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Perceptions of the Impact of High-Level-Machine-Intelligence from University Students in Taiwan: The Case for Human Professions, Autonomous Vehicles, and Smart Homes

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Abstract: There is a "timing optimism" that artificial general intelligence will be achieved soon, but some literature has suggested that people have mixed feelings about its overall impact. This study expanded their findings by investigating how Taiwanese university students perceived the overall impact of high-level-machine-intelligence (HLMI) in three areas: a set of 12 human professions, autonomous vehicles, and smart homes. Respondents showed a relatively more positive attitude, with a median answer of "on balance good", toward HLMI's development corresponding to those occupations having a higher probability of automation and computerization, and a less positive attitude, with a median of "more or less neutral", toward professions involving human judgment and social intelligence, and especially creativity, which had a median of "on balance bad". On the other hand, they presented a highly positive attitude toward the AI application of the smart home, while they demonstrated relatively more reservation toward autonomous vehicles. Gender, area of study, and a computer science background were found as predictors in many cases, whereas traffic benefits, and safety and regulation concerns, among others, were found as the most significant predictors for the overall impact of autonomous vehicles, with comfort and support benefits being the most significant predictor for smart homes. Recommendations for educators, policy makers, and future research were provided.

Keywords: artificial intelligence; technological unemployment; autonomous vehicles; smart home; perceptions

1. Introduction

Modern society is witnessing a recent resurgence in "artificial intelligence (AI) optimism", but some researchers [1] have pointed out there is a distinction between "timing optimism", or the belief that artificial general intelligence (AGI) will be achieved soon (evolving from current stages of artificial narrow intelligence) and optimism about the beneficial effects of human-level AGI. Müller and Bostrom [2] surveyed experts' opinions on the future progress of AI. They assessed, on the one hand, timing for both "high-level-machine-intelligence" (HLMI), corresponding to AGI in this study, and for HLMI greatly surpassing the performance of every human in most professions, indicated as artificial superintelligence (ASI). On the other hand, they asked the participants to evaluate the overall positive and negative impacts of AGI on humanity. They employed the terminology of HLMI to address "human-level-intelligence", as being able to perform most human professions at least as well as a typical human. The research findings suggested that for the 50% mark, the overall median for HLMI to exist was 2040, and a significant probability for ASI was within 30 years after HLMI. In addition, for the

impact of ASI, there was a one chance in two that this development would turn out to be "extremely good" or "on balance good", while one out of three would be "on balance bad" or "extremely bad" for mankind.

A later study also used HLMI to address the widely recognized notion of human-level AI and AGI, and investigated expert opinions on the timing of AI achieving human-level performance through diverse AI milestones, whether practical applications of AI or the automation of various human jobs [3]. Experts predicted AI will outperform humans in the next ten years in many activities such as folding laundry (by 2022) and translating languages (by 2024), and in human vocations such as truck driver (by 2027), retail salesperson (by 2031), and surgeon (by 2053). Respondents from different regions showed significant differences in HLMI predictions, with Asians expecting HLMI to be achieved earlier than North Americans. Regarding the chances of HLMI having a positive or negative long run impact on humanity, the median probability was 25% for "on balance good" and 20% for "extremely good" outcomes, whereas the probability was 10% for "on balance bad" and 5% for "extremely bad" (e.g., human extinction) outcomes.

Even though the above studies [2,3] provided probabilities of ASI or HLMI to have positive or negative long run impacts on humanity, they did not specify for which applications the impact would be viewed as "on balance good", "more or less neutral", or "on balance bad". Therefore, the primary purpose of this study is to identify a few popular areas concerning the impact of AI technologies, and to illustrate how people assess the impact accordingly. One area is to extend the AI milestones research [3] by investigating the overall impact of HLMI for specific human professions, since the issue of AI-driven automation and future human occupation has drawn a lot of attention recently [4–7]. The other two areas selected are the relatively well-researched domains of AI application, autonomous vehicles, and smart homes. As two of the most rapidly developed domains of HLMI application, the benefits and concerns of the autonomous vehicle and smart home as perceived by the public have been explored in some studies [8–22], but opinions of the benefits and concerns have seldom been discussed together and empirically examined. A secondary purpose of this present study, then, is to find out how positive benefits and potential concerns and risks play roles upon people's perception about autonomous vehicles and smart homes.

As the AI technologies continue to advance, the impact of AI has become a global topic of interest for researchers from both technological and social science backgrounds. It is the responsibility of the social science community to examine related issues more systematically, that is, not only for academic but also for policy-based reasons. One approach is to provide information regarding how the general public perceives AI's overall impact upon mankind, and its potential use to improve peoples' lives by helping to solve some of the world's greatest problems in fields such as inefficiency, transportation, and the environment, and, at the same time, to diminish its potential risks and negative impacts, including issues of security, privacy, and malicious use, among others. To better capture how the academic community has built up our initial understanding regarding these three areas, the related literature was reviewed.

