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Ethics of Intelligent Vehicles Technology: A Comprehensive Review

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Abstract: Intelligent vehicles technology is growing with new developments and mobility systems. These developments arise so many implications in an ethical manner. Specifically in some scenarios i.e., vehicle uncontrolled situations by automation systems, program failure conditions in driving time, and many more. In this situation, who is responsible? The literature section explored the existing studies of who, how and when designed the ethics. The policy makers and standard organizations are designed some policies and recommended to the government which present following the policy system. These policies are only concerned about public health, environmental issues, road safety, traffic congestion and many more. But in few areas found implications i.e., data privacy, cyber security, cost and decision-making system etc. by existing studies. To improve this autonomous technology public fully acceptance is must. For the adoption of this technology, users get more benefits such as travel time, safety, mobility, no traffic, less environment issues etc. and at the same time some factors also influencing. Ethical and policy systems are linked to acceptance of this technology. Above ethics, policy and public acceptance of these technology areas are investigated and found to have some implication gaps. This paper aims to present the existing studies and implications in ethics, policy and public acceptance of this technology area. In future, this review study will recommend to all those doing research, engineers, philosophers, policy design government sections to develop the sustainability system in intelligent vehicles.

Keywords*: Autonomous driving, Ethics, Decision making system, Intelligent Vehicles, Mobility, sustainability, User and vehicles behavior system.,*

1. Introduction:

Automation technology plays a vital role in the engineering, science and economy matters. Major advantages are reducing the continuous human efforts and increasing the technology outputs. In this technology, Autonomous vehicles were introduced in the 1950's which were controlled by remote. Currently this technology is updating up to fully automatic control. Some major benefits have to compare with manual control vehicles i.e., traffic congestion, environment issues, road accidents, mobility, travelling time, safety, security and vehicle efficiency. Paradox of this technology has many implications in ethical, policy systems and people's acceptance of autonomous vehicles. So, we considered the above implications as objectives of this review work.

In this work, independent variables are autonomous vehicles, dependent variables are policies and ethics, mediator variable is public acceptance and attitude, moderator variable is classified reasons of mediator variables. These variable implications are explained below with literature review.

1.1. Intelligent Vehicle Ethics

Ethics is a system of moral principles and it was derived from the Greek word “ethos”. Ethos' meaning was character or custom. Ethics are mainly classified by 3 areas such as Meta Ethics, Normative Ethics and Applied Ethics. Based on these ethics derived some theories i.e., Relativism, Universalism, Utilitarianism, Hedonism, Deontology, Pluralism, Absolutism and Consequentialism. Autonomous Vehicles technology comes under the Artificial intelligence ethics section in Applied Ethics. So many philosophers yielded different theories and introduced artificial intelligence ethics related to autonomous technology. These autonomous vehicles ethics are addressed and explained in the literature review section. The applied ethics principle is concerning a person or a system impel behaviour in a specific situation and its decision-making system. The present following ethics are having the implications and facing challenges every day.

Fig 1 Ethics Factors on Autonomous vehicles

Every time these ethics are revised and explored to particular applications or situations. For implementing these ethics in autonomous vehicles technology, a lot of factors influence the manufacturers, stakeholders, policy makers, users, consumers etc These factors are graphically represented in figure 1.

2. Literature Review

In this section explained and addressed the existing study individually about ethics, polices and public acceptance of this technology and their influencing factors.

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2.1. Intelligent Vehicle Ethics:

The four ethical policies which are implemented practically on real time moving the vehicle. In German government designed the 20 ethics guidelines to design autonomous vehicles. So, all automotive engineers are designing the vehicle based on that ethics but the complication was these ethics are not designed by practically. These proposed for practical ethics are very helpful to design autonomous vehicles. The discussions about the ethical issues of autonomous vehicles. These issues are addressed by the existing technical and scientific reports. Most of the private companies are influencing the users to own the autonomous vehicle but companies are taking very low risk ethically if any crashes are happening. Majority of industries are still exploring the trolley problem of autonomous vehicle ethical issues. The research gaps between autonomous vehicles' decision-making process by using ethical framework i.e., deontology, pluralism, utilitarianism, absolutism, relativism. Some issues are also discussed about uncontrollable vehicle situations, decision making process and people's attitude about these vehicles. A decision-making algorithm inspired by the autonomous vehicle's ethics i.e., contractarianism, utilitarianism and egalitarianism. This proposed method detects the severity of behaviour of autonomous vehicles and avoids collisions. But these policies are having different perceptions and behaviour systems in ethical matters. The different users' attitude and autonomous vehicle behaviour at crash situations. By ethically presenting those autonomous vehicles are not responded when accidents happen by themselves or others but humans will respond. These types of trolley problem questions raise so many ethical issues for designing the autonomous vehicle.

