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Board 2A: WIP:Opportunities in Cultural Dimensions between Architecture and Civil Engineering students in Ecuador

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Work in Progress: Opportunities in Cultural Dimensions between Architecture and Civil Engineering students in Ecuadorr

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Abstract

Nowadays, due to the great demand for infrastructure, the expertise of architects and civil engineers in their respective fields of knowledge has been valued, generating a greater need for collaboration and an effective workflow. However, from the educational foundations, a gap has been created between these branches of construction to the point that their teaching approaches are different, thus forming a deficiency of understanding between them and complex working environments in professional life. This study seeks to understand the cultural differences between civil engineering and architecture students, based on Hofstede's theory of cultural dimensions. Five dimensions are evaluated: Individuality, Power distance, Uncertainty avoidance, Masculinity, and Long-term orientation. Data were collected from four groups: civil engineering students pre-pandemic and post-pandemic and architecture students' pre-pandemic and post-pandemic to determine if the new teaching methods associated with the COVID 2019 pandemic, may cause variations in the results giving openness to further research. All surveys were administered to students at the Universidad San Francisco de Quito USFQ, in Spanish, and reviewed by native speakers. The results provided statistical information on the significant differences in cultural dimensions between engineers and architects so that it was possible to discuss the possible causes of the creation of the gap between the two branches of construction as well as to understand variations in pre-pandemic and post-pandemic student outcomes and recommendations that can be taken to reduce barriers to cooperation between civil engineers and architects.

Introduction

Before the 19th century, infrastructure was carried out by a single professional, who played the role of both civil engineer and architect. In 1818 the Institute of Civil Engineers appeared in Great Britain, and it was not until 1834 that the Royal Institute of British Architects was formed in the same country. The creation of these two institutions gave rise to different specializations in each profession. On the one hand, engineering and structural problems and, on the other hand, design and functional specifications [1]. This event initiated the creation of a gap between both construction branches that has been growing until today so that even though both professions share similar design objectives the standards experienced are different [2], [3]. Nowadays, due to technological advances and the growth of the demand for infrastructure, experience

in both fields is valued [4] [5], demanding collaboration between these two disciplines starting from the educational process. For this reason, it is important to understand the perceptions of the working group where culture plays a very important role during the process. [6],[3],[7].

This gap or conflict between civil engineers and architects is an under-researched phenomenon that is emerging around the world. In New Zealand, a study assessing the quality of interdisciplinary relationships and the perception of collaborators found that architects disagreed with the lack of vision and the traditional way that engineers have in their designs, while, on the other hand, engineers complained about the lack of structural and mechanical understanding of architects. [8] In another study analyzing the experience of 46 engineers in the profession, similar results were obtained, highlighting the challenges of lack of mutual respect and trust during the construction process [9]. These results encourage us to think about the existence of behaviors related to the dimensions of culture.

This study hypothesizes that the growth of this gap between the two professions can be understood as the cultural differences that have been implanted from academic training, analyzing it from the point of view of Hofstede's theory of culture. [1] Culture can be defined in several ways, for Hofstede "Culture is the collective programming of the mind that distinguishes the members of a group or category of people from others" [10], i.e., it represents the behavior of a person and in turn can differentiate groups which share the same culture [11]. Through these concepts and theories, we can analyze this cognitive distance between students of civil engineering and architecture and propose pedagogical exercises to close the existing gap between both branches of study. It is important to emphasize that the 2019 coronavirus disease (Covid-19), has generated a great impact on education [12], causing higher education to move to remote learning models where the campus is blocked due to the spread of the virus[13],[14]. Social distancing creates a barrier that affects experiential learning [12], [15], [16], this factor leads us to analyze that there may be differences between pre-pandemic and post-pandemic student cultures due to the drastic change in education.

The purpose of this study focuses on civil engineering and architecture students in Ecuador. In most countries, universities generate a division between the two disciplines both physically and in the curriculum [8]. The Universidad San Francisco de Quito (USFQ), a private liberal arts university in the city of Quito - Ecuador, is not an exception to the generation of this gap, so to quantitatively analyze the culture in these student groups a study was conducted by applying the theory of cultural dimensions of Hofstede, where the questionnaires proposed by Sharma [17] were used, to collect relevant information of the culture in these two branches of construction in Ecuador. By understanding the cultural dimensions, we will be able to develop pedagogies that allow better collaboration between engineers and architects to improve communication, reducing conflicts and helping to have a more productive work environment in the future.

