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Research Article

Principal Component Analysis of Indicators of Clients' Satisfaction from Veterinary Services Delivery in a Small Animal Hospital in Accra, Ghana

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ABSTRACT

Introduction: Satisfaction surveys have been used to collect clients' opinions, experiences, and needs across different services, helping ensure that services are appropriate for clients' needs. The present study aimed to determine which of the 17 selected service delivery indicators for small animals were significantly associated with overall client satisfaction at a small animal hospital in Accra, Ghana.
Materials and methods: from March to October 2023, 208 respondents visiting the small animal teaching hospital in Accra, Ghana, were interviewed using purposive sampling. Principal component analysis (PCA) was used to select and condense the 17 indicators that impact overall client satisfaction into a few key factors to clarify the underlying patterns and variances.
Results: The current results indicated that 16 out of the 17 indicators selected for their potential impact on clients' overall satisfaction with small animal services were retained. The indicators were regrouped into five components based on common features, accounting for approximately 70% of the variance in overall satisfaction. The first component, comprising service quality, efficiency, staff attitude, staff effectiveness, service availability, and staff competence, explained 25.3% of the variance. The second component, composed of medicine availability, vaccination availability, service accessibility, and meeting client needs, indicated 16.3% of the variance. The third component, composed of service charges and total time spent, included 10.5% of the variance. The fourth component involved medicine costs and availability, accounting for 9.3% of the variance. The fifth component, which was determined by service timeliness and gender, accounts for 7.7% of the variance.
Conclusion: The current findings emphasize important indicators that should be prioritized to improve overall client satisfaction with small animal services. Addressing the identified indicators could improve service delivery for small animals.

1. Introduction

Principal component analysis (PCA) is a technique used to analyze the interrelationships among a large number of variables and to represent these variables using a smaller set of variables with minimal information loss[1]. The PCA helps to simplify large datasets by reducing their dimensions, making them easier to interpret[2]. Frequently, the variables being examined demonstrated high correlation and required transformation into a new set of uncorrelated variables known as principal components[2]. These new variables are linear combinations of the original variables, derived in order of decreasing importance.[2] The PCA has been used in several studies conducted by Krefis et al.[3], Ampaw et al.[4], Achiri et al.[5] in Ghana; however, its application in veterinary medicine is novel and has not been investigated.

Client satisfaction has been defined as the level of satisfaction experienced by users of a service, and it reflects the gap between the expected service and the experience of the service from the client's point of view[6]. Another definition of client satisfaction is as a customer's overall attitude toward a service provider or as an emotional response to the gap between their expectations and actual

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experiences, especially in relation to fulfilling a specific need, goal, or requirement desire[7]. Satisfaction is related to feelings of acceptance, happiness, relief, excitement, and delight[8]. Customer satisfaction is important because satisfaction influences repurchase intentions, whereas dissatisfaction has been seen as a primary reason for customer defection or discontinuation of purchase[9]. Client satisfaction leads to repeated service use, loyalty, and retention[10], whereas dissatisfaction decreases the chances of continued use and results in negative attitudes toward the commercial brand[11].

To determine clients' opinions, experiences, and needs across different services, satisfaction surveys are used. It is necessary to identify clients' perceptions of service quality to manage resources to meet their expectation[12]. Meeting expectations requires identifying, prioritizing, and improving weak service areas and ensuring that valuable resources are allocated to the most effective areas. Being satisfied with the services that are offered can really help to build a more loyal and steady client base over time[13].

There are few studies on identifying the factors that influence client satisfaction with pet veterinary services in Ghana. Previous studies have been conducted on satisfaction with the delivery of veterinary services to mainly livestock owners, including poultry, in peri-urban areas in Ghana[14-16]. The present study aimed to identify which of the 17 selected services (hidden constructs) provided at an animal hospital in Accra, Ghana, were associated with clients' overall satisfaction.

2. Materials and methods

2.1. Ethical approval

Clients were verbally asked for consent before completing the questionnaire. The questionnaire contained only gender and age, with no personal identifiers traceable to individuals. The age classes were in year ranges. Confidentiality was also assured to each client. Approval for the study was given by the coordinator of Small Animal Teaching Hospital (SATH), School of Veterinary Medicine (SVM), University of Ghana, Legon, Ghana. The study was carried out according to the protocols of the Helsinki Declaration of the World Medical Association involving informed consent, anonymity, and confidentiality. The study used the same questionnaire as published by Turkson[16].

