Measuring the Ergonomic Risk Factors Associated with the Perceived Risk of COVID-19: A Case of Residents in the Philippines

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Abstract

The COVID-19 pandemic has caused the general population to remain indoors, since the government ordered a national lockdown on March 15, 2020, because of the rising cases in the country. Amidst the lockdown, citizens were still required to do their jobs and studies at home. This resulted in numerous ergonomic problems and discomforts since not all Filipinos have a decent workstation in their respective houses. The conducted research observes the ergonomic- based risk factors with the perceived risk of COVID-19, specifically about the residents of Paranaque City. A study from Davis et al (2020) discusses the different setups of employees that were analyzed by experienced ergonomics, and it showed that some employees have very poor ergonomics such as having non-adjustable chairs and wrong positioning of monitors, etc. The researchers have applied a quantitative research design to gather the necessary data to prove the hypothesis. Online surveys were used to acquire data from the residents, the medium used for the research are social media applications. The data gathered suggests that most respondents are aged 20 and below, had attended high school, were primarily students, office clerks, etc. The results show that a significant number of residents from the Paranaque area feels at risk of getting COVID-19. It was also concluded that most of the respondents were concerned for their family's safety. Research conducted by Mertens et al (2020) also shows that a large percentage of people are worried that their loved ones might get infected with COVID-19.

Keywords
Ergonomics, risk factors, perceived risk, COVID-19, pandemic

1. Introduction
Due to the COVID-19 pandemic, workers were forced to change their mode of work. Their jobs were required to perform their jobs remotely. But even after all this, there is still a huge number of COVID-19 cases. One possible factor is the ergonomics of the worker's environment. There are three areas of ergonomics that is included in the study, these are Physical, Cognitive, and Macro-ergonomics. The Physical area of ergonomics is concerned with workplaces and workstations since it affects the physical aspect of a worker. This area is interested in the physiological, anatomical, anthropometric, and biomechanical aspects of humans. Larrea-Araujo, et.al (2021) concluded that several musculoskeletal disorders can be developed when having a poor physical ergonomic

setup. The Cognitive area of ergonomics is based on the understanding of human perception, mental processing, and memory, it is concerned with how effectively a product or an equipment's use corresponds to the cognitive abilities of its users. Heavy workload may limit the brain's ability to function properly (Henry,2021). With the brain not functioning properly, one will have a higher risk of COVID-19. The last area of ergonomics, Macroergonomics, is focused on the development and implementation of human-organization interface technology, which is concerned with the improvement of organizational structure and related work processes. Rey (2021) concluded that there is stilla 20% of the Philippines' low-income population who have not yet received their monetary help from the government. With the 20% not yet receiving their monetary help, these people will have to work harder to provide for their own families, making them at a higher risk of getting infected with the virus. There are many studies that cover the effects of ergonomic risk factors to COVID-19 infection that can be found in the current literature but there is only a small portion of information regarding measuring the risk factors consisting of the 3 domains of ergonomics. That is why further research that addresses the risk factors of COVID-19 in these domains is necessary.The research focuses on measuring the ergonomic based risk factors with the perceived risks of COVID-19 in the Philippines, specifically Parañaque City. In the Philippines, there are no published studies yet on the effect of the ergonomic based factors focusing on the 3 domains of ergonomics namely, physical, cognitive, and macro ergonomics on the perceived risk of COVID-19. Although there are some studies that relate to the ergonomics and the perceived risk of COVID-19, there is still a large aspect that is not covered such as the prolonged lockdown and the controversial face shields.

Thus, the study aims to measure the ergonomic-based risk factors with the perceived risk of COVID-19 in the Philippines. However, the study's primary focus will be on Parañaque City's residents. The study's objectives include measuring the perceived level of COVID-19 risk of residents in Paranaque City, measuring the level of ergonomic risk factors (physical, cognitive, and macro ergonomics) of residents in Paranaque City, and determining the significant relationship and effect of the ergonomic risk factors on the perceived COVID-19 risk of residents in Paranaque City.

2. Literature Review

Ergonomics is the study and application of human behavior and performance in socio-technical systems. Zunjic (2017) defines ergonomics as a multidisciplinary discipline that analyzes the impact of work means, situations, processes, and goods on humans and adjusts their design.