Background

To guide this study, we used the cultural dimensions model of Hofstede, who based his research on a survey of IBM employees in more than forty countries in 1966 [18], [19]. To characterize the cultural traits of different societies. [1], [11]. For Hofstede, culture

is defined as the collective propagation of the mind, which manifests itself not only in values but also in more superficial forms [19]. Hofstede introduced the concept of dimensions of culture by investigating the philosophical opposition between the specific and the general, the different and the similar, which are comparative studies that make the dimensions of culture be represented as a particular choice [19]. Through this study, Hofstede initially identified four independent problems related to a dimension of culture, which with studies conducted in subsequent years would be added one more resulting in five dimensions of a culture where thanks to these models individuals in a society can fall into one pole or another of each of these five mentioned above [18],[1],[11], the same as they are: Individualism, Power distance, Uncertainty avoidance, Masculinity, and Long-term orientation [20].

Individualism relates to the degree to which people belong to a group, and is considered in societies where relationships are weak, i.e., people look out for themselves or their families [21]. On the other hand, collectivism is the opposite of individualism and considers societies that can form integrated groups with strong norms of unity creating strong societies [21],[18]. **Power distance** or PDI gives us information about the dependency relationship. For example, in countries with small power distance, the treatment between bosses and subordinates is collaborative and more communicative so that they can correct or express their ideas with their superiors, which in cultures with large power distance would not be possible [22]. This dimension addresses the measure of power inequality [18]. **Uncertainty avoidance** or UAI considers how individuals in society cope with future possibilities of risk and describe the attempts of members of society to achieve a position in conflict situations or the ability to operate under uncertainty [21]. For Hofstede cultures with high uncertainty avoidance consider unstructured situations intimidating, on the other hand, cultures capable of accepting uncertainty tolerate opinions and adopt relativistic philosophies [18].

Masculinity evaluates the delegation of responsibilities and emotional roles between both genders within a society, [21] so that assertive roles are given to the masculine pole and caring roles to the feminine pole [18]. In societies with feminine tendencies, both men and women share sets of values related to the quality of life, cooperation, and help between people while in masculine societies they focus on competence and materiality [21]. **Long-term orientation** refers to the promotion of activities and virtues oriented to future rewards so that society allows itself to have habits of perseverance and saving; on the other hand, short-term orientation promotes virtues that relate to the present and the past, making societies more traditionalist, fulfilling the needs of the community [21],[23].

Although Hofstede's cultural dimensions have been studied and used for years, some researchers realized shortcomings such as analyzing culture using the nation as a unit, the fallacy of assuming that cultural dimensions developed based on national surveys can be applied at the individual level, and the unreliability of collecting data from a single company [24],[17]. As an example, Hofstede's research placed the United States as the most individualistic country among the 40 countries studied so researchers challenged stereotypes that U.S. citizens of European origin were more individualistic than citizens of other ethnic groups [25]. On the other hand, it is also possible that other non-cultural factors such as demographics, economic status, or environment provide information about the differences between countries [1]. As a result Sharma who also

believed that Hofstede's theory is too general, said that the dimensions should not be measured as opposites, for example, individualism and collectivism are direct opposites for Hofstede which implies that a person who is not an individualist is a collectivist which is not the case, For Sharma, these dimensions should be measured separately [17], because of this through a literature review on Transcultural psychology, Sharma restated the five dimensions into ten cultural orientations and adjusted Hofstede's questionnaire [1], [17].

However, based on studies we can argue that Hofstede's methodology can be reliable if we meet the necessary validity considerations [24], and even though it is applied to classify users nationally, it is a very useful framework that can be used in the area of academic discipline in this way it is possible to study cultures and subcultures in the areas of engineering and architecture in the context of Ecuador and the United States [1], [11].

Using an online tool from Hofstede [26], we can make a comparison between the cultural dimensions of Ecuador and the United States. Figure 1 shows a visual representation of the five cultural dimensions with updated data from the countries of study.

