



Patient Satisfaction and Health-Related Quality of Life After Cardiac Catheterization: A Predictive Model

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Abstract

Coronary heart disease, a leading global cause of death, including in Indonesia, is managed through promotive, preventive, and curative approaches, with cardiac catheterization evolving as a common non-surgical intervention method in Indonesian hospitals, aiming to improve patients' quality of life and outcomes. This study examines the factors affecting patients' satisfaction following cardiac catheterization and their impact on health-related quality of life (HRQoL). Data was collected from 154 respondents at three private hospitals in Surabaya, Indonesia, through online questionnaires and analyzed using Partial Least-Structural Equation Modeling (PLS-SEM). This study found that treatment outcome, physician-patient communication, attentive care, organization of care, and servicescape significantly influence patient satisfaction (p -value < 0.05 ; CI 95%). In turn, patient satisfaction positively impacts HRQoL ($p = 0.000$, $\beta = 0.848$). The results indicate that the model has moderate explanatory power and strong predictive relevance in estimating patient satisfaction following cardiac catheterization. This study benefited hospital administration in improving patient satisfaction with catheterization services.

Introduction

Coronary heart disease, caused by the narrowing of coronary blood vessels or atherosclerosis, remains one of the leading causes of death worldwide, including in Indonesia (Dang *et al.*, 2024). This disease affects more than half a billion people, causing 20.5 million deaths in 2021 (World Health Organization, 2024). In the management of cardiac patients, which includes promotive, preventive, and curative approaches, cardiological technology, such as cardiac catheterization, has evolved as a non-surgical intervention method available in both public and private hospitals in Indonesia (Dang *et al.*, 2024; Kemenkes Republik Indonesia, 2020). Continuous improvement in managing coronary heart disease is crucial as it increases morbidity and mortality rates and affects the patient's quality of life, both the physical and psychological

aspects (Sugiharto *et al.*, 2024). Quality of life is crucial for evaluating a therapy's success (Henien *et al.*, 2020). Studies have shown that coronary intervention improves quality of life compared to regular medication (Mall *et al.*, 2020). More specifically, previous research has demonstrated that catheterization can improve the health-related quality of life (HRQoL) of coronary heart disease patients, particularly among older adults undergoing percutaneous coronary intervention (PCI) (Karimi & Brazier, 2016).

In Indonesia, many hospitals offer cardiac catheterization services, equipped with good facilities and trained specialists, including those in private hospitals. Regarding the universal health care coverage system, patients who require catheterization can be referred to private hospitals in Indonesia (Muharram *et al.*, 2024). Therefore, private hospitals compete

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by highlighting patient satisfaction to attract new patients. However, patient satisfaction with post-catheterization at this hospital remains unclear, as the satisfaction surveys are more general for various types of services. The current patient-reported questionnaire is not endemic to heart patients. Not to mention the evaluations are more often based on clinical outcomes rather than direct feedback from patients, which is important in patient-centered care (Agustini *et al.*, 2020; Salsabila *et al.*, 2023). As such, more thorough survey studies are needed to understand patients' conditions. The results of a more thorough survey can provide valuable insight for the hospital and care management, because patient satisfaction can encourage adherence to routine treatment.

Therefore, this study analyzes the factors that influence patients' satisfaction and quality of life following catheterization services. The findings can provide academic and practical references for managing cardiac catheterization services in the hospital under study and other private hospitals offering similar services in Indonesia. This study is built upon Donabedian's (Donabedian, 1988) quality theory in the 1988 Structure-Process-Outcome (SPO). The process is viewed through patient satisfaction post-catheterization, and the treatment outcome is proxied from the HRQoL. Data collected through surveys on patients' satisfaction allows for the identification of service factors that need improvement, which, in turn, helps management design more optimal services (Batbaatar *et al.*, 2017; Okunrintemi & Nasir, 2020). This study identifies interpersonal care as a determinant of patient satisfaction, including patient-physician communication and attentive care (Donabedian, 1988; Gessesse *et al.*, 2022). Aside from interpersonal aspects, studies have also shown that service facilities significantly affect patient satisfaction, with physical environment factors like cleanliness and comfort also playing a role. Additionally, treatment outcomes are crucial for satisfaction, with health improvement positively impacting satisfaction, while complications result in the opposite (Batbaatar *et al.*, 2017; Sahib & Mohammad, 2016).

