11th Scientific Meeting of the SIS Group
"Statistics for the Evaluation and Quality in Services"

BOOK OF SHORT PAPERS

Editors
Andrea Bucci
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STATISTICAL METHODS FOR EVALUATION AND QUALITY: TECHNIQUES, TECHNOLOGIES AND TRENDS (T^3)

EDIZIONI Il Viandante

IES 2023 - Statistical Methods for Evaluation and Quality: Techniques, Technologies and Trends (T^3)

BOOK OF SHORT PAPERS

Editors: Andrea Bucci, Alfredo Cartone, Adelia Evangelista and Andrea Marletta

Book of Short papers
11th International Conference **IES 2023**
Statistical Methods for Evaluation and Quality: Techniques, Technologies and Trends (T^3)

University 'G. d'Annunzio' of Chieti-Pescara

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Preface

Statistical thinking, design and analysis play a crucial role in social life and are useful to society at large. Besides, promoting advanced methodological research is useful to facilitate the dissemination of ideas related to various fields of interest. For this purpose, experts in statistics, data analysis, data mining, statistical methods for decision making, machine learning and related methods come together to understand and analyse phenomena through data.

In line with this objective, the Statistics Group for the Evaluation and Quality of Services (SVQS; www.svqs.it) of the Italian Statistical Society (SIS) has been organizing the Innovation and Society (IeS) conference biennially since 2009, focusing on new developments and ideas in statistics applied to the evaluation and quality of public and private services, attracting national and international statisticians and data scientists. The meeting contributes to spot light on the main statistical approaches and methodologies for the evaluation of public services currently in use in different contexts, as well as to facilitate discussion on the impact of innovative statistical evaluation systems for these services, involving various economic and social policy actors.

The conference "Statistical Methods for Evaluation and Quality: Techniques, Technologies and Trends (T^3)" recorded valuable contributions that are reported in this volume. The papers underscore how the growing availability of data has tasked social and economic actors, organizations, and researchers with the management and analysis of large volumes of unstructured and heterogeneous data. In recent years, many tools for both qualitative and quantitative models have been developed to better describe and understand complex systems and their underlying behaviors, and the papers reported in this volume bear witness to this.

Techniques, technologies and trends: the study of data complexity presents the potential to provide analyses with increased frequency and timeliness, accuracy and objectivity, and to define sustainable models. Traditional quantitative methods for capturing socioeconomic data have often shown limitations in their ability to examine underlying systems, and with the three 'T' just mentioned, the outlines of future developments are starting to emerge.

The volume reports 127 contributions in the following areas:

- Advanced statistical methods for pattern recognition
- Advances in statistical learning from high-dimensional data
- Data analysis for web sources
- Distance and depth-based statistical learning methods for robust data analysis

- Economics and environment
- Education and labour
- Inequalities in the labour market
- Innovations and challenges in official statistics
- Labour market: trends, perspectives and new challenges
- Methodological and applicative contributions for evaluating sustainable development
- Methodological developments and applications for the assessment of student competencies
- Networks data analysis: new perspectives and applications
- New advanced statistical methods for data science
- Recent advances in statistical learning and data analysis
- Statistical analysis and modeling of environmental pollution data
- Statistical methods and complexity for evaluation in finance
- Statistical methods and composite indicators for healthcare
- Statistical methods and models for land monitoring with spatio-temporal data
- Statistical methods for environmental monitoring and sustainability
- Statistical methods for the analysis of university student choices and academic performance
- Statistical methods for the assessment of transport services and sustainable emissions
- Statistical methods for education and educational services
- Statistics in sports
- Tourism and territory.

The Conference event attracted many contributions as well as numerous Authors, not just from Italy but also from abroad. Over the three-day meeting, the Community has the opportunity to witness some of the state-of-the arts, new trajectories, and methodological challenges in 24 solicited sessions, 7 sessions of free contributes, two round tables - organized by Maurizio Vichi and Matilde Bini respectively - and three keynotes sessions with Ron S. Kennet of Samuel Neaman Institute of Israel, Luigi D'Ambra of Federico II University of Naples, and the former Minister Enrico Giovannini from University of Tor Vergata.

