ANTHROPOMORPHIC ROBOT FACTORS AND SHOPPERS' ACCEPTANCE OF AUTONOMOUS SERVICE ROBOTS IN SHOPPING MALL COMPLEXES IN LAGOS STATE, NIGERIA

Olubukola Akinbodun

Department of Business Administration,
Faculty of Management Sciences. University of Lagos,
University Road, Akoka, Yaba, Lagos, Nigeria
E-mail: bukola_sarah@yahoo.com

Abstract*:* This study examines the influence of anthropomorphic robot factors on shoppers' acceptance of autonomous service robots in shopping mall complexes. It also contributes to the Service Robot Acceptance Model from the context of a developing country by validating three robot factors such as appearance, social capability and usefulness from shoppers' perspectives.
Keywords: Anthropomorphic, Autonomous service robot, Appearance, Usefulness, Social capability.

1. Introduction

Shopping malls as one of the retail platforms is witnessing rapid digital disruptions [1], as extant studies have shown that retail industry is specifically affected by these changes [2]. In addition to technology disruptions in retail industry, the global outbreak of COVID-19 was a critical threat to the safety of shoppers most especially in the public spaces such as shopping malls [3], and these effects of digitalization and COVID-19 global outbreak exerted pressure in the direction of products offer to the public. Management as well put efforts at finding new and better approaches to managing relationships with customers, employees and other stakeholders [1,4]. This applies to both developed and developing economies.

Furthermore, technological revolution is driving automation and by extension making technology autonomous [5]; extant studies have shown that new technologies affect consumers' journey in a number of ways [1], as a result of these technological revolution, many countries around the world currently considering how autonomous service robot can be considered in the society and make it useful in public settings such as shopping malls, hospitals, museums, airports among many others [6]. Although, some developed countries have already keyed into the adoption of the autonomous service robots. Developing countries are also working in that direction, for instance, Nigeria recently launched its first humanoid robot called Omeife in Africa. The estimated value of 6.8 billion dollars covers Africa and other markets across the globe [7]. The economic value of this revolution appears promising, therefore, there is the need as to investigate shoppers in Lagos state, Nigeria whether they will engage the use of autonomous service robots when fully introduced.

In addition, anthropomorphic autonomous service robot is referred to an entity that has human – like features in appearance and behaviour with inbuilt Artificial Intelligent which has the capability to use big – data knowledge from the customer database. Then the robot can switch performance from one task to another independently of itself, such as helping shoppers navigate the store, planning information, locating information and products as well as completing purchase transactions [8]. Service robots are found to be of benefit to shoppers in the shopping mall in terms of offering convenience, time saving, more accurate offer, faster results, and polite interactions.

Moreover, anthropomorphic robot factors referred to factors of autonomous service robots that elicit anthropomorphism in terms of its features and behaviour such as appearance, social capability and usefulness [9,10]. Several studies have found that anthropomorphic robot factors influence the acceptance of service robot; and majority of these studies were conducted in the developed countries. Again, it is important to examine the relevance of service robots in the developing economies such as in Lagos State which is the commercial capital of Nigeria. In addition, acceptance of autonomous service robots is still a contemporary issue in consumer research [11], and acceptance model such as Technology Acceptance Model (TAM) is found inadequate to explain the complexity in acceptance of robot, because robot is perceived to be more human-like than other technologies [12]. Accordingly, Service Robot Acceptance Theory (SRAT) which was advanced by [13]. The theory has been empirically proven in the developed countries, and can therefore be applied across different cultural settings Nigeria inclusive. On this note, the current study is set to fill the gap(s) by examining the influence of

anthropomorphic robot factors on its acceptance in shopping mall complexes in Lagos State, Nigeria.

Research Hypothesis

The null hypotheses for the study is stated thus:

H_0: effect of anthropomorphized robot factors (appearance, social capability and usefulness) will not significantly influence acceptance of anthropomorphic autonomous service robots in shopping mall complexes in Lagos State, Nigeria.