Maslow's hierarchy of needs comprises physiological needs, safety, love and belonging,

esteem, and self-actualization. These needs influence human motivation and behavior, including health-related behaviors. Alderfer's Existence, Relatedness, and Growth (ERG) theory modifies Maslow's (Maslow, 1954) hierarchy to be more flexible, covering existence, relatedness, and growth needs (Guterman, 1974). Feldman, (2018) argues that these needs impact general psychology and health behaviors. In other words, Maslow, (1954) theory can help explain the complex dynamics between psychological and physical factors that influence patients' post-procedure experiences and quality of life. As such, this study applies this framework to understand factors affecting patient satisfaction post-cardiac catheterization and its impact on health-related quality of life (HRQoL). This framework posits that physical needs, safety, social relationships, self-esteem, and self-actualization influence patient satisfaction after cardiac catheterization. This satisfaction will subsequently impact patients' HRQoL, considering the moderation of the perceived severity of heart disease.

Meanwhile, Nightingale's principles emphasize the impact of a clean, healthy environment on patient healing (Riegel *et al.*, 2021). The theory, evolving through the late 20th century, highlights how the physical and social environment affects patient outcomes (Masters, 2011). Davies, (2012) underscores the importance of a supportive environment in patient care relevant to cardiac catheterization (Putra *et al.*, 2025). This theory suggests that cleanliness, safety, comfort, and social support contribute to patient satisfaction and HRQoL post-procedure. Next, Linder-Pelz links patient satisfaction to attitudes and perceptions before care, based on Fishbein and Ajzen's attitude theory (Fishbein & Ajzen, 1977; Linder-Pelz, 1982). Linder-Pelz, (1982), in Anderson *et al.*, (2007) states that patient satisfaction is influenced by their perception of the quality of medical services received, including effective communication, attention to patient needs, and the attitude of medical personnel, as well as their experiences with the medical equipment and procedures. Along the same vein, Jean-Pierre *et al.*, (2014) highlight that patient satisfaction reflects core dimensions of healthcare quality and patient-centered care, impacting health

status, quality of life, adherence to treatment, and communication. This theory identifies factors like medical staff interaction, service quality, procedural experience, and trust in the medical team as determinants of patient satisfaction post-cardiac catheterization.

Lastly, Ferrans *et al.*, (2005) and Ojelabi *et al.*, (2017) discuss HRQoL as an outcome measure in clinical trials and health research, focusing on the effects of health status, illness, and treatment on quality of life. This model considers both biological and physical factors influencing HRQoL. In the context of post-cardiac catheterization, factors such as pre- and post-procedure physical condition and potential complications are significant. Patient satisfaction is viewed as a crucial outcome, influenced by the extent to which patient expectations are met. Based on the previous studies and SPO theory, this research proposes a model where heart patient satisfaction is influenced by treatment outcomes, patient-physician communication, attentive care, organization of care, and hospital servicescape, with perceived severity as a moderating factor. These factors impact satisfaction and indirectly affect health-related quality of life. The model was empirically tested on post-catheterization patients at a private hospital in Surabaya, with quantitative analysis of survey data.

Method

This quantitative study examines the influence of patient satisfaction on HRQoL among cardiac catheterization patients at a private hospital in Surabaya. The study employs a cross-sectional design, collecting patient data via a structured online questionnaire in April 2024. A 5-point Likert scale was utilized to measure the latent variables. The

research adheres to a systematic data analysis framework, incorporating statistical reliability and validity testing methods. The research population comprises individuals who underwent cardiac catheterization in the three private hospitals in Surabaya City, Indonesia, under study within the past two years. Due to challenges in obtaining a comprehensive sampling frame, a non-probability purposive sampling technique was employed. The sample consisted of 154 patients meeting specific criteria, i.e., undergoing cardiac catheterization within the past two years, aged between 17 and 70 years, first-time cardiac catheterization between 2022 and 2023, stable hemodynamics, absence of psychiatric diagnoses, NYHA class I-III, and no significant disabilities. Meanwhile, the exclusion criteria were patients with extensive lesions, complications, seizures, visual impairments, inability to sit upright, uncontrolled medical conditions, and those who deceased or withdrew from the study.