2. Literature Review

The issue of technological unemployment resulting from AI achieving human-level performance has generated broad concerns, and researchers differ on the possible magnitude of its effects on the labor market in the decades ahead. A study released by Oxford University in 2013 invited a panel of experts on AI to classify 702 occupations based on how likely AI technologies could feasibly replace them. They found that about 47% of total U.S. employment is at risk [4]. Specifically, relating the probability of computerization distribution across the occupational employment spectrum, workers in the transportation (e.g., truck drivers), production (e.g., factory operators), and services (e.g., clerks) were seen as most likely to be substituted, whereas occupations related to "fine arts", "originality", "social perceptiveness", "persuasion", "assisting and caring for others", and "negotiation" exhibited relatively high values in the low-risk category. Furthermore, the study suggested that wages and

educational attainment presented a strong negative relationship with an occupation's probability of computerization.

By contrast, the organization for Economic Co-operation and Development (OECD) released a study in 2016, which employed a task-based approach by taking into account the heterogeneity of workers' tasks within their occupation, over the occupation-based approach of the previous study. The threat seemed much less pronounced, estimating that only 9% of jobs are at risk of being completely displaced, on average, across 21 OECD countries [5]. This study emphasized that even in the high risk categories, workers also perform tasks that are difficult to automate, such as those involving face-to-face interaction. Moreover, it challenged the idea of potential automation as a threat that will ultimately result in technological unemployment since: (1) technological substitution often does not take place as expected due to economic, legal, and societal reasons; (2) workers can adjust to and accommodate the situation along with the process; and (3) technological advances may also generate new job profiles.

In response to a heated argument, the U.S. White House Council of Economic Advisers released a report in December, 2016, examining the impact of AI-driven automation on the economy and policy [6]. This report documented several insightful implications. First, to the degree that wages and education are correlated with skills, there would be a large decline in demand for low-skilled workers and little decline in demand for higher-skilled. Secondly, humans still maintain a comparative advantage over HLMI in areas of social intelligence, creativity, and human judgment. Thirdly, the committee identified four categories of jobs that might experience growth in the future: (1) people to actively engage with AI on completing a task, because, instead of replacing human work, the conception of "augmented intelligence" stresses the machine's role as an assistant to enhance human productivity; (2) a need for high-skilled software and engineering related to AI development; (3) roles related to the monitoring, licensing, and maintaining of AI; and (4) new occupations generated in response to paradigm shifts.

On the other hand, Kai-Fu Lee, a Taiwanese-born American computer scientist, saw four waves of AI development with different keywords: data, business, perception AI, and autonomy; and predicted dramatic changes will be happening soon [7]. However, he also indicated that AI, with all its capabilities, will never be capable of creativity or empathy. He predicted HLMI will automate 40% to 50% of all jobs in the U.S., with the coming scale, pace, and skill-bias of the AI revolution meaning we are facing a historically unique challenge, in contrast to techno-optimists' citing the industrial revolution as "proof" that things always work out for the best. He proposed that in the future, while AI deals with the routine optimization tasks, human beings will bring the personal, creative, and compassionate touch.

While the relationships between HLMI and specific human professions are still at the stage of assessing the magnitude of its impact on future labor market, rather than on its positive and negative application potentials, the concerns and benefits of AI application of the autonomous vehicle have been well-explored. One study surveyed more than 5000 people from 109 countries to collect opinions on autonomous driving. Regarding the concerns over autonomous vehicles, respondents were relatively more worried about software hacking and misuse, legal problems in an accident, and technical safety, than on personal data privacy [11]. On the other hand, regarding the benefits of autonomous vehicles, studies across countries have found out that the potential positive impacts included: fewer traffic accidents, safer roads for cyclists, greater independence for those who cannot drive, lower vehicle emissions, less stressful driving, and so on [12–14]. A study polling 347 Austinites from the USA reported that respondents perceived the primary benefit of autonomous vehicles to be fewer crashes, with technical failure being the top concern [12], whereas an online survey from Budapest in Hungary revealed energy consumption reduction is expected as the most agreed positive impact [13]. Similar results were also documented in a report on "The Challenge and Impact of Autonomous Vehicle Development in Taiwan: Socioeconomic Impact" [15], which indicated that the benefits were: reduced traffic congestion, enhanced mobility for the elderly and disabled, environmental friendliness, and lowered fuel consumption, while the potential risks included lack of legal regulation, technical safety, privacy, and data misuse. Lastly, several studies have found age to be

associated with the intention for adoption of autonomous vehicles, with younger people expressing higher interest [16,17].