Physical ergonomics evaluates workspaces, including postures, manual jobs, and repetitive movements to prevent injury. HCW manually moving deceased bodies poses an ergonomic danger (Rathore & Gupta, 2020); this can produce uncomfortable posture and musculoskeletal disorder symptoms. (Vargas et al., 2020) Inadequate workstation design exposes employees to unpleasant conditions that impair their health. The study highlighted how ergonomic designs promote staff performance and sustainability by providing comfort. Physical inactivity affects viral immunity (Sallis et al., 2021). Inactive people were more likely to be hospitalized or die from COVID-19 than active people. (Araujo et al., 2021) evaluated COVID-19's influence on teleworkers who worked from home, including the incidence of difficulties in their physical surroundings. According to the discussion, defective ergonomic equipment in teleworkers' workstations caused pain and discomfort. In addition, Larrea-Araujo (2021) found that respondents with physical environment concerns had more musculoskeletal problems, which increased their COVID-19 risk. According to a study, the lack of ergonomic work equipment and a dedicated working environment is the most significant health concern for teleworkers in Europe (Buomprisco et al., 2021). COVID-19 is also increasing workplace injuries (Barker et al., 2020).

On the other hand, cognitive ergonomics connects products to users' mental capacity. It explains how a job influences the psyche and vice versa. (Kalakoski et al., 2020) stated several factors affecting the cognitive area of ergonomics, such as disruptions, interruptions, and information overload. These factors induce cognitive strain and reduce work happiness. (Marzouki et al., 2021) examines social media and pandemic worry. The study found that social media may affect cognitive components by causing concern about COVID-19 difficulties and dangers. Narvaez & Noroa (2021) studied how cognitive ergonomics might improve workstations and surroundings. Poor ergonomics frustrate and exhaust workers, according to the study. Mental and emotional faith in government to handle financial and healthcare difficulties during a pandemic can boost individuals' well-being. Cognitive health correlates with confidence in the government's ability to solve the COVID-19 pandemic (Barrafrem et al., 2021). Heavy workload may limit the brain's ability to function properly (Henry, 2021). These variables produce poor "cognitive ergonomics" in health care. Poor cognitive ergonomics increase physicians' cognitive load.

Macroergonomics is a branch of ergonomics that focuses on the design of organization systems as stated by (Kleiner, 2005). On a larger scale, the macro ergonomics of a city can affect the perceived risk of COVID-19. Throughout the duration of the pandemic, the government has been implementing Non-Pharmaceutical Interventions (NPI) to lower the COVID-19 risk, particularly its health protocols, financial aid, and its vaccination system for these systems are designed in order to fight the pandemic. In a study conducted by (Giorgi et. al., 2021), they have found that there is only a marginally drastic effect on, particularly 5 - 10%, mortality rate among males in Switzerland when wearing face masks on public indoor places for a prolonged period of time. As for the vaccination system, COVID-19 vaccination must be inclusive for fair distribution of vaccines, and this should be the top priority as stated by (Armocida et. al., 2021). Meanwhile, in an article written by (Rey, 2021), 80% of the low-income population in the National Capital region Plus (NCR+) are given financial aid by the government. This means that the remaining 20% will have to work to supply their daily needs amidst the spike of COVID-19 cases in the region and will be exposed to the COVID-19 risks. This information suggest that the government has a larger role in mitigating the perceived risk for COVID-19 by creating systems that the public is required to follow and ensuring that these systems will have a drastic effect in lowering the risk of the perceived risk of COVID-19.

3. Methods

3.1. Conceptual Framework

Figure 1 shows the conceptual framework of this study. Based on this figure, this study is mainly focused on determining the ergonomic risk factors affecting the perceived COVID-19 risk among residents in Paranaque city. The ergonomic-based factors are divided into three domains: physical, cognitive, and macro ergonomics. In each area of ergonomics, the diagram shows the different risk factors that the study considered when conducting the survey. The Physical Ergonomics of this study focused more on the work-from home set-up of the respondents. The Cognitive area of ergonomics contained risk factors such as work demands, mental workload, fatigue, stress, anxiety, government trust, educational level, access to information, and the use of social media, affecting the mental state or cognitive capabilities of users. Macro ergonomics is the area of ergonomics that is concerned with risk factors such as government lockdown, community mobility, health facilities, government stringency, population density, occupation type, vaccine access, and the government's financial support. The framework included age, gender, household income, residential type, and comorbidities as its demographics.