Data was analyzed using Partial Least Squares - Structural Equation Modeling (PLS-SEM) with SmartPLS 4 software. The outer model was assessed for reliability and validity using Cronbach's alpha, composite reliability, and average variance extracted, or AVE. The inner model was evaluated using bootstrapping and the cross-validated prediction ability test (CVPAT). The hypothesis testing was based on p-values, confidence intervals, and path analysis. Additionally, importance-performance map analysis (IPMA) and PLS-POS were employed to assess construct performance and data heterogeneity. The outer model evaluation ensures the indicators are reliable and valid for measuring latent variables. In this model, treatment outcomes, patient-physician communication, attentive care, organization of care, and hospital servicescape, with perceived severity,

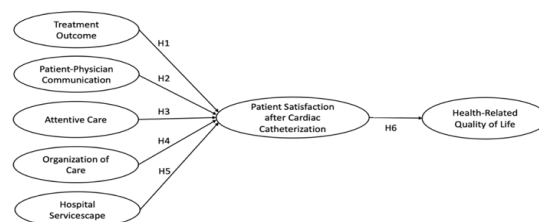


Figure 1. Research Framework

organization of care, and hospital servicescape are hypothesized to positively influence patient satisfaction with cardiac catheterization. In addition, patient satisfaction after cardiac catheterization is hypothesized to influence HRQoL positively.

Result and Discussion

The descriptive statistics in Table 1 provide a comprehensive overview of the demographic, educational, occupational, and medical characteristics, offering valuable insights into the population under investigation. The participant pool comprised 154 individuals, with a slight predominance of females, comprising 58.4% (n=90) of the sample, compared to 41.6% (n=64) of males. The age distribution of respondents revealed a concentration in the middle-aged group, with 67.5% (n=104) of participants falling within the 30-51 age range. It was followed by 17.5% (n=27) in the 51-65 years age bracket, 10.4% (n=16) over 65 years, and a smaller group of 4.5% (n=7) between 18-30 years. Regarding educational attainment, a significant portion of respondents were high school graduates, represented 56.5% (n=87) of the sample. Those holding a bachelor's degree accounted for 32.4% (n=50), while 6.5% (n=10) had obtained a postgraduate degree, and 4.5% (n=7) held a diploma. This educational distribution suggests that many participants possess foundational academic qualifications, with a smaller subset achieving higher education.

Occupational status among respondents varied, with the majority identifying as employees (35.0%, n=54). Entrepreneurs reached 21.4% (n=33) of the group, followed by homemakers at 15.6% (n=24). Other occupations included those categorized as "Others" (14.2%, n=22), civil servants, military, or police personnel (6.5%, n=10), professionals (2.6%, n=4), and part-time workers (1.3%, n=2). Additionally, 3.2% (n=5) of respondents were retired, reflecting a diverse occupational background among participants. Regarding medical history, specifically the frequency of catheterization procedures, most respondents (70.1%, n=108) had undergone the procedure twice. A further 28.6% (n=44) had undergone catheterization once, while a small proportion

(1.3%, n=2) had undergone the procedure three or more times. The timing of these procedures was also noteworthy, with 70.1% (n=108) reporting their last catheterization occurred 1-2 years ago, 18.2% (n=28) within the past six months to 1 year, 7.8% (n=12) within the last 1-6 months, and 3.9% (n=6) within the last month.