In terms of the smart home, as another well-explored domain of AI application, many studies have established its benefits, while a few have discussed its risks and barriers. A survey of young students in France examined the smart home in terms of its safety of living, improved health management, increased control of the facility, and reduced resource waste [18]. A survey of UK homeowners reported perceived benefits included: saving energy, time, and money, improving security, and providing care [19]. A survey of 30 subjects from ten Singaporean families found that users of all ages were wishing for service robots to help handle home chores, while some age groups also expected companionship [20]. Overall, a recent review suggested that the functions of the smart home can be categorized into comfort, monitoring, health therapy, and support, while it has health-related, environmental, and, financial benefits, and offers psychological well-being and social inclusion benefits [21]. Regarding barriers and risks, studied documented concerns over smart homes and smart city services were similar to those over autonomous vehicles, or many of the HLMI applications: privacy and security, trust, and costs [22,23].

Finally, to understand how university students perceive the development and sustainability of AI, a study was conducted with technical and humanistic specializations at two universities in Romania on their attitudes toward AI and its possible impact upon certain areas of social life [24]. Undergraduate students demonstrated a general positive attitude toward AI, with 58.3% believing the development will have a positive influence on society. Regarding overall feelings about AI by gender and studies, there was a relatively higher percentage of male students reported as optimistic compared to females, and, similarly, a relatively higher percentage of technical students being optimistic as opposed to humanistic ones. In contrast, there was a relatively higher percentage of females that reported concern about AI development as compared to their male counterparts, and humanistic students compared to technical. In terms of specific AI applications, over 70% of the participants reported they would agree to let their family adopt an autonomous car if they knew its accident rate was lower than that of drivers'. However, 36.3% of the respondents were aware that along with AI development there is a threat of the disappearance of certain employment sectors.

3. Research Methodology

3.1. Research Questions

This study is part of a larger project entitled, "Competition or Collaboration between Human Beings and AI?" sponsored by the Ministry of Science and Technology in Taiwan, with a focus on "AI applications and their social impact". The project was funded for Taiwanese social science researchers to work side by side with their technological counterparts to explore the opportunities and the challenges AI generates. As the first year of a four-year-project, we set out to investigate Taiwanese z generation's perceptions of the impact of HLMI on a set of human professions, autonomous vehicles, and smart homes, with two layers: the assessment of the overall impact on mankind, and the predictors of attitudes toward the impact. The specific research questions of this present study are as follows:

1. What are the students' attitudes toward the overall impact regarding HLMI for specific human professions?
2. What are the students' attitudes toward the overall impact regarding HLMI for the autonomous vehicle and the smart home?
3. Among personal backgrounds of gender, area of study, and having computer science (CS) expertise, what are the significant predictors of attitude toward the overall impact of HLMI for specific human professions?
4. Among factors related to personal background, benefits, and concerns, what are significant predictors for attitude toward the overall impact of the autonomous vehicle?

5. Among factors related to personal background, benefits, and concerns, what are significant predictors for attitude toward the overall impact of the smart home?

3.2. Participants

A pilot study was conducted in March 2019, and formal survey data was collected in May 2019. Information on sample distribution is shown in Table 1.

Table 1. Sample distribution of questionnaire survey (N = 562).

Variables	Value		Percentage (%)
Gender	Male		49.1%
	Female		50.9%
Level	Undergraduate		73.5%
	Master		24.7%
	Ph.D		1.8%
College	Science and Engineering (64.1%)	College of Science	7.7%
		College of Life Science	4.8%
		College of Nuclear Science	7.1%
		College of Engineering	16.2%
		College of Electrical Engineering and Computer Science	28.3%
	Humanities, Social Science, Management, Education, and Arts (35.9%)	College of Humanities and Social Sciences	8.0%
		College of Technology Management	13.0%
		College of Education	12.1%
		College of Arts	1.2%
		Tsing Hua College	1.6%
CS membership	CS membership (from the department of CS or had taken courses from CS-related interdisciplinary programs)		32.0%
	Non-CS membership (did not have CS-relevant background)		68.0%

3.3. Measurements

3.3.1. Overall Impact of HLMI on Human Professions

Overall impact of HLMI was assessed by a scale translated from earlier studies [2,3]: "How positive and negative would be the overall impact on mankind". The back-translation method was used for all measures in the questionnaire to ensure consistency of meaning across languages. Specifically, participants of this present study were asked to respond to: "How would you assess the overall impact on mankind of AI's capability of carrying out the following specific human professions at least as well as a typical human", for 12 items, that served as indicators: AI factory operator, AI translator, AI retail salesperson, AI tutor, AI accountant, AI news production staff, AI money-management specialist, AI researcher, AI artist/creative talent, AI surgeon, AI truck driver, and AI home service robot. These items were constructed based on multiple sources, some from previous studies [3–7] for representing HLMI milestones, or highest and lowest on a scale of probability of computerization, and some from popular science new media in Taiwan, such as Business Next, or TechOrange, for their controversial discussions of AI and job replacement. For the purpose of this study, this measure utilized a ten-point Likert scale, ranging from 1 (extremely negative) to 10 (extremely positive).