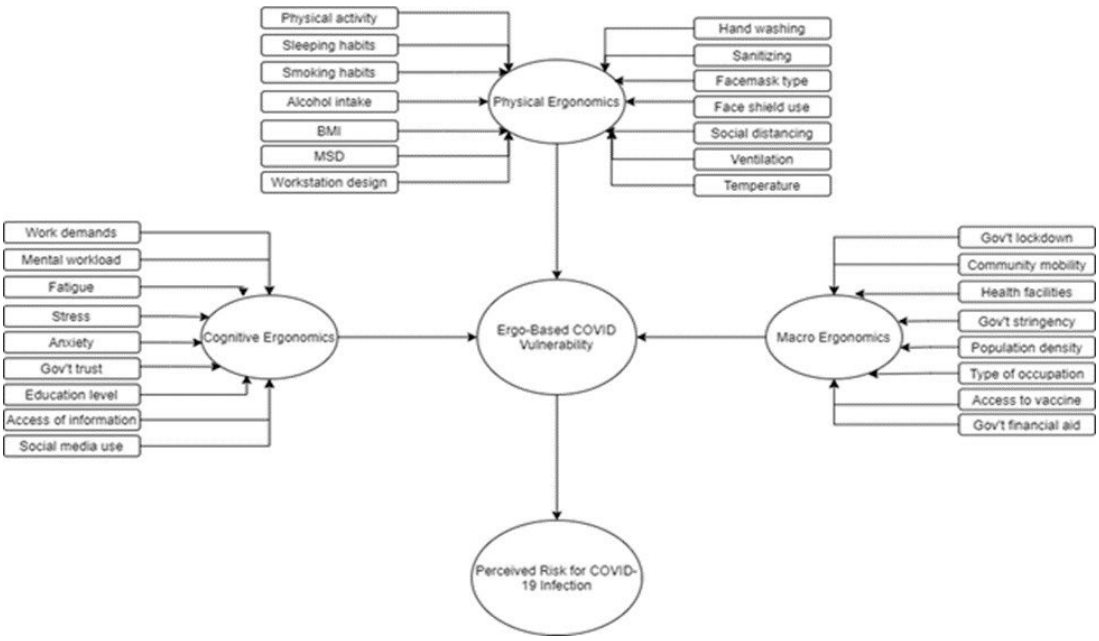

Figure 1. Ergo-Based Framework for Perceived Risk of COVID-19

3.2. Respondents

This study requires Paranaque residents. Anyone in Paranaque City who can access the researchers' social media survey form can participate. The government has temporarily banned face-to-face interactions in schools, offices, and other public spaces to prevent viral spread. People now work and study from home, which can generate physical and mental stress. The researchers needed 250 Paranaque residents with a 10% margin of error. All ranging from 20 below up to 100 years of age. Each respondent completed questions on the researchers' Google form. The respondents include students and workers, people who are engaging in online classes or online work. COVID-19 protocols make them more prone to ergonomic risks.

3.3. Statistical Analysis

The researchers used three methods for statistical analysis. (a) Descriptive Statistics - which include demographic profiling to classify the respondents into sub-groups; (b) Inferential Statistics, which helped in determining the relationship between the two variables. This includes the Pearson Correlation test which displays the strength of the relationship between two or more variables in the study; Lastly is the Multiple Regression Analysis. This shows the degree to which a factor has an impact on the perceived risk of COVID-19.

4. Data Collection

For the data collection, this study utilized a cross-sectional survey design. The researchers measured the degree to how ergonomics affects the perceived COVID-19 risks via physical ergonomics, cognitive ergonomics, and macro ergonomics. To indicate possible risks concerning ergonomics in the physical area, the researchers asked participants about their body-mass index, smoking habits, alcohol intake, sleeping habits, physical activity, musculoskeletal discomfort, design of workstation, handwashing, sanitizing, use of facemask, use of face shield, social distancing, ventilation, and temperature. To indicate possible risks concerning ergonomics in the cognitive area, the researchers inquired about participants' government trust, education level, access to information, mental workload, fatigue, stress, anxiety, use of social media, and their work demand and resources. Lastly, to indicate possible risks concerning ergonomics in the macro-ergonomic area, the researchers asked participants about their insights on government lockdown, community mobility, health facilities, government stringency, population density, type of occupation, access to the vaccine, and government financial aid. The google survey form consists of multiple-choice types and Likert scale questions. The questionnaire is divided into three sections namely the demographic profile, perceived risk of COVID-19, and perceived vulnerability to COVID-19. The demographics section contains 12 questions, the Perceived Risk for COVID-19 section contain 8 questions, and lastly, the Perceived Vulnerability to COVID-19 section contains 30 questions. See the appendix at the end of this chapter for the survey form.

