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Values of trust in AI in autonomous driving vehicles

Ru Lian

Department:

VALUES OF TRUST IN AI IN AUTONOMOUS DRIVING VEHICLES

by

RU LIAN

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Approved by:

Keng Siau, Advisor
Fiona Fui-Hoon Nah
Cecil Eng Huang Chua

ABSTRACT

Automation with artificial intelligence technology is an emerging field and is widely used in various industries. With the increasing autonomy, learning, and adaptability of intelligent machines such as self-driving cars, it is difficult to regard them as simple tools in human hands. At the same time, a series of problems and challenges such as predictability, interpretability, and causality arise. Trust in self-driving technology will impact the adoption and utilization of autonomous driving technology. A qualitative research methodology, Value-Focused Thinking, is used to identify the values of trust in autonomous driving vehicles and analyze the relationship between these values.

Keywords: Artificial Intelligence; Autonomous driving vehicles; Trust; Value-Focused Thinking

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1. INTRODUCTION

Artificial intelligence (AI) technology is implemented in many areas and is now a part of our life (Siau, 2018). Speech recognition, visual recognition, machine learning, and other related technologies have advanced rapidly. AI has performed well in many areas, such as finance, retail, medical, automobile, forecasting the future, facilitating human convenience, and relieving humans of dangerous and monotonous works (Siau et al., 2018). In fact, many decisions in our life need to be predicted in advance, and with the development of technology, the prediction ability of artificial intelligence is almost always better than that of human beings. However, the development of science and technology has been facing many challenges. On the one hand, people are always skeptical of new things. For most people, it is often difficult to remember the right things, but they are always sensitive to the mistakes of others. As far as AI is concerned, at the present stage, it is not possible to give a reasonable explanation of the decisions made by AI, which can be understood by ordinary people. These many factors have led to a human distrust of AI. On the other hand, for those who are not familiar with AI, there must be fear and doubt about the unknown in their hearts; for those who know AI, they may have expressed concern about immature technology.

A new round of scientific and technological revolution is underway. Autonomous driving vehicles have virtually become the postal child of emerging scientific and technological achievements in AI (Hyder, Siau, & Nah, 2019). Autonomous driving technology has begun to stand at the front end of the scientific and technological stage, attracting worldwide attention and symbolizing the advancement and achievement of AI.

Autonomous driving vehicles are of great significance to the improvement of vehicle traffic (Luettel, Himmelsbach, & Wuensche, 2012). Advanced driving vehicles reduce fuel consumption and pollution. Faster response time increases highway capacity and traffic flow. The state-of-the-art anti-collision system greatly reduces the occurrence of accidents. Smarter traffic routing systems save drivers' time (Luettel, Himmelsbach, & Wuensche, 2012). However, humans have a less tolerant attitude towards mistakes made by autonomous driving vehicles compared to errors committed by human drivers. Therefore, it is essential to identify and learn the values of trust in AI in autonomous driving vehicles to customers. This research will provide a better understanding of trust in autonomous driving vehicles. A better understanding of trust in autonomous driving vehicles will help to advance the adoption of autonomous driving technology.

In this paper, we study the value of trust in AI to the customer to identify the fundamental values of trust in AI that the customers care about in autonomous driving. We use the Value-Focused Thinking (Keeney, 1996) method to identify the values of trust in AI and study the relationship between these values. A means-ends objective network will be one of the main outputs of this study. In the end, we provide the conclusion, contribution, and recommendations. We may find a way to solve the AI trust crisis, so that there will be more opportunities for human-computer interaction, so that people can better accept, understand and use AI, and prepare for AI to fully enter human life someday in the future.

2. LITERATURE REVIEW

2.1. IMPORTANCE OF VALUE

Value is the goal and guiding principle of our life (Posner, & Munson, 1979). To a certain extent, value guides our family, life, and social life and determines our attitudes, beliefs, and behaviors (Erdem, Oumlil, & Tuncalp, 1999). Our values specify what we care about in a decision context and indicate what are the better means to achieve the ends in a context. Therefore, it becomes important to understand value -- what is important to people and what people want (Posner, & Munson, 1979). Identifying value can help people make better decisions and choices.

2.2. TRUST IN AI

AI is a machine built by human beings that can perform many tasks requiring intelligence from the human (Wang & Siau, 2019). Currently, AI can be interpretable or uninterpretable. Interpretable AI is based on logic and rules. The other is difficult to interpret and may consist errors; and it is based on examples and data analysis. (Rossi, 2019). For AI, as the future core technology, building trust in this technology is a long-term task. Questions have been raised on whether human beings would be safer with or without AI, and how to make AI beneficial to human beings. AI can make mistakes, just like human beings (James, 2018).

