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Online Learning Participation Intention after COVID-19 Pandemic in Indonesia: Do Students Still Make Trips for Online Class?

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Abstract: In response to the COVID-19 pandemic, educational institutions worldwide have made online learning their primary channel. While the various benefits of e-learning have influenced governments to extend the use of this platform after the pandemic, there is the question of the intention of students toward online learning (i.e., participation and location) after the pandemic. This research aims to examine the intention of undergraduate students to do online learning post-COVID-19 pandemic and explore the factors that affect them in Indonesia. To that end, this study distributed an online questionnaire to 906 undergraduate students in mid-2021 in Bandung, Indonesia, and used the Discriminant Analysis (DA) and Multinomial Logistics Regression (MNL) model to explore the factors that influence the intention for e-learning after the pandemic. Teaching quality and time management benefits were found to influence students' intention to spend more days on e-learning. Lower frequency of e-learning is associated with communication problems, internet problems, and unfavorable conditions at home. While the substitution effect is found in e-learning for students who are able to focus during online class, the neutral effect is found for students who experience internet problems and have a lower monthly allowance. E-learning also modifies trips for students who have higher monthly allowances and experience dizziness from long screen time. Students who reside in well-developed neighborhoods tend to prefer to attend online classes from home.

Keywords: online learning; COVID-19; travel; substitution; modification; neutrality

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1. Introduction

As part of the rapid development in Information and Communication Technology (ICT), telecommuting—the practice of working/studying from home with the use of ICT—has transformed our day-to-day activities, disrupting the need for travel and physical presence [1,2]. Meanwhile, discussions on the impact of telecommuting began in the early 90s [1,3] and various research have tried to examine its impact on congestion mitigation and environmental sustainability [4–7]. An optimistic expectation for its impact on sustainability has led governments worldwide, as well as businesses and educational institutions, to promote telecommuting. However, while some scholars have found that telecommuting indeed decreases travel, which is referred to as a substitution effect [8,9], others have found that the modification, neutral, and induced travel effects will also result from telecommuting [6,10]. Therefore, it needs to be noted that telecommuting cannot be examined only based on its positive impact of decreasing travel but also based on its potential to modify and induce travel from telecommuting, which offsets the travel substituted [6,10,11].

Online learning, as part of telecommuting, has also been proposed as a way to reduce the need for travel and physical presence for students. This will allow institutions to manage their physical and non-physical resources, as well as increase access to education, especially in developing countries [12,13]. While there are various types of internet-based learning, online learning is considered the most advanced distance learning method that offers connectivity, flexibility, and the ability to promote varied interactions [14]. The popularity of online learning has been growing in various countries, such as the US, South Korea, Australia, and Germany [15–17]. In Indonesia, the adoption of online learning is promoted by the regulation of the University Certification Agency (UCA), which requires universities to adopt its practices in a certain proportion. Therefore, online learning has been steadily growing in the past few years and has been gaining momentum during the COVID-19 pandemic due to school and university closure, as well as mobility restrictions imposed by governments [18,19]. The global COVID-19 pandemic has pushed educational institutions to adopt online learning as the only channel for their education activities [20,21].

From the perspective of education itself, online learning has been found to provide more time for lecture preparation, accommodate individual pacing and regulated studies, allow for material reuse, and give more flexibility to teachers as well as students [22,23]. From the perspective of travel, the absence of travel in online learning saves teachers and students the time and cost of travel, giving them the opportunity to conduct activities that improve their wellbeing. On the other hand, increased screen time from online learning has been found to increase stress and anxiety, adding more quarantine and lockdown-related stressors that have consequently led to exhaustion and burnout [24]. While several challenges remain for both universities and students, the benefits of online learning have led to the decision to continue its adoption after the pandemic [25,26] and there are questions on how students will conduct online learning with the mobility restriction lifted.

Most of the research on online learning focuses on evaluating its effectiveness, students' readiness, and its impact on wellbeing [13,16,17,20,24]. For instance, a study by Baber [22] found that social interaction is key to the effectiveness of online learning in India during COVID-19. A study by Clark et al. [27] found an improvement in the performance of students associated with online learning during COVID-19 in China. However, research on the impact of online learning on travel is rarely conducted. One such research was done by Versetijlen [28] in 2019 and found that online learning potentially reduces the need for travel to campus as well as non-study trips in the Netherlands. However, this research is limited, as the Focus Group Discussion (FGD) and the research were conducted in 2019 when online learning was not as intensive as it is today. Therefore, further research is needed to investigate the effects of online learning on travel preferences, especially with the online learning experience during COVID-19.

Examining the impact of online learning on travel after the COVID-19 pandemic in Indonesia is important for several reasons. First, in Indonesia, students make up a substantial portion of the population within the age bracket of 15–24 years old at 17% (46 million people) of the population [29], and therefore, their travel contributes significantly to traffic congestion. Second, with such a significant number, student travel contributes to the production of Greenhouse Gas (GHG) emissions, which consequently accelerates climate change [28], and many universities worldwide are looking for ways to reduce their emission [30]. Therefore, understanding the impact of online learning can be beneficial to comprehend its impact on sustainability. Lastly, the current generation of students has the characteristics of Gen Z, which is educated, has a stronger attachment to digital transformation, and reportedly employs a different lifestyle [31,32]. Therefore, the behavior of Gen Z students may reflect a future trajectory, and such examination may be used as the basis for managing future travel demands in urban areas.

