ISSN 2616-5783 Vol.8, Issue 4: 10-15, DOI: 10.25236/AJHSS.2025.080402

Determinants of Shanghai Residents' Willingness to Accept the Da Vinci Surgical Robot in the Context of AI-Assisted Healthcare: A Binary Logistic Regression Analysis

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Abstract: *With the deep integration of AI and healthcare, the Da Vinci surgical robot—an iconic innovation in intelligent minimally invasive surgery—has gradually entered the public spotlight. This study employs a binary logistic regression model, incorporating key variables from the Health Belief Model (HBM) and the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2), to empirically investigate the factors influencing Shanghai residents' willingness to accept the Da Vinci surgical robot. A total of 1,214 valid questionnaires were collected. The results show that performance expectancy, facilitating conditions, policy support, and trust tendency have significant positive effects on acceptance, while perceived privacy risk has a significant negative effect. Price value and social influence did not reach statistical significance. Among all factors, facilitating conditions emerged as particularly crucial, with an odds ratio (OR) of 18.687, highlighting its key role in shaping public acceptance. Based on the findings, this paper proposes promotion strategies from the perspectives of enterprises, hospitals, and government to facilitate the adoption of surgical robotics and enhance public willingness to accept the technology.*

Keywords: *Da Vinci surgical robot, willingness to accept, binary logistic regression model*

1. Research Background

The integration of healthcare and artificial intelligence (AI) has become a strategic priority in Shanghai's industrial development. On April 6, 2021, the Shanghai Medical Insurance Bureau included "AI-assisted therapeutic technologies" in the scope of basic medical insurance coverage, effectively reducing the financial burden on citizens for adopting new technologies and treatments. In December 2024, the Shanghai Municipal Government released the Work Plan for the Development of Medical AI in Shanghai, aiming to promote the deep integration of AI with clinical medicine, foster the research and application of technologies such as laparoscopic surgical robots, and enhance the intelligence level of medical devices.

The Da Vinci surgical robot is currently the most mature and widely used laparoscopic surgical robotic system globally. Throughout its development, the system has achieved several technological breakthroughs, including high-resolution 3D imaging, multi-jointed robotic arms, precise control algorithms, and advanced remote operation capabilities. As the industrialization of domestically produced surgical robots continues to accelerate, Chinese companies are increasingly winning bids and expanding their market share. The domestic laparoscopic surgical robot industry is experiencing strong momentum, with local enterprises entering a crucial development window. Inspired by the Da Vinci system as a benchmark, Chinese surgical robot manufacturers are striving to catch up, with promising prospects both in domestic and international markets.

2. Research Significance

Through investigating public willingness to accept the Da Vinci surgical robot, it is possible to gain deeper insights into its level of acceptance and potential demand in the healthcare market. Such understanding can facilitate the wider adoption of this technology across medical institutions,

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particularly in grassroots and remote areas, thereby contributing to the overall improvement of healthcare service quality. Moreover, the data collected can support more rational allocation of medical resources. By precisely aligning public needs with available healthcare services, communication costs can be reduced, and the efficiency of resource utilization can be enhanced.

In addition, survey-based research can provide valuable insights into public perceptions and expectations regarding new medical technologies. This enables the development of targeted science communication and public education initiatives aimed at dispelling misconceptions and increasing trust in modern medical technologies. Enhancing public health awareness and creating a supportive social environment are essential steps toward the successful promotion and implementation of innovative healthcare solutions.

3. Literature Review

The emergence of the Da Vinci system marked a significant milestone in the development of surgical robotics, signifying the transition from experimental research to clinical application. Since the early 21st century, with the successful deployment of the Da Vinci Surgical System, an increasing number of medical institutions have begun to adopt robotic-assisted surgery[1].

In recent years, international scholars have continued to explore the application of the Da Vinci system—especially its updated versions—in more complex and advanced surgical procedures. Olson, B. et al. (2023) investigated the use of Da Vinci robots as a substitute for transoral robotic systems and found that the outcomes were comparable. They concluded that the Da Vinci system is a feasible alternative for such procedures under certain conditions[2]. Covas Moschovas, M. et al. (2024) compared the performance of the new Da Vinci Surgical Robot 5 with earlier models in assisting radical prostatectomy and reported optimal surgical outcomes for both, while noting the need for further clinical research[3]. Christopher Seifen et al. (2025) documented the first case in Germany of robot-assisted bilateral benign tonsillectomy using the Da Vinci SP system, demonstrating the technical feasibility of this procedure[4].

Compared with international advancements, there remains considerable room for technological development in China. Importantly, public willingness to accept new technologies will play a critical role in determining the pace of their market adoption and clinical implementation.