Mayer, Davis, and Schoorman (1995) gave the definition of the essence of trust, that is, in interpersonal relationships, people are willing to show a sense of vulnerability when facing the behavior of others. Trust is a fragile phenomenon that constantly shows

and develops. Compared with creating trust, it is easier to be destroyed. There are many factors that affect consumer trust, such as the consumer's cultural background and country. Consumers may have formed values with national culture in their early years (Jarvenpaa, Tractinsky, & Saarinen, 1999).

Trust is essential to both individuals and organizations, but there are few systematic theoretical explanations for the development of trust and the role it plays. Therefore, McAllister (1995) proposes interpersonal trust and two aspects of measuring trust: emotional trust and cognitive trust. These two aspects are causally related, but each plays a unique role, and the level of cognitive trust is higher than that of emotional trust. Taking interpersonal relationships as an analogy, trust is the intermediary between humans and automation (Ghazizadeh et al., 2012). Rempel, Holmes, and Zanna (1985) propose three dimensions of automated trust over time, namely predictability, dependability, and faith. These concepts provide the theoretical basis for this article.

From the perspective of assuming that learning and intelligence can be accurately described, studying artificial intelligence can make machines that imitate human beings, enable them to read any language, create abstract concepts, solve various problems of people at present, and be able to perfect themselves (McCarthy et al., 1955). Technology, such as AI, if popularized in a society, can undoubtedly be beneficial to human development. Although many surveys show that people are afraid of relying too much on AI, they are willing to trust human experts with wrong views. As the premise of communication, trust is undoubtedly the most important in human social communication. But whether it is for human beings or artificial intelligence, trust is subjective. If we want AI to benefit mankind, people have to trust AI (Siau & Wang, 2018).

What we need to solve is not only people's trust in AI technology but also trust in AI creators and trust in companies that produce AI products (Siau & Wang, 2020). If there is an issue of trust, the application of AI or any strategic measure deemed to be threatening will bring risks of additional losses to the company and customers.

2.3. TRUST IN AUTONOMOUS DRIVING TECHNOLOGY

Autonomous driving technology can be traced back to the 1980s (Luettel, Himmelsbach & Wuensche, 2012). For example, the navigation laboratory vehicle designed by Carnegie Mellon University can operate in a structured environment (Dickmanns, 2007); Early motorway driving techniques studied by the University of the Bundeswehr Munich (Thorpe, Herbert, Kanade, & Shafter, 1991). There is also a system that can automatically decide when to change lanes, but still requires human approval (Dickmanns & Zapp, 1987). Until now, considering safety factors, the law stipulates that all self-driving cars used in public transportation must have a human driver, known as a safe driver (Thorpe, Herbert, Kanade, & Shafter, 1991). It can be seen from this, whether from the government's point of view or the public's point of view, there is still some way to go in giving the task of driving to AI with complete confidence and trust.

Autonomous vehicles with autonomous driving are currently one of the technologies in the field of transportation that is of most concerned to the public (Beiker, 2012). Automation with artificial intelligence technology is an emerging field and is widely used in various industries. The research by Hengstler, Enkel, and Duelli (2016) studies the trust of the system in cultivating artificial intelligence applications. They regard trust as a separate structure and elaborate on the driving mechanism of

establishing technical trust and communication trust. First, before using the technology, the technology must be certified and approved, and policies must be formulated because operation safety is the first condition and prerequisite to trust startup performance. Second, data security, that is, operational security, will have a significant impact on technical trust.

The self-driving car belongs to a kind of intelligent robot. Kuipers (2018) put forward a fatal dilemma in his article: how will the self-driving car react when facing the choice of sacrificing pedestrians or passengers? No matter which one it chooses, the result seems unsatisfactory. In fact, the probability of this kind of dilemma is very low. We can find a third way to avoid this situation in a short period of time through daily exercises, such as training the perception and knowledge of self-driving cars. In ordinary driving, self-driving cars can win trust by demonstrating compliance with social norms, starting with traffic rules. Therefore, self-driving cars are likely to be the first example of a universally trusted robot. The design of autonomous vehicles should focus on how the robot's daily behavior can prove their credibility.

The 2019 Deloitte Global Auto Consumer Research Survey shows that the speed of investment in advanced auto technologies in the auto industry is accelerating again, but self-driving cars are far from arousing consumer interest (Roberts, 2019). The disinterest of consumers is due to the lacking trust of automation technology to the great extent. From the perspective of the overall situation, the advanced automobile technology led by the self-driving technology is undoubtedly one of the most effective ways to solve the global pollution problem, which has made many resource-poor countries get rid of their

dependence on oil. The impact of electrification and automatic vehicles on society and the value they provide are huge.