This paper aims to examine the intention of undergraduate students to adopt online learning post-COVID-19 pandemic and explore the factors that affect such an intention. Specifically, this study's contribution is two-fold. First, the study aims to explore the intention of undergraduate students to continue to adopt online learning and the factors that affect such an intention following the COVID-19 pandemic, during which undergraduate students have substantially adopted e-learning. Second, the study seeks to examine online learning behaviors based on empirical data from a developing country (Indonesia). To the author's best knowledge, most previous studies were done in developed countries. Considering the gap in terms of infrastructure quality, living standards, social structure, and culture between developing and developed countries, a separate study will enrich the knowledge on how online learning should be managed in developing countries. With those objectives, an online questionnaire was distributed for this study to undergraduate students in mid-2021 to capture the online learning experience during the pandemic as well as their intention to continue adopting online learning post-COVID-19. To explore the factors that influence the students' intention to continue with online learning, the questionnaire asked a set of questions on the residential built environment, attitude towards online learning, and negative experiences during online learning. This study used the Discriminant Analysis (DA) [33] and Multinomial Logistics Regression (MNL) [34] models to explore the factors that influence e-learning behavior.

The remainder of the paper is structured as follows: the next section discusses the literature on online learning and the COVID-19 pandemic; the third section describes the research design, data collection process, and respondents' characteristics; the fourth section presents the estimation model followed by discussions; while the last part of the paper concludes the study.

2. Online Learning Behavior and the COVID-19 Pandemic

ICT development has reshaped our daily activities, including how people conduct learning activities. Online learning has been developed in the interest of improving the efficiency and accessibility of education [14,20]. There is a variety of online learning methods and Moore et al. [14] have discussed the different definitions of e-learning, online learning, and distance learning based on their development and environment. Some studies [14,35,36] have described online learning as the most recent and improved method of distance learning that offers more flexibility and capability. Several studies [12,13] have identified the various benefits of online learning and its rise in popularity all over the world. The main driver behind the growing adoption of online learning extends beyond its ability to improve access to education and quality of learning into its potential to reduce the cost of education [13,37]. On the other hand, the benefits of e-learning are also felt by students, as they can learn at their own pace with the availability of online materials as well as the time and cost wasted for traveling are reduced [12,28,38]. The popularity of e-learning is proven by a market size of USD 222 billion in 2020, which was pushed by the mobility restriction imposed by governments in light of the COVID-19 pandemic [39].

Various studies [27,28,35] have examined online learning behaviors to identify ways to make online learning more effective and to attract more students to adopt the method. Several studies that investigate the effectiveness of online learning have underlined instructors/lecturers, learning method, and interaction as key factors to the effectiveness of online learning [20,38]. Other scholars have also found ICT infrastructure and reliability as factors that influence online learning behavior. Since the use of ICT is key to online learning, communication breakdown, and technical difficulties are among the variables that influence the favorability of online learning [40–42]. Moreover, the favorability of online learning was also found to be influenced by the readiness and ability of the students or the instructors to use ICT for online learning [17,43,44]. Various studies [45–47] have underlined the influence of gender, ethnicity, class, and financial capacity on ICT use and online learning behavior. With the rapid development of ICT devices, learning through mobile devices poses both opportunities and challenges; while it provides flexibility in learning, it also limits those who do not have connectivity and access to these devices [13].

Moreover, studies also underline the experiences had during online learning as an influencing factor in online learning participation. A study by Vonderwell and Zachariah [44] found that students have been overwhelmed by information overload and the workload of online learning. The unattractive interface of online learning platforms has also been found to be associated with negative experiences during online learning and has led to a declining interest in participating or continuing online learning [13,44]. Moreover, the overlapping learning environment and home life at home have forced students to play a variety of roles. As a result, the complexity of home conditions has also been found to influence the online learning experience [48].

The examination of online learning also began with its implication on travel behavior. As a part of telecommuting, online learning has been expected to reduce the need for travel and physical presence for students. The potential impact of online learning on travel has been examined by universities as part of the development strategy to decrease their emissions. Many universities and colleges around the world are looking for ways to reduce their carbon footprint and studies in the US, UK, and the Netherlands have estimated an emission between 300 and 630 kg CO_2 [49–52]. While studies on the impact of e-learning on travel remain limited, a study by Versetijlen [28] in the Netherlands found that online learning has potentially reduced the need for travel to campus as well as for non-study-related trips.

However, given the complexities of the influence of ICT infrastructure quality, culture, and financial capacity on online learning, calculating the amount of travel eliminated by online learning is not that simple. Mokhtarian [3] has categorized the impact of ICT on travel into four categories: substituting travel, inducing new travel, modifying inevitable travel, and having no (net) impact on travel (neutrality). Since the advancement of ICT with smartphones, laptops, and other devices, students can attend online classes anytime and anywhere, which might result in the choice behavior of online learning. More importantly, online learning relies heavily on the quality of ICT, including the internet, which is often unequal throughout different areas, especially in developing countries [42]. Because of this, students must find a place that can offer a quality and stable internet connection to learn online, which ends up modifying their campus trip.

Moreover, the adoption of online learning has grown significantly during the COVID-19 pandemic. The human-to-human transmission of COVID-19 has pushed governments worldwide to impose mobility restrictions by prohibiting most offline activities, including educational activities [18,21]. Educational institutions in various countries have been recommended or required to implement online learning for all levels of education. After more than a year of online learning, several studies have examined its impact on the performance and wellbeing of the students. Such impact on the students' performance was found to be positive in a study by Gonzalez et al. [53], which analyzed the students' performance during COVID-19 in Spain. A study by Aguilera-Hermida [54] in the US, however, found that both students and teachers still prefer offline learning over online. Uneven distribution of the required ICT infrastructure for online learning was found to be an influencing factor by a study in Pakistan during COVID-19 [55]. The study found that online learning was not able to produce the desired result as a vast majority of students were unable to access the internet due to technical as well as financial issues.

