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Correlational and Configurational Analysis of Factors Influencing Potential Patients' Attitudes toward Surgical Robots: A Study in the Jordan University Community

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Abstract: The literature on surgical robots (SRs) usually adopts the perspective of healthcare workers. However, research on potential patients' perceptions and the publics' points of view on SRs is scarce. This fact motivates our study, which assesses the factors inducing the SRs acceptance in the opinion of potential patients. We consider three variables, based on the unified theory of acceptance and the use of technology (UTAUT): the performance expectancy (PE), the effort expectancy (EE), and the social influence (SI); pleasure (PL), arousal (AR), and the perceived risk (PR). To deal with empirical data, we used the ordered logistic regression (OLR) and the fuzzy set comparative qualitative analysis (fsQCA). The OLR allowed us to check for a significant positive average influence of the UTAUT variables and PL, on the intention to undergo robotic surgery. However, the PR had a significant negative impact, and AR was not found to be significant. The FsQCA allowed the identification of the potential patient profiles, linked to acceptance of and resistance to SRs and confirmed that they are not symmetrical. The proposed input variables are presented as core conditions in at least one prime implicate robotic-assisted surgery acceptance. The exception to this statement is the PR, which is affirmed in some recipes and absent in others. The recipes explaining the resistance to SRs were obtained by combining the absence of PE, EE, SI, and PL (i.e., these variables have a negative impact on rejection) and the presence of the PR (i.e., the perceived risk has a positive impact on a resistance attitude toward SRs). Similarly, arousal played a secondary role in explaining the rejection.

Keywords: robot services; surgical robots; robot acceptance; unified theory of acceptance and use of technology (UTAUT); smart technologies; regression methods; fuzzy set qualitative comparative analysis (fsQCA)

MSC: 62J05; 94D05; 62P25; 91F99

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1. Introduction

1.1. Initial Considerations

The use of surgical robots (SRs) has grown exponentially since the second decade of the 21st century and is now a standard alternative to traditional ordinary surgery (OS) and minimally invasive surgery (MIS) techniques [1]. There is a wide literature displaying health professionals' points of view about the advantages and drawbacks of SRs, with respect to those of OS and MIS [2–5]. However, the successful implantation of SRs does not depend only on health workers' perceptions, but is also linked to public opinion about SRs and to potential and actual patients' willingness to undergo robotic-assisted surgery. So, Boys et al. [4] report from a survey carried out in the USA, about an average positive perception of SRs, by a sample of potential patients. In their sample, most answers indicated that robotic surgery was perceived as safer, faster, less painful, and offered better results than OS or MIS. Jank et al. [6] also reported a positive perception of SRs in a set of patients with a cochlear implantation. However, [7,8] found in their samples a preference of MIS over robotic techniques. Our paper, as [4,7], is focused on the perceptions of potential patients' or the publics' points of view, rather than of actual patients.

The unified theory of acceptance and use of technology (UTAUT) by Venkatesh et al. [9] is a useful instrument to model the attitudes toward the use of SRs, from both professionals' and patients' (actual and potential) perspectives. From the perspective of a surgeon, a UTAUT input factor, such as the easiness expectation, may be focused on his/her perceived job performance (for example, the absence of haptic feedback could be a barrier to SRs). Krishnan et al. [10] and BenMessaoud et al. [11] used this theoretical framework to systematize the advantages and drawbacks of SRs, and assessed their attitudes from the perspective of health workers. UTAUT factors have also been found to be relevant in explaining actual and potential patient attitudes toward robotic surgery [6,8,12]. For example, an issue that may impact the patient performance expectancy, is that robotic surgery usually allows a faster recovery than OS and MIS. Likewise, not only UTAUT factors are significant in explaining the acceptance of robotic-assisted surgery, but also emotional factors [8,12] and cognitive factors, such as the perceived risks [7,12].

The above questions motivated this study to examine how three UTAUT factors (performance expectancy, easiness expectation, and social influence), two affective variables, and the perceived risk influence, combine to influence the intention to undergo surgery that, if needed, will be carried out by a robot. This study used a survey conducted in Jordan's university community. Specifically, we attempted to answer two questions.

RQ1: *What are the average influence and statistical significance of the explanatory variables of intention to undergo, if needed, intervention by a SR?*

RQ2: *How do input variables combine to produce acceptance and induce SR rejection to potential patients?*

To answer RQ1, as in [8,12], we use the ordered logistic regression (OLR). With regard to RQ2, a suitable analytical method to deal with the combinatory effects of factors and their asymmetric influence in inducing and non-inducing a given output is the fuzzy set qualitative comparative analysis (fsQCA) [13,14]. This analytical framework has been applied in several market and business analyses. Thus, whereas [15–18] use fsQCA to evaluate the factors that induce acceptance of new technologies, [19] identified several paths that lead to companies adopting environmental practices in firms. Likewise, fsQCA has been applied to assess risk factors in audit processes [20] and explore the entrepreneurial intention of university students [21]. Moreover, although fsQCA has been used in health research [22–24], all reviewed empirical literature on robot acceptance performs quantitative analyses using correlational methods, such as a regression analysis.

Thus, the novelty of this study can be summarized in two ways. This work contributes to the scarce literature on patients' (actual or potential) attitudes toward robotic surgery. Moreover, to the best of our knowledge, the use of fsQCA as an analytical tool in this context is novel. We show that fsQCA and OLR are complementary analytical tools, because they allow for the analysis of data from two non-excluding focuses. OLR is a variable-oriented technique that allows the measurement of the net incidence of each input variable on the attitude toward SRs. In contrast, fsQCA is case-oriented. Thus, fsQCA will allow us to identify patterns of potential users that are consistently associated with a favorable perception of robotic-assisted surgery, but also profiles that are strongly linked to negative perceptions of SRs.

1.2. Theoretical Background

The technology acceptance model (TAM) [25] and UTAUT [10,26] have been used extensively to evaluate the acceptance of new technologies in healthcare settings from a professional perspective [27–30] and from the users' points of view [31–34]. In the more concrete field of SRs, it has been applied to explain the intention to use SRs by doctors and nurses [10,11] and to evaluate the potential and actual patients' attitudes toward SRs [6,8,12]. To explain attitudes toward SRs by potential patients, we use three constructs of the UTAUT model: performance expectancy, easiness expectation, and social influence.

Performance expectancy (PE) is the degree of usefulness perceived by the user of a new technology [25]. Surgical robots provide many advantages, such as a reduced hospital stay, decreased postoperative pain, and a lower incidence of wound infections [2–5,11]. Moreover, SRs are well suited for telesurgery. In this regard, Boys et al. [4] stated that many people prefer telesurgery by a prestigious surgeon to conventional surgery by a less experienced doctor. The positive impact of actual and potential SRs on performance expectancy has been confirmed in several studies [6,8,12]

Effort expectancy (EE) is the perceived simplicity and comfort of using a new technology [25]. Users are more likely to develop a positive attitude toward a new technology if they perceive it to be comfortable, easy to use, and accessible. The relevance of this construct to users' attitudes toward robots was observed in [35–37]. Despite SRs reducing the effective time of surgical intervention, the entire embedded process may be longer [11]. Another factor that may reduce the ease of using SRs is that not all hospitals are equipped with this technology, and this kind of surgery can become less accessible [38]. Likewise, the information provided in an informed consent document is more difficult to understand than that of other surgery types [2]. Several authors have found that EE has a significant positive influence on the perception of SRs [6,11].

