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Religiosity and Attitudes towards Robots: Results from a Global Survey

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Abstract. Religion is one lens through which people understand and interpret the world around them. In this article, the authors investigate how an individual's religiosity impacts perceptions of robots, using data from a large-scale global survey of attitudes toward robots (N=1263). To investigate how religion impacts such perceptions, cluster, factor, and regression analyses were used. The findings illustrate that there are three discernible clusters of individuals exhibiting different levels of religiosity and different perceptions of robots, showing that less religious individuals are more likely to be robophilic. At the same time, no differences were found between respondents with medium and high levels of religiosity. While there is a clear indication that there is a negative relationship between religiosity and attitudes toward robots, religiosity does not have a particularly strong impact on perceptions toward robots. The analysis illustrates that there are other factors more clearly associated with perceptions of robots such as people's perceptions of the positive and negative societal impacts of robots. In addition, there seems to be no notable relationship between perceptions of robots and the demographics of individuals, illustrating that the gender, wealth, and education of an individual may not play a strong role in shaping perceptions toward robots.

Keywords: Human-robot interaction, robophilia, robophobia, demographics, innovative personality.

Introduction

With the increased capability of automation technologies and the increased need for automation in developed countries due to labor shortages (Webster, 2021), the wider implementation of robots in all sectors of the economy is inevitable and will result in much more automated economies and societies (Hudson, 2019; Ivanov, 2021). While much of manufacturing has been largely robotized for many years now (Ferreira & Fletcher, 2022), there are many sectors in the economy that have benefitted from the use of robots, such as medicine (Desai et al., 2018), agriculture (Bechar, 2021), education (Alnajjar et al., 2021), and tourism/hospitality services (Ivanov & Webster, 2019b), among others.

One of the directions of the research on robots that has received enormous attention is the attitudes towards and acceptance of robots (De Graaf & Allouch, 2013; Hudson, Orviska & Hunady, 2017; Hwang, Park & Kim, 2020; Ivanov & Webster, 2019a; Ivanov, Webster & Garenko, 2018; Ivanov, Webster & Seyyedi, 2018; Koverola et al., 2022; Li & Wang, 2022; Xu et al., 2015, among many others). Studies have indicated that the attitudes towards and the acceptance of robots depend on factors related to the robots (e.g. perceived usefulness, ease of use, autonomy, appearance/anthropomorphism, reliability, safety, emotional skills, etc.), the users (abilities/skills, personal innovativeness, demographic characteristics, culture, etc.), the tasks robots need to perform (e.g. perceived appropriateness of the task), social pressure, and numerous other factors.

One component of the acceptance of robots that has been underresearched is the role of robot users' religiosity on their attitudes towards robots. The topic is important, because attitudes towards robots are positively related to the acceptance of robots (Li & Wang, 2022). Hence, the potential negative role of religiosity of people in shaping their attitudes towards robots would be a hindrance towards the wider implementation of service and social robots.

While there is a significant body of literature that focused on the linkage between religiosity and specific types of technologies such as genetic technology (Allum, Sibley, Sturgis, & Stoneman, 2014) or nanotechnologies (Brossard et al., 2009; Scheufele et al., 2009), religiosity is largely overlooked in the studies on robots. In a pioneering study, Katz and Halpern (2014) found that religiosity is positively related to robophobia, i.e. more religious people tend to hold more negative views towards robots. A similar negative relationship between religiosity and attitudes was found by Giger et al. (2017) in the context of social robots and by Modliński, Gwiaździński and Karpińska-Krakowiak (2022) for autonomous vehicles. In their research on sex robots, Ma, Tojib and Tsarenko (2022) find that religiosity moderates the relationship between mistrust in science and the perceived substitutability of sex robots to human-to-human sexual interactions; specifically, the relationship is more negative in more religious states. Previous studies have also found that personal innovativeness had a moderating effect on peoples' perceptions of robots (Hyun et al., 2022) and that this is positively related to the willingness to pay for robot-delivered services (Chuah et al., 2022). The dehumanization effect of automation technologies was found to have a positive impact on people's fear of automation (Ivanov, Kuyumdzhiev & Webster, 2020) and a negative impact on the intentions to use self-driving taxis (Tussyadiah, Zach & Wang, 2017), while perceived benefits are positively related to the intentions to use robots (Lutz & Tamó-Larrieux, 2020) and to trust in self-driving taxis (Xie et al., 2022). The findings of previous studies give the ground to formulate the following hypotheses:

- H1: Religiosity is negatively related to the attitudes towards robots.
- H2: Personal innovativeness is positively related to the attitudes towards robots.
- H3: Perceived social benefits of robots are positively related to the attitudes towards robots.
- H4: Perceived dehumanization effect of robots is negatively related to the attitudes towards robots.

1. Methodology

A large-scale online survey was developed to learn about individual attitudes towards robots in the service sector, including a few questions relevant to religiosity that are analyzed here. The online survey was made available from March 2018 to October 2019. The IRB of a United States University granted permission for the research project. A grant was awarded to the research team so that incentives could be offered to respondents to encourage higher response rates and completion rates.

Respondents were required to be above the age of 18 and there were no further criteria necessary for an individual to complete the survey online. The survey was developed originally in English and was translated into 11 other languages by native speakers to allow for a greater global reach. The researchers disseminated the link to the questionnaire by email and through various social media groups. As a result, data were collected from about one hundred countries. Six examples of robots were shown to the respondents so that they would have an agreed upon starting point to visualize the concept of the robot used in the research. The key characteristics of the sample are shown in Table 1.

Table 1. Sample's characteristics

Characteristic		Total	Share	Number of respondents			Statistic
				Cluster 1	Cluster 2	Cluster 3	
Gender	Female	699	55.3	202	234	263	$\chi2 = 0.414$ df = 2 p = 0.813
	Male	564	44.7	154	191	219	
Age	18-30	621	49.2	178	211	232	$\chi2 = 2.877$ df = 10 p = 0.984
	31-40	305	24.1	88	105	112	
	41-50	195	15.4	55	61	79	
	51-60	90	7.1	22	29	39	
	61-70	43	3.4	10	16	17	
	71+	9	0.7	3	3	3	

Table 1. Sample's characteristics (continuation)

Characteristic		Total	Share	Number of respondents			Statistic
				Cluster 1	Cluster 2	Cluster 3	
Education	Secondary or lower	188	14.9	57	56	75	$\chi 2 = 5.571$ df = 6 p = 0.473
	2 year / Associate degree	85	6.7	30	22	33	
	Bachelor	393	31.1	110	135	148	
	Postgraduate (Master, Doctorate)	597	47.3	159	212	226	
Economic wellbeing	Much less wealthy than average for the country	42	3.3	7	19	16	$\chi 2=31.607$ df=12 p=0.002
	Less wealthy than average for the country	78	6.2	26	24	28	
	Slightly less wealthy than average for the country	129	10.2	47	48	34	
	About the average for the country	417	33.0	131	147	139	
	Slightly more wealthy than average for the country	374	29.6	88	125	161	
	More wealthy than average for the country	190	15.0	50	55	85	
	Much more wealthy than average for the country	33	2.6	7	7	19	
Country of residence	United States of America	358	28.3	79	145	134	$\chi 2=154.782$ df=32 p=0.000
	Bulgaria	258	20.4	74	56	128	
	China	49	3.9	22	6	21	
	United Kingdom of Great Britain and Northern Ireland	43	3.4	14	12	17	
	India	41	3.2	11	24	6	
	Taiwan	36	2.9	25	7	4	
	Italy	33	2.6	11	7	15	
	Russian Federation	33	2.6	13	9	11	
	Turkey	31	2.5	12	8	11	
	Portugal	26	2.1	4	14	8	
	Malaysia	22	1.7	8	14	0	
	United Arab Emirates	21	1.7	5	13	3	
	Brazil	21	1.7	4	14	3	
	Spain	17	1.3	3	2	12	
	France	15	1.2	8	1	6	
	Germany	15	1.2	4	1	10	
	Other (79 countries)	244	19.3	59	92	93	

