Study on Acceptability of Hyperloop in Kerala

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***Abstract*— The conventional mode of transportation of people consists of four unique types and that are rail, road, water, and air. These modes of transport tend to be either relatively slow, expensive, or a combination of both. Hyperloop is a new mode of transport that seeks to change this pattern by being both fast andinexpensive for people and goods. Hyperloop is a proposed mode of passenger and freight transportation that propels a capsule-likevehicle through a near-vacuum tube at more than airline speed. Passengers may enter and exit Hyperloop at stations located eitherat the ends of the tube, or branches along the tube length. It quickly becomes apparent just how dramatically the Hyperloop could change transportation, road congestion and minimize the carbon footprint globally. The purpose of this study was to determine the user acceptability of hyperloop. However, user acceptability is important for the enforcement and widespread useof these technical innovations. An online study on the acceptability of hyperloop based on quantitative data of a sample presented. The results show a remarkably high level of overall intention to use the hyperloop public transport system in Kerala in the future.**

Keywords*— *Hyperloop; Propels; Vacuum Tube; Capsule

I. INTRODUCTION

The Hyperloop is a concept for high-speed transportation, consisting of capsules traveling at high speeds in a tube with near vacuum pressure. Imagine travelling from Thiruvananthapuram to Kasaragod in one hour without boarding a plane and with nowaiting time or emissions. These are the ambitious targets of hyperloop, a radical mobility innovation currently under development. The core technology of the hyperloop is based onvehicles designed to transport people in low-pressure tubes, accelerated by a magnetic levitation belt. Hyperloop technology presents opportunities for shortened travel time, a lower infrastructure footprint and an exceptionally low use of energy. Virgin Hyperloop One (VH1), a technology company with headquarters located in California, United States, has developeda full-scale test facility that uses the core elements of hyperlooptechnology. Key factors for the successful introduction of the hyperloop as a mass transportation solution include overcoming technical and economic challenges, as well as gainingacceptability among potential users. However, research on users perspectives toward hyperloop technology remains scarce. Theaim of this study is to generate a deeper understanding of user acceptability of hyperloop technology by identifying users' willingness to use this mode of transportation and the factors that support user acceptability or rejection of the new technology.

The key challenge of this study is that most potential users are not currently aware of hyperloop technology and its development. Therefore, it is of particular interest to examine how different levels of user knowledge about hyperloop affectits overall acceptability.

II. LITERATURE REVIEW

Potla Jithendra (2018) investigated that the hyperloop is thenew mode of transportation alongside road, rail, air and water.The study reveals the theoretical evaluation of the currentmaglev as well as the evacuated tube technology and concluded that the Hyperloop is feasible if properly designed. It has thepotential to be much more efficient in terms of energy usage ofpods traversing down the tube. Author came out with a resultthat the transportation of passengers can be possibly done in avery less time at cheaper rates. Further improvements in thistechnology can lead to more reduction in price with greater sustainability.

Wang Zhiqiang and Huang Yage (2017) use questionnaire survey method, collected data from Suzhou metro passengers and evaluated data to common dynamic guidance information,based on the survey result, analysed the availability, clarity andcomprehensibility characteristics of dynamic guidance information in various medium. Their analysis find that metro passengers have certain expectation on the dynamic guidance information's effect, hoping accompanied by perfect dynamic information during the travel process to improve the service experience. The analysis shows that passenger's age, education level and taken subway's frequency will affect it's dynamic guidance way's acceptability, but not outstanding.

S Roopa and M.S. Rani (2017) have studied the questionnaires that are frequently used in quantitative marketing research andsocial research. They achieved the purpose of questionnaireresearcher need to put in place of reliability and validity, formatof the questionnaire, logical arrangement, knowledge, classification behaviour, perception of question, length and output of the questionnaire. They reveals in depth information about requisites like constructing a questionnaire, pilot testing them, standardizing them and reframing the poor questions and provide an estimate of the average time each questionnaire will taken to complete.

III. METHODOLOGY

To investigate the acceptability of ultra-high speed ground transportation system for passenger and cargo , we conducted an online survey. In preliminary survey we conducted a pilot questionnaire survey to find out about the awareness of hyperloop among the public. we awarded participants by provided certain information and introduction video about hyperloop. In final questionnaire survey began with questionnaire related to the use of current means of transport, problems and challenges faced by passenger during traveling, attitude of people towards fastest mode of transportation. Answers could be given on a five-point Likert scale. We used open question to get insights about the participants previous experiences and attitude toward the fastest mode of other transport. Demographic data were collected at the end of the questionnaire. The questionnaire was tested in pre-tests for comprehensibility and revised. Subsequently, the survey was advertised in Kerala in various social networks and online platforms and released from 05/05/2021 – 14/05/2021. The survey was completed by 337 participants, 45.4% of whom were female. Most of them preferred to travel in fastest mode than current option.