Social influence (SI) is the degree to which a person perceives that others believe that they should use a new technology [9]. The opinions of the family and physicians are often relevant when choosing a surgeon and SRs [6,8,12]. Likewise, it must be noted that not all professionals support the use of SRs over conventional techniques [5,11]. However, the presence of SRs is perceived in public opinion as a sign of prestige [5].

While evaluating user attitudes toward robots, several authors have emphasized the importance of cognitive and emotional factors [39–41]. The acceptance of SRs depends not only on rational decision-making, but also on emotions and wishes [6,8,12,42]. We have taken into account these reports in such a way that to explain robotic-assisted surgery, we combine the three UTAUT factors exposed above with a cognitive variable, a perceived risk, and two affective variables, pleasure and arousal.

Perceived risk (PR) has been used to study the acceptance of wearable technologies for healthcare applications [43], attitudes toward cyborg implants [44], and the perception of SRs [7,8,12]. SRs affect surgical risks in several ways. The first is related to the capability of SRs to reduce human risks, such as hand tremors and surgeon imprecision. The second perspective concerns the patient's perception of risk, which is linked to the fact that a SR is a disruptive device and innovation that often induces fear [7]. Notice that any failure of the robot during surgery could expose the patient to serious risk. Furthermore, this variable is connected to trust, since the increase in risk perception could be a result of trust absence [45–48].

Pleasure (PL) expressed during the interaction with robots can significantly impact acceptance, either positively or negatively, as well as a person's emotional state [49,50]. As far as we are concerned, this construct can also be assimilated into less anxiety and post-operative pain, a more pleasant intervention recovery, and better aesthetic results [42].

Arousal (AR) refers to a state of feeling stimulated or active in a certain situation [51]. Its impact on the acceptance of cyborgs is shown by [52]. Furthermore, feelings of arousal promote behavioral engagement, as can be seen in the use of social robots in autism therapy [53].

1.3. Research Questions and Hypotheses

As mentioned in Section 1.1. This study aimed to answer two research questions. While the first question, RQ1, inquires about the statistical significance of the assessed input factors to explain the acceptance of SRs, the second query, RQ2, asks about how explanatory variables combine to induce the acceptance and non-acceptance of robotic surgery. Notice that, whereas RQ1 is common in the literature on robots and surgical robot acceptance, RQ2, which asks about how factors combine to produce a willingness and rejection toward robotic-assisted surgery, has still not been addressed. This affirmation can be extended to the literature on the user's attitude toward robots of any kind.

To answer the first question, we evaluated the direction of the relationship between acceptance (ACCEPT) and PE, EE, SI, PR, AR, and PL., accordingly, with the exposition in Section 1.2. Thus, we propose the following hypotheses:

Hypothesis 1.1 (H1.1). *Performance Expectancy is linked positively with SRs' acceptance.*

Hypothesis 1.2 (H1.2). *Effort Expectancy is linked positively with SRs' acceptance.*

Hypothesis 1.3 (H1.3). *Social Influence is linked positively with SRs' acceptance.*

Hypothesis 1.4 (H1.4). *Perceived Risk is linked negatively with SRs' acceptance.*

Hypothesis 1.5 (H1.5). *Arousal is linked positively with SRs' acceptance.*

Hypothesis 1.6 (H1.6). *Pleasure is linked positively with SRs' acceptance.*

To answer the second question, which assesses the combinatorial effects of input variables on SRs' acceptance and rejection, we propose testing the following hypotheses:

Hypothesis 2.1 (H2.1). *The combination of the high evaluations (presence) in PE, EE, SI, AR, and PL items, and low evaluations (absence) in PR, produces SRs' acceptance.*

Hypothesis 2.2 (H2.2). *The combination of the low evaluations (absence) in PE, EE, SI, AR, and PL items, and high evaluations (presence) in PR, produces SRs' rejection*

Hypothesis 2.3 (H2.3). *The combination of the evaluations of PE, EE, SI, PR, AR, and PL to explain the acceptance and rejection is not symmetrical.*

2. Material and Methods

2.1. Survey Description

The target population of the study was the Jordanian university community, including embedded students, professors, and other workers. The answers were provided using Google Forms, and the hyperlink was provided individually to 1000 individuals. With this selection we tried to attain sex parity, a representation of all collectives of the university community, and reaching quotas by branches of Science. One of the authors of the paper was available to all respondents to answer any question about the research and questionnaire. For example, if the respondent inquires about the content of an informed consent document, an example of that was provided (see https://www.medpro.com/roboticsurgery-informedconsent that could be accessed on 4 November 2022). This also applied, of course, to clarify the nuances in similar questions or giving, if demanded, a more detailed information about robotic surgery by providing studies [2,4]. The survey was conducted in the second half of 2019, using social networks. The final number of responses used in this study was 379, with a success rate of 37.9%. The 62.1% of failed surveys embed those that were not answered and those that did not respond to at least one question. The responses were anonymous. A total of 47% of the respondents were women and 53% were men. Respondents' ages were distributed as follows: between 18 and 24 years (51%), between 25 and 34 years (24%), between 35 and 44 years (13%), and above 44 years (12%). The responses from the public universities and private universities were 64.3% and 35.7%, respectively. Likewise, 26% of individuals were linked to computer and engineering studies, 43% to social sciences, 13% to health sciences, and the rest to arts and humanities studies. Therefore, similar to [4,7,12], the responses used in this study did not come from actual patients but from potential users.

Notice that the use of university community members to develop an assessment of robot acceptance in a non-educational setting has been carried out in several papers [54–56]. We believe that considering Jordan's university community to develop our study, can allow us to obtain relevant results for several reasons. First, the answers must be provided using electronic methods. Practically, all members of the university community are familiar with these procedures and have an easily available electronic device to complain about the survey. Therefore, the success rate may be greater than that of the other collectives.

Taking the university environment as a reference, ensures that the surveyed persons have a cultural status high enough to understand the information in the questionnaire. Surely most of the respondents were aware beforehand about the existence of surgical robots, had an idea about the procedures linked with health services, such as "informed consent", and the complexity that may present an informed consent in a surgery setting.

In any university environment, there is a great diversity of perspectives, regarding technological advances. Members of the community are devoted to health sciences, engineering, basic sciences, humanities, etc. It is expected that their point of view, despite being diverse, has a solid foundation that, of course, could be biased toward technological arguments and philosophical opinions. Moreover, in a university community, it is not difficult to achieve parity between men and women.

We are interested in the opinions of potential patients. Of course, any person could need surgery at any moment, so he/she is a subject of study. However, we also feel that more reliable answers come from persons who, if they needed a surgical intervention, have the possibility to choose between more than one alternative. That freedom embeds choosing hospital and surgeon/surgery techniques, but also has available enough monetary resources to expend in that medical service. Usually, members of the university community belong to families of upper middle and high social classes and/or have/aspire to qualified jobs with considerable wages.

Therefore, we feel that our sample could provide interesting results about SRs acceptance, linked to members of social classes with high cultural status from Jordan, but also from other Middle Eastern countries with similar cultural strata, such as Turkey and Lebanon.