3.3.2. Overall Impact of the Autonomous Vehicle

Overall impact of the autonomous vehicle was assessed with the same wording as the above mentioned item: "How would you assess the overall impact on mankind of the autonomous vehicle", but with a five-point Likert scale, ranging from 1 (extremely negative) to 5 (extremely positive).

3.3.3. Overall Impact of the Smart Home

Overall impact of the smart home was also assessed with the same wording "How would you assess the overall impact on mankind of the smart home", but with a five-point Likert scale, ranging from 1 (extremely negative) to 5 (extremely positive).

3.3.4. Benefits and Concerns of the Autonomous Vehicle

Participants' perceptions of the benefits and concerns of the autonomous vehicle were measured using scales translated from multiple sources. As shown in Table 2, "Traffic Benefits", consisted of five items [12–15], "Environmental Benefits" consisted of three items [12–15], "Data Privacy and Security Concerns" consisted of two items [11,12,15], "Safety and Regulation Concerns" consisted of two items [11,12,15], and finally, since unemployment caused by the development of autonomous vehicles was considered a concern as a negative impact, two individual items were added to the questionnaire [5,6]. All items for this measure utilized a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

Table 2. Main variables and measurement items related to the autonomous vehicle and the smart home.

Variables	Measurement Items
Benefits and Concerns of the Autonomous Vehicle	
Traffic Benefits (Alpha reliability = 0.765)	Autonomous vehicles could reduce accidents
	Autonomous vehicles could increase the safety of the scooter user
	Autonomous vehicles could reduce the stress of driving
	Autonomous vehicles could solve the problem of the moving of the elderly and the physically challenged
	Autonomous vehicles could reduce traffic jams
Environmental Benefits (Alpha reliability = 0.823)	Autonomous vehicles could reduce air pollution
	Autonomous vehicles consume less fuel
	Autonomous vehicles have the potential for being environmentally friendly
Data Privacy and Security Concerns (Alpha reliability = 0.732)	Autonomous vehicles have concerns for privacy
	Autonomous vehicles have concerns for software hacking and misuse
Safety and Regulation Concerns (Alpha reliability = 0.663)	Autonomous vehicles have concerns for reliability and technical safety
	Autonomous vehicles cause concerns over when a car accident happens, and who is responsible for it
Unemployment Caused	Autonomous vehicles may cause unemployment (for example, truck or taxi driver)
Job Opportunity	Autonomous vehicles may produce new job profiles (for example, engineers for related technology)
Benefits and Concerns of the Smart Home	
Comfort and Support Benefits (Alpha reliability = 0.810)	Smart homes could increases safety of living
	Smart homes increase life comfort
	Smart homes help health management
	Smart homes increase control of the facility
	Smart homes could make the life of the elderly and the physically challenged more convenient
Environmental Benefits (Alpha reliability = 0.661)	Smart homes could reduce resources waste
	Smart homes have the potential for being environmentally friendly
Data Privacy and Security Concerns (Alpha reliability = 0.819)	Smart homes have concern for privacy
	Smart homes have concern for software hacking and misuse
Safety and Regulation Concerns (Alpha reliability = 0.583)	Smart homes have concern for reliability and technical safety
	Smart homes cause concern over when an accident happens, and who is responsible for it
Unemployment Caused	Smart homes may cause unemployment (for example, security guard)
Job Opportunity	Smart homes may produce new job profiles (for example, engineers for related technology)

3.3.5. Benefits and Concerns of the Smart Home

Participants' perceptions of the benefits and concerns of the smart home were also measured by scales translated from multiple sources. Also shown in Table 2, "Comfort and Support Benefits" consisted of five items [18–21], "Environmental Benefits" consisted of two items [18–21], "Data Privacy and Security Concerns" consisted of two items [22,23], "Safety and Regulation Concerns" consisted of two items [22], and finally, two individual items related to employment were also added. All items for this measure utilized a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

4. Results

4.1. Overall Impact of HLMI upon Mankind

With N = 562, the range of scores from 1 (extremely bad) to 10 (extremely good), the means and standard deviations of perceived impact of HLMI regarding 12 human professions, ranking from the highest scores to lowest, were shown in Table 3.

Table 3. Descriptive statistics of overall impact of HLMI on 12 human professions.