Among the many factors that affect customers' choice of automated driving technologies, safety is undoubtedly the first. Robert (2019) once put forth a golden standard to measure the safety of vehicles -- the mileage traveled by vehicles before an accident. The average human drives for about ten years before an accident. However, this method ignores the problem. When calculating the mileage of manually driven vehicles, the process often takes several years, so the result will not be affected by a particular accident. On the contrary, when calculating the mileage of automatic vehicles, only one death case is enough to change the final conclusion trend. Therefore, for improving the safety of automated vehicles, we may need to spend more time and effort. Otherwise, it is difficult to prove that automated vehicles are safer or as safe as manual vehicles. Also, consumers' trust in the system will affect their satisfaction and willingness to continue (Lankton, McKnight, & Thatcher, 2014). Until these factors are significantly improved, consumers will have a slow process of applying these technologies on a large scale.

Different customers may have different ideas and expectations when face with trusting AI products. Research in this area is limited and this research will help to fill the void. It is also hoped to find out the factors that really perplex or affect consumers regarding the value of artificial intelligence technology.

3. RESEARCH METHODOLOGY

3.1. MEANS-ENDS CHAIN THEORY

The Means-Ends Chain Theory (MEC) theory is the foundation of understanding Value-Focused Thinking (VFT). It describes the primary objectives and means objectives, and the relationships between the objectives. The Means-Ends Chain Theory (MEC) identifies the linkages between the attributes that exist in products, the consequences to the consumers provided by the attributes, and the personal values that the consequences reinforce (Gutman, 1997). In other words, the MEC helps to understand how consumers link attributes of products with particular consequences, and how these consequences satisfy their personal values. MEC theory is widely used in social market research. A means-ends chain is a model that explains how a product or service helps people achieve the desired final state (Gutman, 1982). The means-ends objective network produced in this research can provide meaningful guidance for researchers and practitioners to understand the values of trust in AI for autonomous driving vehicles.

3.2. VALUE-FOCUSED THINKING APPROACH

In Value-Focused Thinking (VFT), values are what we care about and values are principles used for evaluation (Keeney, 1996). Values are used to evaluate the actual or potential consequences of action and inaction of proposed alternatives and decisions. A value can also be a person's principle or standard of behavior and judgment of essential things. Thus, values are the driving forces for decision-making. Value is the principle by which customers evaluate the desirability of the results they desire to achieve (Keeney,

1994). VFT used in this research can help to discover hidden objectives and make information collection more effective (Keeney, 1994).

VFT provides a systematic approach to identify and organize values (Keeney, 1992). VFT is useful in obtaining the value that customers consider essential in a specific environment. It can also discover the relationship between these critical fundamental values and the ways to realize the values. VFT is used to derive the means-ends objective network in a specific decision-making context (Sheng, Siau, & Nah, 2010).

VFT, a proven method, is also of great help to improve the reliability and validity of the data and results, so it has been applied to various disciplines and fields (Sheng, Nah, & Siau, 2005). Table 3.1 is partial literature of previous VFT approach applications. From these literatures, we can see that using VFT method can discover hidden and missed objectives, and can identify the relationships between objectives (Sheng, Nah, & Siau, 2005).

Table 3.1 Partial Literature Utilizing VFT Approach.

Author	Literature utilizing VFT approach
Keeney, R. L. (1994)	Creativity in decision making with value-focused thinking
Keeney, R. L. (1996)	Value-focused thinking: Identifying decision opportunities and creating alternatives
Keeney & McDaniels (1992)	Value-focused thinking about strategic decisions at BC Hydro
Keeney, R. L. (1999)	The value of Internet commerce to the customer
Merrick et al. (2005)	Understanding organizational safety using value-focused thinking
Selart & Johansen (2011)	Understanding the role of value-focused thinking in idea management
Sheng et al. (2005)	Strategic implications of mobile technology: A case study using Value-Focused Thinking

Table 3.2 Partial Literature Utilizing VFT Approach. (cont.)