Amid the various benefits and drawbacks of online learning, some countries have been planning to extend the adoption of online learning even after the COVID-19 pandemic. In Indonesia, the Ministry of Education has announced plans to implement online learning after COVID-19 under certain criteria [25,26]. Meanwhile, the University Certification Agency (UCA) issued a regulation on online learning that requires universities to implement online learning in a certain proportion to receive higher accreditation. Even with the plans to extend the implementation of online learning after COVID-19, however, an examination of its impact on travel is still rare. Even more limited is such examination from the perspective of a developing country such as Indonesia, which is facing different conditions in terms of quality of infrastructure, economy, social condition, and culture compared to developed countries. Moreover, research on online learning and its impact on travel is also important given the market size of online learning (USD 222 billion in 2020), which is expected to grow with a CAGR of 12.7% in 2021–2026. With such a significant contribution, examining the impact of online learning on travel will provide valuable insights into the sustainable management of students' travel demands in urban areas.

3. Methodology

3.1. Research Framework

The research was designed based on the theoretical framework of the impact of ICT and online learning on travel [3,28,56] with a focus on the factors that influence e-learning [15,24]. With the objective of exploring the intention to continue adopting online learning post-COVID-19, this study divides the analysis into two. The first is to explore the preference in terms of the weekly online learning schedule after COVID-19, and the second is to explore the preference in terms of the location for the online learning after COVID-19. While the first analysis explores the weekly frequency of online learning preferred by students, the second analysis examines the effect of online learning on travel, which is defined by Mokhtarian [1,3,56] as substitution, modification, and neutral. The preference for a weekly online learning schedule after COVID-19 was analyzed using the DA model. The DA [33] is a multivariate analysis that can explore the classification of a group through the generate discriminant function. The DA is mostly used in studies [57,58] that are primarily interested in comparing or testing the differences between a set of variables. Meanwhile, the preference for the location for online learning after COVID-19 was analyzed using the MNL model [34], which has been used by various previous studies to examine choice behavior [59,60].

Both models accommodate various variables as predictors in exploring the factors that affect the intention to adopt online learning post-COVID-19. Previous studies have underlined the influence of social interactions [22,61], technological readiness and skills [62], the quality of the teaching method and instructor [27,63], and infrastructure availability [64,65] on online learning experience and effectiveness. In reviewing past literature, this study focuses on personal and ICT characteristics, the built environment, attitudes, and negative experiences related to online learning. On attitude toward and negative experience during online learning, the study refers to studies by Saade et al. [66], Dray et al. [62], and Ng [67]. Meanwhile, in relation to the factor of the residential built environment, the study refers to studies by Ewing and Cervero [68] and Rizki et al. [69]. Figure 1 describes the framework of the analysis.

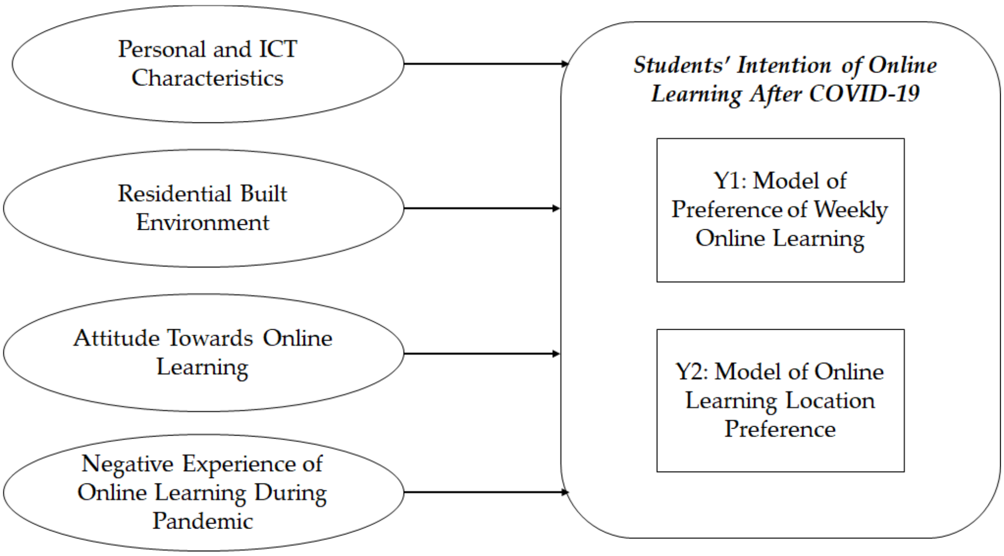

Figure 1. Research framework.

3.2. Questionnaire and Data Collection

This study distributed questionnaires to undergraduate students in Bandung, Indonesia. Based on the research framework in Figure 1, the questionnaire was divided into five parts. The first part contained questions about e-learning behavior during COVID-19, which consist of questions related to average daily hours for class and discussion with peers, as well as the number of days in a week spent for online learning. In the second part, students were asked about their attitude towards online learning (such as understanding the lecture, the ability to focus, the amount of travel cost saved, ICT skills improvement, etc.) using a five-point Likert scale, where '1' represents "strongly disagree" and '5' represents "strongly agree". The second part consists of questions about negative experiences during online learning using a five-point Likert scale, where '1' represents "strongly disagree" and '5' represents "strongly agree". Using the literature from Saade et al. [66] and Dray et al. [62], the questions on negative experience cover such issues as communication problems, dizziness from long screen time, a lack of proper explanation from the lecturer, internet problems, etc. In the third part, students were asked about their intention to adopt online learning after COVID-19. This part consists of two questions: preference on weekly online learning frequency and location for online learning. The fourth part of the questionnaire consists of fifteen questions about the residential built environment [68] from the accessibility of the residence to the design and green space of the residence. In the last part, drivers were questioned on their attitude towards working behavior, with respect to negative effects on health and financial needs fulfillment, among others. The answer to the built environment questions was also given through a five-point Likert scale, where '1' represents "strongly disagree" and '5' represents "strongly agree". The students' socio-demographic and ICT characteristics were asked in the last part.