We introduced the survey as follows: *According to recent news published in Newsweek magazine, the smart tissue autonomous robot (STAR), a robot used to perform surgery, has been proven to be more precise than expert human surgeons in performing the same task in laparoscopic surgery. Consider that the robot can perform the required surgery. Indicate the extent to which you agree or disagree with the following statements on a scale of 0 (strongly disagree) to 10 (strongly agree), 5 being neither 'agree nor disagree; "I will accept to use services offered by a robot (if I need a surgery)"*. To give enough but not overwhelming information to respondents, the link to the news article was provided in the survey (https://www.newsweek.com/2016/05/20/robot-soft-tissue-surgery-pig-bowels-455765.html, accessed on 2 June 2016). Likewise, if the surveyed person was interested in having more in-depth information on SRs, the references [2,3] were provided. Notice that the success rate was below 40%, i.e., 60% did not complete the survey, surely because they did not feel informed enough, as well as because they had no motivation to gather more information on the issue. Moreover, we suppose that the responses, which come from people with a high cultural status, were given honestly, due to the respondents who felt they were aware enough to give an opinion about the issue, as a potential patient or "public". All items in the questionnaire were rated on a Likert 11-point scale (0–10). Table 1 shows these items and the descriptive statistics of the responses. The measurement scales for PE, EE, and SI were adapted from previous studies on healthcare technology acceptance [34,47]. The measurement scale of the PR was based on that in [57]. Whereas in the question linked to "being risky" it is evaluated if SRs present a risk, i.e., may cause harm; the question linked with "uncertainty about the performance" embeds more aspects: uncertainty about the time needed to recover from the intervention, number of days in the hospital, duration of the surgery, etc. To model the emotional dimensions of arousal and pleasure, we have used the scale in [58]. Table 1 presents the questions and descriptive statistics of the survey.

Table 1. Items in the survey and descriptive statistics.

Item	Average	Median	Q1	Q3	Std. dev.	IV
Output item: Behavioral intention						
ACCEPT = If needed, I will accept being assisted by a surgical robot (SR).	4.66	5	1	8	3.48	7
Input construct: Performance expectancy						
PE1 = I find SRs useful.	4.11	4	1	6.5	3.27	5.5
PE2 = SRs allow a better recovery from interventions.	3.97	4	1	6	3.23	5
PE3 = SRs help to achieve a faster recovery from interventions.	3.92	4	1	6	3.22	5
PE4 = SRs allow a more efficient intervention	4.16	4	1	6	3.21	5
Input construct: Effort expectancy						
EE1 = The information in the consent document will be easy for me.	4.97	5	2	7	3.26	5
EE2 = The intervention by a SR is more comfortable than other types of surgery.	4.82	5	2	7	3.23	5
EE3 = It will be easy to access hospitals equipped by SRs.	5.39	6	3	8	3.35	5
EE4 = It will be easy to achieve a good interaction with medical services that provide SRs.	5.47	5	3	8	3.19	5
Input construct: Social influence						
SI1 = People who influence me think that I should use the services offered by SRs.	4.61	5	2	7	3.11	5
SI2 = People who are important to me think that I should use SRs.	4.60	5	2	7	3.11	5
SI3 = People whose opinions I value, prefer that I use the services offered by SRs.	4.66	5	2	7	3.12	5
Input construct: Perceived risk						
PR1 = The services offered by SRs are risky.	5.74	5	3	9	3.16	6
PR2 = There is too much uncertainty in the performance of SRs.	6.18	6	4	9	3.05	5
PR3 = Compared with other surgeries, the services offered by SRs is riskier.	5.84	6	4	8	3.12	4
Input construct: Pleasure						
PL1 = When I think of the service being provided by a SR, I feel: Unhappy—Happy	4.89	5	2	8	3.38	6
PL2 = When I think of the service being provided by a SR, I feel: Annoyed—Pleased	4.78	5	2	7	3.17	5
Input construct: Arousal						
AR1 = When I think of the service being provided by a SR, I feel: Relaxed—Stimulated	4.76	5	2	7	3.06	5
AR2 = When I think of the service being provided by a SR, I feel: Calm—Excited	4.93	5	2	8	3.17	6

Note: Q1 and Q3 represent the 1st and 3rd quartile. Std. dev is the standard deviation and IV = Q3–Q1.

2.2. Quantitative Analysis

To evaluate the research questions, we used an ordered logistic regression (RQ1) and fsQCA (RQ2). We then proceed sequentially as follows:

Step 1. We checked the reliability of the measurement scale using Cronbach's alpha, the convergent reliability, and the average variance extracted. We also performed the exploratory factor analysis.

Step 2. To answer RQ1, we fitted an ordered logistic regression (OLR) to ACCEPT [8,12] in a similar setting. For the value of the input variables, we took their standardized loadings, obtained in Step 1. The sign of the coefficients and their statistical significance will lead us to assess hypothesis H1.1–H1.6, and so, provide an answer to RQ1.

Step 3. The first step in performing the fsQCA and evaluating RQ2, is to build the membership function of the response variable. It was evaluated on an 11-point Likert scale; therefore, we considered the thresholds for absolute non-membership, indeterminacy, and full membership; the values were 2, 5, and 8, respectively [13]. Therefore, for the jth observation of the output variable ACCEPT, ACC_j, the membership value is defined in [59] as

$$m_{ACC_j} = \begin{cases} 0 & ACC_j \leq 0.2 \\ \frac{ACC_j - 0.2}{0.6} & 0.2 < ACC_j \leq 0.5 \\ 0.5 + \frac{ACC_j - 0.5}{0.6} & 0.5 < ACC_j \leq 0.8 \\ 1 & ACC_j > 0.8 \end{cases} \quad (1)$$

Step 4. Given that the explanatory variables embed several items, we transformed the factor loadings obtained in Step 1, after performing the exploratory factor analysis into the membership scores using the 5, 50 and 95% percentiles as thresholds [15]. For the ith variable X_i, the value of the jth observation $x_{i,j}$ is transformed into a membership value $m_{x_{i,j}}$, as follows [59]:

$$m_{x_{i,j}} = \begin{cases} 0 & x_{i,j} \leq X_i^{5th} \\ \frac{x_{i,j} - X_i^{5th}}{2\left(X_i^{50th} - X_i^{5th}\right)} & X_i^{5th} < x_{i,j} \leq X_i^{50th} \\ 0.5 + \frac{x_{i,j} - X_i^{50th}}{2\left(X_i^{95th} - X_i^{50th}\right)} & X_i^{50th} < x_{i,j} \leq X_i^{95th} \\ 1 & x_{i,j} \leq X_i^{95th} \end{cases} \quad (2)$$

where X_i^{kth} stands for the kth percentile of X_i.

Step 5. Run the necessity analysis of the input factors for the acceptance and nonacceptance [14]. The presence or absence of a given input factor is considered as a "necessary condition" to generate the presence or absence of the output variable, if the consistency (cons) > 0.9. Otherwise, the factor must be combined with other factors to obtain a sufficient condition. At this step, we define the consistency that a variable W_i produces the response Y, whose jth observation is y_j as

$$Cons_{W_i \to Y} = \frac{\sum_j min\left\{m_{Y_j}; m_{w_{i,j}}\right\}}{\sum_j m_{Y_j}} \quad (3)$$

where W_i may symbolize X_i or its negation ~X_i, and consequently, $w_{i,j}$ is its jth observation. Similarly, Y could be ACCEPT or its negation (~ACCEPT). It should be noted that the membership degree in the negated variable ~X_i, of the jth observation is $m_{\sim x_{ij}} = 1 - m_{x_{ij}}$. Therefore, for ~ACCEPT, we state $m_{\sim ACC_j} = 1 - m_{ACC_j}$.