Author	Literature utilizing VFT approach
Kajanus et al. (2004)	The use of value focused thinking and the A'WOT hybrid method in tourism management
Arvai et al. (2001)	Testing a structured decision approach: value-focused thinking for deliberative risk communication
Siau et al. (2004)	The value of mobile commerce to customers
Nah et al. (2005)	The value of mobile applications: a utility company study

The VFT process includes the following steps (as shown in Figure 3.1):

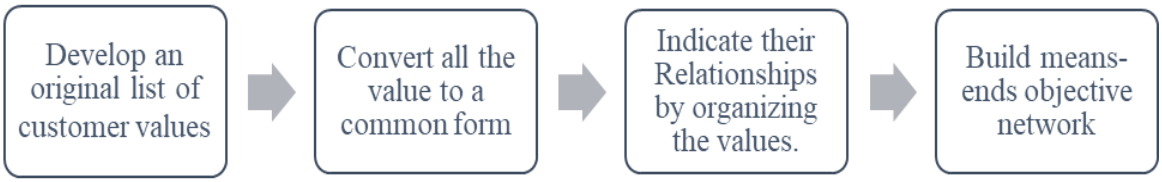

Figure 3.1 Process of Value-Focused Thinking approach.

(1) Develop an original list of customer values.

We have individual interviews with subjects and ask the subjects the values that he or she believes will affect trust in AI in autonomous driving technology. When the interviewee does not generate any further new concepts, we consolidate a list of the raw concepts. The consolidated list should ideally have the values necessary to describe all personal values. Prompting questions used in the interview include:

1. What are the benefits of trusting AI in autonomous driving?

2. What problems or concerns can arise in trusting AI in autonomous vehicles?

3. What are the important factors that affect the trust of AI in autonomous driving?

4. If there is no limitation at all, what are the features or functions you wish to have in autonomous vehicles for you to trust the AI?

(2) Convert all the values to a common form.

After asking the subjects questions about the values of trust in AI in autonomous driving vehicles, we expressed these values as 'objectives.' In other words, we converted the values into a common form. By converting each item into a corresponding objective (i.e., the desired objective), we have the list of values in a standardized format.

(3) Indicate their relationships by organizing the values.

After categorizing the objectives, it is necessary to distinguish between fundamental objectives and means objectives. The fundamental objectives are what the decision-makers think is important in this situation, and the means objectives refer to how to achieve the objectives (Keeney, 1992). We continue to ask 'why is this important?' about the definite objectives set by the subjects. If the objective of the answer is one of the basic causes of the problem in a specific situation, this objective is the fundamental objective. If the objective of the answer is to influence other objectives, this objective is the means objective (Sheng, Nah, & Siau, 2005).

(4) Build means-ends objective network.

The last step of VFT method is to build means-ends objective network, which describes the primary objectives and means objectives and the relationships between the objectives (Keeney, 1992)

3.3. RECRUITMENT OF SUBJECTS

Subjects will be students at a Midwest university in the US that are 18 or older, and adults and professionals in the IT field. Roughly equal numbers of female and male subjects will be recruited. The final number of subjects is expected to be around 40-50 as the saturation point is expected to be around 30 subjects. Some subjects may be interviewed by phone.

4. PILOT STUDY

The pilot study was conducted to test the procedure of interviews and data collection. We recruited eight subjects for the pilot. The consent form and demographic information survey were provided to the subjects before the interview. In case some subjects were not familiar with the term AI or autonomous driving vehicles, we provided the definitions of these two terms to the participants. Each interview lasted about 25-40 minutes. The interviews were audio-recorded, and notes were taken by the interviewer during each interview. Based on feedback from the pilot study, some minor adjustments were made. For instance, the instructions and questions about the interview procedures were made more explicit and more refined.

5. DATA COLLECTION AND ANALYSIS

5.1. SUBJECTS

We interviewed 50 subjects regarding the values of AI in autonomous driving vehicles by using the VFT approach. Among the 50 subjects, 26 of them are students at Missouri S&T and 24 of them are adults from industries. There are equal number of male and female, and all subjects are 18 or older. Since our research focuses on the value of trust in AI in autonomous driving technology, the participants we recruited have at least heard of AI and autonomous driving technology, and a small number of people have experience in driving autonomous driving vehicles. We will also introduce the definitions of AI and autonomous driving technology to the participants before the interview begins so that the subjects can have a general understanding of this field. The saturation point defined the size of the sample, which is a regular ending rule for qualitative research. Demographic information with important related background and information is summarized in Table 5.1.

Table 5.1 Summary of Demographic Information of Subjects.