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Network Analysis approach to customer satisfaction and service quality detection: an application to health-care services

Network Analysis per la rilevazione della customer satisfaction e della qualità del servizio: un'applicazione ai servizi sanitari

Corrado Crocetta, Maria Gabriella Grassia, Marina Marino, Rocco Mazza, Violetta Simonacci and Agostino Stavolo

Abstract In health-care systems, outsourcing refers to the practice of contracting external providers to perform certain functions or services that are traditionally performed by health system. So, health systems can often achieve cost savings by reducing the need for in-house staff and resources. It can also present challenges where patient confidentiality and data privacy are paramount. The objective of the paper is to assess the satisfaction levels of health systems with the outsourced services they utilize. To accomplish this, the paper employs Social Network Analysis (SNA)

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to create a methodology that considers both customer satisfaction and quality detection.

Abstract *Nei sistemi sanitari, l'outsourcing si riferisce alla pratica di stipulare contratti con fornitori esterni per svolgere determinate funzioni o servizi che tradizionalmente sono svolti dal personale del sistema sanitario. In questo modo, i sistemi sanitari possono spesso ottenere risparmi sui costi riducendo la necessità di personale e risorse interne. Essa, però, presenta criticità in quanto deve rispettare il principio di riservatezza dei pazienti e la privacy dei dati. Dunque, l'obiettivo del lavoro è definire il livello di soddisfazione che i sistemi sanitari esprimono nei servizi esterni ai quali si riferiscono. Per fare ciò è stata utilizzata la Social Network Analysis (SNA) al fine di sviluppare una strategia che consideri la customer satisfaction e la quality detection.*

Key words: social network analysis, health-care services, outsourcing, service quality detection, customer satisfaction

1 Introduction

Applied statistical studies play a crucial role in assessing the quality of services provided in the health sector [15], assessing various factors such as patient satisfaction, safety measures and efficiency, to identify areas of improvement and develop strategies for enhancing the quality of care. In recent years, this field has also started a process of outsourcing many activities [10].

Outsourcing involves delegating essential services or operations of an organization to a provider who specializes in that area [6]. One of the primary motivations behind hospital executives' decision to outsource support services is to lower operational costs [17], by reducing expenses associated with personnel, training, and equipment [5]. This approach enables healthcare institutions to free up resources, improve efficiency and customer satisfaction, and focus on delivering high-quality core services [16].

It is essential for decision-makers to ensure that outsourced services are being carried out by competent professionals, regardless of the nature of the service being provided [11], but also must ensure strict compliance with all relevant regulations, with a special focus on maintaining data privacy and security.

The phenomenon has been investigated through different perspectives and with different methodologies of analysis. Social network analysis (SNA) has been extensively used [1] to help improve the effectiveness and efficiency of decision-making processes [9] that improve patient safety and quality of care. Therefore, the objective of this study is to employ social network analysis (SNA) to assess the quality of Apulian outsourced healthcare services and develop a strategy that considers the overall satisfaction level of the services provides.

2 Methodology

Social Network Analysis (SNA) refers to a set of methods and techniques that detect the connections within a network, as well as the roles and positions that individuals play within it [12]. Networks are defined as systems in which actors, or so-called nodes, are connected to each other via links [18]. They are classified as *one*-mode networks, i.e. with a single set of nodes that have links between them, but there are also two-mode networks, or bipartite networks [13], that have two different sets of nodes and identify relationships between classes of actors [4]. Many mathematical techniques are available to measure networks [18]. Degree centrality (d_i^*) is a measure of the centrality of a node *i* in a network based on the number of connections. It is defined by $d_i^* = d_i / n - 1$ and it is normalized by dividing by the maximum number of ties possible, which in a graph of *n* nodes is *n-1*. Betweenness centrality is a measure of how often a node acts as a bridge along the shortest path between two other nodes. The betweenness of node k in an ordinary graph is defined by:

$$b_k = 1/2 \sum_{i,k}^{n} \sum_{j,k}^{i} \frac{g_{ikj}}{gij}$$

where g_{ij} is the number of geodesic paths from node *i* to node *j*, and g_{ikj} is the number of geodesic paths from *i* to *j* that pass-through *k*. Betweenness is ordinarily normalized by dividing by (*n*-1) (*n*-2).

Density is the number of existing links in a network divided by the maxim number of possible links:

$$D = \frac{n_1 n_2}{(n_1 + n_2)(n_1 + n_2 - 1)}$$

A high density indicates a higher level of interconnection between members.

Diameter is the length of the longest geodesic in the bipartite graph, within components [4]. Social Network Analysis (SNA) has found wide application in various fields and disciplines. It is often used to improve decision-making processes and organizational performance in business organizations, and to inform the implementation of change management programs [7]. The information flow develops targeted interventions aimed at improving the quality and efficiency of care delivery [8;14]. For monitoring performance reports, outsourcing management should prioritize the softer factors that underpin the organizational relationship, such as commitment, trust, respect, and shared understanding [2]. Effective relationship management can enhance outsourcing governance by enabling managers to efficiently monitor the quality of the relationships with service providers [3]. It has also proven useful in communication and collaboration among healthcare professionals, the dissemination of new practices, and knowledge sharing among clinicians [10].

3 Data

For this paper, we utilized survey data collected between 2020 and 2022 from employees of the ASL of Foggia through a questionnaire. We submitted the questionnaire to head nurses, primaries, and managers of the directorate general to assess the quality of services offered by the provider company. The questionnaire is divided into modules, with the first part seeking information on the interviewee's district of affiliation, role, and area of competence. The second part contains evaluation modules on the company's services, including auxiliary, cleaning, maintenance, transport, emergency, management, and hospitality. The third part - on which our study is based - is about the relation between ASL sanitary and manager staff, and the services offered by provider. The formal interactive process between these actors would involve several steps, defined by organizational hierarchy. The questionnaire aims to trace the informal social structure inside sanitary organization as respond to Covid emergency. In this regard we interviewed not only manager staff but also head nurse. The questionnaire was administered to the same individuals over the course of three years, so the information contained refers to the evolution of relationships over the time range considered.

4 Results

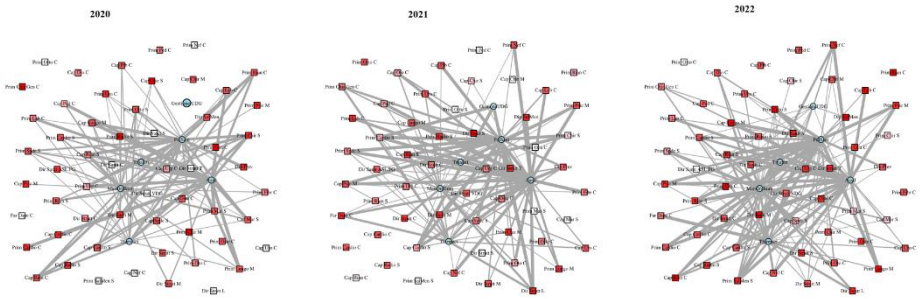

Fig. 1 Network evolution in 2020, 2021 and 2022

Figure 1 illustrates the changes in network evolution over three years, namely 2020, 2021, and 2022. Specifically, the nodes of the actors have been indicated with the rectangle symbol; the circles represent the services they refer to. The different shades of red indicate the level of satisfaction: the closer to pink, the lower the satisfaction rating. Rectangles with a white color indicate a non-response. Finally, the thickness of the link was weighted according to the frequency of monthly contact: the more double the link, the more the service was contacted by the subject.