Step 6. Find the logical implicates that fit the output results by running the Boolean minimization algorithm in [60] on the truth table. If we symbolize the negation of a variable as "~", we adjust independently the Boolean functions:

ACCEPT = f (PE, EE, SI, PR, PL, AR) (4)

~ACCEPT = f (PE, EE, SI, PR, PL, AR) (5)

Thus, (1) explains the acceptance of robots and (2) explains the rejection. It implicates that it come directly from the algorithm [60] to conform to the so-called qualitative comparative analysis complex solution (CS).

Step 7. CS is usually difficult to interpret because it is built with no more assumptions than data. A simplified solution, known as a parsimonious solution (PS), is fitted with [33] and any remainder over a non-observed configuration of variables to make the solution as easy as possible [14].

Step 8. To continue the minimization process, it must be supposed for the non-observed configurations that an input variable contributes to the output exclusively when it is present, absent, or in both cases, by using well-founded hypotheses. This step allowed us to obtain an intermediate solution (IS) [14]. In our study, we use the hypotheses tested to answer RQ1, which are displayed in Section 1.3. Therefore, to implement this step, the PE, EE, SI, PL, and AR (PR) have a positive (negative) influence on ACCEPT.

For an in-depth explanation of Boolean minimization procedures in the CS, PS, and IS, see [61].

Step 9. To measure the explanatory power of a given recipe, its consistency (cons) and coverage (cov) must be determined. Let be a possible prime implicate (configuration or recipe) Z, that without a loss of generality, we build up as $Z = W_1 \bullet W_2 \bullet \ldots \bullet W_r$, where $1 \leq r \leq n$, n is the number of input variables in the configuration and "*" stands for the Boolean product. Therefore, we obtain, for the jth observation

$$m_{Z_j} = min\left\{m_{w_{1,j}}; m_{w_{2,j}}; \ldots; m_{w_{r,j}}\right\} \quad (6)$$

The consistency of recipe Z in producing output Y (ACCEPT or ~ACCEPT) is

$$Cons_{Z \to Y} = \frac{\sum_j min\left\{m_{Z_j}; m_{Y_j}\right\}}{\sum_j m_{Z_j}} \quad (7)$$

The coverage of recipe Z to produce Y is:

$$Cov_{Z \to Y} = \frac{\sum_j min\left\{m_{Z_j}; m_{Y_j}\right\}}{\sum_j m_{Y_j}} \quad (8)$$

The consistency measures the membership degree of a combination of causes (recipe) within the outcome set. This was similar to the statistical measure of significance [62]. There is a wide consensus that, to consider an essential prime implicated as a sufficient condition, cons > 0.75 (or better cons > 0.8). The coverage measures the proportion of outcomes explained by a recipe; that is, it is a measure of empirical relevance similar to R^2 [62].

Step 10. To assess the impact of the input variables and their combinations on the acceptance and rejection of robot-assisted surgery, the solutions from the fsQCA must be interpreted. There is no unified point of view regarding which solution (CS, PS, or IS) should be taken into account. CS uses only empirical data; however, the recipes in this solution are often difficult to interpret. In this regard, [13] proposed combining both the IS and PS to state the core (from the PS) and peripheral (present only in the IS) conditions.

3. Results

When validating the scales (Table 2), we observed for all the constructs, that while Cronbach's alpha and composite reliability were > 0.7, the average variance extracted was >0.5. Table 2 also shows that in all dimensions, the exploratory factor analysis extracted a significant proportion of the variance in the first factor, since the loadings were >0.7. Thus, we provide robust evidence for the internal consistency of all explanatory constructs.

Table 2. Results of the factor analysis and the scale validation measures.

	Factor Loading	**Cronbach's Alfa**	**Composite Reliability**	**Average Variance Extracted**
Performance Expectancy		0.941	0.957	0.849
PE1	0.938			
PE2	0.922			
PE3	0.934			
PE4	0.891			
Effort Expectancy		0.953	0.966	0.875
EE1	0.927			
EE2	0.933			
EE3	0.942			
EE4	0.940			
Social Influence		0.926	0.953	0.871
SI1	0.927			
SI2	0.945			
SI3	0.927			
Perceived Risk		0.873	0.922	0.798
PR1	0.895			
PR2	0.885			
PR3	0.900			
Pleasure		0.821	0.918	0.849
PL1	0.921			
PL2	0.921			
Arousal		0.875	0.941	0.889
AR1	0.943			
AR2	0.943			

Table 3 presents the results of the regression. The ORL model is significant (pseudo R^2 = 23.44%, LR statistic = 402.94, $p < 0.001$). Regarding the explanatory variables, as we expected, we adjusted a positive significant sign for the PE ($p < 0.001$), EE ($p < 0.001$), SI ($p = 0.022$), and PL ($p = 0.005$); therefore, H1.1, H1.2, H1.3, and H1.5 are accepted. For the perceived risk, we also found a negative marginal effect ($p = 0.001$); therefore, H1.4 was also accepted. However, arousal was not found to be significant ($p = 0.9268$); thus, H1.6 was rejected.

Table 3. Results of the ordered logistic regression on intention.

Variable	**Marginal Effect**	**z-Statistic**	***p*-Value**
PE	0.653	5.792	<0.001
EE	0.519	5.879	<0.001
SI	0.245	2.297	0.0216
PR	−0.243	−3.889	0.0001
PL	0.246	2.816	0.005
AR	−0.008	−0.091	0.927
pseudo-R^2	23.90%		
LR-statistic	402.94 ($p < 0.0001$)		

Table 4 presents the results of the necessity analysis. With the exception of the PR, the presence of income variables reaches a greater consistency than their negation to explain the acceptance, and the negation of these factors attains a greater consistency than their presence to explain the resistance. With regard to the PR, we observed the opposite result. Therefore, these findings are in accordance with the expected sign of the relationship between variables in H1.1-H1.6. The necessity analysis also revealed that there is no variable whose unique presence/absence is a necessary condition to produce acceptance/resistance, since always cons < 0.9. This fact reinforces the need for further configurational study [13].

Table 4. Necessity analysis of the income variables on ACCEPT and ~ACCEPT.