2.2. Study design

The present study adopted a quantitative approach and was carried out at SATH, SVM, University of Ghana, Legon, Ghana. A closed-ended questionnaire, similar to that conducted by Turkson[16], with a few modifications, was designed. A purposive sampling technique was used for the present study. The target population comprised clients who accessed veterinary services at the SATH hospital, Ghana. Individuals who had received services at the facility at least once before 2023 were recruited. All new clients of the facility were excluded. The questionnaire was administered from March to October 2023. No data were collected in August 2023 when the hospital was closed. A total of 208 (36.9%) out of 564 eligible participants were interviewed (Table 1). An electronic version of the questionnaire in Google Form was administered to clients in person who agreed to be interviewed when they accessed the hospital services for their pets. The questionnaire was completed in an average of 12 minutes.

Table 1. Information of the respondents interviewed for perceptions on pet health service delivery, Accra, Ghana

Variable	Category	Count (number)	Percentage
Gender	Male	131	63.0%
	Female	77	37.0%
Age	< 20 years	2	1.0%
	20-29 years	50	24.0%
	30-39 years	73	35.1%
	40-49 years	51	24.5%
	50-59 years	21	10.1%
	60 and over	11	5.3%
Animal	Dogs	188	90.4%
	Cats	20	9.6%

2.3. Data analysis

The data were exported to Microsoft Excel and analyzed using SPSS version 25. Tables were used to explore the data. The Chi-square test was used with a significance level set at 0.05. The PCA function in SPSS 25 was used to reduce the 17 indicator variables into a smaller set that accounted for most of the variance in the original variables. The independent variables were affordability of services, staff attitude, staff technical competence, quality of services, staff efficiency, staff effectiveness, accessibility of services, services meeting the needs of clients, total time spent in facility, timeliness, service availability, availability of pet vaccinations, availability of medicine, charges for services, cost of medicine, gender of pet client, and species of pet. The dependent variable was overall satisfaction. The independent variables were defined as follows. Affordability of medicines, availability of medicines, vaccination availability, affordability of services, service charges, timeliness, hospital efficiency, service quality, Staff attitude, staff competence, service Accessibility, and meeting clients' needs.

The Kaiser-Meyer-Olkin (KMO) statistic quantifies the proportion of variance among variables that may be common, indicating suitability for factor analysis. The Bartlett's test assessed whether the correlation matrix was suitable for factor analysis. This test examines the null hypothesis that the correlation matrix equals the identity matrix, implying that the variables are unrelated and thus unsuitable for structure detection. Additionally, the scree plot was used to address a central problem in factor PCA and to determine the number of meaningful components (factors) to retain.

3. Results and Discussion

The respondents were predominantly male (63.0%), and the largest proportion of participants belonged to the 30-39-year age group (35.1%), indicating that the perspectives collected strongly reflect the experiences of middle-aged adults. Furthermore, dog owners constituted the majority of respondents (90.4%), indicating that the subsequent findings on service delivery are closely related to canine healthcare in Accra, Ghana.

The primary animal species observed at the hospital were dogs (90%), consistent with the findings of Turkson et al.[17] at the SATH in Accra, Ghana. The present findings were consistent with those of Leeper et al.[18] who found that dogs were the most common species (85%) presented at the Veterinary Teaching Hospital at Michigan State University, Michigan, USA.

The KMO measure of sampling adequacy was 0.631, just above the minimum threshold of 0.60, indicating acceptable results. The Bartlett's test indicated a highly significant result (χ^2= 435.8, df = 136, p < 0.0001). The result of the Bartlett's test (p = 0.00001) suggested an adequate sample size. Bartlett's test confirmed that the correlations among the variables in the dataset were statistically significant (p = 0.00001) and not attributable to chance, indicating that the data structure was appropriate for factor reduction. The data were considered suitable for factor analysis because some of the variables were intercorrelated.

Table 2 presents the communalities for the 17 indicators before component extraction. The Initial column shows a value of 1.000 for each variable, indicating the total variance before analysis. The Extraction column shows the proportion of each variable's variance that was accounted for by the retained principal components. The extracted communalities ranged from 0.269 to 0.831. A higher value indicated that the variable was well-represented by the factor solution. Based on the present results, most variables had communalities above 0.50, indicating that the underlying components captured a substantial portion of their variance.