Variables	Mean	Standard Deviation	Variables	Mean	Standard Deviation
Profession			Profession		
AI home service robot	8.18	1.63	AI factory operator	7.54	2.40
AI translator	7.35	2.31	AI accountant	7.15	2.27
AI retail salesperson	6.97	2.42	AI money management specialist	6.51	2.36
AI truck driver	6.11	2.36	AI surgeon	5.92	2.66
AI news production staff	5.76	2.62	AI researcher	5.46	2.64
AI tutor	4.96	2.23	AI artist/creative talent	2.67	2.49

To compare the assessment of the magnitude of impact on 12 human professions and that of autonomous vehicles and of smart homes, and also to make data more equivalent with previous research [2,3], we combined the ten-point scale of the former into a five-point scale. Figure 1 presents the distribution of the percentages of students reporting positive or negative impacts perceived on 14 items, 12 about AI performing human professions or tasks at least as well as a typical human being, the remaining two about AI applications in autonomous vehicles and smart homes. Results suggested that eight items were found to have more than 50% of respondents reporting seeing the impact of HLMI on mankind as "extremely good" and "on balance good", ranging, from highest percentage to lowest: smart homes (90%), AI home service robots (86%), AI factory operator (74%), AI translator (69%), AI accountant (68%), AI retail salesperson (62%), AI money management specialist (55%), and autonomous vehicles (54%). These categories had a median answer of "on balance good". On the other hand, six indicators had more than 25% of the respondents considering the impact as "extremely bad" and "on balance bad": AI artist/creative talent (65%), AI tutor (41%), AI researcher (37%), AI news production staff (33%), AI surgeon (30%), and AI truck driver (25%). Most of them had a median answer of "more or less neutral" with only one exception: AI artist/creative talent was "on balance bad". In general, the order of the impacts for the 12 human professions, ranging from positive to negative, by distribution of student percentages, was exactly the same by means, showing a consistent tendency. In addition, the impact of the smart home was perceived to be highly positive, with only 0.5% indicating "on balance bad", while the impact of the autonomous vehicle was seen as more positive than negative, with 11.6% considered it to be "on balance bad", and 0.2%, "extremely bad". Furthermore, the overall impact of autonomous vehicles was perceived to be slightly more positive than the impact of HLMI in an AI truck driver.

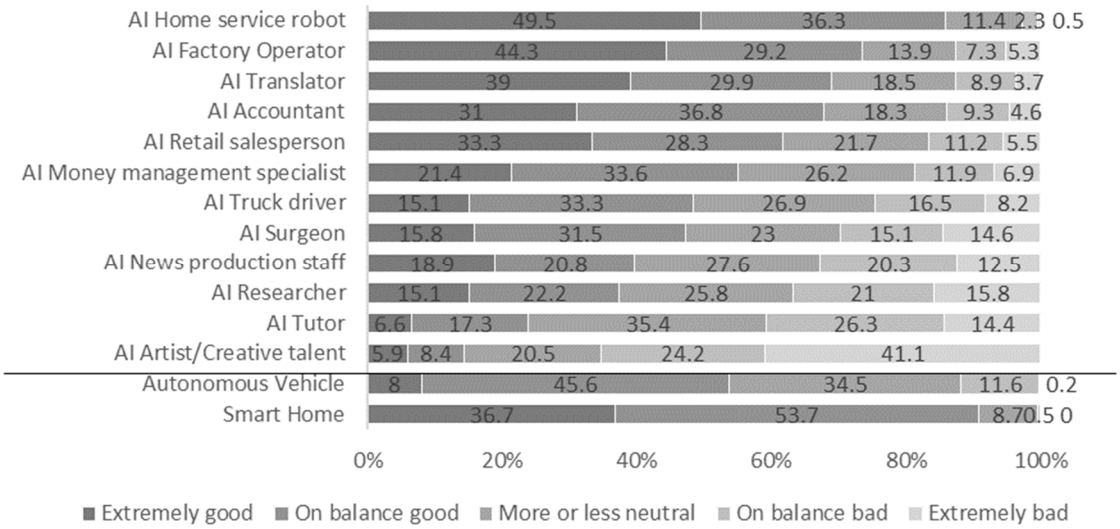


Figure 1. Overall impact of high-level-machine-intelligence (HLMI) on 12 human professions and impacts of the autonomous vehicle and smart home, as shown by distribution of percentage of students with a five-point scale.

4.2. Gender, Study Areas, CS Membership, and HLMI Impact

First, *t*-tests were performed on the 14 indicators of HLMI impact on mankind using three background variables: gender (male vs. female), areas of study (science and engineering majors versus humanities, social science, management, education and arts majors), and CS membership (students from CS or CS-related interdisciplinary programs vs. no CS-relevant background). Significant differences by gender, areas of study, and CS membership were found across all the indicators with only a few exceptions: impact of home robots by gender and by area of study, as well as impact of smart homes by gender and CS membership. Moreover, results consistently showed that male students were significantly more positive toward the impact of HLMI than their female counterparts, science and engineering majors significantly more positive than humanities, social science, management, education and arts majors, and students who had a CS background significantly more positive than their non-CS counterparts.

Since the three background variables are highly correlated, stepwise regressions were performed to decide which variables were significant predictors of opinions of HLMI's overall impact. Stepwise regression is a combination of the forward and backward selection techniques. In the process, the variable that has the highest R-Squared will be selected at the first step, and then at the next each step, the candidate variable that increases R-Squared the most will be added, until the significance has been reduced below the specified tolerance level.