Table 1. Sample's characteristics (continuation)

Characteristic		Total	Share	Number of respondents			Statistic
				Cluster 1	Cluster 2	Cluster 3	
Religiosity (construct)	Mean	0	-	0.097	1.155	-1.090	F=6031.869 (p=0.000)
	Standard deviation	1.000	-	0.255	0.363	0.289	
Attitudes towards robots	Mean	5.26	-	5.15	5.17	5.41	F=4.401 (p=0.012)
	Standard deviation	1.415	-	1.333	1.535	1.351	
Total		**1263**	**100.0**	**356**	**425**	**482**	

Note:
Coding: Attitudes towards robots: 1-Extremely negative, 4-Neither positive nor negative, 7-Extremely positive

To learn about the religiosity of individuals, respondents were given a seven-point level of agreement scale and asked the following three statements: "*I consider myself a religious person*," "*Religion plays an important role in my life*," and "*Religion plays a positive role in my life*." A similar scale was used to measure respondents' level of agreement to statements related to innovative personality, perceived benefits of robots, and the perceived dehumanization effect of robots (reverse coding used). To measure an individual's attitudes towards robots, respondents were asked three questions measuring their attitudes towards robots in general, specific types of robots (i.e. service robots) and robots applied in a specific context (i.e. robots in travel, tourism and hospitality). This allowed to account for the type of robots and the particular uses that may influence a person's perceptions. Participants in the survey responded using a seven-point scale, ranging from "1=extremely negative" to "7=extremely positive." The sources of the items are provided in a note to Table 2. In addition, several control variables were used for common demographic features measured (gender, age, education, the self-proclaimed level of economic wellbeing of the respondent). Cluster, factor, and regression analyses were employed for data analysis.

2. Results

Table 2 illustrates the outcomes of exploratory factor analysis. The results indicate that the constructs have very high reliability (Cronbach alpha: min = 0.791, max = 0.960; composite reliability: min = 0.9073, max = 0.9860) and extracted variance (min = 62.961, max = 92.645).

Table 2. Exploratory Factor Analysis

Constructs and items	Mean	Standard deviation	Item loadings	Cronbach alpha	Composite reliability	Variance extracted
Religiosity				0.960	0.9860	92.645
I consider myself a religious person	3.56	2.055	0.959			
Religion plays an important role in my life	3.60	2.096	0.971			
Religion plays a positive role in my life	3.87	2.028	0.957			
Innovative personality				0.791	0.9073	62.961
I consider myself to be creative and original in my thinking and behaviour	5.43	1.220	0.797			
I seek out new ways to do things	5.46	1.202	0.818			
I usually adopt new products before my friends do	4.47	1.581	0.703			
Others see me as an innovative person	4.98	1.275	0.848			
Perceived social benefits				0.919	0.9570	67.731
Robots will be responsible for many of the good things we will enjoy in life	4.38	1.634	0.814			
Robots will improve our standard of living	4.90	1.514	0.871			
Robots will bring us a bright future	4.40	1.559	0.844			
Life will be easier with robots	5.01	1.464	0.858			
Robots will make our lives more convenient	5.26	1.388	0.851			
Robots will eliminate a lot of tedious work for people	5.49	1.345	0.710			
Robots will make people happier	3.96	1.610	0.802			

Table 2. Exploratory Factor Analysis (continuation)

Constructs and items	Mean	Standard deviation	Item loadings	Cronbach alpha	Composite reliability	Variance extracted
Perceived dehumanization				0.883	0.9380	63.410
Robots will hurt our human relationships in society (r)	3.55	1.804	0.839			
In the future, robots will dominate society (r)	4.51	1.730	0.664			
The overuse of robots may be damaging and harmful to human beings (r)	3.18	1.711	0.843			
The overuse of robots may be damaging and harmful to the society as a whole (r)	3.22	1.820	0.838			
People will become slaves to robots (r)	4.81	1.766	0.745			
Robots will dehumanize the workplace (r)	3.40	1.780	0.831			
Attitude towards robots				0.893	0.9612	82.585
Attitude towards robots in general	5.26	1.415	0.871			
Attitude towards service robots	5.09	1.518	0.938			
Attitude towards service robots in travel, tourism and hospitality	4.84	1.637	0.916			