2. Literature Review - Theoretical Framework

2.1. Elicited Agent Knowledge Theory of Anthropomorphism

This theory was developed by [9]. Elicited agent knowledge theory of anthropomorphism is one of the theories of anthropomorphism that involves psychological determinants which affect an individual's tendency to anthropomorphized non-human entities, and improves anthropomorphic judgment because people engage in the use of knowledge related to self or related to human generally when judging or evaluating non – human entities. Based on the elicited agent knowledge theory of anthropomorphism, the researcher assumes that shoppers will engage in the use of their self – knowledge to improve their anthropomorphic judgments in evaluating autonomous service robots in the shopping malls. Therefore, the interaction between shopper and autonomous service robots will be more understandable and favourable [9]. Elicited agent knowledge theory of anthropomorphism is applicable to human – robot interaction in this study to examine whether shoppers will use their self-knowledge to improve their evaluations and interactions with anthropomorphic autonomous service robots in the shopping malls.

2.2. Service Robots Acceptance Theory (SRAT)

The Service Robots Acceptance Theory was developed by [13]. And it posits that consumer acceptance of assistive social robots (service robots) is based on how robots can effectively deliver as regards functional needs, social-emotional, and relational needs in order to achieve role congruence [13]. This theory builds on the original Technology Acceptance Model (TAM) by including social-emotional and relational needs. Therefore, Service Robots Acceptance Theory was employed because it dealt with the anthropomorphic robot factors and the dependent variable considered in this study. In addition, it has been proven empirically in the studies of robot acceptance.

2.3. Conceptual Model

Fig. 1 shows the two variables considered in the study. The two (2) variables are independent variable (anthropomorphized robot factors) and the dependent variable (acceptance of autonomous service robots). The variables are explained in the sub section 2.4 below:

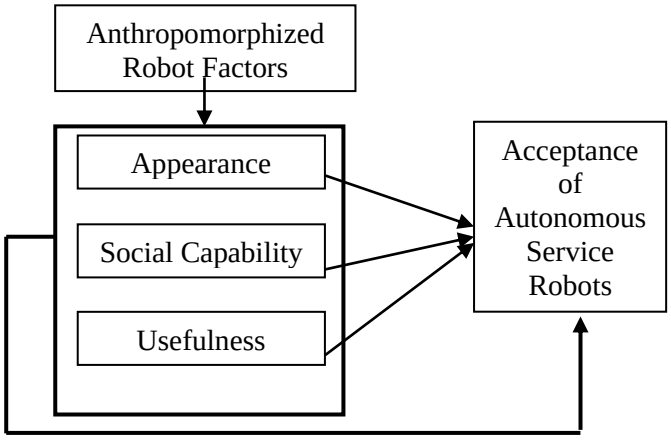

Fig. 1. Conceptual Model of Anthropomorphic Robot Factors

2.4. Anthropomorphized Robot Factors

Anthropomorphized robot factors are the robot factors that can be attributed to human qualities, and they are considered as appearance [14]; social capability [10]; and usefulness [15].

Appearance

This can be defined as the degree to which shoppers believe that anthropomorphic autonomous service robots possess human – like physical features [14]. Perception of an object can be influenced by external appearance [5]. In addition, it facilitates human-robot interaction [10] which can be used to determine robot's acceptance in a public domain such as shopping mall complexes.

Social Capability

This can be defined as the perceived ability of anthropomorphic autonomous service robots to exhibit social behaviour. Social capability can be expressed in form of robots' sociability and communicability [14].

Usefulness

Usefulness is classically defined as the degree to which a person believes that the usage of a particular system will enhance his or her job performance [16]. However, usefulness in robots' studies is defined as the robot's abilities to provide advice and information that are knowledgeable [14,15].

2.5. Acceptance of Anthropomorphic Autonomous Service Robots

This can be described to the extent to which anthropomorphic autonomous service robots are positively evaluated by the user in terms of its

trustworthiness and functionality. Previous studies have also shown that acceptance of robot somehow follows related process of acceptance as regard other technologies, and the full incorporation of robots in the people's daily activities seem to rely on how they anthropomorphize robots [17].

2.6. Empirical Review

[17] conducted a study to explore the acceptance and relationship building with a social robot in Netherlands. The sample was six (6) elderly people comprising of four females and two males within the range of 50 years and above. The findings indicate that appearance, attractiveness, sociability, usefulness received the most attention in the participants' experiences. Also the findings considered usefulness as a fundamental factor in long – term human – robot interaction. Furthermore, in [18] study, factors for determining acceptance of social robots for domestic purpose were investigated among Dutch people. Quantitative method was employed, and a sample of 1,649 consisted male and female from age 18 and above was selected from the general Dutch population via random sampling technique. And the findings showed that usefulness play a significant role in acceptance of social robots. Also social norms have influence on attitudes toward human – robot interaction. However, the result showed that the Dutch people have negative attitudes toward social capability of social robots and they prefer robots that are less anthropomorphic both in appearance and behaviour.