Table 2. Communalities of indicators from the principal component analysis on client satisfaction

Independent variables	Initial	Extraction
Affordability of medicines	1.000	0.615
Availability of medicines	1.000	0.677
Vaccinations availability	1.000	0.778
Service affordability	1.000	0.510
Service charges	1.000	0.831
Medicines cost	1.000	0.712
Timeliness	1.000	0.653
Total time spent	1.000	0.767
Effectiveness of service delivery	1.000	0.811
Efficiency of service delivery	1.000	0.822
Service quality	1.000	0.748
Staff attitude	1.000	0.681
Staff competence	1.000	0.792
Service accessibility	1.000	0.637
Species of the animal	1.000	0.269
Gender of owner	1.000	0.699
Meeting clients' needs	1.000	0.731

Definitions of the components include Affordability of medicines: Ability to pay for medicines, Availability of medicines: Availability of veterinary medicines in hospitals for saling to clients, Vaccination availability: Availability of pet vaccinations, Service affordability: Ability to pay for services, Service charges: Charges for services rendered, Medicines cost: Cost of medicines on the market, Timeliness: Time taken to receive help, Total time spent: Time from arrival to leaving the facility, Effectiveness of service delivery: How effective do you think the hospital is in reducing discomfort, disease, death, and dissatisfaction?, Efficiency of service delivery: How well are resources used to achieve desirable results?, Service quality: The degree to which the service meets the client's expectations, Staff attitude: Interpersonal relations shown by staff, Staff competence: The technical competence of staff (knowledge, skills, and actual performance), Service accessibility: How easy are individuals able to reach and obtain services? Meeting clients' needs: Meeting the needs of clients for veterinary services.

A scree plot is a standard output in PCA. The scree plot for the present results demonstrated a distinct elbow at the fifth component (Figure 1). The curve descended sharply from the first to the fifth component and then began to level off. The present result indicated five components, providing strong and consistent evidence to retain a five-component solution.

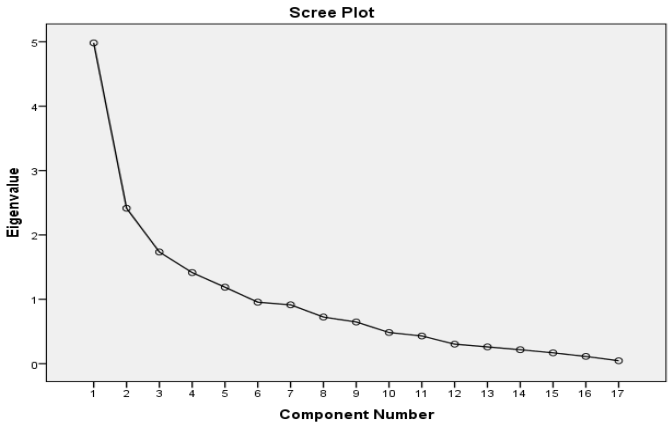

Figure 1. Scree plot for determining the number of retained components in the principal component analysis. Scree plots give a visual presentation of the number of components with Eigenvalues above 1.

Table 3 provides the PCA results. It shows how the variances for each component account for the total variance observed. Five components had eigenvalues exceeding 1.0, including Component 1 (4.983), Component 2 (2.414), Component 3 (1.735), Component 4 (1.415), and Component 5 (1.188). This result empirically confirmed the five-component solution suggested by the scree plot in Figure 1.

Table 3. Total variance explained by the principal components from the factor analysis.

PCA components	Initial eigenvalues		
	Total	Variance	Cumulative percentage
1	4.983	29.310%	29.310%
2	2.414	14.203%	43.513%
3	1.735	10.206%	53.719%
4	1.415	8.324%	62.043%
5	1.188	6.987%	69.030%
6	0.955	5.619%	74.649%
7	0.914	5.379%	80.028%
8	0.725	4.262%	84.290%
9	0.648	3.812%	88.102%
10	0.485	2.850%	90.952%
11	0.430	2.531%	93.483%
12	0.303	1.782%	95.265%
13	0.261	1.534%	96.799%
14	0.217	1.276%	98.075%
15	0.169	0.993%	99.068%
16	0.113	0.665%	99.733%
17	0.045	0.267%	100.000%

In PCA, all variables were assigned an initial variance (total communality). The final communalities of each variable represent the proportion of variance accounted for

by the chosen factor solution. The final result did not include animal species because its communality was less than 0.30. The factor solution was considered satisfactory since at least two-thirds of the variance of each variable was shared with the factors.