Notes:
1. Extraction method: Principal Component Analysis; Rotation method: Varimax with Kaiser Normalization.
2. Coding: 1-Strongly disagree, 7-Strongly agree; (r) – reverse coding
3. Sources of items: *Religiosity*: Simon & Grabow (2014) and expanded by the authors; *Innovative personality*: Parasuraman & Colby (2015); Wiedmann et al. (2010); *Perceived social benefits* and *Perceived dehumanization effect*: Tussyadiah, Zach & Wang (2017) and expanded by the authors; *Attitudes towards robots*: developed by the authors

Table 3 identifies three distinct clusters. Cluster 2 ($n = 425$) includes respondents exhibiting high religiosity – the mean responses to the three statements in the construct vary between $M = 5.87$ and $M = 6.06$. Cluster 3 ($n = 482$) is on the other extreme – the respondents exhibiting low religiosity. Their mean responses to the statements range between $M = 1.35$ and $M = 1.77$. Cluster 1 ($n = 356$) includes respondents who provided mostly neutral responses (min $M = 3.69$, max $M = 4.10$). The differences between the responses of the three clusters to the items in the construct are all statistically significant at $p < 0.001$. The demographic characteristics of the three groups of respondents are presented in Table 1. They do not differ in terms of gender, age, or education (all three p-values > 0.05) but in regard to economic wellbeing and country of residence. In particular, more wealthy respondents considered themselves less religious ($\chi2 = 31.607$, $p = 0.002$). Bulgarian respondents were largely classified in Cluster 3 (low religiosity), while the majority of respondents from The United States, India, Portugal, Malaysia, United Arab Emirates, etc., in Cluster 2 (high religiosity) ($\chi2 = 154.782$, $p = 0.000$). The three clusters had different attitudes towards robots (see Table 1 and Figure 1) and the differences between them were statistically significant ($F_{\text{robots in general}} = 4.401$, $p = 0.012$; $F_{\text{service robots}} = 4.222$, $p = 0.015$; $F_{\text{robots in tourism}} = 3.428$, $p = 0.033$). Specifically, the findings show that lower levels of religiosity elicit more positive attitudes towards robots and the differences with the mean responses on people with high religiosity are statistically significant ($p<0.05$ for all three Bonferoni post hoc tests). Therefore, support for service robots seems negatively associated to religiosity.

Table 3. Cluster analysis

Construct and items	Mean	Cluster means			F test
		Cluster 1	Cluster 2	Cluster 3	
Religiosity					
I consider myself a religious person	3.56	3.69	5.87	1.42	3279.451***
Religion plays an important role in my life	3.60	3.81	5.96	1.35	4220.205***
Religion plays a positive role in my life	3.87	4.10	6.06	1.77	4655.909***
Number of respondents (Total=1263)		356	425	482	

Notes:
1. Coding: 1-Strongly disagree, 7-Strongly agree.
2. *** Significant at p < 0.001