5. Results and Discussion

5.1. Demographics

The demographics include gender, age, educational attainment, occupation, household size, total household income in a month, residential type, comorbidities, BMI, type of face mask used, and usual temperature at home. The demographic information is needed to provide the data regarding the research participants, specifically from the Paranaque area. The data gathered from the surveys show results wherein most respondents were from the age range of 20 and below, who had educational attainment of attended high school, were primarily students, office clerks, etc. Household size of 5 or more, with a total household income of Php 40,001 - Php 70,000 in a month, lived in a single-detached home, no comorbidities, normal BMI, typically uses medical masks, and had a household temperature level of neutral.

5.2. Numerical Results

In table 1, the perceived risk for COVID-19 can be seen. A significant amount of people from Paranaque City agree that they feel at risk of getting COVID-19, with most of them worried that their family might get COVID-19. From the given range of 1-5 (strongly disagree to strongly agree), most of the respondents strongly agree with the given perceived risk "I worry that my family member might get COVID-19."

Table 1. Summary of Perceived Risk

Items	Mean	Std. Dev.	Range	Agreement
I feel that I am at risk of getting COVID-19	3.31	1.37	1-5	agree
I worry that my family member might get COVID-19.	4.05	1.23	1-5	agree
I think that my health will be severely affected if I get infected with COVID- 19.	3.71	1.3	1-5	agree
I feel disturbed when I think about coronavirus disease.	3.7	1.25	1-5	agree
I think that there is a stigma related to COVID-19.	3.78	1.12	1-5	agree
I will not go to the hospital because of the risk of getting infected with COVID-19.	2.93	1.41	1-5	agree
I am afraid to contact people with flu symptoms	4.01	1.05	1-5	agree
If I get infected with coronavirus, I think I cannot manage my daily activities.	3.73	1.3	1-5	agree

Table 2 shows the summary of the physical ergonomic risk factors. Five (5) factors have an impact on the perceived risk of COVID-19. These factors are how much sleep an individual gets, how active physically an individual is, how comfortable an individual is wearing a face shield if an individual feels musculoskeletal discomfort, and how an individual's work chair is set up. This means that if an individual is either sleep-deprived, lacks physical activity, is uncomfortable in wearing a face shield, feels musculoskeletal discomfort, and his/her work chair is poorly set up, the more likely an individual will contract COVID-19.

Table 2. Summary of Physical Ergonomic Risk Factors

Items	Mean	Std. Dev.	Range	Agreement
In recent weeks, I often smoke	1.6	1.18	1-5	disagree
In recent weeks, I often drink alcohol	1.89	1.25	1-5	disagree
In recent weeks, I don't get enough sleep	3.68	1.35	1-5	agree
In recent weeks, I do not engage much in physical activity	3.33	1.47	1-5	agree
I do not often wash my hands with soap and water	1.66	1.06	1-5	disagree
I do not often sanitize my hands with alcohol when I touch surface	1.69	1.18	1-5	disagree
I feel uncomfortable in wearing face mask	2.47	1.32	1-5	disagree
I feel uncomfortable in wearing face shield	3.9	1.38	1-5	agree
I do not often practice social distancing	2.09	1.15	1-5	disagree
I do not have proper ventilation at home	2.03	1.21	1-5	disagree
In recent weeks, I feel musculoskeletal discomfort	2.74	1.36	1-5	agree
My work chair is not ergonomically designed	2.88	1.57	1-5	agree

The summary for the cognitive risk factors can be seen on table 3. Al factors except an individual's access to information have an impact on the perceived risk for COVID-19. For instance, if an individual stresses about COVID-19 or he/she does not trust the pandemic response by the government, the chances of an individual being infected by COVID-19 are higher than those who do not.

Table 3. Summary of Cognitive Risk Factors

Items	Mean	Std. Dev.	Range	Agreement
I do not trust the government response in COVID-19	3.79	1.15	1-5	agree
I do not have access to the media and other sources of information	1.74	1.09	1-5	disagree
I feel that I spend too much time on social media	3.72	1.25	1-5	agree
In recent weeks, I feel pressured to respond to work-related messages	3.57	1.27	1-5	agree
In recent weeks, I feel mentally overload	3.98	1.15	1-5	agree
In recent weeks, I feel anxious about COVID-19	3.48	1.2	1-5	agree
In recent weeks, I feel stressed about COVID-19	3.48	1.29	1-5	agree
In recent weeks, I feel tired and fatigued	3.74	1.24	1-5	agree
I do not know about COVID-19 contact tracing applications	2.56	1.4	1-5	agree

Lastly, the macro-ergonomic risk factors can be seen on table 4. For the macro-ergonomic risk factors, based on the given survey, all of the factors affect the perceived risk for COVID-19, except their access to healthcare services and their access to the COVID-19 vaccination program.