For the 12 indicators related to human professions, results are presented in Table 4. Gender was found to be the most significant predictor for AI accountant, AI truck driver, and AI news production staff, and the variable of areas of study was found to be the most significant predictor for AI factory operator, translator, retail salesperson, and money management specialist, while CS membership was found to be the most significant predictor for AI home robot, surgeon, researcher, tutor, and artistic/creative talent, the latter three representing the relatively low-score categories.

Table 4. Stepwise regressions of attitudes toward the overall impact of HLMI on human professions by background (gender, area of study, and CS membership) as predictors.

Step	Variable	β	t	Step	Variable	β	t
AI Home Robot				**AI Factory Operator**			
1	CS membership	0.084	2.002 *	1	Studies	0.103	2.355 *
				2	CS membership	0.091	2.081*
AI Translator				**AI Accountant**			
1	Studies	0.132	2.869 **	1	Gender	0.162	3.834 ***
2	Gender	0.095	2.122 *	2	CS membership	0.099	2.359 *
3	CS membership	0.087	2.019 *				
AI Retail Salesperson				**AI Money Management Specialist**			
1	Studies	0.119	2.838 **	1	Studies	0.115	2.566 *
				2	Gender	0.111	2.474 *
AI Truck Driver				**AI Surgeon**			
1	Gender	0.136	3.067 **	1	CS membership	0.164	3.933 ***
2	CS membership	0.120	2.778 **	2	Gender	0.149	3.577 ***
3	Studies	0.092	2.024 *				
AI News Production Staff				**AI Researcher**			
1	Gender	0.176	4.188 ***	1	CS membership	0.132	3.128 **
2	CS membership	0.109	0.109 **	2	Gender	0.113	2.683 **
AI Tutor				**AI Artistic/Creative Talent**			
1	CS membership	0.146	3.367 ***	1	CS membership	0.201	4.687 ***
2	Studies	0.112	2.585 **	2	Studies	0.093	2.158 *

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

4.3. Benefits and Concerns of the Impact of the Autonomous Vehicle and the Smart Home

Similarly, with the range of scores from 1 (extremely negative) to 5 (extremely positive), the means and standard deviations of the perceived impact of HLMI regarding autonomous vehicles and smart home, as two dependent variables, were shown in Table 5. At the same time, their two sets of independent variables, each including two benefit scales and two concern scales, as well as a pair of individual variables related to AI and employment, ranking from the highest scores to lowest were also shown in Table 5, with the range of scores from 1 (strongly disagree) to 5 (strongly agree).

Table 5. Descriptive statistics of main variables related to opinions on the overall impact of autonomous vehicles and smart homes.

	Variables	Mean	Standard Deviation	Variables	Mean	Standard Deviation
	Autonomous Vehicle			**Smart Home**		
Dependent	Overall impact of autonomous vehicle	3.50	0.81	Overall impact of smart home	4.27	0.64
Independent	Safety and regulation concerns	4.41	0.55	Comfort and support benefits	4.40	0.46
	Autonomous vehicles may produce new job profiles	4.19	0.67	Data privacy and security concerns	4.39	0.66
	Autonomous vehicle may cause Unemployment	4.10	0.80	Smart homes may produce new job profiles	4.25	0.67
	Data privacy and security concerns	3.95	0.69	Environmental benefits	4.23	0.61
	Traffic benefits	3.84	0.57	Safety and regulation concerns	4.19	0.64
	Environmental benefits	3.52	0.75	Smart homes may cause unemployment	3.80	0.96

Again, to decide how background variables, benefits, and concerns help predict the assessment of the overall impact of autonomous vehicles and smart homes, two stepwise regressions were performed. Table 6 suggests, on the left side, that the overall impact of autonomous vehicles, traffic benefits, safety and regulation concerns, gender, and the prospect of producing new job profiles were found to be significant predictors, accounting for 30.9% of the variance, with safety and regulation concerns negatively associated. In the model, β, or the standardized regression coefficient, refers to how many standard deviations a dependent variable will change, per standard deviation increase in the predictor variable, whereas the t value is for testing the hypothesis that this variable should be added to or deleted from the model. Generally speaking, the larger the β coefficient and t-value, the more important the variable is. It is interesting to note, traffic benefits account for 28.5% of variance alone for the assessment of the overall impact of autonomous vehicles.

Table 6. Stepwise regressions of opinions on the overall impact of autonomous vehicles and smart homes by background variables, benefits, and concerns as predictors.