The network consists of a two-mode network, encompassing the social relations occurring between two categories of actors. In the comments, we will refer to the dimension related to asl employees in terms of overall satisfaction with the services

offered by the provider. We have also included the structural indices of the network over the time range analyzed. The mode related to services is analyzed with respect to the centrality they occupied within the network.

Table 1 Structural measures and satisfaction

Network	***Density***	***Diameter***	***Average satisfaction***
2020	0.37	3.00	8.15
2021	0.40	4.00	7.54
2022	0.50	4.00	8.26

The 2020 network is characterized by a higher number of isolated nodes, which characterize the lower level of network density (Tab. 1). Management of the Territorial Care Unit is identified as an isolated node, as can be seen in Fig1. In 2021, this service has become widely used, with thick links indicating a higher frequency of contacts. In 2022, service utilization was highest, indicating an increasing need to outsource activities outside hospitals, also demonstrated by a higher value of network density (0.51). As shown in Tab.1, the density measures over the years increased, indicating a progressive increase in the social activity carried out by the service-related actors. Despite this, the network for the first year has a smaller diameter value than the others, as networks with a smaller diameter tend to be more efficient in transmitting information. Considering the average satisfaction level, we see that it remained high in all three years, with a value of 8.15 in 2020. However, in 2021 there was a decrease to 7.5, followed by an increase in 2022 to 8.26, indicating the highest satisfaction with the services. So, we can say that satisfaction with the services offered by SanitaService appears to have high values overall, denoting another quality of the proposed activities.

Table 2 Centrality measures of networks

	2020		***2021***		***2022***	
Services	***Degree***	***Betweenness***	***Degree***	***Betweenness***	***Degree***	***Betweenness***
ManOrdImm	0,483	0,125	0,483	0,114	0,69	0,291
Tfarmaci	0,328	0,045	0,31	0,303	0,552	0,135
Tmalati	0,172	0,005	0,086	0,042	0,121	0,002
PulSani	0,466	0,096	0,483	0,101	0,569	0,14
Ausil	0,414	0,091	0,569	0,147	0,534	0,117
GestioneUDG	0	0	0,052	0	0,121	0,003

Through feedback on perceptions of the quality of services provided, possible areas for improvement can be identified. The degree centrality measure identifies the actors or services that are central in the network according to their average distance from other actors or services in the network. According to the Tab.2, we can state that in 2020 the services that were most in demand were regular maintenance of properties, cleaning and sanitization and auxiliary services. We can note that in 2021 the auxiliary service becomes the main one to be used, followed by maintenance and Cleaning.

This could be due to the emergency from COVID-19, which has increasingly led to the need for activities related to the securing of buildings through disinfestation and sanitization activities, but also to the need for external auxiliary personnel consisting of both personal care and support activities for healthcare facilities. In 2022, on the other hand, the auxiliary service is replaced by medicines transport. Indeed, the betweenness centrality of a service indicates the number of times it is on the shortest path between two other services through an actor. According to the measure, the services reported earlier are confirmed for 2020.

However, in 2021, the transportation of medicines emerges as the service with the highest value, indicating its increased importance. In the last year, however, the situation changes again, and building maintenance activities regain their importance.

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This book collects the papers presented at the 11th Scientific Meeting of the SIS Group "Statistics for the Evaluation and Quality in Services" *Statistical Methods for Evaluation and Quality: Techniques, Technologies and Trends (T^3)*, which took place at the University of Chieti-Pescara, on 30th August-1st September, 2023.
The papers, which had been selected through a refereeing process, contain topics on statistical approaches and methodologies for the evaluation of public services in different contexts, and cover the areas of digital transition, e-commerce and digital marketing, enterprises, environment and territory, healthcare and wellness, finance, bank and FinTech, justice system, labour market, official statistics, public administration, food and wine, school, education and training, social, sports, sustainability, tourism, transport, university and research, well-being and welfare.

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