An identified ethical gap between the safety problems of autonomous systems. The ethical gap means that responsibility, liability, security aspects. This work also presented the difference between the semantic gap, responsibility gap and liability gap of ethical design. These gaps are referred to for future development and control the risk factors. The different perceptions and arguments of the trolley ethical cases of intelligent vehicles. Few arguments are outlined and explain the difference of right or wrong arguments. Finally suggested some positive arguments for develop the ethics of intelligent vehicles. Introduced technology ethics based on the automation attitude and decisions for designing intelligent vehicles. In the explored work on ethics, most are the trolley problems only. By using human and machine interface some realistic ethical problems and decision systems are solved practically. These solved ethics are very helpful to framing intelligent vehicle technology. The criticism report of risk, uncertainty, value sensitive design and partiality ethics on intelligent vehicles. Most ethics are dilemmas when it comes to reality scenarios. So many ethical challenged questions are discussed and criticized with questions.

Intelligent vehicles ethics are designed by the trolley problem. But in this trolley problems also have unethical solutions. Here presented the few identified problem which is ethically wrong. These trolley problems are having their limitations, solved only in simulation not in practically, political influence for designing these ethics and not solved in unpredicted situations. The current ethical system of intelligent vehicles. These ethical systems are not sufficient for users' liability. Here also found out the gap between the ethics i.e. accountability, transparency, ownership, human control, tort rules and bias system on society influencing factors. Ethical and legal issues are raising the when intelligent vehicle reason for road crash or accident. The ethics are designed based on the results of pre-programmers. In reality some do not succeed ethically. An ethical knob is designed and proposed in the Altruistic, Impartial and Egoistic modes for analysis of the situation and taking the decision by ethical choices. The legal, ethics, social and economic factors of intelligent vehicles. The above theories problems are finding and few are solved by considering the public opinions i.e., users, engineers, stakeholders etc. Most of the discussions about the ethical system of intelligent vehicles successfully have not yet completed and not conducted transparently. Few countries' legislations are designed in only liability, security and safe driving aspects. The human drivers vs. fully intelligent driving vision on uneven driving conditions. While using fully intelligent vehicles, the risk factor is very low but ethically it's wrong to replace the human driver and describe the plausible mechanism for solving these ethical challenges in intelligent vehicle design.

The review about the ethical questions on intelligent vehicles behavior to human life. These ethics are divided into mandatory and personal ethics. The mandatory ethics is related to the society's perception about intelligent vehicles and the personal ethics states about the current users who own this type of vehicle. In the ethical situation most users are in a dilemma and are scared about owning this vehicle. Finally, by using game theory method i.e. The Prisoner's Dilemma solution results showed most of users are interested on personal ethics only. The intelligent vehicles ethics for design the accident algorithms. Automotive engineers are not accepted. 100% of intelligent vehicles avoid accidents in all scenarios. These algorithms are mainly concerned with the decision making of vehicle, legal responsibility of accidents and vehicle attitude in uncertain situations. In these concern areas also having the issues are explained. Intelligent vehicle ethical systems raise so many issues to engineers in decision making tasks. Some ethics are designed by morals but in the practical evaluation process its ethical process. So in this research work proposes some minimum requirements of designing the ethics and its more help to design the intelligent vehicles. The new kind of ethical bot and practically validated with some scenarios. The existing AI devices are communicating, making decisions on their own and working beyond the programmers' instructions. Many debates concluded that these all are the unethical or illegal devices i.e., self-driving vehicle. This new AI device was accountable to program i.e., continuously monitoring, auditing the work and if required hold the operation also.