3. Methodology

3.1. Research Design

This study employed a cross – sectional survey research design by using quantitative method aimed at obtaining information for examining the relationship between anthropomorphic robot factors and acceptance of autonomous service robots via a structured online questionnaire.

3.2. Population of the Study

The population of the study comprises of shoppers in Lagos Mainland, Local government, Lagos state. The study concentrated on these shoppers irrespective of their demographical factors such as religious afflictions, marital status, gender, age, and educational background in Lagos metropolitan. Hence, the total targeted population is 948,004 [19]. As the figure represent the total population of people living under Lagos Mainland Local government, Lagos state.

3.3. Sample Size Selection

In order to determine the sample size for this study. Taro Yamane's formular for sample size determination was used as follows:

$$n = \frac{N}{1 + N(e)^2} \quad (1)$$

$$n = \frac{948,004}{1 + 948,004\ (0.06)^2} = 277 \quad (2)$$

Where: n represents sample size,

N represents total Population

e represents sampling error, which is 0.06

3.4. Sampling Technique

This study adopted non-probability sampling technique, as this technique give the researcher the opportunity to select units from a study population that is of interest to a particular study. Thus, convenience sampling technique was adopted due to the respondents' accessibility to the researcher.

3.5. Study Instrument

The instrument used in this study for data collection comprises of structured multiple – choice questionnaire in online environment. Constructs of the instrument were adapted from the scales of appearance, social capability, and usefulness of [10], adjustment were made to the sequence and the content of the items, based on this study's analysis which were pre-tested during the pilot study process. This study's scale items were scored using a five - point Rensis Likert scale, which ranges from strongly disagree (1) to strongly agree (5).

3.6. Procedure for Data Collection

In the study, online survey was conducted. It contained two different phases: The first phase in the online survey consisted of the introduction and the study description. Participants first see an introductory information screen displaying welcome message and statement of assurance of confidentiality As regards the second phase; the respondents receive instruction about the video clip. On the subsequent pages, the participants view short video of the autonomous service robot, after watching this video clip, the participants answer a set of questionnaire. Thereafter, the participants then complete the demographic section which include various questions such as gender, age, education etc.

3.7. Pilot Study

The research instrument was subjected to a pilot test in order to assess its clarity and appropriateness. The pilot test was conducted based on the responses from twenty-five (25) purposively selected respondents who were not part of the sample size. The pilot test includes

the content and face validity that involved the judgments of experienced academics such as university lecturers and doctoral students in the departments of Marketing and Computer Science in the university of Lagos. In addition, the test of reliability was conducted and the Cronbach's alpha coefficient for each of the constructs were determined as shown in Table 1 below.

Tab. 1. Reliability Test

S/N	Constructs	N	Items	Cronbach Alpha
1	Appearance	22	6	.810
2	Social Capability	22	7	.826
3	Usefulness	22	5	.847
4	Acceptance	22	4	.804

4. Data Analysis

4.1. Data Analysis Results

This study employed both descriptive and inferential statistical methods for data analysis. Thus, the respondents' demographic profiles were analyzed via descriptive statistic, while regression analysis was used as the type of inferential statistic to analyze the formulated hypothesis. During the data cleaning, 279 online questionnaires were filled, out of which 237 were found usable for this study, while 42 questionnaires had incomplete data and were deleted from the data set.

4.2. Respondents' Demographic Data Analysis

The demographic data of the respondents were analyzed using descriptive statistics. 237 online survey were found usable. The percentage and frequency distributions revealed the following: As regards gender distribution male (56.5%) responded more than their female counterpart (43.5%). Concerning the age distribution, shoppers within age brackets of 20 to 30 years (54%) responded more than other categories, followed by shoppers within the age brackets of 30 and 40 years (20.7%). As regards marital status distribution, single represented the major respondents (73.8%). For religion distribution, Christian (73.4%) responded more than respondents from other religions. As regards the educational qualification distribution, respondents with WASC/GCE/NECO (43.0%) and HND/B.Sc./B.Ed./LI.b. etc. (40.1%) were the major respondents. For occupation distribution, students (62.0%) responded more than other categories. As regards monthly income distribution, (62.5%) of respondents that earned monthly income of N49,999 or less responded more. And as regards the years of shopping experience distribution, (31.6%) respondents with shopping experience between 1 to 5 years responded more than other categories.