This study uses PLS-SEM for the inferential analysis, a non-parametric, second-generation multivariate technique effective for simultaneously estimating complex relationships between variables. Unlike covariance-based SEM, PLS-SEM uses a composite approach, making it suitable for exploratory and explanatory research. The analysis was conducted using SmartPLS 4, involving two stages: evaluating the measurement model (outer model) for reliability and validity and assessing the structural model (inner model) for explanatory power and significance. Advanced analytics, such as PLS-IPMA and PLS-POS, were also employed to produce more robust results. The outer model evaluation ensures the indicators are reliable and valid for measuring latent variables. The analysis involves testing indicator reliability, construct reliability, construct validity, and discriminant validity. The calculation uses SmartPLS 4 and includes assessments of outer loadings, Cronbach's alpha, composite reliability, and average variance extracted, or AVE.

In this study, hypothesis testing was performed using the inner or structural model to evaluate the significance and coefficients between latent variables. The output involves examining paths in the model. This inferential statistical analysis aims to generalize the effects on the population. Hypotheses are supported if they meet two criteria. The first is that they must match the hypothesized directions. The second is the significance. Where p-values from bootstrapping must be ≤ 0.05 with a 95% confidence level to indicate a significant relationship. Confidence intervals (CI) are used for significance testing (Hair *et al.*, 2022). A CI with no zero and between the 5% lower and 95% upper bound suggests a significant effect, as shown in Table 2. The hypothesis testing results reveal that hypotheses H1, H2,

H3, H4, and H5 are supported, as shown by the p-values below 0.05 and confidence intervals that do not include 0. It indicates significant effects. All standardized coefficients for these hypotheses are positive, aligning with the estimated directions. The highest impact is found in Treatment Outcome (H1), with the highest coefficient at 0.335, while the smallest coefficient is in Hospital Servicescape (H5) at 0.131. Therefore, treatment outcome has the highest effect on patient satisfaction with cardiac catheterization. Likewise, Patient Satisfaction has a positive impact on HRQoL (H6). The hypothesis is supported with a p-value below 0.05 and a positive coefficient, indicating that higher satisfaction after cardiac catheterization improves HRQoL.

Key metrics for assessing the model quality include R^2 , f^2 , and Q^2 -predict for the target construct or dependent variables. The hypothesis testing examines the significance and coefficients obtained through bootstrapping in SmartPLS 4, which provides significance levels and coefficients without assuming normally distributed data. Before reporting hypothesis results, the model's quality needs to be evaluated based on the Variance Inflation Factor (VIF), R^2 , f^2 , and Q^2 -predict. It ensures the model's explanatory and predictive capabilities. The outcome of the inner model, shown in Figure 3, is derived from bootstrapping with a percentile setting, 10,000 re-samples, a one-tailed test, and $\alpha=0.05$. The arrows in Figure 2 illustrate the structural relationships between variables in the research model, consisting of one dependent variable and five independent variables. The inner model displays the p-values (in parentheses) for six paths in the model, and their respective coefficients. The inner model also shows the statistical significance of indicators via p-values for the relationships between constructs and their reflective indicators (yellow boxes). The R^2 values within the blue circles indicate the model's explanatory and predictive power. The findings reveal that all paths in the structural model have p-values ≤ 0.05 , with $\alpha=0.05$ and a 95% confidence level, indicating significant effects across all paths.

The first step in evaluating the structural model is to check for multicollinearity

among the independent variables. It is crucial because the model includes five independent variables that might be strongly correlated. Multicollinearity occurs when two or more independent variables are highly correlated, leading to increased standard errors and reduced predictive accuracy. Multicollinearity in PLS-SEM is assessed using the inner VIF, which should be less than 3 to indicate no multicollinearity issues. VIF values between 3 and 5 are considered acceptable but suggest potential issues. Values above 5 are deemed critical and indicate significant multicollinearity problems. The VIF results show all values below 3, with the highest being 3.170 for Organization of Care. It suggests that the model has no significant multicollinearity issues, making it acceptable to variable correlations.