The results of the PCA indicated the latent constructs that could be used to determine the unique salient factors influencing overall client satisfaction. The scree plot (Figure 1) assisted in extracting five components that influence the overall satisfaction of clients. An eigenvalue of less than one concept also revealed five constructs with a very strong influence on overall satisfaction. After assessing all 17 factors that could contribute to overall satisfaction, five were identified as rotated principal components.

Table 4 presents the rotated component matrix, displaying the factor loadings of each survey variable on the five retained components. The rotated solution provided a clear and interpretable structure. The five components, including service execution, resource access, transactional efficiency, drug costs, and timeliness/demographic, represented distinct, non-overlapping themes that collectively explained the key drivers of client satisfaction during the present study.

Table 4. Rotated component matrix showing factor loadings for the five-component solution

Independent variables	Component				
	1	2	3	4	5
Service quality	0.834	0.136	0	-0.112	-0.122
Efficiency of service delivery	0.881	0	0	-.129	0.151
Staff attitude	0.787	0.177	0.131	0	-0.105
Effectiveness of service delivery	0.875	0.159	0	-0.130	0
Staff competence	0.834	0.124	-0.218	0.179	0
Service accessibility	0.627	-0.112	0.128	-0.339	0.124
Medicines cost	0	0.245	0	0.687	0.420
Service charges	0	0.119	0.864	0.176	-0.194
Affordability of medicines	0-.140	0	0	0.762	0
Availability of medicines	0.134	0.803	0	0	0
Vaccinations	0.146	0.773	-0.127	0.323	-0.198
Service availability	0.103	0.680	0.144	0	0.101
Total time spent	0.135	0	0.851	0	0.134
Timeliness	0	0.434	0.165	0	0.652
Species of the animal	-0.494	0	0	0	-0.122
Gender of owner	0	0.356	0.221	-0.123	-0.712
Meeting clients' needs	0.114	0.694	0.290	-.0388	0

The PCA revealed five key components influencing client satisfaction. The first component, composed of service quality (0.83), efficiency (0.88), effectiveness (0.88), attitude of staff (0.79), service availability (0.63), and staff competence (0.83), was able to explain 25.3% of the variance. The second component covered the availability of medicines (0.80), the availability of pet vaccination (0.77), service accessibility (0.68), and meeting needs (0.69), with 16.3% of the variance explained. The third component included service charges (0.86) and total time spent (0.85), which explained 10.5% of the variance. The fourth component was composed of medicine cost (0.69) and availability of drugs (0.76), explaining 9.3% of the variance. The fifth component covered timeliness (0.65) and the gender of the respondent (0.71), explaining 7.7% of the variance. All five hidden components could explain almost 70% of the variance in the determinants of overall satisfaction. In the present study, the first three components accounted for 52% of the total variance, consistent with the findings of Yunusa et al.[19], who reported that the first few components account for the largest proportion of the total variance. The correlations indicated the strength of each original variable's association with the new component.

4. Conclusion

The present study identified salient hidden attributes clients considered when contributing to overall satisfaction with veterinary service delivery for pets in Accra, Ghana. The PCA, when applied to the data, effectively reduced the dimensionality of 17 variables into five artificial composite variables that were uncorrelated and independent of each other and explained 69% of the variation in the original dataset. The five composite variables should be considered to improve client satisfaction with services delivered in the Small Animal Teaching Hospital. Accra, Ghana. Future studies should investigate more animal clinics or hospitals in Ghana and compare regional service qualities.

Declarations

Competing interests

There were no conflicts of interest relevant to the present study.

Authors' contributions

Paa Kobina Turkson conceptualized and prepared the questionnaire instrument, supervised, curated, and analyzed the data, and wrote and reviewed the paper. Celine Naa Dede Coopson was involved in collecting and analyzing the field data. Anthony Joseph Turkson analyzed, interpreted, and provided guidance in PCA. All the authors read and approved the final manuscript.

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Ethical considerations

The study was done according to the ethical standards of the relevant national and institutional guidelines for research and publication. All procedures were conducted in accordance with ethical principles, and the authors confirm that they have followed the journal's guidelines for ethical publication. No AI tools were used in the writing up of this paper.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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