IV. RESEARCH APPROACH AND SAMPLE

Data were collected from 5 May 2021 to 14 May 2021 via an online study conducted in the Kerala, a representative sample of the overall population was utilized. The following results refer to the representative sample. The sample size was 337 participants. The sample consisted of 54.6% male and 45.4% female respondents. A wide variety of education levels and income groups were represented in the sample. More than 63.8% of respondents preferred to travel in fastest mode than current mode of travel, where the majority of respondents reported using metro once in life.

At the beginning of the questionnaire, hyperloop-related associations were collected from participants who had prior knowledge about the technology. Afterwards, all participants were provided with a short explanation of key facts about hyperloop. The questionnaire further covered a wide range of acceptability-related topics, including participants' reasons for using hyperloop, fears and concerns, willingness to use the technology and expectations of success.
The influence of prior participant knowledge about hyperloop on their acceptability of the technology was examined in two ways. The first analysis only considered participants' preexisting knowledge about hyperloop. In the second analysis,

participants were provided with more hyperloop-specific information, including facts about travel speed, interior design and technical details. To examine the impact of the additional information, some acceptability-related topics (e.g. participant opinion and willingness to use the technology) were asked a second time after the additional information was provided

Table 1 Travel time comparison

Route :Thiruvananthapuram – Kasaragod				
Distance	**Hyperloop**	**Air**	**Train**	**Bus**
530 km	35 mins		11 hrs 53mins	12hrs 15 mins
Route :Thiruvananthapuram – Cochin				
200	13 mins	55 mins	4 hr	3hrs 30min

"Hyperloop Alpha" emphasizes that the hyperloop technology will be completely solar powered. However, maglev and HSR are also electric and could in theory also be solar powered. Focusing on the amount of energy required, HT found that for most routes hyperloop would be 2 to 3 times more energy efficient than air on a passenger mile basis; however, maglev and HSR also use 1/3 the energy of air on a passenger mile basis. The emphasis on solar power tends to obscure the fact that no technology is entirely clean because there is energy consumed in manufacture and construction of the technology.

Table 2 Energy Consumption

	Hyperloop	**Air**	**HSR**
Fuel	Electric	Jet Fuel	Electric
Power Source	Solar powered with backup batteries	petroleum	100% renewables via purchase of offsets (CAHSR) Grid, so mix of all energy sources in region. There is no reason HSR couldn't be solar powered as well.
Energy Consumption (BTUs per Passenger Mile)	Short route: 5-6x more fuel efficient than air Other routes: 2- 3x more fuel efficient than rail	3,230 BTU/p-m	975 BTU/p-m
Emissions Operating Phase	Zero	High, but improving over time	Depends on Electric Source
Emissions Construction Phase	Not zero due to manufacturing of tube and vehicles	Additional due to manufacturing of vehicles and construction of airport facilities	Additional due to manufacturing of guideway and vehicles

V. RESULTS

A. Sample characteristics

Table 3 shows a summary of the demographic characteristics of respondents. A large portion of the respondents (n=117) were aged between 18 and 25 years, and the respondents listed college as their highest level of educational attainment. Based on this information, we inferred that they were either students or had only recently graduated from university. Despite all of population being at the age level of 18–25, the youngest age level also accounted for the largest age group in population attendant in the survey. Younger people being more interested in the project theme, and online surveys typically attracting younger people.

