information, or decisions must repeatedly pass through CO, workload concentration or temporary unavailability may affect several service pathways simultaneously.

This interpretation is consistent with the qualitative characterization of the Journey Coordinator as responsible for both operational and pedagogical matters and as an actor connected to multiple institutional service channels. The structural and qualitative evidence onverge in indicating organizational dependence on CO, rather than simply demonstrating that CO is the “best-performing” actor.

The Student node also presents comparatively high betweenness at 12.750. This result is consistent with the structure of the SSSC, in which students independently access multiple

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service channels. Their position therefore links several points in the service network from the demand perspective.

GM and GA occupy secondary brokerage positions. Their betweenness values are considerably smaller than that of CO but remain among the highest in the network, reinforcing their role as managerial connectors between different institutional areas.

At the other extreme, SG and FI present betweenness values of 0.000. This indicates that, under the shortest-path configuration analyzed, these actors do not function as intermediaries between other pairs of nodes. This does not mean that their organizational functions are unimportant; rather, their structural role is more specialized and less dependent on brokerage.

Integration of Density, Degree, Distance and Betweenness

The combined analysis of the four structural characteristics provides a more robust interpretation than any individual indicator considered separately.

CO combines the highest degree-related value (25.000), the smallest reported distance value (16.000), and the highest betweenness centrality (27.574). This combination identifies CO as the structurally most prominent actor in the SSSC. GM and GA form a secondary managerial layer, combining comparatively high connectivity, low distance values, and relevant betweenness scores.

The Student node presents a different structural pattern. Its high connectivity and betweenness reflect the multiplicity of channels available to students rather than a formal organizational coordination role. This distinction illustrates why centrality metrics must be interpreted according to the organizational function of each node.

The overall pattern suggests a network with moderate global connectivity but substantial local concentration. Density indicates that the system has a meaningful number of relationships, while actor-level metrics show that those relationships are not evenly distributed. In particular, the network relies strongly on CO and, to a lesser extent, GM and GA. Thus, this configuration may explain why qualitative observations identified difficulties related to service routing and interdepartmental coordination. Importantly, however, this interpretation represents convergence between qualitative and structural evidence rather than statistical proof of causality.

Relational Dimension of the SSSC

The relational analysis complements the structural indicators by examining the intensity and characteristics of interactions represented in the network. The three-level scale adopted in the study distinguishes relationships with lower interaction from intermediate and highly integrated relationships, enabling the network to capture differences in relational intensity rather than simply the presence or absence of ties.

The empirical network shows that relationships are not homogeneous. Some actors maintain more intensive connections, while other links remain comparatively weak. The case description particularly identifies fragmented communication between frontline and back-office areas and difficulties in directing student requests toward the appropriate institutional unit.

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From a relational perspective, this heterogeneity is relevant because network density alone does not guarantee integration. Two departments may be formally connected while still maintaining limited information exchange or weak coordination. Consequently, strengthening the SSSC does not necessarily require maximizing the number of relationships; it requires improving the quality, clarity, and functional relevance of critical relationships.

The relatively central positions of CO, GM, and GA indicate that managerial actors play important roles in connecting the service system. At the same time, the concentration of these relationships suggests that greater horizontal coordination among other departments could reduce unnecessary dependence on intermediaries.

The relational findings support a shift from a predominantly fragmented service logic toward stronger interdepartmental coordination, clearer responsibilities, and greater information sharing. These actions should be interpreted as managerial implications derived from the structural and qualitative evidence rather than as interventions whose effectiveness was directly tested by the study.

Cognitive Dimension of the SSSC

The cognitive analysis indicates that student support also depends on how institutional actors understand procedures, interpret demands, share organizational knowledge, and use information when resolving student requests. The qualitative evidence suggests that fragmentation of communication channels is accompanied by differences in access to and understanding of information regarding service procedures.

In this context, network structure and organizational knowledge are interconnected. A highly central actor such as CO may accumulate not only relationships but also information about multiple processes. Although this concentration can facilitate problem solving, it can also create knowledge dependency if procedures and service-routing information are insufficiently distributed across the network.

The cognitive dimension reinforces the importance of organizational learning, standardized information, shared procedures, and mechanisms through which frontline actors can access the knowledge required to resolve routine requests. Increasing the resolution capacity of service channels could reduce unnecessary referrals and decrease dependence on highly central actors.

Digital technologies may support this process by facilitating information access, documenting service histories, standardizing routing rules, and improving visibility across departments. More broadly, digital transformation research indicates that technologies associated with Industry 4.0 can strengthen information processing, organizational visibility, analytical capacity, and data-supported decision-making when integrated with organizational processes (Garcia et al., 2026). Nevertheless, the present study did not empirically evaluate Customer Relationship Management (CRM) systems, artificial intelligence, machine learning, or automated decision-support technologies.

Rather, CRM, integrated service platforms, automation, artificial intelligence, and analytical tools represent managerial possibilities and directions for future investigation. Their potential relevance arises from the structural problems identified in the network especially fragmented

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information, multiple channels, and dependence on central actors, but their effectiveness would require subsequent implementation and empirical evaluation.