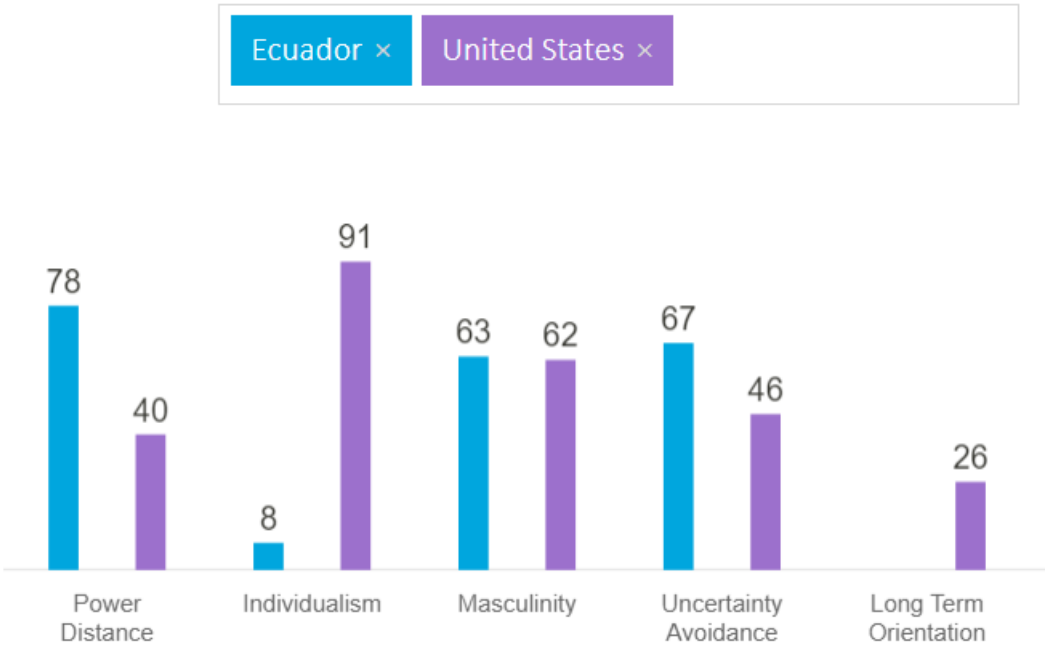


Figure 1. Comparison between Ecuador and the United States according to Hofstede [26].

Ecuador scores almost twice as high as the United States in power distance, which means that Ecuador is a society that is mired in inequality, but it is culturally accepted and this is often related to race and social class, therefore authoritarian powers such as the armed forces play an important role in the political life of the country [26]. On the other hand, the United States with a lower score emphasizes the premise that justice, rights, and opportunities are equal for all, thus the culture in this country values people

for their experiences rather than relationships, encouraging more interaction between superiors and subordinates [18].

Regarding individualism Ecuador has a very low score which explains that it has a very collectivist culture, so belonging to a social group is very important for its inhabitants [26], in this culture relationships, are prioritized over tasks so tasks may be completed quickly due to the cooperative effort, About the power distance score, Ecuadorians avoid conflict to maintain harmony within the group, on the other hand, it is a very supportive culture with their own, however, this implies that outsiders will find barriers to relate to each other and will be excluded [18]. On the other hand, the United States has a very individualistic culture according to the score obtained, implying that the inhabitants take care of themselves and their direct family, depending little on the support of the authorities, in this culture, people are less inclined to the creation of deep friendships and are limited to business relationships [18]. In masculinity Ecuador and the United States have very similar scores, this explains that societies are driven by competition and the search for success, the difference between these two countries lies in that Ecuador is driven by competition and competes against other groups due to its low individualism score, thus seeking groups that grant status on the other hand, the United States reflects its competition individually, creating a culture where everyone "strives to be the best they can be" and that "the winner takes all" [26].

Uncertainty avoidance in Ecuador is relatively high which means that it uses different mechanisms to avoid ambiguity, in this culture emotions are expressed openly and conservatism prevails even though the rules are not always respected, about its collectivist characteristic this also reflects that the traditions of each group are always highly respected [18]. The United States, on the other hand, is below average, which means that its members accept new ideas and try new things; this can also be seen in the high level of innovation and creation of new products in the country [26], [18]. Finally, with long-term orientation Ecuador does not have a score within the Hofstede tool for now, however in the United States its low score reflects that citizens are not pragmatic, this is reinforced in that Americans have strong ideas about what is good or bad so they can refer to issues such as abortion the use of drugs among other controversial issues, also in the country companies measure performance in the short term, this drives people to seek to obtain quick results [26].