Before the final survey, the questionnaire was tested by 30 respondents and experts to assess the quality of the questions and to avoid the possibility of survey biases. After the revision, the questionnaire was distributed between 19 March and 13 May 2021. The method used to distribute the questionnaire was convenience sampling using an online web-based questionnaire distributed through various online forums (i.e., WhatsApp, Facebook, Instagram, Twitter, and Line). Furthermore, like other surveys during COVID-19, the online survey was done to avoid face-to-face interactions to minimize the spread of COVID-19. However, limited accessibility has always been an issue for online questionnaires. People who have a smartphone or access to the internet with familiarity with social media can more easily participate in the survey. However, considering that the majority of Indonesians had access to a smartphone and the internet in 2020 [70,71], such a limitation was not regarded as serious. To ensure the distribution of the questionnaire, the web-based questionnaire was distributed by the authors, students, and several surveyors that were recruited through the association of undergraduate students in Bandung. The surveyors helped distribute the questionnaire through their social media accounts. The questionnaire has filter questions to identify whether the respondent is a university student and whether the respondent's university is located in Bandung. Only undergraduate students that study in a university located in Bandung and live in Bandung would proceed to answer the remainder of the questionnaire. These filter questions were included to eliminate the possibility of survey biases by ensuring only the right respondents can answer the questions. The collected data sets were reviewed and 906 sets out of 945 respondents were used for further analysis.

3.3. Respondents' Characteristics

The questions regarding the respondents' intention for online learning after the pandemic were focused on how respondents will conduct online learning, as well as the preferred weekly frequency. Using the typology of ICT impacts on travel outlined by Mokhtarian [1,3], respondents were provided four action options regarding the way they will conduct e-learning post-pandemic. The first option is to conduct online learning alone at home, which refers to the substitution effect. The second option is to conduct online learning at home together with some friends or at their friends' homes. Since such activity still generates trips—either a trip from the respondent's house to his or her friend's or vice versa—but eliminates several trips to campus, this action is defined as semi-substitution. The third option is to conduct online learning on campus, which refers to the neutral effect. The last option refers to the modify effect as students conduct e-learning in a place outside of their home or campus (i.e., café, internet station, restaurant, etc.). Moreover, the students were also asked about their preference on the number of days in a week where they conduct e-learning after the pandemic with three response options (i.e., 1–2 days, 3–4 days, >4 days). The details of respondents based on their responses are available in Table 1.

The majority of online learners (48.8%) intend to conduct online learning alone at home. Students who conduct online learning, either at home or at a friend's home, make up 19.9% of the total respondents. Surprisingly, 21.3% of respondents intend to make a trip to the campus to conduct online learning. Only 10% of respondents express their intention to conduct online learning in other places outside of their home or campus. Moreover, students prefer to spend 3–4 days in a week online learning. Only 14.4% of respondents want to spend 1–2 days online learning in a week.

Table 1. Details of online learning/e-learning intention (n = 906).

Online Learning Intention		Proportion (%)
Location of online learning preference	Substitution: e-Learning at Home	48.8
	Semi-substitution: e-Learning at Home Together	19.9
	Modification: e-Learning at Other Places	10.0
	Neutrality: e-Learning on Campus	21.3
Weekly online learning preference	1–2 days	14.6
	3–4 days	68.1
	>4 days	17.3

The statistics reveal the interesting fact that a substantial proportion of students do not intend to conduct e-learning at home. Moreover, based on the preferred number for e-learning in a week, it seems that students prefer a combination of offline learning and e-learning in certain proportions in terms of the number of days. The preferred proportion implies that the respondents are facing certain constraints in conducting e-learning at home. In addition, the modification and neutral effects of e-learning show a need for demand management and a clear e-learning adoption strategy post-pandemic.

The characteristics of the respondents are presented in the upper half of Table 2. The majority of respondents are male (57.4%), 19–20 years old (48.2%), and in their second year (29.5%). Most of the respondents have a monthly allowance of less than IDR 1 million or equal to around USD 70. In terms of ICT characteristics, most respondents have at least one smartphone or laptop at home and use a smartphone or a router for wi-fi to support e-learning. Table 2 also shows their e-learning behavior during the pandemic, in which most of the respondents spend more than 4 days a week taking online classes at 4–5 h a day. They also allocate, on average, 3–5 h for discussion every day.

Table 2. General characteristics of respondents (n = 906).

Variables		Proportion (%)
Personal Characteristics		
Gender	Male	57.4
	Female	42.6
Age	<19 years old	6.8
	19–20 years old	48.2
	21–22 years old	37.2
	>22 years old	7.7
Year	4th year student	23.8
	3rd year student	19.5
	2nd year student	29.5
	1st year student	11.9
	>4th year student	15.2
Monthly allowance [a]	<IDR 500,000 (<USD 35)	33.0
	IDR 500,000–IDR 1,000,000 (USD35-70)	27.6
	IDR 1,000,000–IDR 1,500,000 (USD70-105)	14.5
	IDR 1,500,000–IDR 2,000,000 (USD105-140)	13.5
	IDR 2,000,000–IDR 3,000,000 (USD140-210)	6.1
	>IDR 3,000,000 (>USD 210)	5.4
ICT Availability		
Availability of smartphone	0	2.0
	1	80.0
	2	15.7
	>2	2.3
Availability of laptop	0	5.6
	1	81.1
	2	10.6
	>2	2.6
Wi-fi/internet	Wi-fi from router	26.3
	Wi-fi from smartphone	36.2
	Both	37.5
Online Learning Behavior During COVID-19		
Weekly online learning during COVID-19	1–2 days	5.4
	3–4 days	45.7
	>4 days	48.9
Average hour of classes a day	<3 h	21.9
	3–5 h	46.5
	5–7 h	28.4
	>7 h	3.3

Variables		Proportion (%)
Average hour for discussion a day	<3 h	26.5
	3–5 h	35.8
	5–7 h	23.6
	>7 h	14.1

[a] USD 1 = IDR 14,250 in October 2021.