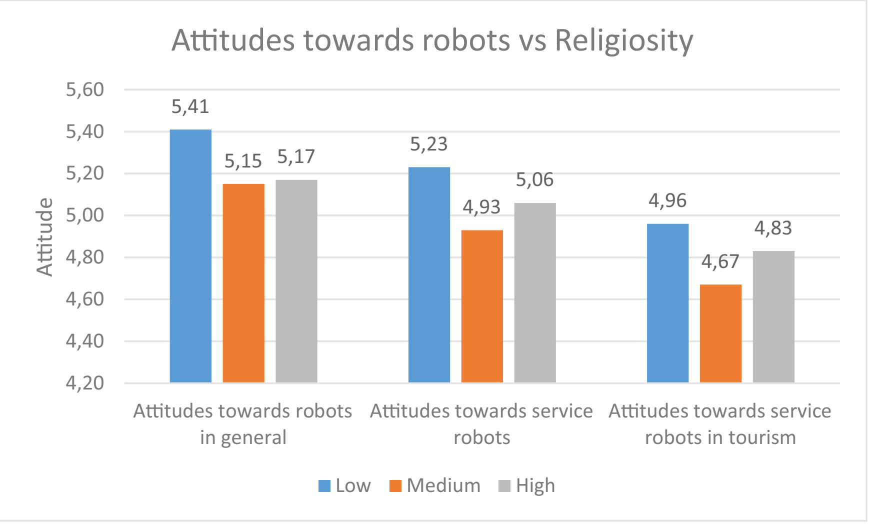

Figure 1. Attitudes towards robots vs Religiosity

To analyze further the impact of religiosity on the attitudes towards robots, four OLS regressions were run. Table 4 presents the regression results. Model 1 illustrates that increasing levels of religiosity are associated with less positive attitudes towards robots and the relationship is statistically significant ($b = -0.077$, $p < 0.01$). However, the adjusted R-squared statistic is unimpressive (adjusted R-squared = 0.006), illustrating that while the bivariate regression illustrates a statistically significant negative relationship between the variables, overall, the model does not explain a great deal of the variation. Model 2 adds the innovative personality as an explanatory variable. The adjusted R2 increases to 0.1. The model reveals that the self-perception as an innovative personality leads to positive attitudes towards robots ($b = 0.308$, $p < 0.001$). Religiosity remains negatively related to attitudes. Model 3 incorporates the two variables that show respondents' perceptions of the social impacts of robots. The findings reveal that the perceived social benefits of robots are positively related to the attitudes towards robots ($b = 0.537$, $p < 0.001$) while the dehumanization effect of robots is negatively related ($b = 0.192$, $p < 0.001$, note that the positive sign of this reverse coded variable shows a negative relationship). The regression coefficient of the innovative personality variable remains positive and significant ($b = 0.108$, $p < 0.001$) while religiosity does not play a role anymore. Model 3 has a very high explanatory power and explains 69.2% of the variation of the attitudes towards robots. The same conclusions can be made in Model 4 which adds the demographic variables – perceived social benefits and innovative personality have a positive relationship to the attitudes towards robots, dehumanization effect has a negative relationship, while the religiosity has no impact. In addition, age has a slight negative impact, i.e., younger respondents had a slightly more positive attitude. Considering the results of the cluster and regression analysis we find support to hypotheses H2, H3 and H4, and partial support to H1 (supported by the cluster analysis and regression models 1 and 2, but not supported by regression models 3 and 4).

3. Conclusions and Future Research

From a theoretical perspective, the findings from the cluster analysis and regression models 1 and 2 show that that religiosity plays a negative role in conditioning attitudes towards robots. In that sense, the findings are in line with the results of previous studies (Giger et al., 2017; Katz & Halpern, 2014; Ma, Tojib, & Tsarenko, 2022; Modliński, Gwiaździński & Karpińska-Krakowiak, 2022) and highlight that there is some linkage between religiosity and attitudes towards automation technologies (Green, 2018). However, the role of religiosity disappears when other variables are considered such as the perceived social benefits and dehumanization effects of robots. In fact, the results from regression models 3 and 4 show that these two variables are much more important than the personality characteristics of people (i.e. religiosity and innovativeness). Therefore, religiosity *per se* is not a vital factor that shapes people's perceptions of robots and is not a hindrance towards their wider adoption in the economy and society because other factors play a more important role (i.e. people's perceptions towards the positive and negative societal impacts of robots). Moreover, the findings show that all three clusters have posi-