4.3. Hypothesis Testing

Table 2 shows the combined influence of the anthropomorphized robot factors that is: appearance, social capability, usefulness, on acceptance of autonomous service robot. In the model summary, the result shows R^2 of .353, indicating that 35.3% of the variation in acceptance of autonomous service robot is accounted for by combined influence of the anthropomorphized robot factors, while there are other variables accounting for the remaining 64.7% that are not considered in this study. Also, the R-value of .594 indicates that there exists a relative strong positive correlation of 59.4% between anthropomorphized robot's factors combined and acceptance of autonomous service robot. In addition, the Durbin-Watson result of 1.526 was less than the thresholds of 2.0, and the variance inflation factor (VIF) for all the independent variables ranges between 1.246 and 2.036 these are below the thresholds of 10.0 [20] which reveals the absence of multi-collinearity problem within the independent variables

Table 2. Model Summary

Model	R	R Square	Adjusted Square	Std. Error of the Estimate	Durbin-Watson
1	.594[a]	.353	.345	2.495	1.526

a. Predictors: (Constant), USF, APP, SCP
b. Dependent Variable: ACP

Table 3 reveals that the overall model is statistically significant (F= 42.392; p<.05) that is the combined anthropomorphized robot's factors had significant influence on acceptance of autonomous service robot. Therefore, the null hypothesis is rejected

Tab. 3. ANOVA[a]

Model	Sum of Squares	Mean df	Square	F	Sig.
Regr	791.868	3	263.956	42.392	.000[b]
Residual	1450.799	233	6.227		
Total	2242.667	236			

a. Dependent Variable: ACP
b. Predictors: (Constant), USF, APP, SCP

Table 4 also shows the contribution of each of the independent variables (anthropomorphized robot's factors) to the dependent variable (acceptance).
Appearance made the strongest contribution to the model (β=.289; t=6.896; p<0.05); followed by usefulness (β=.195; t=3.283; p<0.05); and social capability (β=.043; t=.828; p>0.05) all having positive significant

relationship with acceptance. However, among the three independent variables, only appearance and usefulness made unique statistical significant contributions to the model.

$$Y = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon \quad (3)$$

$$ACC = a + \beta_1(APP) + \beta_2(SCP) + \beta_3(USF) \quad (4)$$

$$ACC = 4.205 + .289 + .043 + .195 \quad (5)$$

Tab. 4. Contribution of anthropomorphized robot's factors to acceptance of autonomous service robot

Model	Unstd Coff. B	Std Cof S.E	Beta	T	Sig.
Constant	4.205	1.229	-	3.421	.001
APP	.289	.042	.406	6.896	.000
SCP	.043	.052	.059	.828	.409
USF	.195	.059	.247	3.283	.001

Model	Collinearity Statistics Tolerance	VIF
Constant	-	-
APP	.803	1.246
SCP	.542	1.846
USF	.491	2.036

a. Dependent Variable: ACP

b. Predictors: (Constant), USF, APP, SCP

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5. Discussion of Findings

The hypothesis states that combined anthropomorphized robot's factors (appearance, social capability, and usefulness) have no significant influen on acceptance of autonomous service robot in shopping mall complexes in Lagos State, Nigeria. The result shows that combined anthropomorphized robot factors have significant influence on acceptance of autonomous service robot, and this is in line with findings of [17]; well as [10]. However, a positive relationship was found between anthropomorphized robot's social capability and acceptance of autonomous service robot but was not statistically significant, and this finding is in line wi [18].

6. Conclusions

Based on the current study's findings, when all the constructs were tested jointly with the use of multiple regression analysis it was discovered that appearance has the most significant influence on acceptance of autonomous service robot, followed by usefulness, while the social capability appeared to be the least based on the perspectives of shoppers in Lagos state, Nigeria, Therefore, this study concludes that as regards acceptance of autonomous service robot in shopping mall complexes in Lagos state, Nigeria, appearance of the autonomous service robot is the most crucial factor followed by the usefulness of the autonomous service robot.

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Personal Notes

Akinbodun Sarah Olubukola is a Ph.D. student in the department of Business Administration, University of Lagos. Along with her supervisors, she had published in three scholarly journals in the fields of marketing and consumer research. Additionally, the focus of this research is on human-robot interaction. In recent years, she has been working on her thesis. Some of the results have been summarized in this paper to make them available for a broader readership.