	ACCEPT			~ACCEPT	
Input	**Consistency**	**Coverage**		**Consistency**	**Coverage**
PE	0.78	0.81	PE	0.45	0.43
~PE	0.41	0.43	~PE	0.82	0.80
EE	0.80	0.76	EE	0.45	0.39
~EE	0.41	0.48	~EE	0.79	0.82
SI	0.78	0.76	SI	0.47	0.41
~SI	0.43	0.48	~SI	0.79	0.81
PR	0.54	0.59	PR	0.66	0.65
~PR	0.62	0.63	~PR	0.60	0.55
PL	0.73	0.75	PL	0.49	0.45
~PL	0.44	0.48	~PL	0.77	0.75
AR	0.73	0.74	AR	0.50	0.46
~AR	0.45	0.49	~AR	0.76	0.75

Tables 5 and 6 show the IS results of the fsQCA for ACCEPT and ~ACCEPT. We can check:

1. The consistency and coverage of the IS in ACCEPT and ~ACCEPT are similar and adequate since cons > 0.8 and cov > 0.7 in both cases. Thus, the configurational analysis explains the acceptance and rejection of surgical robots.
2. In the explanatory recipes of ACCEPT, the variables of the PE, EE, SI, PL, and AR were affirmed. Moreover, the PR is negated, as expected, in three recipes; however, it is present within two prime implicates. Therefore, H2.1, is accepted for all explanatory factors, except for the perceived risk. In the configurations explaining ~ACCEPT, the input constructs the PE, EE, SI, PL, and AR always appear negated and the PR affirmed. Therefore, these findings are consistent with H2.2.
3. In Table 5, we can see that the most relevant conditions to explain ACCEPT are the EE, as it is a core variable in six configurations, and the PR, given that it is a core variable in five prime implicates. However, the sign of the influence of the PR is not univocal. However, the performance expectancy seems to be the least relevant factor because its presence is a core condition in only two configurations. The variables of the SI, AR, and PL have an intermediate importance, because they are the core conditions in the three recipes.
4. Table 6 shows that the absence of the PE and the presence of the PR are the most relevant conditions to explain rejection. They come in four prime implicates as the core conditions. The absence of the EE and SI (PL) is the core condition in three (two) recipes, that is, these three variables seem to be less important in explaining a resistance toward SRs than the PE and PR. Finally, arousal is negated in the two recipes but as a peripheral condition. Thus, AR does not seem to be relevant in explaining ~ACCEPT.
5. From the comparison of the configurations in Tables 5 and 6 and our comments in the above paragraph about the most/least relevant variables inducing ACCEPT and ~ACCEPT, we can conclude that there is a clear asymmetry of the effects of the input variables to produce acceptance and to induce rejection. Therefore, H2.3 is accepted.

Table 5. fsQCA intermediate solution (IS) ACCEPT = f (PE, EE, SI, PR, PL, AR).

Recipe	1	2	3	4	5	6	7
PE	●		●	•		•	
EE	●	●		●	●	●	●
SI	●	●	●				•
PR			⊗	⊗	⊗	●	●
PL			●		•	●	●
AR		●		●	●		
cons	0.862	0.871	0.845	0.858	0.850	0.851	0.853
cov	0.656	0.607	0.457	0.457	0.429	0.488	0.479
Cons of IS	0.829						
Cov of IS	0.739						

Note: The big circle (●) indicates the presence of a condition, and circles with x (⊗) indicate its absence. Large circle is for the core conditions, small circles are for the peripheral condition and a blank space, is for the "don't care" condition.

Table 6. fsQCA intermediate solution ~ACCEPT = f (PE, EE, SI, PR, PL, AR).

Recipe	1	2	3	4	5
PE	⊗	⊗	⊗		⊗
EE			⊗	⊗	⊗
SI	⊗	⊗	⊗ (small)	⊗	
PR		●	●	●	●
PL	⊗	⊗ (small)		⊗	⊗ (small)
AR				⊗ (small)	⊗ (small)
cons	0.880	0.874	0.876	0.872	0.882
cov	0.624	0.496	0.517	0.473	0.469
Cons of IS	0.855				
Cov of IS	0.704				

Note: The big circle (●) indicates the presence of a condition, and circles with x (⊗) indicate its absence. Large circle is for the core conditions, the small circles for the peripheral condition and blank space, for the "don't care" condition.

4. Discussion

This paper shows the results of a study about the public/potential patients' perception of robotic-assisted surgery within the Jordan university community. Therefore, our study is in line [4,7,12]. that assess the public's point of view on surgical robots and also close to [54–56], that studied several issues linked to people's attitude toward robotic services in a non-educational setting, within a university context. The survey contained a link to an article in Newsweek magazine on robotic-assisted surgery and, likewise, the target population had a high cultural status. Therefore it is expected that many respondents were aware of the existence of SRs and had some elementary information on the topic. Likewise, one of the authors of the article gave informational assistance to respondents. For example, if it were demanded, in-depth information about SRs [2,3] were provided. It is expected that if any person did not feel that they were aware enough to give an opinion as "public", and also had no motivation to obtain information about it, simply did not answer the survey. In this regard, the response rate of our sample was 40%.

The explanation capability of the ordered logistic regression (OLR) was high, since McFaddens' $R^2 > 20\%$, which in a logistic regression setting could be considered excellent [63]. The results of the OLR showed a significant positive relationship between the performance expectancy (PE), easiness expectation (EE), social influence (SI), and pleasure (PL) with the acceptance of robotic-assisted surgery, if needed (ACCEPT). Similarly, the perceived risk (PR) displays a negative and significant relationship with ACCEPT. However, the results did not show a significant effect on arousal (AR). The values of the coefficients suggest that the PE and EE have the greatest impact on ACCEPT, while the SI, PR, and PL display a similar importance. Therefore, hypotheses H1.1-H1.5 are accepted but H1.6 is rejected.

The fsQCA models fitted for ACCEPT and ~ACCEPT presented satisfactory adjustment measures (cons > 0.8 and cov > 0.7). Even though in all recipes, the sign of the input variables to explain the resistance to SRs is as we expected, this does not follow when fitting ACCEPT. As we expected, the PE, EE, SI, PL and AR are present in the prime implicates, but the PR is present in some recipes and negated in others. These findings lead us to reject H2.1, and accept H2.2. The EE and PR (PE) were the least relevant variables to explain ACCEPT. When fitting ~ACCEPT, the PR and PE (AR) appear to be the most (least) decisive explanatory factors. This suggests that the impact of the input variables on ACCEPT and ~ACCEPT are not mirror opposites, and thus hypothesis H2.3 is not rejected. This is in accordance with the fact that the explanation of the acceptance and resistance of any disruptive technology is not symmetrical [64].

Whereas the results of the OLR quantified the average impact of every variable on the intention to undergo surgical intervention, by means of its marginal effect, the fsQCA displayed how these factors interact to produce acceptance and non-acceptance. Both instruments provided complementary information. Thus, the marginal effects fitted with the OLR indicated that the variables with the greatest impact attitude toward SRs were the PE and EE. The use of the fsQCA allowed us to observe that both variables impacted with the expected sign in both acceptance and resistance to SRs. However, to induce acceptance, the EE, which participated in six of the seven recipes, had a greater influence than the PE, which only participated in two configurations as a core condition. Moreover, when explaining resistance, we found that the absence of the perceived performance was more relevant than the absence of the easiness expectation. While the PE participates as a core condition negated in four out of five recipes, the EE does so in three prime implicates.

The marginal effects fitted for the SI, PR, and PL indicate that the average impact of these variables on acceptance is similar. Moreover, the use of the fsQCA allows us to discover how the impact of social influence and pleasure on attitude and resistance differs from that of the perceived risk. The SI and PL are present (absent) in all primer implicates, in which these constructs are conditions that explain acceptance (rejection). Therefore, the SI and PL have approximately symmetrical effects on the willingness and resistance. With regard to the perceived risk, we can observe that it is negated in three configurations and present in two prime implicates explaining ACCEPT; that is, the net effect of the PR on the favorable attitude toward SRs could be null. Moreover, the PR was present in four of the five configurations, explaining the resistance. Therefore, the negative marginal effect of the impact of the PR on attitudes toward SRs is strictly due to the strong influence of the perceived risk on rejecting robotic surgery. Therefore, the influence of the PR on ACCEPT and ~ACCEPT is clearly asymmetrical.