Table 4. Regression analysis

Dependent variable: *Attitudes towards robots*	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Unstandardized Coefficients	**Standardized Coefficients**	**t**	**Unstandardized Coefficients**	**Standardized Coefficients**	**t**	**Unstandardized Coefficients**	**Standardized Coefficients**	**t**	**Unstandardized Coefficients**	**Standardized Coefficients**	**t**
	B	**Beta**		**B**	**Beta**		**B**	**Beta**		**B**	**Beta**	
Constant	0.000		0.011	0.000		0.012	0.001		0.070	0.244		2.355*
Religiosity	-0.077	-0.077	-2.714**	-0.073	-0.073	-2.718**	-0.010	-0.010	-0.464	-0.007	-0.007	-0.343
Innovative personality				0.308	0.308	11.497***	0.108	0.108	5.025***	0.115	0.115	5.245***
Perceived social benefits of robots							0.537	0.537	22.220***	0.527	0.527	21.667***
Perceived dehumanization effect of robots							0.192	0.192	8.162***	0.200	0.200	8.483***
Gender										0.029	0.014	0.685
Age										-0.004	-0.053	-2.282*
Education										-0.033	-0.043	-1.882
Economic well-being										0.016	0.021	0.962

Table 4. Regression analysis (continuation)

Dependent variable: *Attitudes towards robots*	Model 1			Model 2			Model 3			Model 4		
	Unstandardized Coefficients	Standardized Coefficients	t	Unstandardized Coefficients	Standardized Coefficients	t	Unstandardized Coefficients	Standardized Coefficients	t	Unstandardized Coefficients	Standardized Coefficients	t
	B	Beta		B	Beta		B	Beta		B	Beta	
Model summary:												
R	0.077			0.318			0.692			0.696		
R2	0.006			0.101			0.479			0.485		
Adjusted R2	0.005			0.100			0.477			0.481		
F-Statistic	7.366**			70.160***			286.273***			146.088***		
Standard error of the estimate	0.99714			0.94861			0.72294			0.71999		
ΔR2	0.006			0.095			0.378			0.006		
ΔF	7.366**			132.182***			451.745***			3.556**		

Notes:
1. Coding: *Gender*: 0 – Female. 1 – Male; *Economic wellbeing* – 1 – Much lower than the average for the country; 7 – Much higher than the average for the country; 2. *** Significant at $p<0.001$, ** Significant at $p<0.01$

tive attitudes towards robots but people with low religiosity have more positive attitudes compared to the other two clusters. Therefore, from a managerial perspective, despite religiosity being negatively associated to attitudes towards robots, robot manufacturers and (service) companies that implement robotic technologies do not need to worry about significant resistance towards robots based on the users' religious beliefs. Although there would always be people who resist robots and do not want to use them for religious reasons, they would be a small share of potential robot users. In time, the greater knowledge about the capabilities and the effects of robots on the economy and society, and the greater exposure to robots in various service settings (e.g. in shopping malls, hotels, restaurants, homes) might work in favor of generating more positive attitudes towards them.

A major limitation of the research is the composition of the sample. Although it was a global sample that included respondents from nearly 100 countries, respondents from the countries of the two authors (USA and Bulgaria) dominate the sample. Additionally, the findings presented in the paper come from a larger study on attitudes towards robots. It did not account for the different types of religiosity and measured the level of religiosity with three statements only. It is possible that other ways of measuring religiosity may elicit different results.

Future research can evaluate the role of religiosity in different cultures and delve into the nuances of religion's role in shaping perceptions towards and acceptance of robots in different cultural contexts. Future research should also investigate very deeply held values and beliefs of an individual to see how belief systems impact an individual's perceptions of various technologies, including robots. For example, Rutjens, Sutton, & van der Lee (2018) made preliminary research exploring how morality and political values impacts upon acceptance or rejection of various technological innovations. Additionally, future research should investigate the ways that very deeply-held values, superstitions, and religious beliefs shape reactions to new technologies in the material world. It is likely that an individual's values and beliefs are formed, shaped by, and challenged by an individual's environment. Thus, it would be fruitful to uncover the dynamic processes in which an individual's deeply-held beliefs are challenged by new technologies in the individual's social environment. Finally, research may also focus on the emerging issue of robot rights (Schwitzgebel, 2023; Tigard, 2023) and the role of religion and religiosity in justifying and accepting them.

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