Table 3 shows the descriptive analysis on multiple questions about the attitude towards e-learning and negative experiences during e-learning. From the description, the average respondents agree that e-learning can save travel costs and time. However, they have expressed issues with the effectiveness of the lecture and the ability to focus during e-learning (below 3). Dizziness, due to long screen time, and communication problems with colleagues are among the most common negative experiences expressed by respondents. Interestingly, the respondents also expressed negative experiences from the conditions at home, such as disruption from other responsibilities at home and surrounding noise. Moreover, the reliability indicators values exceed the critical value of 0.7, which is for general dimension as well as indicating that the variables have good internal consistency [72].

Table 3. Description of attitude towards online learning and negative experience.

Variables [a]	Mean	Std. Deviation
Attitude towards online learning (α= 0.848)		
It's interesting because the method is fun	2.803	0.809
I am focused when conducting online learning	2.575	0.897
I understand the lecture	2.678	0.830
I can save travel cost	4.072	0.946
It provides time efficiency as there is no need for travel	3.884	0.957
It improves my ICT skills	3.442	0.914
It allows me to manage my schedule more efficiently	3.221	0.939
It allows me to spend more time with family	3.818	0.955
It provides more flexibility in discussing with colleagues	2.986	1.108
It is easy to get help from other colleagues	3.050	1.036
Negative experiences (α= 0.787)		
Communication problems with colleagues	3.626	0.962
Long screen time makes me dizzy	4.055	0.855
Lecturer doesn't explain clearly/well	3.426	0.810
Burdened with other works at home	3.487	0.957
Problem with the internet	3.148	0.959
Difficulty in discussing with/asking questions to the lecturer	3.369	0.902
Conditions around the house make it difficult to focus	3.483	1.005

[a] Likert scale of 1 representing "strongly disagree" to 5 representing "strongly agree"; α = Cronbach alpha.

Since this study also explores the effects of the residential built environment on e-learning behavior, this study performed a factor analysis on the 15 questions on the built environment aspects. Exploratory Factor Analysis (EFA) was applied with varimax rotation to provide adequate information about the variables under examination, eliminate correlated variables, and simplify the factor structure [33]. For practicality in interpreting the factor group, variables with factor loadings of less than 0.5 were removed. The value from the Kaiser–Meyer–Olkin (KMO) sampling adequacy test is higher than the cut-off value of 0.8, as shown in Table 4, which indicates that the sum of the partial correlations is small relative to the sum of the population. The three factors generated through the EFA were constructed from 15 variables: closer to various public amenities, residing in well-developed and safe neighborhoods, and green environment and good pedestrian networks. The three factors represent the built environment conditions of the respondents' home locations. The reliability of these factors is also described in Table 4, which all exceed the critical value of 0.7, indicating that the component has good internal consistency [72].

Table 4. Factor analysis of the residential built environment.

	Descriptive [a]	**Component**		
Built Environment Variables	**Mean (S.D.) (α = 0.882)**	**Closer to Various Public Amenities and Transport Infrastructure (α = 0.879)**	**Residing in Well-Developed and Safe Neighborhoods (α = 0.844)**	**Green Environment and Good Pedestrian Networks (α = 0.804)**
Closer to shopping facilities	3.699 (0.849)	0.860		
Closer to public facilities	3.615 (0.834)	0.857		
Closer to city center	3.498 (0.897)	0.776		
Closer to main road	3.863 (0.778)	0.851		
Good internet network	3.424 (0.870)	0.590		
Closer to public transport networks	3.469 (0.899)	0.620		
High security and low crime	3.307 (0.852)		0.540	
More bungalow houses	2.714 (1.024)		0.752	
Available parking space	3.221 (0.954)		0.814	
A well-designed neighborhood	3.139 (0.859)		0.852	
Tidy arrangements and more trees	3.224 (0.906)		0.812	
Closer to bicyle and pedestrian facilities	3.172 (0.954)			0.760
Comfortable pedestrian facilities	2.959 (0.962)			0.804
Closer to parks and green space	3.175 (0.955)			0.574
Closer to sport facilities	2.934 (0.947)			0.686
Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization				
Kaiser-Meyer-Olkin Measure of Sampling Adequacy			0.885	
Bartlett's Test of Sphericity [χ2; df.; *p*-value]			[6899.461, 105, 0.000]	

S.D. = standard deviation; [a] Likert scale of 1 representing "strongly disagree" to 5 representing "strongly agree"; α = Cronbach alpha.

4. Results

4.1. Preference on Number of Days of e-Learning in a Week

The result of the DA on e-learning frequency preference is described in Table 5. Before interpreting the result, the evaluation of the model quality is reported. The result of Box's M test shows that the null hypothesis of equal population covariance matrices is not rejected. With a sample size of more than 900 respondents and 20 independent variables, the ratio of cases to independent variables is more than 5:1. This increases the model's general representativeness, as suggested by Hair et al. [33]. Wilks' lambda of this model indicates that the function is highly significant. The classification result implies that 45.0% of respondents were classified correctly, which is higher than the threshold value of the proportional chance criterion (33.5%). Based on statistical and practical significance, it can be judged that the overall model results are acceptable.

Table 5. Estimation of preference on weekly e-learning model.