Age			Education	
18-24	24%		Bachelor's degree	52%
25-34	66%		Master's degree	42%
35-44	8%		Professional degree	2%
45-54	2%		Doctorate or higher	4%
Annual income			Own a driver license	
Less than $24,999	66%		<1 year	54%
$25,000 - $49,999	12%		1-3 years	33%
$50,000 - $74,999	14%		3-6 years	10%
$75,000 - $99,999	8%		6-10 years	6%
			>10 years	8%

5.2. OBTAINING FUNDAMENTAL AND MEANS OBJECTIVES

Using the questions mentioned before, we collected an initial list of relevant values to trust in AI in autonomous driving vehicles following the VFT approach. Asking "why is that important" is to distinguish means objectives and fundamental objectives. In this way, subjects can critically consider the relationship between these objectives (Sheng, Siau, & Nah, 2010). This process was duplicated until the fundamental objectives appear. That is to say, when the researcher asked the subjects, "why is that important?", the subjects' answer was similar to "I think it is important because it is important". This answer means that we have found the potential fundamental value.

The interviews were attended in various forms, including face-to-face interviews, video interviews, and telephone interviews. Each interview proceeded until the subject has exhausted his/her list of values. Each interview lasted about 20 to 30 minutes, and the researcher made audio recordings and notes during each interview.

5.3. RELIABILITY AND VALIDITY

In the second phase of the research, which is after the means-ends objective network was constructed, subjects filled out a questionnaire to assess their agreement with the fundamental and means objectives. The 7-point Likert scale was used (strongly disagree = 1 to strongly agree = 7). We collected questionnaires from 50 subjects, and the average score of each objective was above 6.23, and the overall average score was 6.61. This indicates that subjects were agreeable to the fundamental and means objectives. To further validate our results, we selected 10 subjects for an in-depth study. We explained the means-ends objective network, and the fundamental and means

objectives to them. For this group of subjects, the results of the questionnaire indicate the average score of fundamental objectives as 6.8 and the average score of means objectives as 6.87. This indicates that the subjects were very positive about the means-ends objective network.

5.4. DATA ANALYSIS

The researchers obtain the means and ends objectives from the transcripts of each interview and transform the values from the notes into common forms. The researchers carefully examined the list of objectives, removed repetitive objectives, and merged similar objectives. Finally, 6 fundamental objectives and 21 means objectives are obtained. Tables 5.2 and 5.3 provide examples as support and evidence for each objective. The relationship of means-ends between objectives is derived from the subjects' answers to the test of "Why Is That Important?".

The means-ends objectives network is created according to the list of 27 individual objectives and the relationships between them. For example, when a subject said that "*It would be better if it could provide the transportation network of the whole city*". The researcher asked that "*Why is that important?*". The subject then replied, "*I hope it can automatically navigate for me*". The researcher continued to ask, "*Why?*". The participant responded, "*because this can avoid some unknown situations on the road, such as road construction or road closure*". After being asked "*Why?*", the participant answered, "*because I can keep informed of the changes in the surrounding environment".* When asked, "*Why?*", the subject continued to state that "*because traffic accidents can be avoided*". The researcher asked, "*Why is that important?*", the participant indicated that

"*so that it can ensure my personal safety and that of passengers*". The example infers the following means-ends chain: "maximize access to traffic network" → "maximize vehicle ability to navigate automatically" → "minimize uncertainty when driving" → "maximize sensing of environment" → "minimize accident" → "maximize safety".

Table 5.2 Fundamental Objectives.

Fundamental objectives	Evidence from interviews
Minimize operating cost	· Companies can reduce manufacturing costs · I am willing to trust it if it can reduce operating costs, including the cost of human resources and material resources
Maximize technology improvement	· I think the premise of believing in autonomous driving technology is that this technology is becoming more and more mature · Producers should focus on developing this technology in order to make more consumers trust
Maximize route efficiency	· It can help me save a lot of time on the road · It can make my life more efficient
Maximize familiarity with autonomous driving vehicles	· I want to know how the self-driving car works, so that I can fully trust it · Nowadays, autonomous driving technology is not common enough, and producers should advertise this technology to customers more
Maximize route accuracy	· It can improve the effectiveness of driving · It can help me drive better
Maximize safety	· As long as its self-driving car can ensure human safety, I am willing to try this technology · If autonomous driving cannot guarantee a safe driving environment, human beings will not fully trust this technology

Table 5.3 Means Objectives.