Through the national analysis provided by the Hofstede tool, it is possible to consider a point of reference to make the academic comparison between construction careers in the two universities of study, for example, in Ecuador due to the high score in power distance it would be expected that students have the same cultural traits. However, different results will likely be reached that open the door to further research to explore the reasons for the results within the university.

The Universidad San Francisco de Quito, a private university located in Quito, was founded in 1988 as the first liberal arts university in Latin America, however, it was not until 1955 that it obtained official recognition from the Ecuadorian government [18],[27]. According to the QS University Ranking, USFQ is ranked #1 in Ecuador and #60 in Latin America [28]. About six thousand undergraduate students are enrolled each year and about five hundred are graduates in the same time frame. The Ecuadorian university has a minority program, awarding scholarships to more than one hundred students from ethnic groups each year [1]. CEAACES ranks USFQ as one of the three

institutions in the country that provides quality education offering 51 bachelor's degrees, more than 15 master's programs, and a doctoral program, taught mainly in Spanish with several options in English [27],[28]. In addition, it has close to 250 general research agreements with international institutions, including 114 student exchange programs in more than 24 countries. Finally, it is the only university in the world that has a campus in both the Galapagos Islands and the Tiputini Amazon Rainforest, allowing students to have the opportunity to share research experiences with researchers from around the world [11].

The COVID 2019 virus gave its appearance at the end of 2019 in the country of China, it did not take long for most countries were already victims of this pandemic [29], many countries took measures to prevent the spread of the disease, one of them was the social distancing by which all educational centers were forced to close the doors of their establishments and seek alternatives to continue with education, it was then where online or remote education was adopted as a way to proliferate the delivery of the teaching and learning process [30]. These challenges brought about by the pandemic and the change in the way of teaching affected both architecture and civil engineering students. In the context of architecture, it is known to be a discipline that requires shared workspaces, being a discipline where students make use of space to develop design work, based on discussion and communication with faculty and peers [13], [31]. Therefore, the social challenges were notable in this period, of which we can highlight the lack of communication, due to the difficulty to receive online comments and work in silos, in this way students noticed the loss of existing competence and the lack of face-to-face interaction, which hindered the expression of ideas, factors that increased the feeling of isolation and discontinuity [31]. On the other hand, in civil engineering, according to studies, the online modality provides more benefits than detriments in education, it is said that downloadable digital materials are more effective for the improvement of learning, however, they cannot completely replace face-to-face learning environments [32]. Hence, there were some concerns from students about the lack of hands-on training, motivation, time management, and fatigue from multiple online sessions [33]. These challenges caused by social distancing may be triggering cultural changes in students who had this type of teaching from the beginning compared to students who entered pre-pandemic times with traditional education.

Methodology

The methodology used for data collection was based on the survey modified by Sharma that reconceptualizes Hofstede's five cultural factors as ten personal cultural orientations, in addition to developing a scale of 40 measurable items, thus establishing greater validity and reliability [17], In this way, we oriented our sample to 100 civil engineering students and 69 architecture students of the Universidad San Francisco de Quito (USFQ). To improve data collection and avoid having erroneous results due to lack of understanding, an adequate translation into Spanish reviewed by native speakers of Spanish for the Ecuadorian online university was performed mainly for students in first years, intermediate years, and last years, in addition, data were collected from surveys conducted in previous years, exactly 39 surveys conducted to civil engineering students in 2020 and 71 architecture students in 2021, to verify the existence of variations due to the COVID 2019 pandemic. With this data in the educational establishment, a comparative analysis was carried out to measure the cultural

differences between the two construction careers studied, which in this case are Civil Engineering and Architecture.

Surveys were administered with 5 multiple choice questions and 40 questions with a scale of 0 - 5, being 0 strongly disagree and 5 strongly agree. The survey was divided into 5 sections with 8 questions each, to obtain a better concentration on the part of the respondents in each of the cultural dimensions. The results were processed using Excel and IBM SPSS software and were analyzed using t-student distribution and a p-value of 0.05 for each question and section to determine if the differences in the cultural dimensions between each academic discipline were significant and relevant. For each section, an average of the questions was obtained and analyzed on a scale of 0 - 5, for the first section a score closer to 5 (strongly agree) would mean that a respondent is a person more inclined to be individualistic, for the second section if the respondent scores closer to zero (strongly disagree) it would indicate that he/she is less comfortable with unequal distributions of power. Thus respectively, the five sections: are individualism, power distance, uncertainty avoidance, masculinity, and long-term orientation.