With the ORL, we have fitted a positive but not significant effect of the AR on attitude toward robotic surgery. Moreover, the use of the fsQCA has shown that the AR has some influence in the attitude toward SRs. In spite of it not being a key variable to explain ACCEPT and ~ACCEPT, its presence is a core condition in three explanatory recipes of acceptance and only a peripheral variable inducing resistance.

We confirmed that the UTAUT variables (PE, EE, and SI) have a significant positive impact on the willingness to use SRs. This finding is in accordance with an important part of the literature on the users' attitudes toward robots and wearable technologies in healthcare services [31–34], concerning social robots [28,35,46,50] and surgical robots [6,8,12]. However, it must be noted that there are several empirical analyses that did not find significant differences in the PE, EE, and/or SI to explain the attitudes in fields, such as healthcare technology acceptance [27,30] and social robots [48].

The perceived risk has a positive impact on the rejection of being operated on by an SR. This finding coincides with that of [7,8,12], who found a relevant negative relation between the PR and the behavioral intention to use SRs. This is also coincident with studies that outline a positive significant link between trust and robot acceptance [28,46,48].

Regarding emotional variables, the fsQCA shows that these factors have a significant relationship with acceptance and rejection of SRs. These results are in accordance with [42,47,48,50].

5. Conclusions

To the best of our knowledge, a combinatorial analysis of the variables that induce the acceptance of robot services (in our case, surgical interventions) has not been performed before. In this regard, this study shows that the fsQCA not only helps to understand how input variables influence acceptance and rejection of robotic-assisted surgery, but also allows the evaluation of the usual asymmetrical impact of the factors inducing acceptance and rejection of a new technology.

On the one hand, with regression, we have measured the mean effect of every variable on the intention to use, if needed, robotic-assisted surgery. On the other, the fsQCA displayed that each factor may influence acceptance and non-acceptance attitudes in different ways. So, social influence and pleasure are significant from a statistical point of view and also seem to impact symmetrically on acceptance and resistance attitudes toward SRs. Moreover, the performance expectancy and easiness expectation, that also display significant marginal effects, influence with asymmetric strength, the acceptance and non-acceptance. So, whereas the EE provides its greatest influence on ACCEPT, the strongest impact of the PE comes when this variable is absent contributing to ~ACCEPT. It must be also remarked that in both cases, the influence of the PE and EE on ACCEPT and ~ACCEPT is congruent with the positive marginal effect fitted for both constructs, since the PE and EE always need to be present to produce acceptance and negated to induce resistance.

The way how the perceived risks contribute to ACCEPT and ~ACCEPT is also different to that of the PE, EE, SI and PL. The PR has a significant negative marginal effect in the OLR and impacts asymmetrically on ACCEPT and ~ACCEPT. So, its presence is a key factor to explain the resistance and therefore, this finding is congruent with its negative marginal effect, fitted with the OLR. Moreover, the PR is not a defined sign to induce ACCEPT, since in some recipes it comes affirmed and in others, negated. Notice that the behavior is not coherent with a significant negative impact on attitudes toward SRs.

Our theoretical approach, which combines the UTAUT variables with the perceived risk and emotional variables, has been useful in explaining attitudes toward SRs. While MacFaddens' R^2 in OLR shows a good explanation capability of this correlational method; the consistency and coverage of the solutions of the fsQCA for ACCEPT and ~ACCEPT display a good adherence of the configurations to the data. Likewise, note that with the exception of one configuration of ACCEPT, which exclusively presents the three UTAUT constructs, all prime implicates explaining acceptance and resistance need to combine the UTAUT factors with the perceived risk and/or emotional variables.

Our findings have implications for the management and health policies. The combination of correlational and configurational analyses is a powerful instrument for analyzing available data to make decisions. While results from the OLR inform about the overall strength of each variable to explain attitudes toward SRs, the fsQCA discovers profiles of potential users and potential rejecters. Whereas effort expectancy seems to be the key variable to explain acceptance, the lack of a perceived utility and the presence of the perceived risk are of special relevance to explain the resistance toward SRs. Therefore, the successful implantation of any new type of SR needs to show a superior performance and is less risky than more traditional surgery techniques, such as endoscopy or laparoscopy.

Note that in the profiles linked to acceptance, there are two configurations (the sixth and seventh) where the perceived risk is affirmed. Hospital managers must be careful with this information because they do not necessarily imply that these profiles come from risk seekers. Surely, people perceive that the potential advantages of robotic surgery coming from the PE, EE, SI, and PL compensate for the perceived risk.

This study has some limitations of this empirical research. This study was conducted in a single country (Jordan). The research sample was from a university environment where students, professors, and administrative workers participated in the survey, and cultural differences, because of the educational and the social class statuses, may influence potential patients' attitudes toward SRs. Likewise, country cultural stratum is also a relevant variable to explain attitudes toward robots. Therefore, the results obtained in this study could be extrapolated, at least partially, to potential patients from countries of the same geographical area and with a similar culture, such as Turkey, Lebanon, or Kuwait, and similar social groups, but not to countries with different cultures and/or people of lower educational status. Thus, further research that broadens the number of countries and their social or cultural status is required.

Moreover, we analyzed a cross-sectional survey; therefore, our results cannot be generalized in the long run. This issue is relevant because, as mentioned in the introduction, robotic surgery is an active and dynamic field. It could be of interest to carry out a longitudinal study to understand how perceptions of SRs evolve along with their improvement.

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References

1. Chen, R.; Rodrigues-Armijo, P.; Krause, C.; Siu, K.-C.; Oleynikov, D. A comprehensive review of robotic surgery curriculum and training for residents, fellows, and postgraduate surgical education. *Surg. Endosc.* **2020**, *34*, 361–367. [CrossRef] [PubMed]
2. Ashrafian, H.; Clancy, O.; Grover, V.; Darzi, A. The evolution of robotic surgery: Surgical and anaesthetic aspects. *Br. J. Anaesth.* **2017**, *119*, i72–i84. [CrossRef] [PubMed]
3. Martinello, N.; Loshak, H. *Experiences with and Expectations of Robotic Surgical Systems: A Rapid Qualitative Review*; Canadian Agency for Drugs and Technologies in Health: Ottawa, ON, Canada, 2020. Available online: https://www.ncbi.nlm.nih.gov/books/NBK562938 (accessed on 13 July 2022).
4. Boys, J.A.; Alicuben, E.T.; DeMeester, M.J.; Worrell, S.G.; Oh, D.S.; Hagen, J.A.; DeMeester, S.R. Public perceptions on robotic surgery, hospitals with robots, and surgeons that use them. *Surg. Endosc.* **2016**, *30*, 1310–1316. [CrossRef] [PubMed]
5. Beyaz, S. A brief history of artificial intelligence and robotic surgery in orthopedics & traumatology and future expectations. *Jt. Dis. Relat. Surg.* **2020**, *31*, 653. [CrossRef] [PubMed]
6. Jank, B.J.; Haas, M.; Riss, D.; Baumgartner, W.-D. Affiliations expand. Acceptance of patients towards task-autonomous robotic cochlear implantation: An exploratory study. *Int. J. Med. Robot. Comp. Assist. Surg.* **2021**, *17*, 1–6. [CrossRef]
7. Muaddi, H.; Zhao, X.; Leonardelli, G.J.; de Mestral, C.; Nathens, A.; Stukel, T.A.; Guttman, M.P.; Karanicolas, P.J. Fear of innovation: Public's perception of robotic surgery. *Surg. Endosc.* **2022**, *36*, 6076–6083. [CrossRef]