Means objectives	Evidence from interviews
Maximize access to traffic network	· I hope it can provide the real-time traffic data · I hope it can show the transportation network of the city
Maximize vehicle ability to navigate automatically	· Cars can provide navigation functions to choose the best route for drivers · It can display road condition information at any time
Maximize access to Internet	· I hope it can provide Internet anywhere · When you need help in a remote place, it can connect to the Internet at any time
Perform other task in transit	· I can answer the phone and work with confidence while driving · It can help me save time for rest, breakfast, and so on
Minimize damage to cars and people	· In the event of an accident, AI can minimize casualties · I hope that autonomous driving technology can avoid vehicle damage
Minimize uncertainty when driving	· There are many uncertain factors in the driving process · Human beings are not quick enough to respond to emergencies
Minimize involvement of driver	· Some sleepy and tired drivers who drive alone can have time to rest · It can replace human driving, for example, after drinking…
Ability to park automatically	· I hope it can park automatically · My parking technology is not good, I hope it can make up for it
Maximize the ability of intervention	· If a human driver makes a wrong decision, it can have the right to intervene · Cars can react faster than humans in emergencies
Maximize sensing of environment	· I hope it can sense the surrounding environment · I can drive normally in a particularly harsh environment
Simplify process to get driver license	· I am very resistant to take the driver's license test · I believe the process of driver's license test in some countries is too complex
Minimize careless driving by new drivers	· I do not trust the driving skills of some drivers very much · Some new drivers are not familiar with cars…
Minimize traffic jam	· It can help me calculate the route without traffic jam and save time · I would like to avoid traffic jams so that I will not miss important meetings
Minimize accident	· If I can trust this technology, its first task is to avoid traffic accidents, at least less than those caused by human beings · I hope it can reduce accidents caused by careless and irresponsible human beings

Table 5.3 Means Objectives. (cont.)

Maximize transparency of vehicle operation	· Companies should publish some test results of autonomous driving, which can make customers feel more relief · I would like to understand the automatic driving technology, such as the working policy and the AI algorithm inside, just like knowing a person
Maximize the quality of life	· It can make many people's lives better · Some people who have no ability or don't want to drive now have the opportunity to drive
Complete adherence to industry and government policies and regulations	· The government should improve the corresponding laws and regulations · Self-driving cars can fully comply with the corresponding regulations and make no mistakes
Maximize price expectation	· I am willing to buy a self-driving car whose price is within my tolerance · I think if the price of self-driving cars is lower, more people will buy them
Minimize energy wasting	· Regular cars will produce gas pollution, while self-driving cars will not · Autonomous driving technology may alleviate environmental problems such as global warming
Maximize clarity of responsibilities by various parties in accidents	· There are many cases of self-driving traffic accidents where the responsible party is not clear · I do not know who should be held accountable if the self-driving car has an accident
Minimize the possibility of losing job	· I'm worried that this technology will make some jobs disappear… · If people fully trust this technology, their trust in drivers will decrease

6. RESULT AND DISCUSSION

After interviewed the 50 subjects, we derived a series of fundamental objectives and means objectives (as shown in Tables 5.2 and 5.3). We also formed a means-ends objective network to describe the objectives and relationships between them (as shown in Figure 6.1). The results are discussed below.

