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Analyzing Factors Influencing IOT Adoption in Vehicles

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Abstract - *Internet of Things (IOT) is going to be the big trend in our modern life. It has large number of applications. IOT technology is going to make the physical machines or equipment smarter. We could control and monitor our vehicles, machines, home appliances with our mobile phones. IOT works with sensors and programs. Adoption of IOT application had already begun in many countries including India. Despite the fact, the rate of IOT adoption is lagging in India, compared to other countries. So, in this study I had identified the factors which affects the adoption of IOT in vehicle, from the literature study. With the help of questionnaire formed I had collected the data from adopters and nonadopters of IOT technology. And I had conducted independent sample T test to compare adopters and nonadopters. Also carried out multiple regression analysis (MRA) to predict the influence of independent factors to the dependent factor that is intention to adopt IOT technology. The software I used for analysis was IBM, SPSS statistics.*

Key Words: Internet of Things (IOT), Intention to adopt, independent samples T test, MRA

1. INTRODUCTION

Internet of things (IOT) is a new technology in our modern life which are used in many countries. It is, connecting physical devices to internet to transfer data. It has brought changes to many sectors in engineering. Automotive sector is the one in it. IOT in vehicles have many applications which is helpful for managing logistics and travels. Which can also help to maintain the vehicle in perfect condition. In certain reviews IOT adoption in India is considerably low even though it has many applications. This shows that there is a need of study on area IOT in vehicles for the future beneficiary.

1.1 Research Objectives

These objectives are the goals of this study, by achieving each goals the research can be concluded to the result and future scope.

- To identify factors influencing IOT adoption in vehicles.
- To prepare a questionnaire on the basis of identified factors and conduct a survey from adopter and nonadopters of IOT users in vehicles.
- To see how far these factors influence intention to adopt IOT in vehicles.
- To compare adopters and nonadopters.

2. LITERATURE STUDY

Study by Amin, Moulay Larbi [4] at UK and Qatar presents a critical review of recent debates about autonomous vehicles (AVs) and analyze the key barriers to their full adoption. This study has is of a mixed research methodology on a selected database of earlier published research works. Thus, the outcomes of this review combine the barriers into two main categories; User/Government perspectives, Information and Communication Technologies (ICT). And a framework of barriers and their relations to AVs system architecture has also been suggested to support future research and technology development.

Gkartzonikas and Gkritza [2], conducted a study at US to examine the individuals behavioral, perceptions and willingness to use AVs. This paper provides a review of studies published in earlier reviewed journals, conference proceedings, and technical academic and private sector reports on surveys about autonomous vehicles (AVs) from 2012 onwards. Studies on AVs focus on capturing individuals' behavioral characteristics and perceptions, studies about individuals' willingness to pay to use AVs are two categories of papers included. This paper has also identified different factors that may affect behavioral intention to ride in AVs. These factors include the level of awareness of AVs; consumer innovativeness; safety; trust of strangers; environmental concerns; relative advantage, compatibility, and complexity; subjective norms; self-efficacy; and driving related seeking scale. And many studies reviewed in this study have examined the behavioral characteristics, perceptions, and attitudes related to AVs using descriptive analysis or some sort of econometric analysis in different countries except India.

Exploring factors affecting the adoption of Internet of Things Services, by Chin-Lung Hsu and Judy Lin [3]. This study applies the value-based adoption model to examine the influences of benefits and sacrifices on the user's perceived value of and intention to use the IoT services. A structural equation modelling approach is applied to a survey of 489 IoT users, with results indicating that perceived usefulness and perceived enjoyment significantly affect behavioral intention through perceived value. Moreover, perceived privacy risk also plays a key factor in determining IoT adoption.

3. RESEARCH METHODOLOGY

1. This research starts with a literature study to formulate objectives of the study and to find out the factors affecting IOT adoption in vehicles. Eleven independent factors had identified they are awareness on IOT, behavior factor, level of innovativeness, social influence, perceived benefits, perceived fee, risk factor, reliability factor, scalability, IOT attributes which influence the dependent factor intention to adopt.
2. Based on these factors a questionnaire was developed with 58 constructs.
3. Data collection from adopter of IOT in vehicles, with 58 constructs, out of these 58 constructs 16 constructs under 3 factors awareness on IOT, behavior factor, level of innovativeness is used to collect data from non-adopters also.
4. Formulation of Hypothesis.
5. Data analysis:
    - Reliability analysis
    - Factor analysis
    - Multiple Regression Analysis (Hypothesis testing)
    - Independent samples T test (Hypothesis testing)
6. Conclusion.

4. RELIABILITY AND FACTOR ANALYSIS

Reliability is well-defined as "extend to which a variable or a set of variables is consistent in what it is intended to measure." If multiple measurements are taken, the reliability measures will all be consistent in their values. Reliability Analysis was conducted on the data obtained.

Here Cronbach's alpha test is used to check reliability of data collected. The values greater than 0.7 is usually acceptable for reliability analysis. Reliability analysis, Cronbach's alpha values for each factor for adopters and non-adopters are tabulated in Table-1 and Table-2. It is seen that all values are greater than 0.7 respectively and are consistent with the required conditions, hence proving that the questionnaire is reliable and consistent.

Factor Analysis (FA) is also conducted on the data. It is used to test whether factor constructs of a group are consistent with their factor loadings. Factor loadings greater than or equal to 0.5 for the constructs are accepted. Kaiser-Meyer-Olkin test was also conducted on the collected data to check the adequacy of the sample. It indicates the proportion of variance of the data taken. Kaiser-Meyer-Olkin test values greater than 0.6 indicates that the factor analysis might be useful with the data.