In this study, the variables Treatment Outcome, Patient-Physician Communication, Attentive Care, Organization of Care, and Hospital Servicescape mediate the five independent variables related to Patient Satisfaction after Cardiac Catheterization. To assess the mediation effect of these variables, both the specific indirect and direct outcomes from the bootstrapping results were examined. The analysis reveals that all indirect effects for the four independent variable paths are significant, with p-values below 0.05. The direct outcomes, which directly influence satisfaction after cardiac catheterization without mediation, are also noteworthy with p-values less than 0.05. It indicates that satisfaction significantly mediates the indirect effects of the five independent variables, i.e., Treatment Outcome, Patient-Physician Communication, Attentive Care, Organization of Care, and Hospital Servicescape, on HRQoL. Among the mediation paths, the most substantial effects were found in Treatment Outcomes and Patient-Physician Communication.

Table 1. Respondents' Characteristics

Descriptions	Categories	Number	Percentage (%)
Gender	Male	64	41.6
	Female	90	58.4
Age	>65 years	16	10.4
	51-65	27	17.5
	30-51	104	67,5
	18-30 years	7	4.5
Education	Postgraduate degree	10	6.5
	Bachelor's Degree	50	32.4
	Diploma Degree	7	4.5
	High school Graduate	87	56.5
Occupational Status	Homemaker	24	15.6
	Employee	54	35.0
	Others	22	14.2
	Part-time	2	1.3
	Retired	5	32
	Civil servant/Army/Police	10	6.5
	Professional	4	2,6
	Entrepreneur	33	21,4
Catheterization procedure	1 time	44	286
	2 times	108	70.1
	3 times and more	2	1.3
Post-catheterization time	<1 month	6	3.9
	1-2 years ago	108	70.1
	1 month to 6 months ago	12	7.8
	6 months to 1 year ago	28	18.2

Table 2. Respondents' Characteristics

	Hypothesis	Std Coeff	p-values	Confidence Interval		Results
				Lower 5.0%	Upper 95.0%	
H1	Treatment Outcome -> Patient Satisfaction after Cardiac Catheterization	0.335	0.000	0.256	0.408	Hypothesis Supported
H2	Patient-Physician Communication -> Patient Satisfaction after Cardiac Catheterization	0.255	0.000	0.175	0.333	Hypothesis Supported
H3	Attentive Care -> Patient Satisfaction after Cardiac Catheterization	0.143	0.003	0.059	0.226	Hypothesis Supported
H4	Organization of Care -> Patient Satisfaction after Cardiac Catheterization	0.213	0.000	0.133	0.292	Hypothesis Supported

H5	Hospital_Servicescape -> Patient Satisfaction after Cardiac Catheterization	0.131	0.006	0.054	0.222	Hypothesis Supported
H6	Patient Satisfaction_after Cardiac Catheterization -> Health-Related Quality of Life	0.848	0.000	0.763	0.919	Hypothesis Supported