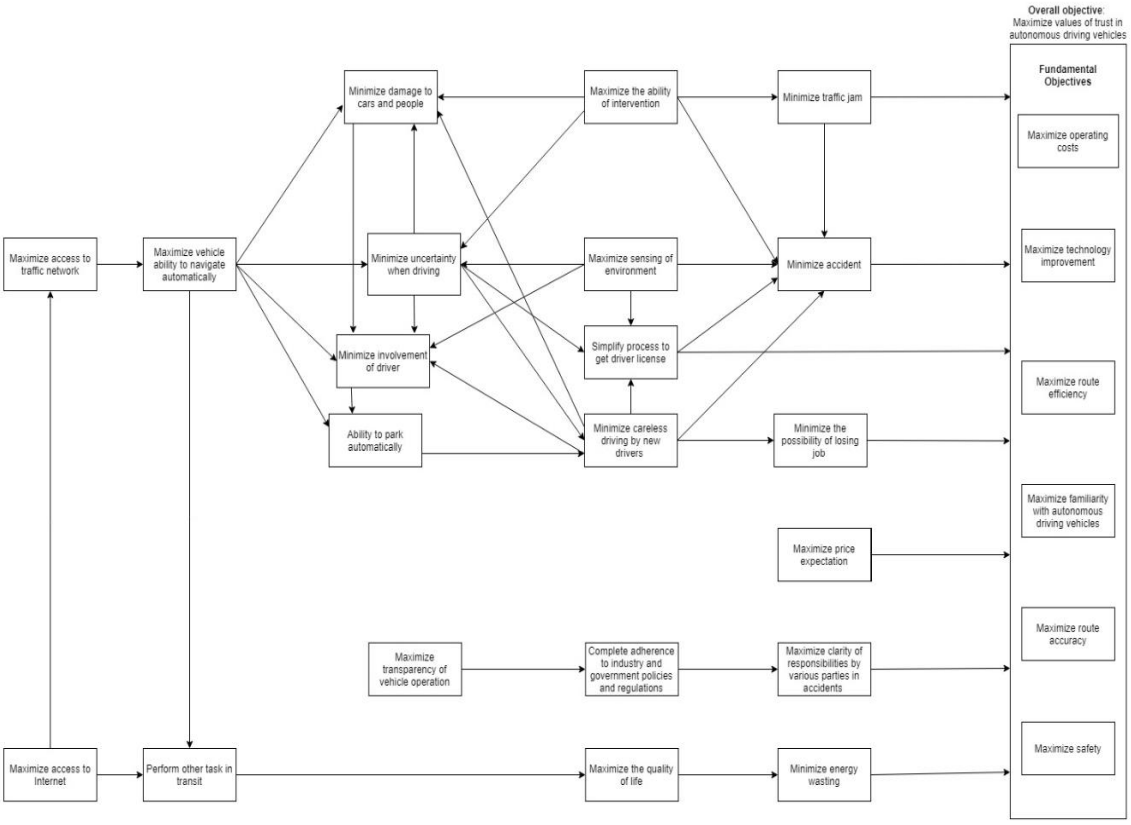

Figure 6.1 Means-ends objective network.

The overall objective of autonomous driving applications and technology in AI is to maximize the values of trust in autonomous driving vehicles. We identified six fundamental objectives in this study: minimize operating cost, maximize technology

improvement, maximize route efficiency, maximize familiarity with autonomous driving vehicles, maximize route accuracy, maximize safety. These six objectives represent the fundamental values of trust in AI in autonomous driving vehicles from ordinary people's perspectives. These objectives are the fundamental reasons that motivate customers to trust in AI in autonomous driving vehicles according to our subjects.

The first fundamental objective is identified as *minimizing operating costs*. The operation costs mentioned here include the manufacturing costs, energy costs, human resources costs, insurance costs, and so on of automobile manufacturers. Although today's self-driving cars are far cheaper than when AI first developed, they are still more expensive than most non-self-driving cars. More than half of the participants mentioned in the interview that if the price of self-driving cars in the market can be reduced to the level of ordinary cars, they are willing to try to buy them. The main reason for the high price of self-driving cars is that enterprises have invested a lot of money in R&D departments to upgrade their technological level. In addition, enterprises also need to consider the customer's personalized, customized service, and ride comfort. Therefore, the company can develop some ride-sharing applications to improve the use of vehicles' frequency and fuel efficiency (Ohnsman, 2018), thus reducing costs. When the safety level is high enough, the manufacturer can remove the airbag and steering wheel to reduce production costs and insurance costs (Davies, 2018). If all self-driving cars use electricity as power, carbon emissions and environmental pollution can be reduced, which can not only reduce manufacturing costs but also gradually help humans reduce dependence on fossil fuels. Besides, the application of autonomous driving technology will undoubtedly replace job positions related to automobile driving and traffic

management. However, on the other hand, in some countries and regions lacking human resources, or in some particularly dangerous environments, autonomous vehicles have become the best choice for human beings obviously. This series of positive impacts of autonomous driving technology will improve the public's trust and application in this technical field.

Another fundamental objective is *maximize technology improvement* and *maximize familiarity with autonomous driving vehicles*. Almost all our subjects showed concern about the maturity of AI technology and autonomous driving technology in interviews. Indeed, the accidents, algorithm problems, and potential safety hazards of autonomous vehicles all indicate this technology's immaturity. Therefore, autonomous driving manufacturers should focus on improving algorithms and technologies, including software and hardware (Ryan, 2019). Researchers believe that the reason for this concern may also be the lack of understanding of AI technology and autonomous driving technology. Therefore, apart from facing technical challenges, manufacturers should appropriately increase the transparency of autonomous driving technology. Weller (2017) mentioned that proper transparency helps build mutual trust and security, and trust depends on honesty. The subjects mentioned in the interview that if they can understand the working principle of autonomous vehicles, experimental test results, and even AI algorithm structure, they will have more confidence in AI and autonomous driving technology. The premise is that manufacturers and the government provide such opportunities to the public, which helps to achieve mutual understanding between machines and human beings. Adrian Weller also pointed out that in some cases, some problems may be more important than understanding the working principle of AI

technology. For example, compared with autonomous driving technology, which operates safely and reliably, reduces casualties, and saves more lives, our need for understanding the working principle is less critical (Lehnis, 2018).