Table 4. Summary of Macro-ergonomic Risk Factors

Items	Mean	Std. Dev.	Range	Agreement
I think people in the community seldom comply with lockdown protocols	3.56	1.13	1-5	agree
I think people in the community frequently visits public places	3.95	1.07	1-5	agree
I think the government response to COVID is not effective	3.83	1.13	1-5	agree
I think contract tracing is not effective	3.04	1.36	1-5	agree
I think the government is not strict in implementing COVID-19 prevention measures	3.67	1.16	1-5	agree
I do not have access to healthcare services	2.21	1.23	1-5	disagree
My area of residence is highly populated	3.1	1.22	1-5	agree
I do not have access to COVID-19 vaccine program	1.83	1.26	1-5	disagree
I do not receive financial support from the government	3.28	1.35	1-5	agree

5.2. Pearson Correlation Analysis Results

The summarization of the correlation analysis between the independent (ergonomic risk factors) and dependent (perceived risk of COVID-19) variables can be seen on Table 5. Based on our demographics, most of our respondents were aged from less than 20 years old and most of them are students, office clerks, ICT professional, technicians, researchers. Based on their age, our respondents are mostly students and because of this, anxiety and the feeling of stress has the highest correlation among all the independent variables. These two independent variables are greatly experienced by students. In an article by Cerquieira et.al. (2021), There was a statistically significant increase in the emotional stress of students in Brazil. This finding is similar to the result of our correlation between the different variables which support that feeling stressed increases the perceived risk to COVID-19. These factors can greatly affect the mental health of students making them more susceptible to the infection of the COVID-19 virus.

Table 5. Summary of Correlation Analysis

Variable	Pearson correlation (r)	p-value	Result	Strength of Correlation
Smoking → perceived risk	-0.018	0.777	not significant	no correlation
Drinking alcohol → perceived risk	-0.05	0.435	not significant	no correlation
not enough sleep → perceived risk	0.194	0.002	significant	minor correlation
no physical activity → perceived risk	0.067	0.291	not significant	no correlation
washing of hands → perceived risk	-0.165	0.009	significant	no correlation
sanitation of hands → perceived risk	-0.146	0.021	significant	no correlation
uncomfortability of wearing face mask → perceived risk	-0.134	0.034	significant	no correlation
uncomfortability of wearing face shield → perceived risk	-0.043	0.496	not significant	no correlation
not practicing social distancing → perceived risk	-0.197	0.002	significant	no correlation
not having proper ventilation → perceived risk	-0.019	0.762	not significant	no correlation
feeling of muscoskeletal discomfort → perceived risk	0.281	<0.001	significant	minor correlation
poor ergonomic designed chair → perceived risk	0.06	0.343	not significant	no correlation
trust within the government response → perceived risk	0.234	<0.001	significant	minor correlation
not having access to medical facilites → perceived risk	0.048	0.453	not significant	no correlation
spending too much time on social media → perceived risk	-0.035	0.584	not significant	no correlation
pressure to reply to messages → perceived risk	0.233	<0.001	significant	minor correlation
mental overload → perceived risk	0.25	<0.001	significant	minor correlation
anxiety → perceived risk	0.475	<0.001	significant	moderate correlation

5.2. Regression Analysis Results

Table 6 shows the results for the Regression Analysis that was done using the Minitab Software. In using the software, the researchers computed the regression for the different areas of ergonomics. It was found that for every one value increased for the cognitive risk factor there is a 0.484 increase to the perceived risk for COVID-19. Therefore, cognitive ergonomics has the highest effect on the perceived risk for COVID-19. The regression equation can be seen on Equation 1.

Table 6. Coefficients for Regression Analysis

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	2.552	0.311	8.22	<0.001	
Physical Risk Factor	-0.186	0.0696	-2.67	0.008	1.15
Cognitive Risk Factor	0.484	0.0738	6.56	<0.001	1.4
Macroergonomic Risk Factor	-0.017	0.103	-0.16	0.869	1.3

$$\text{Perceived Risk} = 2.552 - 0.1860\ \text{Physical Risk Factor} + 0.4840\ \text{Cognitive Risk Factor} - 0.017\ \text{Macroergonomic Risk Factor} \quad (4)$$

The study's results were also tested if it was accurate using a normality test and a residual test. As seen on Figure 2, the data falls between the line and the data that are in the residual plots are equal. This result verifies that the data that was used in the study was indeed precise and valid.