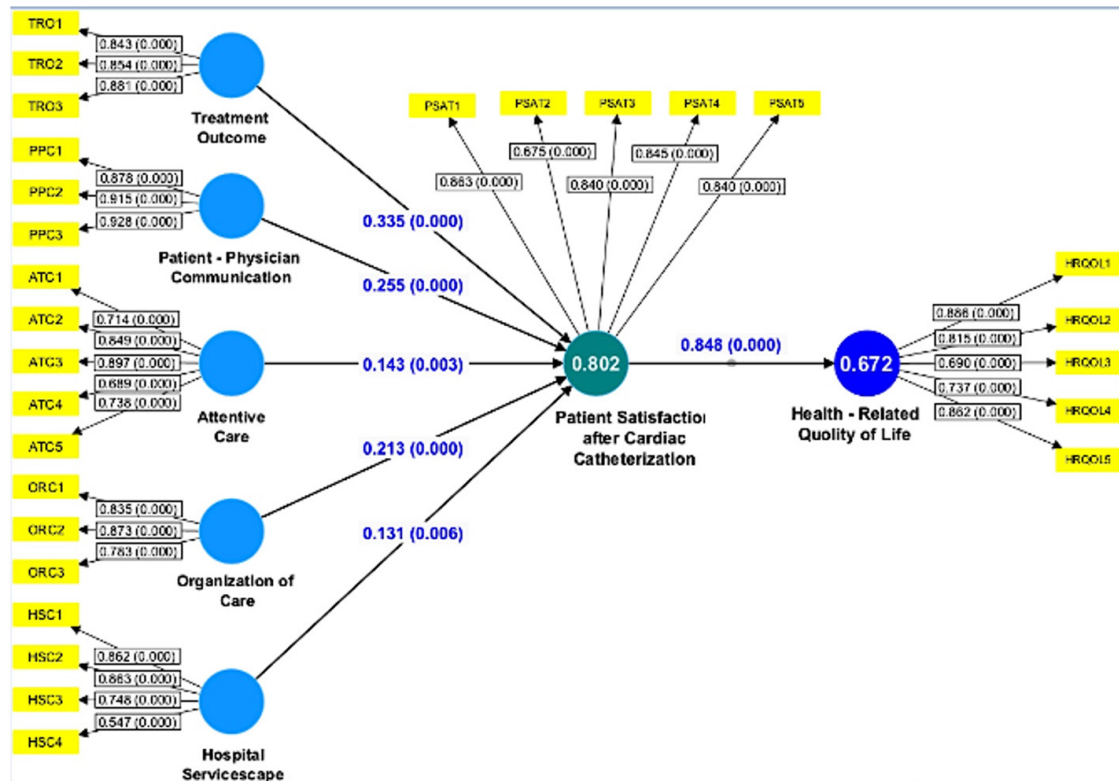


Figure 2: Structural Relationships Between Variables in the Research Model
Source: PLS-SEM processed data

To derive managerial implications from the PLS-SEM analysis, Importance-Performance Mapping Analysis (IPMA) was conducted using the PLS IPMA. This analysis maps the positions of constructs and variables by combining descriptive analysis (mean performance) with inferential analysis (total effect). From the IPMA results for the target construct HQRoL, the mean importance is 0.283, and the mean performance is 63.255. Values below these means are considered low performance, while values above are high. The vertical and horizontal lines drawn from these means create four quadrants in the mapping diagram. This mapping helps identify variables with good performance and those needing

improvement. It also guides organizational and work environment factors that management should prioritize when implementing HRQoL programs, promoting efforts to improve these organizational factors.

In the IPMA construct output, patient satisfaction after cardiac catheterization is in the upper-right quadrant, indicating it is crucial and performing well. Thus, patient satisfaction after cardiac catheterization is a strong determinant of HQRoL. Table 3 shows the mean importance and performance values for the indicators of the six independent variables. The mean importance is 0.057, and the mean performance is 55.603. Indicators below these means are considered low performance, while

Table 3. The IPMA Construct Values

Importance-performance map of HRQoL	Importance	Performance
Treatment Outcome	0.274	53.109
Patient-Physician Communication	0.209	72.528
Attentive Care	0.117	61.805
Organization of Care	0.174	71.377
Hospital Servicescape	0.107	56.499
Patient Satisfaction after Cardiac Catheterization	0.817	64.210
Mean	0.283	63.255

those above are high. The mapping plot for the indicators is divided into four quadrants based on these means.

The IPMA output for the HRQoL target construct shows two indicators, PSAT2 and PSAT5, in the top-right quadrant. These are the most critical indicators with high total effect values, which means they are crucial and performing well for the patients, so hospital management should maintain their performance to achieve HRQoL. In the bottom-right quadrant, indicators PSAT1, PSAT3, PSAT4, TRO1, TRO2, and TRO3 are essential but need improvement to meet patient expectations. The hospital management could pay more attention to these indicators to improve satisfaction and, thus, HRQoL.

The results of this study indicate that the six hypotheses were supported with adequate data evidence. The analysis also showed that the research model can adequately explain and predict the dependent variable, HRQoL. This study supports previous research highlighting the importance of organizational, operational, and environmental factors in hospitals. HRQoL is influenced by various factors, including biological function, symptoms, functional status, general health perception, natural characteristics, and individual characteristics (Dyer *et al.*, 2010; Glickman *et al.*, 2010). HRQoL indicates the success of therapy and a patient's health status (Henien *et al.*, 2020).