TABLE 3 Demographic data of the respondents

Items	Descriptions	Population (total= 337)	
		Frequency	*%*
Gender	Male	184	54.6
	Female	153	45.4
Age	Below 18	17	5.0
	18-25	117	34.7
	26-30	53	15.7
	31-40	86	25.5
	41-50	32	9.5
	51-60	10	3.0
	Above 60	22	6.5
Education	Up to SSLC	17	5.0
	Higher Secondary & Diploma	23	6.8
	Under-Graduate	212	62.9
	Post-Graduate & above	85	25.2
Annual income	Up to 9999	35	10.3
	10000-19999	34	10.1
	20000-29999	48	14.2
	30000-39999	62	18.4
	40000-49999	98	29.1
	50000-79999	39	11.6
	Above 79999	21	6.2

B. *Traffic Forecast :Thiruvananthapuram – Kasaragod : Ridership over different horizon years.*

For future estimations, base year was considered as 2019-20, commissioning year as 2025-26 and horizon year as 2052-53. The daily ridership was estimated for four different scenarios as Pessimistic, Business-As-Usual, Realistic and Optimistic built-up based on variations in parameters such additional infrastructure developments, additional traffic generated, growth rates based on all India GDP and difference in mode-wise probability of shift from potential trips. The daily ridership was observed to be varying between approx. 54,000 daily trips in worst scenario to 1, 14,000 trips in optimistic scenario in 2025-26.

TABLE 4 Ridership forecast

Parameters	2025-26	2029-30	2041-42	2052-53
Ridership	79,934	94,672	1,32,944	1,58,946
Passenger. km	58,35,182	6911,056	97,04,912	1,16,03,058
Average trip length (km)	200	200	200	200

C. *Prior knowledge and associations with hyperloop*

The majority of respondents (55.8%) stated that they knew nothing about hyperloop technology prior to the study. Those who had heard of hyperloop beforehand only knew that it is a high-speed train. Therefore, hyperloop was positively associated with being fast. It was also associated with being modern, innovative and sustainable in a positive way. It is interesting to note that speed also held negative associations for some respondents. Other common negative associations included that hyperloop is expensive and dangerous. Overall, participants' associations with hyperloop were predominantly positive . Notably, respondents who reported a high level of prior knowledge about hyperloop had more positive associations with the technology than those who had only limited knowledge about hyperloop prior to the study. Men had significantly more knowledge about hyperloop than women, and overall, male participants had a more positive opinion than female participants regarding the technology. There was no observed difference between age groups with regard to prior knowledge or opinions about hyperloop.

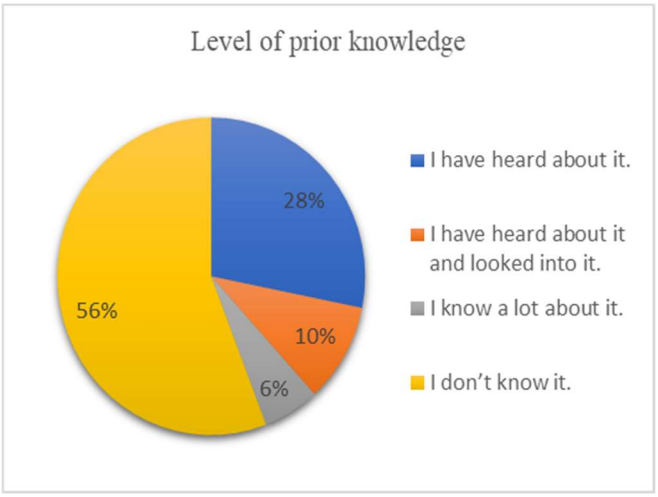

Fig. 1 Level of Prior Knowledge

D. *Reasons and barriers for using hyperloop*

As expected, the study data confirmed that the most important reason people would prefer to use hyperloop is the fast travel time. Other expected benefits that participants claimed would support their use of hyperloop included environmental friendliness, a quiet and comfortable ride and pricing that is comparable to other means of transportation. When asked to what extent they expected hyperloop to provide these benefits, respondents reported that they expected all but one of these benefits (pricing) would be provided by hyperloop. In other words, potential users expect hyperloop developers to deliver on their promises, but they assume that the technology will be priced higher than other means of transportation. Interestingly, social aspects such as the desire to impress others or to differentiate oneself from others by using hyperloop were not regarded as important. Participants' negative associations regarding hyperloop indicate possible barriers to usage. Potential users reported that they were most concerned about the lack of windows and the lack of employees in the hyperloop vehicles. Other concerns included potential failure of the

technology, as well as the low-pressure environment and the high travel speed. However, only a minority of all respondents stated that they had concerns about hyperloop. In general, female respondents had more concerns than male respondents, and there were no differences between age groups.