Managerial Implications

The findings suggest that improvement initiatives should prioritize the configuration and coordination of relationships rather than simply increasing the number of channels available to students. The simultaneous presence of multiple service channels and concentrated brokerage around CO indicates that channel availability does not necessarily correspond to distributed resolution capacity.

A first managerial implication is therefore to review service-routing responsibilities and identify demands that could be resolved without passing through highly central actors. A second implication concerns strengthening horizontal information exchange among frontline and back-office areas. Standardized procedures, shared information repositories, and clearer escalation rules may help distribute organizational knowledge and reduce unnecessary intermediation.

Digital integration tools, including CRM and workflow-management systems, may be considered as possible mechanisms to support these changes. Likewise, automation and artificial intelligence may represent future opportunities for classifying requests, supporting routing decisions, identifying recurring demands, or providing analytical support. However, their adoption should follow process redesign and empirical evaluation rather than being considered an immediate consequence of the network analysis.

Overall, the results demonstrate that the investigated SSSC is characterized by moderate network density, heterogeneous relationship intensity, and strong structural dependence on a limited number of central actors, particularly the Journey Coordinator. The principal contribution of the network analysis is therefore not to identify a single “problem node,” but to reveal how service delivery depends on the configuration of relationships among actors. This systemic perspective provides a more precise basis for managerial decisions concerning integration, workload distribution, communication, and organizational learning. The original results likewise identify CO as the dominant intermediary and describe the network as moderately connected and dependent on a small number of central actors.

CONCLUSIONS

The analysis of the Student Service Supply Chain (SSSC) in the investigated Higher Education Institution demonstrated that student support operates through a network of academic, administrative, managerial, and digital actors whose interactions are unevenly distributed. The structural analysis revealed a network density of 40.95%, indicating an intermediate level of connectivity, while the actor-level indicators showed a marked concentration of structural importance in a limited number of nodes. In particular, the Journey Coordinator (CO) occupied the most prominent position in the network, combining the highest degree-related value, the highest betweenness centrality, and the lowest reported distance value among the analyzed actors. These results indicate that the SSSC is functionally connected but structurally dependent on a small number of actors, especially CO.

The findings also showed that service performance cannot be understood solely from the existence of multiple contact channels. Although students have access to several service points, the network configuration indicates that many interactions converge on intermediary and managerial actors. This pattern, combined with the qualitative evidence concerning fragmented communication and service-routing difficulties, suggests that the main challenge

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lies not simply in increasing connectivity but in improving the distribution, clarity, and coordination of relationships across the service system. The study contributes to the understanding of the SSSC as an interconnected organizational network rather than as a collection of isolated departments or service channels.

From a theoretical perspective, the study extends the Service Supply Chain approach to the higher education context by integrating structural, relational, and cognitive dimensions in the analysis of student support. The use of Social Network Analysis made it possible to identify differences in connectivity, accessibility, and brokerage among institutional actors, while the qualitative evidence provided organizational meaning to these structural patterns. This multidimensional perspective contributes to the literature by demonstrating how network structure can be used to complement traditional service assessments in HEIs.

From a managerial perspective, the results suggest that improvement initiatives should prioritize the redistribution of responsibilities, clarification of service-routing procedures, strengthening of interdepartmental communication, and greater dissemination of operational knowledge among frontline and back-office actors. Integrated information systems, CRM platforms, workflow automation, analytical tools, and artificial intelligence may represent potential mechanisms to support these improvements; however, they were not directly implemented or evaluated in this study. Thus, they should be interpreted as managerial implications and opportunities for future investigation rather than as empirically validated solutions.

The study also has limitations that must be considered when interpreting its findings. First, it was conducted as a single-case study in one private Higher Education Institution located in Paraná, Brazil, which limits the generalizability of the results to other institutional contexts. Second, the empirical analysis focused on ICT-related programs, and the service structure observed may differ from that found in other academic areas. Third, the relational network was constructed from interviews, observations, and organizational assessments, which introduces a degree of subjectivity in the identification and classification of relationships. Fourth, the study adopted a cross-sectional perspective based on data collected during a specific period, which does not capture possible changes in network structure over time. Finally, no statistical tests were performed to establish causal or associative relationships between network indicators and student satisfaction or the institutional NPS. Consequently, the NPS should be interpreted only as contextual evidence rather than as an outcome explained by the network structure.

Future research should replicate the analysis in different HEIs, academic areas, and institutional contexts, as well as employ longitudinal designs to examine how student service networks evolve over time. Comparative studies could also investigate whether different network configurations are associated with service responsiveness, satisfaction, retention, or other performance indicators. In addition, future studies may experimentally assess the effects of digital integration tools, CRM systems, automation, artificial intelligence, and knowledge-sharing mechanisms on the structure and performance of student service networks. These directions can help advance the understanding of Service Supply Chains in higher education and strengthen the empirical basis for managerial interventions aimed at improving student support.

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