8. Ammer, E.; Mandt, L.S.; Silbersdorff, I.C.; Kahl, F.; Hagmayer, Y. Robotic Anxiety—Parents' Perception of Robot-Assisted Pediatric Surgery. *Children* **2022**, *9*, 399. [CrossRef]
9. Venkatesh, V.; Morris, M.G.; Davis, G.B.; Davis, F.B. User Acceptance of Information Technology: Toward a Unified View. *MIS Quart.* **2003**, *27*, 425–478. [CrossRef]
10. Krishnan, G.; Mintz, J.; Foreman, A.; Hodge, J.C.; Krishnan, S. The acceptance and adoption of transoral robotic surgery in Australia and New Zealand. *J. Robot. Surg.* **2019**, *13*, 301–307. [CrossRef]
11. BenMessaoud, C.; Kharrazi, H.; MacDorman, K.F. Facilitators and barriers to adopting robotic-assisted surgery: Contextualizing the unified theory of acceptance and use of technology. *PLoS ONE* **2011**, *6*, e16395. [CrossRef]
12. Torrent-Sellens, J.; Jiménez-Zarco, A.I.; Saigí-Rubió, F. Do People Trust in Robot-Assisted Surgery? Evidence from Europe. *Int. J. Environ. Res. Public Health* **2021**, *18*, 12519. [CrossRef]
13. Pappas, I.O.; Woodside, A.G. Fuzzy-set Qualitative Comparative Analysis (fsQCA): Guidelines for research practice in Information Systems and marketing. *Int. J. Inf. Manag.* **2021**, *58*, 102310. [CrossRef]
14. Ragin, C. *Redesigning Social Inquiry: Fuzzy Sets and Beyond*, 1st ed.; Chicago University Press: Chicago, IL, USA, 2008.
15. Andrés-Sánchez, J.; Arias-Oliva, M.; Pelegrín-Borondo, J.; Almahameed, A.A.M. The influence of ethical judgements on acceptance and non-acceptance of wearables and insideables: Fuzzy set qualitative comparative analysis. *Technol. Soc.* **2021**, *67*, 101689. [CrossRef]
16. Arias-Oliva, M.; de Andrés-Sánchez, J.; Pelegrín-Borondo, J. Fuzzy Set Qualitative Comparative Analysis of Factors Influencing the Use of Cryptocurrencies in Spanish Households. *Mathematics* **2021**, *9*, 324. [CrossRef]
17. Pappas, I.O.; Giannakos, M.N.; Sampson, D.G. Fuzzy set analysis as a means to understand users of 21st-century learning systems: The case of mobile learning and reflections on learning analytics research. *Comput. Hum. Behav.* **2019**, *92*, 646–659. [CrossRef]
18. Zhang, J.; Long, J.; von Schaewen, A.M.E. How Does Digital Transformation Improve Organizational Resilience?—Findings from PLS-SEM and fsQCA. *Sustainability* **2021**, *13*, 11487. [CrossRef]
19. Muñoz-Pascual, L.; Curado, C.; Galende, J. Fuzzy Set Qualitative Comparative Analysis on the Adoption of Environmental Practices: Exploring Technological- and Human-Resource-Based Contributions. *Mathematics* **2021**, *9*, 1553. [CrossRef]
20. Porcuna-Enguix, L.; Bustos-Contell, E.; Serrano-Madrid, J.; Labatut-Serer, G. Constructing the Audit Risk Assessment by the Audit Team Leader When Planning: Using Fuzzy Theory. *Mathematics* **2021**, *9*, 3065. [CrossRef]
21. Castelló-Sirvent, F.; Pinazo-Dallenbach, P. Corruption Shock in Mexico: fsQCA Analysis of Entrepreneurial Intention in University Students. *Mathematics* **2021**, *9*, 1702. [CrossRef]
22. Ragin, C.C. Using qualitative comparative analysis to study causal complexity. *Health Serv. Res.* **1999**, *34*, 1225–1239.
23. Andres-Sanchez, J.; Belzunegui-Eraso, A. Explaining Cannabis Use by Adolescents: A Comparative Assessment of Fuzzy Set Qualitative Comparative Analysis and Ordered Logistic Regression. *Healthcare* **2022**, *10*, 669. [CrossRef] [PubMed]
24. Lee, S.S.-Y. Using fuzzy-set qualitative comparative analysis. *Epidemiol. Health* **2014**, *36*, e2014038. [CrossRef]
25. Davis, F.D. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quart.* **1989**, *13*, 319–340. [CrossRef]
26. Venkatesh, V.; Thong, J.Y.L.; Xu, X. Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Quart.* **2012**, *36*, 157–178. [CrossRef]
27. Chow, M.; Chan, L.; Lo, B.; Chu, W.P.; Chan, T.; Lai, Y.M. Exploring the Intention to Use a Clinical Imaging Portal for Enhancing Healthcare Education. *Nurs. Educ. Today* **2013**, *33*, 655–662. [CrossRef]
28. Alaiad, A.; Zhou, L. The Determinants of Home Healthcare Robots Adoption: An Empirical Investigation. *Int. J. Med. Inform.* **2014**, *83*, 825–840. [CrossRef]
29. Abdekhoda, M.; Dehnad, A.; Zarei, J. Determinant factors in applying electronic medical records in healthcare. *East Mediterr. Health J.* **2019**, *25*, 24–33. [CrossRef]
30. Hossain, A.; Quaresma, R.; Rahman, H. Investigating Factors Influencing the Physicians' Adoption of Electronic Health Record (EHR) in Healthcare System of Bangladesh: An Empirical Study. *Int. J. Inform. Manag.* **2019**, *44*, 76–87. [CrossRef]
31. Sun, Y.; Wang, N.; Guo, X.; Peng, Z. Understanding the Acceptance of Mobile Health Services: A Comparison and integration of alternative models. *J. Electron. Commer. Res.* **2013**, *14*, 183–200.
32. Chang, M.Y.; Pang, C.; Michael-Tarn, J.; Liu, T.S.; Yen, D.C. Exploring User Acceptance of an E-hospital Service: An Empirical Study in Taiwan. *Comp. Stand. Inter.* **2015**, *38*, 35–43. [CrossRef]
33. Chu, X.; Lei, R.; Liu, T.; Li, L.; Yang, C.; Feng, Y. An Empirical Study on the Intention to Use Online Medical Service. In Proceedings of the 15th International Conference on Service Systems and Service Management (Icsssm), Hangzhou, China, 21–22 July 2018; pp. 1–7. [CrossRef]
34. Talukder, M.S.; Chiong, R.; Bao, Y.; Malik, B.H. Acceptance and Use Predictors of Fitness Wearable Technology and Intention to Recommend: An Empirical Study. *Ind. Manag. Data Syst.* **2019**, *119*, 170–188. [CrossRef]
35. Heerink, M.; Kröse, B.; Evers, V.; Wielinga, B. Assessing Acceptance of Assistive Social Agent Technology by Older Adults: The Almere Model. *Int. J. Soc. Robot.* **2010**, *2*, 361–375. [CrossRef]
36. Graaf, M.M.; Allouch, S.B.; Klamer, T. Sharing a life with Harvey: Exploring the acceptance of and relationship-building with a social robot. *Comput. Hum. Behav.* **2015**, *43*, 1–14. [CrossRef]
37. Chi, O.; Denton, G.; Gursoy, D. Artificially intelligent device use in service delivery: A systematic review, synthesis, and research agenda. *J. Hosp. Market Manag.* **2020**, *29*, 757–786. [CrossRef]