4. Conduct of Investigations

The questionnaire survey served as the primary method for this study and constituted a key source of data for the quantitative analysis of the overall population. The questionnaire items were developed based on the core constructs of the Health Belief Model (HBM) and the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2)[5]. Data were collected through a combination of online distribution and offline field visits using printed questionnaires.

To ensure the validity and analytical value of the questionnaire, a pilot study was conducted prior to the formal distribution. A total of 210 questionnaires were distributed during the pilot phase, and the feedback was used to revise and refine the final version. Subsequently, 1,300 questionnaires were formally distributed, and 1,214 valid responses were collected, yielding a high effective response rate of 93.38%.

To ensure the reliability, consistency, and structural soundness of the instrument, the final questionnaire underwent a series of tests, including reliability analysis, confirmatory factor analysis (CFA), and runs tests. Only after confirming its robustness was the questionnaire data used for further statistical analysis.

5. Analysis of Factors Influencing the Willingness to Accept the Da Vinci Surgical Robot Based on Binary Logistic Regression

Considering that the dependent variable—willingness to accept the Da Vinci surgical robot—is categorical with only two response options ("yes" or "no"), binary logistic regression was employed for the analysis.

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5.1. Variable Definition and Model Specification

5.1.1. Notation of the Dependent and Independent Variables

	Code	Variable Name
Control Variables	C_1	Gender
	C_2	Occupation
	C_3	Monthly Income
	C_4	Education Level
Independent Variables	X_1	Performance Expectancy
	X_2	Privacy Risk
	X_3	Price Value
	X_4	FacilitatingConditions
	X_5	Policy Support
	X_6	Trust Tendency
	X_7	Social Influence
Dependent Variable	Y	Willingness to Accept

5.1.2. Model Specification

Assuming that the factors influencing residents' willingness to accept the Da Vinci surgical robot follow a logistic distribution, and based on seven key independent variables, a binary logistic regression model is constructed as follows:

$$Y = ln(\frac{P}{1-P})$$

$$\ln(\frac{P}{1-P}) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_m X_n$$

Y is the dependent variable, which follows a binary logistic distribution and represents the probability of the event occurring, while 1 − P represents the probability of the event not occurring. X denotes the set of independent variables. In this study, the values of Y are binary, taking only 0 or 1, so the goal of the model is to ensure that, when the actual value is 1, the predicted value is as close to 1 as possible. The terms X_1, X_2, ..., X_7 on the right-hand side of the equation represent the independent variables (i.e., the influencing factors). The corresponding coefficients β_1, β_2, ..., β_7 are the estimated parameters, commonly referred to as regression coefficients in statistical analysis.

The analysis adopts a backward stepwise regression technique for variable selection, using a significance level of P = 0.05 as the inclusion criterion for the final model.

5.2. Model Evaluation

5.2.1. Omnibus Test Results

Table 1. Omnibus Test Results of Model Coefficients in the Binary Logistic Regression

		Chi-square (χ^2)	Degrees of Freedom (df)	Significance (p)
Step 1	Model	485.329	11	0.000
Step 2a	Model	485.324	10	0.000
Step 3a	Model	484.421	9	0.000
Step 4a	Model	482.692	8	0.000

According to Table 1,In the two processes of stepwise regression, if the significance (P-value) is less than 0.05, it indicates that at least one variable included in the fitted model has a statistically significant OR value, indicating that the overall model is meaningful.

5.2.2. Hosmer–Lemeshow Test

As shown in the Table 2, the p-value in the Hosmer–Lemeshow goodness-of-fit test is 1.000, which is greater than the threshold of 0.05. Therefore, the null hypothesis is accepted, indicating that the model demonstrates a good fit to the data.

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Table 2. Hosmer–Lemeshow Test Results

Step	Chi-square (χ^2)	Degrees of Freedom (df)	Significance (p)
1	0.367	8	1.000
2	0.368	8	1.000
3	0.327	8	1.000
4	0.503	8	1.000

5.3. Regression Results and Interpretation

Table 3. Final Regression Results of the Binary Logistic Model

Variable	Coefficient (B)	Std. Error (S.E.)	Wald	df	Significance (p)	Exp(B) (Odds Ratio)
Performance Expectancy	1.469	0.735	3.990	1	0.046	4.345
Privacy Risk	-1.833	0.882	4.319	1	0.038	0.160
Facilitating Conditions	2.928	1.222	5.737	1	0.017	18.687
Policy Support	1.841	0.823	4.998	1	0.025	6.301
Trust Tendency	1.115	0.469	5.657	1	0.017	3.050
Dependent Variable: Residents' Willingness to Accept the Da Vinci Surgical Robot						

According to the Table 3 ,the results indicate that during the backward stepwise binary logistic regression process, after controlling for demographic variables such as gender, occupation, monthly income, and education level, two variables—price value and social influence—were excluded from the model. The remaining variables—performance expectancy, privacy risk, facilitating conditions, policy support, and trust tendency—all have p-values less than 0.05, indicating a statistically significant influence on residents' willingness to accept the Da Vinci surgical robot.