E. Willingness to use

Participants were asked how likely it is that they would use hyperloop in the future. Despite their generally low level of current knowledge regarding the technology, half of the participants (51.8%) reported that they would use hyperloop. The previously mentioned reasons for using hyperloop, as well as fears and barriers to its use, impact participants' willingness to use the technology. Statistical methods were employed to examine which of the reasons for using hyperloop had the greatest impact on participants' willingness to use the technology. As expected, short travel time appeared to be the factor with the strongest impact on participants' willingness to use hyperloop. The second strongest predictor in the analysis was the joy of usage. In other words, a respondent's expectations of whether hyperloop will provide a joyful experience has a significant influence on their decision about whether to use the technology. Additionally, the results indicate that a high level of prior knowledge and information about hyperloop significantly increase participants 'willingness to use the technology.

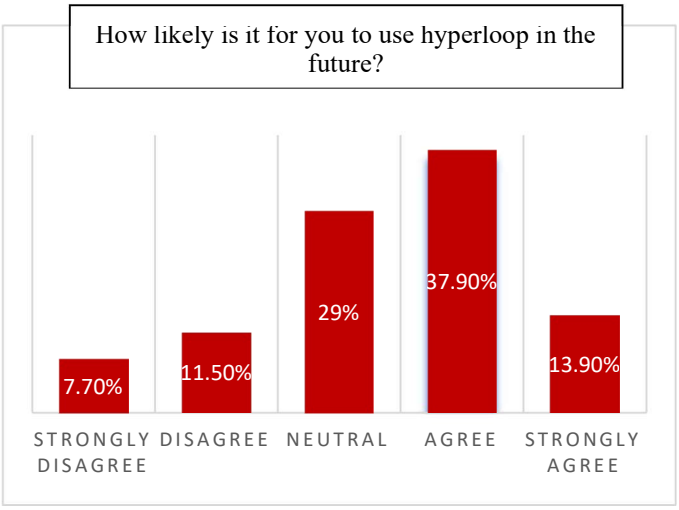

Fig. 2 Willingness to use hyperloop in future

Male participants had more prior knowledge of the technology than their female counterparts. In accordance to this, male participants were more Agree than female participants to report willingness to use hyperloop. Interestingly, age-specific differences were observed in participants' willingness to use the technology, despite the lack of age-related differences in prior knowledge about the technology. Specifically, younger participants reported that they were more likely to use hyperloop than older respondents. Participants under 30 are more likely to use hyperloop than participants older than 50. The data indicate that younger participants were more likely than older participants to expect the hyperloop travel experience to be fun, which may strongly influence their willingness to use the technology. This finding indicates that participant knowledge based on prior travel experience could lead to higher acceptability of the new technology.

Respondents were asked whether they believed that hyperloop would be successful in their state. The majority of respondents believed that hyperloop would be successful in the Kerala, which indicates high societal acceptability. The data show that individual and societal acceptability are strongly correlated in that people who are likely to use hyperloop themselves consider others likely to use it as well.

F. Effects of provided knowledge

As previously discussed, participants' prior level of knowledge regarding hyperloop had a positive influence on their acceptability of the technology. This study also examined to what extent provision of additional information about hyperloop would influence participants' acceptability of the technology. Respondents were provided with information about hyperloop, including facts about the speed and the technology itself, as well as images of the hyperloop interior. Respondents' opinions and expectations of the success of hyperloop technology remained on the same level after exposure to this information. Further, the results indicate that provision of additional information may increase participants' acceptability of hyperloop. This effect was particularly pronounced among respondents who had little prior knowledge about the technology, as well as respondents who reported few concerns about the technology.

VI. CONCLUSION

In general, the study findings indicate a high level of acceptability of hyperloop among the population. Most participants had positive associations about the technology, and more than half of participants indicated that they would be willing to use hyperloop once it becomes available. These results are surprising because of the early stage of development of hyperloop technology and the resulting lack of knowledge about the technology among the population. Based on these findings, providing information about hyperloop could positively influence the attitude toward the technology, leading to even higher willingness to use hyperloop. However, increasing knowledge in the population may also lead to the opposite, because of new concerns that could be raised. Thus, the further development of the technology's overall acceptability in the society will depend on the way its core benefits and potential risks are publicly communicated by stakeholders. Stakeholder interesting in introducing hyperloop as future means of transport should put emphasis on the core perceived benefits of the technology (e.g. fast travel time and joy of use), as well as the main perceived concerns of the technology (e.g. lack of windows and lack of staff). The study results indicate that provision of additional information may help to overcome the objections of those with few concerns. To convince potential users with high levels of concerns to use the technology, other strategies will be needed, such as live experience of hyperloop. The potential impact of these strategies on acceptability of hyperloop technology will require further evaluation.

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