38. Milner, M.N.; Anania, E.C.; Candelaria-Oquendo, K.; Rice, S.; Winter, S.R.; Ragbir, N.K. Patient perceptions of new robotic technologies in clinical restorative dentistry. *J. Med. Syst.* **2020**, *44*, 33. [CrossRef]
39. Sætra, H.S. The foundations of a policy for the use of social robots in care. *Technol. Soc.* **2020**, *63*, 101383. [CrossRef]
40. Tan, S.Y.; Taeihagh, A.; Tripathi, A. Tensions and antagonistic interactions of risks and ethics of using robotics and autonomous systems in long-term care. *Technol. Forecast. Soc. Chang.* **2021**, *167*, 120686. [CrossRef]
41. Wirtz, J.; Patterson, P.G.; Kunz, W.H.; Gruber, T.; Lu, V.N.; Paluch, S.; Martins, A. Brave New World: Service Robots in the Frontline. *J. Serv. Manag.* **2018**, *29*, 907–931. [CrossRef]
42. McDermott, H.; Choudhury, N.; Lewin-Runacres, M.; Aemn, I.; Moss, E. Gender differences in understanding and acceptance of robot-assisted surgery. *J. Robot. Surg.* **2020**, *14*, 227–232. [CrossRef]
43. Yang, H.; Yu, J.; Zo, H.; Choi, M. User Acceptance of Wearable Devices: An Extended Perspective of Perceived Value. *Telemat. Inform.* **2016**, *33*, 256–269. [CrossRef]
44. Murata, K.; Arias-Oliva, M.; Pelegrín-Borondo, J. Cross-cultural study about cyborg market acceptance: Japan versus Spain. *Eur. Res. Manag. Bus. Econ.* **2019**, *25*, 129–137. [CrossRef]
45. Raigoso, D.; Céspedes, N.; Cifuentes, C.A.; del Alma, A.J.; Múnera, M. Survey on Socially Assistive Robotics: Clinicians' and Patients' Perception of a Social Robot within Gait Rehabilitation Therapies. *Brain Sci.* **2021**, *11*, 738. [CrossRef] [PubMed]
46. Han, J.; Conti, D. The Use of UTAUT and Post Acceptance Models to Investigate the Attitude towards a Telepresence Robot in an Educational Setting. *Robotics* **2020**, *9*, 34. [CrossRef]
47. Graaf, M.M.A.; Allouch, S.B.; van Dijk, J.A.G.M. Why Would I Use This in My Home? A Model of Domestic Social Robot Acceptance. *Hum. Comput. Interact.* **2019**, *34*, 115–173. [CrossRef]
48. Conti, D.; Di Nuovo, S.; Buono, S.; Di Nuovo, A. Robots in Education and Care of Children with Developmental Disabilities: A Study on Acceptance by Experienced and Future Professionals. *Int. J. Soc. Robot.* **2017**, *9*, 51–62. [CrossRef]
49. Damholdt, M.F.; Nørskov, M.; Yamazaki, R.; Hakli, R.; Hansen, C.V.; Vestergaard, C.; Seibt, J. Attitudinal change in elderly citizens toward social robots: The role of personality traits and beliefs about robot functionality. *Front. Psychol.* **2015**, *6*, 1701. [CrossRef]
50. Chen, N. Acceptance of Social Robots by Aging Users: Towards A Pleasure-Oriented View. In *International Conference on Cross-Cultural Design*; Springer: Cham, Switzerland, 2018; pp. 387–397. [CrossRef]
51. Das, G. The Effect of Pleasure and Arousal on Satisfaction and Word-of-Mouth: An Empirical Study of the Indian Banking Sector. *Vikalpa* **2013**, *38*, 95–103. [CrossRef]
52. Reinares-Lara, E.; Olarte-Pascual, C.; Pelegrín-Borondo, J. Do you want to be a cyborg? The moderating effect of ethics on neural implant acceptance. *Comput. Hum. Behav.* **2018**, *85*, 43–53. [CrossRef]
53. Rudovic, O.; Lee, J.; Mascarell-Maricic, L.; Schuller, B.W.; Picard, R.W. Measuring Engagement in Robot-Assisted Autism Therapy: A Cross-Cultural Study. *Front. Robot. AI* **2017**, *4*, 36. [CrossRef]
54. De Graaf, M.M.; Allouch, S.B. Exploring influencing variables for the acceptance of social robots. *Robot. Auton. Syst.* **2013**, *61*, 1476–1486. [CrossRef]
55. Bishop, L.; van Maris, A.; Dogramadzi, S.; Zook, N. Social robots: The influence of human and robot characteristics on acceptance. *Paladyn J. Behav. Robot.* **2019**, *10*, 346–358. [CrossRef]
56. Cormons, L.; Poulet, C.; Pellier, D.; Pesty, S.; Fiorino, H. Testing Social Robot Acceptance: What If You Could Be Assessed for Dementia by a Robot? A Pilot Study. In Proceedings of the 6th International Conference on Mechatronics and Robotics Engineering (ICMRE), IEEE, Barcelona, Spain, 12–15 February 2020; pp. 92–98. [CrossRef]
57. Faqih, K.M.S. An Empirical Analysis of Factors Predicting the Behavioral Intention to Adopt Internet Shopping Technology Among Non-Shoppers in a Developing Country Context: Does Gender Matter? *J. Retail. Cons. Serv.* **2016**, *30*, 140–164. [CrossRef]
58. Mazaheri, E.; Richard, M.O.; Laroche, M. Online consumer behavior: Comparing Canadian and Chinese website visitors. *J. Bus. Res.* **2011**, *64*, 958–965. [CrossRef]
59. Ragin, C. *User's Guide to Fuzzy-Set/Qualitative Comparative Analysis*; Department of Sociology, University of California: Irvine, CA, USA, 2018; Available online: http://www.socsci.uci.edu/~{}cragin/fsQCA/download/fsQCAManual.pdf (accessed on 13 April 2022).
60. McCluskey, E.J. Minimization of Boolean functions. *Bell Syst. Tech. J.* **1956**, *35*, 1417–1444. [CrossRef]
61. Mendel, J.M.; Korjani, M.M. Charles Ragin's fuzzy set qualitative comparative analysis (fsQCA) used for linguistic summarizations. *Inf. Sci.* **2012**, *202*, 1–23. [CrossRef]
62. Thiem, A. Set-relational fit and the formulation of transformational rules in fsQCA. *Compasss WP Ser.* **2010**, *2010*, 61. Available online: http://www.compasss.org/wpseries/Thiem2010.pdf (accessed on 13 April 2022).
63. McFadden, D. *Quantitative Methods for Analyzing Travel Behaviour on Individuals. Some Recent Developments*; Cowles Foundation Discussion Papers 474; Cowles Foundation for Research in Economics, Yale University: New Haven, CT, USA, 1977.
64. Gauttier, S. 'I've got you under my skin'—The role of ethical consideration in the (non-) acceptance of insideables in the workplace. *Technol. Soc.* **2019**, *56*, 93–108. [CrossRef]