The ethical analysis of intelligent vehicles road crushes with existing issues which is addressed by Patrick Lin's. In these discussions questions whether by tort liability ethical law manufacturers should be responsible for any accidents or whether humans are giving any attention in driving to avoiding the accidents. Finally concluded that all who own these intelligent vehicles are not morally responsible. How intelligent vehicles reduce road accidents; improve the efficiency of vehicles and usage of road space. Most of the users trust these vehicles to avoid crashes but still somewhere crashes happen by these vehicles. Considering these scenarios, ethically the computer will be responsible for not controlling the vehicle. Here are some ethics which are practically implemented by intelligent vehicles to avoid crashes. Road transportation is a very risky task to avoid crashes. It is also significant to computer operated vehicles. By fully intelligent vehicles ethics concluded, these vehicles are avoided crashes at any scenario to save the driver. Criticisms of the ethical

Table 1. Meta information of previous Ethics surveys

S.No	Ethics	Findings
1	Relativism	User's individual factors and ethical states of self-driving vehicles. Designed ethical frame work for avoidable accidents and acceptance. Pedestrians and users safety implications from intelligent vehicles.
2	Universalism	Presented the Universalism ethics are hitherto for intelligent vehicles decisions. Validated the different scenarios by virtually through ethical trolley problems. Addressed the liability implication in robotics applications and decisions.
3	Utilitarianism	Refine the non-consequential ethical theories and explored the alternative ethics. Introduced the social welfare function for solve the trolley problem by ethically Investigated the technology, safety, utilitarianism factors towards user acceptance. Discussed the implications about to design of social internet of things. Described Human decisions in virtually by Utilitarianism manner. Proposed a trolley problem solution using Utilitarianism and AI algorithms. Addressed the Utilitarianism and liberty Artificial intelligence solutions.
4	Hedonism	Primary settings for ethical frame work in decision-making model. Positive perception and acceptance from society by ethical manner.
5	Deontology	Intelligent system interacting with the society and human beings. Ethical crash algorithms for uncontrolled vehicle behaviour. Trolley problem of AVs behaviour in unavoidable accidents situations. Designed ethical frame work for controlling the intelligent systems.
6	Pluralism	Integrative ethical decision-making framework deigned for AV ethical implications By ethical Knob, preference to both passengers and third parties. Considered an AV's behaviour as selfish or utilitarian.
7	Consequentialism	Discussed the topography of safety and ethics. Crash-optimization algorithms for ethical dilemma solutions. Analysed the trolley problem of intelligent vehicles ethics. Presented robustness and implications of ethics with path planning examples. Proposed a predictive control framework for ethical decision making.
8	Absolutism	Designed ethical frame work for avoidable accidents and acceptance.

decision-making systems also explained with the practical applications.

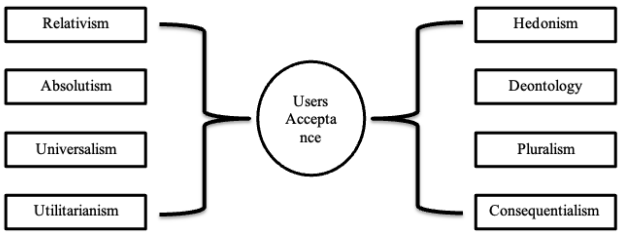

Fig 2 Ethics are linking to User Acceptance of Autonomous technology

3. Conclusion

Developments in intelligent vehicles technology and mobility systems have provided more acceptances from users. This study explored and highlighted the three dimensions of intelligent technology are ethics, policies implications and their factors affecting the public acceptance. Above three dimensions Meta information and their findings clearly shown in Table 1. For designing the ethical framework and policy systems affecting factors also shown in Figure 2. The findings are in this paper presented:

In ethical system, identified the several implications i.e., trolley problems from the existing studies. Types of ethics i.e., Relativism, universalism, utilitarianism, hedonism, deontology, pluralism, consequentialism and absolutism are also explained with who and when adopted these ethics for Intelligent vehicles technology. These ethics, few are concerned about human health and the surrounding environment. Some are the adoption for machine ethics i.e., artificial intelligence ethics, robotics ethics and intelligent vehicles ethics. The implementation of ethics presented in this paper helps to prominence development towards sustainability.

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Author contributions

Sailatha Karpurapu: Literature data collection, processing, analysis, writing original draft, **Naga Venkata Raghuram:** Supervision, writing - review and editing. Authors have read and agreed to the final version of the manuscript.

Conflicts of interest

The authors declare no conflicts of interest.

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