Variables	Dependent Variables Group Means			F	Structural Matrix	
	1–2 Days	3–4 Days	>4 Days		F1	F2
Residential built environment conditions						
Closer to various public amenities and transport infrastructure	0.122	−0.051	0.097	2.520 [a]	−0.160	−0.316
Residing in well-developed and safe neighborhoods	−0.081	0.040	−0.089	1.544	0.151	0.225
Attitude towards online learning						
It's interesting because the method is fun	2.659	2.799	2.943	4.464 [b]	−0.340	0.266
I am focused when conducting online learning	2.364	2.575	2.752	6.800 [b]	−0.395	0.372
I understand the lecture	3.985	4.065	4.172	1.455	−0.206	0.126
I can save travel cost	3.780	3.880	3.987	1.697	−0.212	0.159
It provides time efficiency as there is no need for travel	3.348	3.428	3.573	2.392 [a]	−0.278	0.123
It improves my ICT skills	3.076	3.211	3.382	3.955 [b]	−0.336	0.216
It allows me to manage my schedule more efficiently	3.682	3.822	3.917	2.201	−0.210	0.233
It allows me to spend more time with family	2.576	3.055	3.057	10.785 [b]	−0.172	0.740
It is easy to get help from other colleagues	2.750	3.110	3.064	6.677 [b]	−0.066	0.600
Negative experiences						
Communication problems with colleagues	3.871	3.635	3.382	9.530 [b]	0.502	−0.378
Long screen time makes me dizzy	4.159	4.031	4.064	1.235	−0.001	−0.261
Lecturer doesn't explain clearly/well	3.523	3.436	3.306	2.730 [a]	0.288	−0.157
Burdened with other works at home	3.629	3.512	3.268	5.857 [b]	0.441	−0.168
Problem with the internet	3.273	3.120	3.153	1.384	0.009	−0.276
Difficulty in discussing with/asking questions to the lecturer	3.530	3.370	3.229	4.017 [b]	0.308	−0.279
Conditions around the house make it difficult to focus	3.652	3.491	3.312	4.174 [b]	0.336	−0.244
Personal characteristics						
Age	20.523	20.348	20.567	1.764	−0.179	−0.220
Monthly allowance	2.515	2.553	2.178	4.060 [b]	0.379	0.083
Goodness of Fit Parameters				FCG	F1	F2
Box's M [F;df1;df2; *p*-value]	[1.687, 420, 403038.808, 0.000]			1–2 days	0.161	−0.467
Eigen Values [Canonical Correlation]	0.061, 0.040 [0.239, 0.197]			3–4 days	0.102	0.109
Wilks' Lambda F1 [*p*-value]	0.906, 0.961 [0.000, 0.013]			>4 days	−0.536	−0.036
Percent Correct	45.00%					

[a] significant at 10%; [b] significant at 5%.; FCG= Function at Group Centroid

In this study, the interpretation uses the structural matrix, which is only for attributes in a structure matrix with loadings higher than 0.30, as suggested by Hair et al. [33]. The structure matrix shows each variable's correlations with each discriminate function and can be interpreted similarly to factor loadings [73]. Function 1 separates students who prefer lower weekly e-learning frequency (0.161) from those who prefer the full e-learning experience (−0.536). Meanwhile, function 2 separates the group of students who prefer 3–4 days of e-learning in a week (0.109) from the group of students that prefer a lower weekly e-learning frequency (0.467).

The first function shows that preference for a higher frequency of e-learning is influenced by the quality of the teaching method. The e-learning benefit of the ability to manage a schedule was also found to influence preference for higher online learning frequency. Higher online learning frequency is also mostly preferred by students that do not have difficulty focusing during e-learning. In contrast, negative experiences have been found to negatively influence preferences on e-learning frequency. Problems such as communication problems with colleagues and lecturers are among the issues that negatively affect preference for higher e-learning frequency. Moreover, household conditions, such as disruption from other responsibilities and noise around the house are also found to negatively influence a preference for higher e-learning frequency. In addition, students who have a higher monthly allowance tend to prefer lower e-learning frequency.

The second function shows that students who believe that e-learning provides flexibility for and accommodate communication with others tend to be associated with a preference for higher e-learning frequency. Interestingly, a built environment is found to shape preference on the frequency of e-learning. Students who reside in places that are closer to various public amenities, as well as transport infrastructure, tend to prefer lower e-learning frequency.

4.2. Preference on e-Learning Location

The estimation of the e-learning location preference model is presented in Table 6. The stepwise method was used to estimate the best possible model to explain e-learning behavior and several insignificant variables were kept in the model due to their interaction with the goodness-of-fit of the model based on review during the stepwise process [74]. Moreover, an analysis of the quality of the model is presented. The model's fitness was analyzed through an overall model fit test (2LL). The null hypothesis that the model with independent variables is as good as the model without independent variables was unable to be retained, consequently implying that the model was fit to explain the data. The pseudo R^2 parameters (Cox and Snell and Nagerlkerke) were found to be higher than 0.2. The cross-tabulation test shows that more than 50% of the data was correctly classified in the model. This is to say that the model is suitable for the variability of the data. The interpretation of the model was based on the reference category of "substitution: e-learning at home alone".

The resulting estimation in Table 6 not only underlines several findings that support past research but also adds new insights into online learning behavior. The preference to conduct e-learning at home is found to be associated with attitude, experience, built environment, and personal characteristics. Students who have a positive attitude towards e-learning, such as in relation to the e-learning benefit of saving travel time and the ability to focus during e-learning, tend to prefer to conduct e-learning alone at home. However, the attitude that e-learning will improve ICT skills tends to be associated with the preference to conduct e-learning at home together with friends. Interestingly, students who experience dizziness due to long screen time tend to prefer to conduct e-learning in other places. However, negative experiences from teaching problems do not seem to result in students changing their e-learning location preference from alone at home. Internet problems were also found to influence students' preference to conduct e-learning from outside of their homes, particularly on campus.