Maximize route efficiency and *maximize route accuracy* are the other two main reasons that affect the values of trust in AI in autonomous driving vehicles for customers. The application of autonomous driving technology has greatly improved people's quality of life. It saves people the time and cost spent on the road so that people can read, work, and study on the way. Automatic navigation and real-time data can avoid traffic jams, and automatic parking also provides great convenience for people. These significantly improve route efficiency and route effectiveness. During the interview, some participants pointed out that they did not like the process of taking the driver's license test and found it complicated, and the autonomous driving technology could help people solve this problem.

Maximize safety is another essential fundamental objective that affects the values of trust in AI in autonomous driving vehicles for customers. All participants made it clear that safety is the primary consideration for trusting AI technology and self-driving cars and using this technology. Traffic accidents have always been one of the biggest causes of death (Bimbraw, 2015). People have reason to worry about giving their lives to others or even machines. Since the appearance of autonomous driving technology, it has been compared with human driving. Although autonomous driving technology has many advantages, it seems that one mistake can easily erase these advantages, which is due to human's zero-tolerance attitude towards errors in autonomous driving technology. Many subjects also mentioned that they would trust and use autonomous vehicles, but the

casualty rate caused by machines was lower than that caused by humans, at least. On the other hand, this technology was invented by human beings, which means that it may make the same mistakes as human beings, and not every human being is suitable for driving. Security here also includes network security, such as hacker attacks, user privacy leaks, and other hidden dangers. Automobile manufacturers should improve their technical strength as much as possible and maximize the safety level and reliability of autonomous driving technology so that customers' concerns can be minimized, and their basic trust in AI technology can be achieved.

The means objectives derived from this research and their relationships demonstrate how the fundamental objectives can be accomplished. The means objectives not only include features or functions of autonomous driving technology, but they also imply possible applications facilitated by autonomous driving technology. Among all the means objectives, *complete adherence to industry and government policies and regulations,* and *maximize clarity of responsibilities by various parties in accidents* are required. Manufacturers should reach an agreement with the government, formulate appropriate laws and regulations, and clarify the responsibilities of all parties to the accident to the maximum extent. If there are no related policies and regulations and autonomous vehicles cannot comply with the industry regulations and the government, then this technology is difficult to be popularized and trusted by the public.

The subjects also emphasized the individual features provided by trusting autonomous driving vehicles that made autonomous driving technology applications valuable. These features include maximizing access to the Internet, minimizing drivers'

involvement, maximizing the ability of intervention, and minimizing uncertainty when driving. These are the means that guide to the rest of the objectives in the means-ends objectives network.

7. CONCLUSION

Artificial intelligence technology and autonomous driving technology have developed rapidly in education, military, and medical treatment, and now they have become the development trend in the future. As illustrated in this research, people's trust in AI and autonomous driving technology is the premise of its development and popularization.

This article studied values of trust in AI in autonomous driving vehicles to the customer by using the VFT approach. We developed a means-ends objective network to describe the objectives and relationships between these objectives. We identified six fundamental objectives based on the means-ends objectives network in this research, which not only represent the fundamental values of trust in AI in autonomous driving vehicles to the customer, but also are the fundamental reasons that motivate customers to trust in AI in autonomous driving vehicles according to our subjects.

8. CONTRIBUTIONS AND FUTURE RESEARCH

This research identifies the fundamental values of trust in AI that the customers care about in autonomous driving. At the theoretical level, this paper provides a basic concept and structure about the values of trust in AI in autonomous driving vehicles. For practitioners, the results of this study will provide suggestions to alleviate the AI trust issue, which will lead to better acceptance of autonomous driving technology and prepare the public for the eventual widespread use of autonomous driving vehicles.

Understanding the value of trust in autonomous driving vehicles is vital to the acceptance and adoption of autonomous driving technology. This study contributes to both the theory and practice in the area. For academics, this systematic qualitative research using VFT provides a comprehensive means-ends objectives network to guide future research in autonomous driving technology and provide a conceptual foundation for future research in trust in the AI field. For practitioners in the autonomous driving vehicles area, the results of this research will guide them in designing and implementing autonomous driving technology that will be more readily accepted and adopted by consumers. This research is part of a stream of research on the value of AI.

In future research, we plan to continue to study the evolving trust in autonomous driving vehicles as the technology advances and people are exposed to autonomous driving vehicles. Future plans for this research include the use of a different research methodology (e.g., survey or in-depth case study) to supplement the results of this research. A survey related to this research will enable us to triangulate the results of this study.

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VITA

Ru Lian received her Master of Science degree in Information Science and Technology at Missouri University of Science and Technology in May 2021. And she received her Bachelor's degree in Metal Material Engineering at Xi'an Shiyou University in June 2019.