Results and discussion

Different results were obtained based on the type of comparison made. Table 1 shows the general comparison between civil engineering students and architecture students where data from different years were collected, which can be differentiated into pre-pandemic and post-pandemic years. Then in Table 2, we have the comparison between architecture students and civil engineering students' pre-pandemic and finally, in Table 3 we have the results of the comparison of students of both branches of construction post-pandemic.

Each of the tables also shows the sample size of each group, the respective arithmetic means, and the level of significance reached through the student's t-test analysis for each of the dimensions with a confidence interval of 95%, additionally marked in red are those significances that are relevant based on the p-value of 0.05. The results show averages with a maximum value of 5 and a minimum of 1, the higher the score, the greater the tendency of the analysis groups towards the dimension described respectively, i.e. based on Table 1 the averages of individualism for both groups exceed the average value of the scale, which means that both groups are more inclined to non-collective work with each other, in the same way, the analysis is performed for each dimension and each comparative.

Table 1: General comparison of Hofstede's dimensions between architecture and civil engineering students.

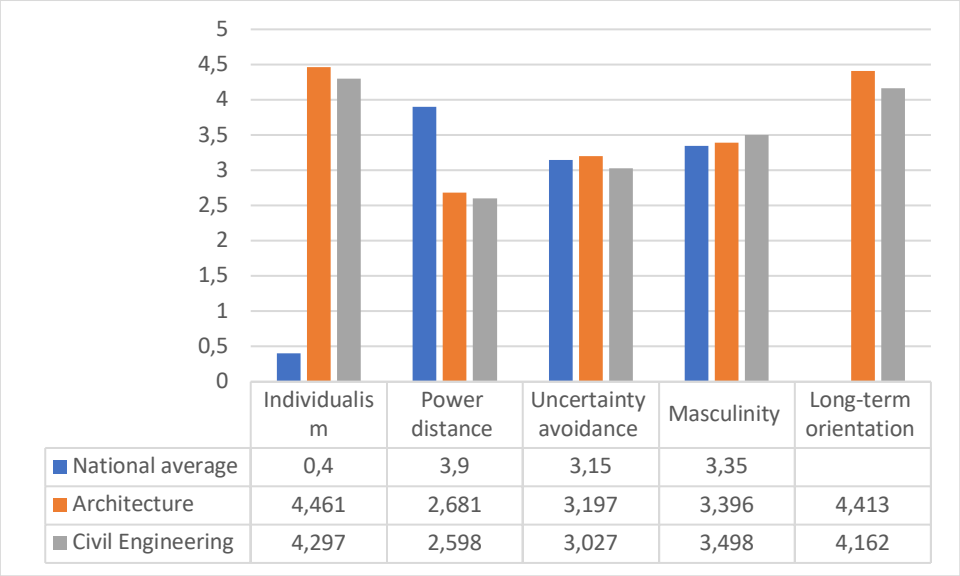
Architecture VS Civil Engineering General Comparison			
Dimension	**Group**	**N**	**Stocking**
Individualism	Architecture	140	4,461
	Civil Engineering	139	4,297
Power Distance	Architecture	140	2,681
	Civil Engineering	139	2,598
Uncertainty Avoidance	Architecture	140	3,197

	Civil Engineering	139	3,027
Masculinity	Architecture	140	3,396
	Civil Engineering	139	3,498
Long-term orientation	Architecture	140	4,413
	Civil Engineering	139	4,162

As a first analysis we start from the general comparison of table 1 and the national results retrieved from Hofstede's virtual tool, as can be seen in Figure 2, we observe a greater and more representative difference in the dimension of individualism, so that, according to the virtual tool, Ecuador is a country that prefers collective work, while USFQ students specialized in construction tend to work more individualistically. A second representative difference can be found in the power distance dimension, according to Hofstede's virtual tool Ecuador is a country in which the relationship between boss and employer is not very collaborative so there are marked hierarchies, on the other hand within the USFQ students focused on construction have an average score on the scale, indicating that there is greater collaboration between student and teacher and that the power difference is not so marked, however, there is respect between the two groups, this may be due to the liberal policies within the educational center. These results corroborate Sharma who suggests that cultural dimensions can be dynamic or fluid since they depend on the context in which they are measured [17],[1].