Table 6. Estimation of online learning location preference model.

Variables	B	t-Stat	B	t-Stat	B	t-Stat
	Semi-Substitution: e-Learning at Home Together		Modification: e-Learning at Other Places		Neutral: e-Learning on Campus	
Intercept	1.194	0.784	0.772	0.394	2.813	1.823 [a]
Residential built environment conditions						
Green environment and good pedestrian networks	0.165	1.658 [a]	−0.170	−1.311	0.253	2.503 [b]
Residing in well-developed and safe neighborhoods	−0.154	−1.597	−0.397	−3.129 [b]	−0.150	−1.488
Attitude towards online learning						
I am focused when conducting online learning	−0.258	−1.964 [b]	0.223	1.324	−0.044	−0.327
I can save travel cost	−0.210	−1.449	−0.307	−1.573	0.006	0.043
It provides time efficiency as there is no need for travel	0.147	1.006	0.105	0.534	0.142	0.978
It improves my ICT skills	−0.360	−2.401 [b]	−0.033	−0.171	−0.393	−2.641 [b]
It allows me to manage my schedule more efficiently	0.435	3.040 [b]	0.118	0.650	0.232	1.633

I understand the lecture	0.064	0.480	−0.259	−1.463	−0.038	−0.278
It provides more flexibility in discussing with colleagues	−0.039	−0.405	−0.038	−0.300	−0.537	−5.156 [b]
Negative experiences						
Long screen time makes me dizzy	0.177	1.321	0.382	2.076 [b]	0.189	1.340
Lecturer doesn't explain clearly/well	−0.471	−3.491 [b]	−0.627	−3.460 [b]	−0.414	−2.988 [b]
Burdened with other works at home	0.053	0.447	0.198	1.234	0.197	1.595
Problem with the internet	0.047	0.439	0.216	1.476	0.199	1.791 [a]
Personal characteristics						
Age	−0.058	−0.898	−0.231	−2.698 [b]	−0.180	−2.727 [b]
Year	−0.011	−0.196	0.155	2.029 [b]	−0.040	−0.654
Monthly allowance	−0.059	−0.836	0.197	2.223 [b]	0.058	0.836
Number of smartphones available	−0.235	−1.043	0.563	2.197 [b]	0.692	3.471 [b]
Number of laptops available	0.493	2.560 [b]	0.059	0.226	0.225	1.156
Male (D)	−0.070	−0.361	0.519	2.026 [b]	0.231	1.176
Goodness of Fit Parameters						
-2LL (0); -2LL (β); [χ2;df.;*p*-value]	2225.38, 2011.63 [213.745, 57, 0.000]					
Cox and Snell R^2; Nagelkerke R^2	[0.211, 0.230]					
Percent Correct (%)	54.20%					

Reference category = "Substitution: e-Learning Alone at Home"; [a] significant at 10%; [b] significant at 5%; (D) = dummy variable 1 yes 0 otherwise.

The residential built environment was found to influence preference for e-learning locations. Students who reside in well-developed and safe neigbourhoods tend to prefer to conduct e-learning alone at home, while students who live in residential locations that have green environments and pedestrian networks tend to prefer to attend online classes on campus. In relation to personal characteristics, older students tend to prefer to take online classes from home, while male students and students who have a higher monthly allowance prefer to attend online classes from other places, such as a café, etc. Interestingly, the availability of a higher number of smartphones tends to be associated with the intention to conduct e-learning from outside of their home.

5. Discussion

The result of the study shows that e-learning behavior after the pandemic is influenced by various factors. While various e-learning challenges during COVID-19 have been indicated by various studies [18,21,48,55], this study found that students are still interested in conducting online learning after COVID-19. The benefits of online learning [12,37] have the potential to appeal to students to adopt it, at least for a certain proportion of days in a week.

Results indicate that the intention to participate in e-learning is influenced by experiences during e-learning, attitude towards e-learning, and the built environment. In line with the results of the study by Hamann et al. [38], students' willingness to participate is influenced by teaching methods, including interactions between students and teachers. Students tend to prefer a higher e-learning frequency when they are able to maintain good communication with each other and with their lecturers. It seems that the perception that offline class better accommodates active interaction, including more immediate response and sensory information [40], has made e-learning less preferable. Previous studies [54,75,76] also indicate that interactions, through discussions and debates, strongly contribute to the stimulation of cognitive learning, which influences students' performance.

In line with the result of the study by Aguilera-Hermida [54] and Kemp et al. [77], attitude towards the benefits of online learning, such as the flexibility to communicate and manage schedules, was found to positively influence the preference to spend more days conducting e-learning. While there are intrinsic and extrinsic motivations [78], such benefits might positively drive students to manage their online classes with the motivation to maintain their performance. The immediate effect of attitude on motivation or, conversely, demotivation, might be the reason for its great influence on participation or engagement. However, Ferrer et al. [78] underlines that a positive attitude towards online learning may not necessarily lead to positive performance without any intrinsic motivation to accomplish or know, on the part of the student. Studies from Martin and Nunes [79] and Kulikowski [80] also underline the elevated efforts from the academics within the e-learning process and the challenges with the improvement of morale and the character-building of students as among the difficult aspects.

This study confirms that unpleasant experience negatively affects the intention to participate in e-learning. Unfavorable home conditions (i.e., other responsibilities or surrounding noise) are found to negatively affect the intention to adopt more days of e-learning. Students often have to assume different roles when studying at home with the household tasks assigned to them [48]. The conflicting roles of a student and a variation of household roles might result in students preferring face-to-face learning, which allows them to focus on their role as students. In addition, since e-learning requires concentration, disruption from the environment (i.e., noise) was found to influence the engagement experience, which lowers interest for adopting higher e-learning frequency. Moreover, the findings also show the effects of the residential built environment, in which students who reside closer to various public amenities and transport infrastructure tend to prefer lower e-learning frequency. It might be that good accessibility to public amenities and transport infrastructure influenced students to make a trip to campus rather than stay at home and do online learning.