Table -1: Reliability and Factor Analysis of Adopters

Factors	Cronbach's alpha value	Kaiser-Meyer-Olkin value
Awareness on IoT	0.876	0.816
Behavior of adopters	0.870	0.772
Level of innovativeness	0.879	0.804
Market factor	0.908	0.771
Social influence	0.841	0.621
Perceived benefits	0.892	0.800
Perceived Fee	0.896	0.660
Risk factor	0.855	0.658
Reliability	0.812	0.617
Scalability	0.782	0.678
Attributes of IoT	0.896	0.766
Intention to adopt IoT	0.911	0.837

Table -2: Reliability and Factor Analysis of Non-adopters

Factors	Cronbach's alpha value	Kaiser-Meyer-Olkin value
Awareness on IOT	0.927	0.868
Behavior	0.888	0.838
Level of Innovativeness	0.879	0.853

In this study 4 constructs out of 58 constructs for adopters were excepted for further study due to the bad factor loadings that is less than 0.5.

5. MULTIPLE REGRESSION ANALYSIS

Multiple Regression Analysis (MRA) is used here to test the hypothesis.

H_0: Factors have no significant influence on intention to adopt IOT.

H_1: Factors have significant influence on intention to adopt IOT.

There are some assumptions needed to be satisfied before conducting the MRA they are:

- Linearity must be there between the outcome factors and independent factors.
- Residuals must be normally distributed.
- No correlation between independent factors.
- Homoscedasticity of variances.

Which are evaluated with scatter plots without curvilinear relation and scattered points, p-p plots with straight line diagonally for normal distribution, Variation Inflation Factor (VIF) between 1 and 10 for no multicollinearity. Those assumptions are satisfied in this study. So, MRA is done to test the Hypothesis.

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.074	.844		.087	.932
	Awareness on IoT	.060	.184	.057	.326	.749
	Level of innovativeness	.081	.166	.088	.492	.630
	Market factor	.192	.132	.214	1.459	.165
	Social influence	-.014	.081	-.020	-.173	.865
	Percieved benefits	.344	.146	.295	2.361	.032
	Percieved fee	-.002	.103	-.003	-.023	.982
	Percieved risk	-.150	.104	-.203	-1.447	.168
	Reliability	.100	.092	.142	1.088	.294
	Scalability	.303	.119	.287	2.545	.022
	IoT attributes	.072	.120	.086	.595	.560

a. Dependent Variable: Intention to adopt

Fig -1: Multiple Regression Analysis

If the significance value of MRA is less than 0.05 we reject the null hypothesis H_0 and accept alternate hypothesis H_1. From Fig-1 it is seen that significance value for factors perceived benefits and scalability is less than 0.05 hence we accept alternate hypothesis that is both factors have significant influence on intention to adopt IOT. As the B value for both factor is positive, positive influence is there. But for other factors we accept null hypothesis as significance value is greater than 0.05.

6. INDEPENDENT SAMPLES T-TEST

Independent samples T- test is conducted here to test another Hypothesis. That is to compare two different population.

H_0: Adopters and non-adopters are not different on basis of awareness on IOT, behavior, Level of innovativeness.

H_1: Adopters and non-adopters are different on basis of awareness on IOT, behavior, Level of innovativeness.

There are some assumptions needed to be satisfied before conducting independent samples T test:

- Factors should represent two different groups.
- Factors should be normally distributed and measured on continuous scale.
- The variances of the test variable should be equal.

Here adopters and non-adopters are of different population measured on continuous scale. Levene's test significance value is greater than 0.05 so equal variance assumed.

Table-3: Independent Samples T-Test

		Levene's test Sig:	**T-Test Sig (2-tailed)**
Awareness on IOT	Equal variances assumed	0.068	0.008
	Equal variances not assumed		0.006
Behavior	Equal variances assumed	0.462	0.141
	Equal variances not assumed		0.162
Level of Innovativeness	Equal variances assumed	0.377	0.121
	Equal variances not assumed		0.146

If the T- test significance value is less than 0.05 we reject null hypothesis H_0 and accept alternate hypothesis H_1. From the Table-3 it is seen that T-test significance value for factor awareness on IOT is 0.008 less than 0.05 hence we reject null hypothesis and accept alternate hypothesis that is adopters and non-adopters are different on basis of awareness on IOT. But for other two factors T-test significance value is greater than 0.05 and hence we accept null hypothesis that is adopter and non-adopters are similar on basis of these two factors Behavior and level of innovativeness.

7. CONCLUSIONS

Here in this study 11 factors affecting IoT adoption in vehicles is determined by literature review and expert opinion. Survey was conducted from 26 adopters and 52 nonadopters by forming questionnaire. Reliability and Factor Analysis was performed to check whether the

preformed factors are reliable and show factor loading consistency. MRA is employed to find relationship of the 11 factors with adoption intention. And it is found that perceived benefits and scalability have positive significant influence on adoption intention. T-Test for differentiating adopters and nonadopters on basis of awareness, behavior and innovativeness. Where awareness is different and other both are similar in adopters and non-adopters.

Adopters and non-adopters are of Logistics and Transport department of Kerala. It is understood from the study that awareness needs to be increased among the people. So, awareness programs and advertisements on IOT is necessary in India. Also, internet connectivity issues needed to be resolved soon for better smarter development of IOT and other such technologies in India.

This study was conducted in Kerala in India which can be extended to other parts of the country. Collected sample size is less and can be increased for more accurate prediction. Study can be extended to find other factors affecting IOT adoption. Cost- benefit analysis was not done in this study, which can be the future scope. Study to improve the relevant factors to increase the adoption can be the future study.

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