Overall Impact of Autonomous Vehicle					Overall Impact of Smart Home				
Step	**Variable**	**β**	**t**	**△R^2**	**Step**	**Variable**	**β**	**t**	**△R^2**
1	AV traffic benefits	0.502	13.537 ***	0.285 ***	1	SH comfort and support benefits	0.390	7.791 ***	0.197 ***
2	AV safety and regulation concerns	−0.120	−3.355 ***	0.013 **	2	SH safety and regulation concerns	−0.169	−4.461 ***	0.033 ***
3	Gender	0.101	2.820 **	0.009 **	3	Studies	0.093	2.513 *	0.012 **
4	AV producing new job profiles	0.082	2.221 *	0.006 *	4	SH environ-mental benefits	0.129	2.590 *	0.008*
					5	SH causing unemployment	−0.084	−2.225 *	0.007 *
Total				0.309					0.256

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

On the other hand, on the right side, the overall impact of smart homes, comfort and support benefits, safety and regulation concerns, background variable of studies, environmental benefits, and the possibility that smart homes may cause unemployment, were found to be significant predictors, accounting for 25.6% of the variance, with two variables negatively linked: safety and regulation concerns, and causing unemployment.

5. Discussions

Even though there is a general "timing optimism" that AGI is to be achieved in the near future [1–3,7], extant literature that has looked into how people assess its overall impact have suggested mixed feelings, by experts and by university students alike [2,3,24]. The purposes of this present study were two-fold: first, to expand their findings by investigating how 562 Taiwanese university students perceived the overall impact of HLMI in three areas: one for human professions, with a set of 12 professions serving as indicators, and two for AI applications related to autonomous vehicles and to smart homes; and, secondly, to explore the predictors for these perceptions, especially for autonomous vehicles and smart homes, which had more empirical evidence to rely on. The key findings of the five research questions are discussed as followed.

RQ1. What are the students' attitudes toward the overall impact regarding HLMI for specific human professions?

While previous studies only provided probabilities of HLMI to have positive or negative long run impacts on humanity, we selected a set of 12 professions based on a literature review and illustrated how young people assessed the impact accordingly. Previous studies or AI experts suggested AI is more suitable for routine optimization tasks rather than areas of creativity, social intelligence, and human judgment [4–8]. A similar pattern was supported by the results of this study, as shown in Table 3 and Figure 1.

Respondents expressed a relatively more positive attitude, and the mean ranged from 6.51 to 8.81, and with a median answer of "on balance good" toward HLMI's impact on six indicators of human professions corresponding to occupations found to have a higher probability of automation and computerization: AI home service robot, AI factory operator, AI translator, AI accountant, AI retail salesperson, and AI money management specialist. A relatively less positive attitude, with a mean ranged from 4.96 to 6.11, and a median answer of "more or less neutral", was found toward HLMI's impact on five indicators of human professions corresponding to occupations that involve human judgment and social intelligence: AI truck driver, AI surgeon, AI news production staff, AI researcher, and AI tutor. Furthermore, the least positive attitude was reported toward the professions involving creativity, with a mean of 2.67, and a median answer of "on balance bad" for AI artist/creative talent.

RQ2. What are the students' attitudes toward the overall impact regarding HLMI for the autonomous vehicle and the smart home?

The technical development and adoption study was well-established for the topics of autonomous vehicles and smart homes, but this study presented an initial picture of how people assess their overall impact on mankind, and median answers of "on balance good" were found for autonomous vehicles and smart homes. Specifically, more than 90% of the respondents reported a positive attitude toward the overall impact of smart homes, but only 54% expressed a positive attitude for autonomous vehicles, as shown in Figure 1, indicating more people had concerns about the impact of autonomous vehicles than of smart homes.

RQ3. Among personal backgrounds of gender, area of study, and having computer science (CS) expertise, what are the significant predictors of attitude toward the overall impact of HLMI for specific human professions?

For factors associated with perceptions of the impact of HLMI regarding various dimensions, previous studies suggested gender and study area might play a crucial role [24], and this observation was supported by this study. Furthermore, in addition to gender and study area, results of this study also found CS expertise to be a significant predictor in many cases, as shown in Table 4. However, it is important to note that background variables only accounted for a limited amount of variance toward the impact of HLMI, for example, the R^2 in Table 4 ranged from 1% to 6%, unlike the R^2 in the cases for autonomous vehicles and smart homes were 30.9% and 25.6%, respectively, indicating a more substantial predictive power, as shown in Table 6, when variables related to benefits and concerns were taken into account in addition to background variables.

RQ4. Among factors related to personal background, benefits, and concerns, what are significant predictors for attitude toward the overall impact of the autonomous vehicle?

For the benefits and concerns about autonomous vehicles and how they help (predicting the overall impact of autonomous vehicles on mankind) as perceived by the university student, first, this study found respondents had relatively higher overall concerns related to "safety and regulation" and "data privacy and security" than to "traffic benefits" and "environmental benefits", as shown in Table 5.

Secondly, however, when we looked at the mean score of individual questionnaire items, the top five were: "Autonomous vehicles cause concerns over when a car accidents happen, and who is responsible for it", "Autonomous vehicles could solve the problem of moving of the elderly and the physically challenged", "Autonomous vehicles cause concern over reliability and technical safety", "Autonomous vehicles may produce new job profiles (for example, engineers for related technology)", and "Autonomous vehicles cause concern over software hacking and misuse". This showed that, while respondents were well-informed about the potential risks and the urgency for technical and legal problem solving, they were also aware of their benefits.