While the study provides evidence of intention to adopt e-learning after COVID-19 among students, it also shows that e-learning does not fully eliminate the need for campus trips, contrary to the result of the study by Versteijlen et al. [28]. With the modification and neutral effect of ICT, as underlined by Mokhtarian [3,56], this study found that students still need to travel for e-learning, such as to campus or other places (i.e., café, internet stations, etc.). This means that the reduction of GHG emissions from e-learning is not as significant as expected. The preference to conduct e-learning at home alone or together, on campus, or in other places, was found to be associated with attitude, experience, the built environment, and personal characteristics.

The substitution effect of e-learning was found to be supported by a positive attitude towards e-learning, especially with the benefit of travel time reduction. This is reasonable since attending online classes at home will eliminate travel time and therefore, students can use the travel time saving to perform other activities they desire. Since complexities related to the e-learning environment influence students' concentration [44]; the substitution effect is also found among students who are able to focus during e-learning. Students' ability to concentrate is influenced by internal and external factors. On one side, interest in and positive attitude towards e-learning were found to influence the ability of students to concentrate [81,82]. On the other hand, the external factors of environmental conditions and the culture in the residential location can pose a challenge for students in maintaining focus during online class [83,84]. Interestingly, problems related to teaching methods do not influence students' choices to conduct online learning outside of their homes. A possible reason for this is that a location change is not perceived to have any effect on improving the learning method and students have the option to further discuss with their colleagues to improve their understanding of the material [85,86].

Supporting the previous argument, challenges related to ICT infrastructure quality were found to drive students to attend online classes outside of their home, such as on campus. In this case, students might find a place or public amenities with high-quality internet services to support their e-learning needs. Students are also influenced to make online learning trips to other places (i.e., café, internet stations, etc.) when they experience dizziness from long screen times. Since the effectiveness of online learning is influenced by the environment [84], it appears that students will look for places that can provide a more conducive or relaxing environment to avoid dizziness.

Moreover, the preference for e-learning location is also shaped by the students' socio-demography, with wealthier students leaning towards attending online classes in other places. A higher financial capacity provides students with more flexibility to choose the place where they attend online classes, even when it generates cost. In addition, male students and those who have smartphones tend to attend online classes from outside of their homes.

The residential built environment was also found to influence behavior in relation to e-learning locations. Students who reside in well-developed and safe neigbourhoods tend to conduct e-learning at home. Well-developed residentials might provide the best quality of infrastructure that can support students in attending online classes. Interestingly, students who reside in locations with green environments and pedestrian networks tend to attend online classes on campus.

6. Conclusions

Mobility and face-to-face activities' restriction in response to the COVID-19 pandemic has forced all educational institutions to migrate to online learning. Amid the e-learning benefits and challenges during the COVID-19 pandemic, some countries are planning to extend the practice of e-learning after COVID-19 ends. Therefore, this study aims to examine how students intend to participate in online learning after COVID-19 ends.

This research found that the quality of teaching method and the benefit of time management capability drive the students' intention to adopt more days of e-learning. A preference for lower e-learning frequency tends to be associated with communication problems, an unstable internet, and unfavorable home conditions. This study also found that e-learning does not fully eliminate the trip for studying. While the substitution effect of e-learning was found with students who are able to focus and have a positive perception that online learning saves them travel time, the neutral effect was found with students who experience internet problems, as well as have a lower monthly allowance. E-learning can modify trips for students who have a higher monthly allowance and experience dizziness from long screen times. Students who reside in well-developed neighborhoods tend to attend online classes from home. Generally, this study found the positive intention of students on performing online learning at a certain proportion, and underlines that the expectation of online learning can reduce emission is not as significant as expected, therefore, a university should consider improving their GHG mitigation strategy within the online learning policy.

Our study presents several important findings that can be used as a basis in formulating policies to maximize the substitution effect of online learning and manage online learning trips. First, the findings suggest that an improvement to the method and quality of teaching that focuses on stimulating quality discussion between students and lecturers is needed. Educational institutions should also promote more active and collaborative communication with their lecturers to avoid communication problems between lecturers and students. Educational institutions should also anticipate students who will conduct online learning on campus by making the needed space or areas available. Second, since home conditions significantly affect e-learning behavior, this study also proposes to ensure the quality of the students' home environment by increasing parents' knowledge on the needs of the students for online classes. Education on online learning for the students' parents is proposed to be given by the educational institution so that students are not burdened by other tasks that overlap with their obligations as students. Lastly, given that internet quality is among the important factors that influence e-learning behavior, ICT improvement, and accessibility should be accommodated by the government. Similar to other developing countries [55], Indonesia has made ICT infrastructure a priority development agenda [87]. To ensure online learning effectiveness, such development can be focused on areas with lower internet quality and a higher number of students.

While this study provides several important findings, it also has limitations, which can be used as a basis for future research. This study covers positive attitudes towards and negative experiences in online learning, while offline learning variables are not included in the analysis. Considerations on the advantages and disadvantages of offline learning and interactions in online learning may provide valuable information to be used in the formulation of online learning policies. Based on the four implications of ICT on travel, as outlined by Mokhtarian [3], this study only explores the substitution, neutrality, and modification effects of e-learning. As students can save travel time with e-learning, a study is needed to examine the effects of e-learning on induced trips to gain a more comprehensive understanding of the impact of e-learning on travel. This will ultimately provide more insight into the effect of e-learning, which can help formulate a more comprehensive sustainable urban transportation policy in the future.

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