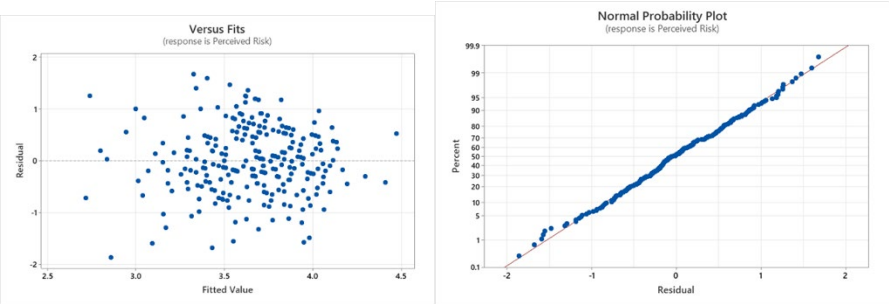

Figure 2. Normality Test and Residual Plots

5.3 Proposed Improvements

The researchers suggest studying how to minimize stress and anxiety during the period of COVID-19 since these two factors have the largest impact on the perceived risk of COVID-19. The researchers would also like for a more in-depth study with a larger population regarding the different areas of ergonomics and their relationship towards the perceived risk of COVID-19 since this research is the first of its kind.

6. Conclusion

Based on the results of the data gathering, there were only six (6) factors that have an impact on the dependent variable, the perceived risk of COVID-19. These factors are feeling musculoskeletal discomfort, trust within the government response, pressure to reply to messages, mental overload, anxiety, and feeling stressed. The factors with the most significance on the dependent variable is anxiety and feeling stressed which are mostly in the cognitive area of ergonomics. These two major factors for the increase of the perceived risk of COVID-19 can be traced as the product of the minor factors for perceived risk like pressure to reply to messages, trust within the government response, mental overload, etc. When an individual's anxiety and stress levels become too high, this might result in a decline in his/her physical well-being which in turn, makes him/her more susceptible to COVID-19 infection. To summarize, based on all of the participants in Paranaque city which mostly consists of people below 20 years old and are students, office clerks, ICT professionals, technicians, and researchers, the area of ergonomics with the most significant the perceived risk of COVID-19 is the cognitive ergonomics particularly stress and anxiety since these factors can have a direct impact on the physical well-being of a person.

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Biographies

Brian Kenneth F. Nanale is a graduating senior highschool student of Mapúa University. He completed his junior year and elementary school from The Cavite School of St. Mark in Bacoor, Cavite. His father and mother both handle and own Mechsys Industrial Corporation, a specialty/ mechanical contractor. Brian pursues to become a Mechanical Engineer in the near future, following his father's footsteps. His research gives him guidance for his future endeavors in the field of Mechanical Engineering.

Neil Ivan B. Bayer is a graduating senior high school student from Mapúa University. He studied in Escuela de San Lorenzo Ruiz from kindergarten to junior high school. His father is a business owner of a video equipment rental company and Ivan also helps in the business when he has free time. His mother is an accountant and secretary in his father's company. He wants to become a racing driver or any profession that is involved in motorsports. The research that he has done makes him prepared for other studies that he encounters in his future career in motorsports.

Robert Ephraim C. Pabiling is currently a graduating senior highschool student of Mapúa University. He finished his junior high school from Diliman Preparatory School and finished his elementary school from The Seed Montessori School. His father is a biologist at the National Power Corporation and also a CEO of his own environmental consultancy while his mother is an Area Manager at Jollibee Foods Corporation. He aspires to be a Mechanical Engineer someday due to his passion in machinery. The involvement of ergonomics in his study helps him heavily as he can apply these in some of his machinery someday.

Ma. Janice J. Gumasing is a professor in Mapúa University teaching at the School of Industrial Engineering and Engineering Management. She completed and received her B.S. degree in Industrial Engineering and her Master of Engineering degree also from Mapúa University. She is a Professional Industrial Engineer (PIE) with over 15 years of experience. She is also a professional consultant of Kaizen Management Systems, Inc. She has taught courses in Ergonomics and Human Factors, Cognitive Engineering, Methods Engineering, Occupational Safety and Health, and Lean Manufacturing. She has numerous international research publications in Human Factors and Ergonomics.