Thirdly, another interesting finding was that the respondents' mean score on "autonomous vehicles may produce new job profiles" was found to be slightly higher than "autonomous vehicle

may cause unemployment", meaning that when the new generation looks at the relationship between autonomous vehicles and employment, they do not necessarily take a pessimistic perspective.

Finally, results from the regression suggested that students who had a higher regard for the traffic benefits brought about by autonomous vehicles, with a lower regard for the safety and regulation risks they could cause, that were male, with a higher regard for the possibility of new job profiles produced by autonomous vehicles (for example, engineers for related technology), tended to have higher positive attitudes toward the overall impact of autonomous vehicles on mankind, with especially the first predictor playing a strongly significant role, as shown in Table 6.

RQ5. Among factors related to personal background, benefits, and concerns, what are significant predictors for attitude toward the overall impact of the smart home?

For the benefits and concerns about smart homes and how they help (predicting the overall impact of smart homes on mankind) as perceived by the university student, first, this study found "comfort and support benefits", "data privacy and security concerns", "environmental benefits", and "safety and regulation concerns" to have similar overall mean scores, as shown in Table 5.

Secondly, when we looked at the mean scores of individual questionnaire items, the top five were:"Smart homes could make the life of the elderly and the physically challenged more convenient", "Smart homes increase the comforts of life", "Smart homes cause concern over software hacking and misuse", "Smart homes cause concern for privacy", and "Smart homes have the potential for being environmental friendly".

Thirdly, compared with the results for autonomous vehicles, the function and benefits of smart homes in providing "comfort and support" were well-recognized by the respondents. At the same time, whereas respondents were more concerned about "safety and regulation" related to autonomous vehicles, they were more concerned about "data privacy and security" related to smart homes.

Fourthly, the mean score for "Smart homes may produce new job profiles" was found to be much higher than that for "Smart homes may cause unemployment". Therefore, the results seem to reflect the young generation's optimistic attitude toward the impact of HLMI on employment, and echoed the suggestions from some of the extant literature [6].

Finally, students who had a higher regard for the comfort and support benefits of smart homes, with a lower regard for their safety and regulatory risks, who were science and engineering majors, with a higher regard for the environmental benefits of smart homes, with a low regard for the possibility of their causing unemployment (for example, security guard), tended to have higher positive attitude toward the overall impact of smart homes on mankind, as shown in Table 6.

6. Conclusions

The above findings have contributed to advance our knowledge of the impact of HLMI in several ways.

For the AI application of the smart home, we have learned Taiwanese university students presented a highly positive attitude toward its impact on mankind, and the more they recognized its comfort and support benefits, among other factors, the higher their overall assessment.

For the AI application of autonomous vehicles, on the other hand, Taiwanese university students expressed more reservation. They showed a high concern over its technical safety and regulation problem, even though the most significant predictor for its overall impact on mankind was found to be the traffic benefits. In other words, the more respondents perceived autonomous vehicles as having the potential benefits of solving the traffic problems, such as reducing the accident rate, and moving the elderly and physically challenged, among others, the more positive they would assess its overall impact. Furthermore, while the potential environmental benefits of autonomous vehicles were widely discussed in the research community, university students in Taiwan did not demonstrate they are informed of it.

For AI achieving human performance on 12 tasks or professions and their relative positive or negative impact, Taiwanese university students expressed a general tendency consistent with the direction that AI experts and the media have analyzed and suggested. Yet, the underlying reasons remained to be examined, since this is a relatively unexplored domain in the research landscape.

Another interesting dimension on the findings was how gender, studies, and CS membership presented an overwhelmingly consistent pattern for showing male, science and engineering majors, and students with a CS background to report more positive assessment on the impact of HLMI.

Therefore, for educators from higher institutions, interdisciplinary courses or team projects are encouraged to provide learning opportunities both on how AI applications can be applied in solving human problems and at the same time preventing its potential risk, especially for the male, science/engineering, and CS-related students to reflect on the latter, and their counterparts to know more about the former.

For policy makers, the issues of infrastructure and regulation related to AI application have to take the lead, so that the public and the society can be more prepared for the AI era.

For researchers, the following directions are suggested for future study: First, people's perceptions of the impact of AGI in other areas, which invite more empirical exploration. Secondly, the potential predictors of individual perceptions of AGI impacts on specific human professions, and how to identity new AGI technology and human collaborations which have beneficial social effects. Thirdly, the benefits and concerns of specific AI applications, which should be systematically examined to achieve better communication between AI experts and the general public. Finally, this study has the limitation of employing only z generation from a university in Taiwan as the research subjects. Since younger people are more positive toward AI development and applications in general, investigation with several samples across various age groups will generate a much greater impact, and thus is also recommended for future work.

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