The findings align with prior studies by Kearney *et al.*, (2019) and Abuzar *et al.*, (2012), emphasizing the significant relationship between patient satisfaction after cardiac catheterization and HRQoL. This study underlines the impact of medical procedures on patients' daily lives and well-being and the role of patient satisfaction after cardiac

catheterization in determining HRQoL. Five independent variables were identified as determinants of patient satisfaction after cardiac catheterization. Previous studies noted that the relationship between treatment outcome and patient satisfaction is not straightforward, but an interaction of various factors. Good treatment outcomes tend to increase patient satisfaction, but other factors also significantly impact the levels of patient experience and satisfaction post-cardiac catheterization (Abdallah *et al.*, 2022; Tran *et al.*, 2019; Wang *et al.*, 2019)

Previous research by Fatehi *et al.*, (2020), Gessesse *et al.*, (2022), and Moslehpour *et al.*, (2022) highlighted the importance of patient-physician communication in patient satisfaction. Studies discussing diabetes also state that effective communication between doctors and patients has a significant impact on patient satisfaction with the care provided (Mafazah, 2012). Similarly, Todorov, (2021) emphasized that attentive care is crucial in evaluating care quality and patient experience. Another researcher also highlighted the importance of good care organizations in enhancing patient satisfaction. These studies have helped healthcare providers identify areas for improvement and develop strategies to upgrade care quality (Aldossary *et al.*, 2023; Mattarozzi *et al.*, 2017). However, another study highlighted the significance of a hospital's physical environment in improving patient satisfaction post-cardiac catheterization and assisting healthcare providers in designing and managing facilities to offer a better patient experience (Amin *et al.*, 2016; Zahid, 2024). The patient experience needs to be examined specifically through its elements. All of these elements of the patient experience are related to overall patient satisfaction (Harjono & Antonio,

2024). The findings in this study confirmed the importance of all the determinants of patient satisfaction found in the previous studies. The analysis also revealed that the research model has moderate explanatory power (R^2), which increases to strong explanatory power in segment analysis (PLS-POS). The model also demonstrated large predictive relevance (Q^2 -predict) for patient satisfaction after cardiac catheterization, confirmed by cross-validated prediction ability tests (CVPAT). Thus, the proposed research model is deemed adequate for explaining and predicting patient satisfaction.

Conclusion

Clear treatment outcomes, effective doctor-patient communication, attentive care, care organization, and hospital escape services have been shown to have a positive and significant impact on patient satisfaction after cardiac catheterization, which in turn has a positive and significant impact on HRQoL. In addition to the factors already mentioned, modern medical technology and infrastructure also improve patients' quality of life and satisfaction after cardiac catheterization. Therefore, this study offers several recommendations for hospital management, such as conducting regular patient satisfaction surveys to monitor and evaluate patient satisfaction, and providing direct feedback on factors that influence their experience during cardiac catheterization. The development or updating of post-catheterization care protocols is also needed, taking into account factors that influence patient perceptions of treatment outcomes, including effective pain management, postoperative care, and long-term care. The implementation of modern technology, improving medical staff communication skills through training, increasing oversight of integrated and coordinated care plans, and facilitating collaboration between departments such as cardiology and psychology, can ensure a holistic approach to patient care and recovery. Recognizing and rewarding medical staff for excellent service can also motivate them to provide high-quality care.

Nonetheless, the study has several limitations. The data were sourced exclusively

from post-cardiac catheterization patients at XYZ Hospital, Surabaya, which restricts the generalizability of the findings. Future studies should test the model in diverse geographical, ownership, and organizational settings to enhance external validity. Additionally, the latent class analysis revealed unexpected data heterogeneity. Future research should identify attributes that distinguish respondent segments for more homogeneous data to improve model prediction. Lastly, the study did not analyze the impact of complications or comorbidities, such as diabetes or hypertension, on patient outcomes and satisfaction. Future research should include sub-analysis or control for these factors to comprehend their influence on patient satisfaction and HRQoL.

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