These results suggest the following interpretations:

1) Performance Expectancy

Performance expectancy has a significant positive effect on acceptance. Compared to respondents with lower levels of performance expectancy, the odds ratio (OR) is 4.345 (>1), indicating that for every one-unit increase in performance expectancy, the willingness to accept robotic-assisted surgery increases by a factor of 4.345.

2) Privacy Risk

Privacy risk has a significant negative effect on acceptance. Using respondents with lower levels of perceived privacy risk as the reference group, the OR is 0.160 (<1), meaning that for every unit increase in privacy risk, the willingness to accept robotic-assisted surgery decreases by a factor of 0.160.

3) Facilitating Conditions

Facilitating conditions exert a strong positive influence on acceptance. Respondents with better facilitating conditions are significantly more likely to accept the technology, with an OR of 18.687, implying that a one-unit increase in facilitating conditions increases acceptance likelihood by approximately 18.7 times.

4) Policy Support

Policy support also shows a positive impact on acceptance. With an OR of 6.301, it suggests that a one-unit increase in perceived policy support increases the likelihood of acceptance by a factor of 6.301.

5) Trust Tendency

Trust tendency is positively associated with willingness to accept. Compared to those with lower levels of trust, respondents with higher trust tendencies are 3.050 times more likely to accept robotic-assisted surgery (OR = 3.050).

Further Considerations:

1) Exclusion of Price Value

The variable price value was excluded during model refinement. The data revealed little variation in

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residents' perceptions of cost, suggesting a lack of discriminative power. The research team hypothesizes that for Shanghai residents, particularly in the context of health and life safety, price is not a primary concern. If the Da Vinci surgical robot can improve surgical accuracy, reduce trauma, and shorten recovery time, many individuals may be willing to pay a premium for greater safety and efficacy.

2) Exclusion of Social Influence

The variable social influence was also excluded. The team speculates that medical decision-making typically involves a high level of perceived risk and professional judgment. In such contexts, individuals may rely more heavily on medical professionals' advice and government policies rather than peer or social opinions.

6. Recommended Measures

6.1. For Manufacturers

Manufacturing enterprises should collaborate with major hospitals to organize VR-based surgical simulation experiences. Through immersive demonstrations, the public can gain a direct and intuitive understanding of the operation process and technical advantages of the Da Vinci surgical robot, thereby alleviating mistrust or skepticism among certain population segments.

6.2. For Hospitals

Hospitals should regularly hold expert lectures to introduce the technical strengths, clinical outcomes, and patient benefits associated with the Da Vinci surgical robot. Additionally, hospitals should actively engage with mainstream media to report on the latest developments and successful clinical cases. Clinical data and long-term follow-up results should be published regularly on official hospital websites.

Hospitals should also establish comprehensive and detailed privacy protection policies, clearly defining the scope of patient privacy and setting clear behavioral standards for medical staff and other personnel regarding the collection, use, storage, and disclosure of patient information. Regular training on privacy protection should be provided to all relevant staff. Moreover, hospitals should adopt advanced information technologies to strengthen the security of patient data.

6.3. For the Government

The government should implement a series of policies focused on medical quality and safety to regulate the market entry of Da Vinci surgical robots, ensuring that all devices meet high standards of quality and safety before being approved for use.

Considering that most Da Vinci surgical robots are imported and relatively expensive, many hospitals currently lack the financial capacity to purchase or lease sufficient quantities. The government should coordinate with financial institutions to offer low-interest or subsidized loans specifically for the acquisition of Da Vinci surgical robots. This would help alleviate the financial burden on hospitals and enable broader deployment of the technology, ensuring wider access for residents and maximizing the public benefit of intelligent surgical systems.

7. Conclusion

Taking the Da Vinci surgical robot as a focal point, this study investigates Shanghai residents' willingness to accept AI-assisted healthcare across seven dimensions: performance expectancy, privacy risk, price value, facilitating conditions, policy support, trust tendency, and social influence. The findings reveal that, except for privacy risk (which has a negative effect) and price value and social influence (which are statistically insignificant), all other factors exert a positive influence on acceptance.

Based on these findings, this paper proposes targeted recommendations for manufacturers, hospitals, and government agencies with the aim of enhancing public acceptance of intelligent surgical technologies.

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