Finally, the rest of the dimensions such as uncertainty avoidance and masculinity have a mean very similar to the national average indicating that there are no differences, finally, in long-term orientation, there is no national average data provided by the virtual platform of Hofstede so the analysis cannot be performed at present, however, it is expected to have data in the future to understand the national environment with the educational environment of students of construction careers.

Figure 2: Relationship between national scores and scores of Architectures and Civil Engineering students.



Similarities and differences in cultural dimensions between architecture and civil engineering in pre-pandemic and post-pandemic.

In the research conducted, we intend to understand the cultures of the careers related to construction at the Universidad San Francisco de Quito (USFQ), at the same time we analyzed that there may be variation in the results due to the year in which the survey was conducted, since as it is known there was a period of a pandemic where many students began their university process online, with which a difference with students who had a traditional process is assumed. Performing a t-test with $\alpha = 0.05$, we obtained results of significance as shown in Table 2, from here we can highlight the significant differences existing between students of Architecture and pre-pandemic civil engineering.

Table 2: Comparison of Hofstede's dimensions between architecture and civil engineering students' Pre-pandemic.

Architecture VS Civil Engineering Pre-pandemic				
Dimension	**Group**	**N**	**Stocking**	**Significance**
Individualism	Architecture	71	4,606	0,001
	Civil Engineering	39	4,410	
Power Distance	Architecture	71	2,754	0,466
	Civil Engineering	39	2,663	
Uncertainty Avoidance	Architecture	71	3,170	0,570
	Civil Engineering	39	3,082	
Masculinity	Architecture	71	3,399	0,187
	Civil Engineering	39	3,514	
Long-term orientation	Architecture	71	4,522	0,004
	Civil Engineering	39	4,162	

Starting with individualism we have a mean of 4.606 for architecture and 4.410 for civil engineering, with a p-value of 0.001, this value shows us that there is a significant difference between both study groups and that due to their high mean value both fall on the more individualistic side of the spectrum. In the power distance dimension, a score of 2.754 was obtained for architecture and 2.663 for civil engineering, with a p-value of 0.466, these data reflect that there is no significant difference between the study groups and that their scores are very close to the average of the spectrum, with architecture being slightly higher. For uncertainty avoidance, we collected means of 3.170 for architecture and 3.399 for civil engineering with a p-value of 0.570, data that show means higher than average leaning more to uncertainty avoidance with a significance level greater than 0.05 which does not make it significant, in this dimension civil engineering is slightly higher than architecture. In masculinity we have a mean of 3.399 for architecture and 3.514 for architecture with a p-value of 0.187, this value is close to the limit value to have a significant difference so with a more conservative analysis we could have a higher significance. Finally, for long-term orientation, we obtained a mean of 4.522 for architecture and 4.162 for civil engineering with a p-value of 0.004, values

that reflect a significant difference between both groups, while leaning towards a future orientation.

Similarly, in Table 3, the t-test analysis was performed with $\alpha = 0.05$, for the comparison between architecture and civil engineering post-pandemic, it should be emphasized that the students in this data group are students who started their educational process differently due to the COVID 2019 pandemic so that most of their education so far has been online.

Table 3 compares Hofstede's dimensions between architecture and civil engineering students post-pandemic.

Architecture VS Civil Engineering Pre-pandemic				
dimension	**Group**	**N**	**Stocking**	**Significance**
Individualism	Architecture	69	4,311	0,477
	Civil Engineering	100	4,228	
Power Distance	Architecture	69	2,621	0,307
	Civil Engineering	100	2,541	
Uncertainty Avoidance	Architecture	69	3,225	0,001
	Civil Engineering	100	2,824	
Masculinity	Architecture	69	3,393	0,279
	Civil Engineering	100	3,485	
Long-term orientation	Architecture	69	4,299	0,008
	Civil Engineering	100	4,042	

Observing Table 3 as a first analysis we can see that there are no marked boxes so there are no significant differences between both study groups, however, there are close values that with a more conservative study could be significant. For individualism, the means for architecture were 4.311 and 4.228 for civil engineering, falling within the individualistic range of the spectrum. For power distance, we have 2.621 for architecture and 2.541 for civil engineering which as in Table 2 are very close to the mean of the spectrum with architecture being slightly higher. For uncertainty avoidance, we obtained 3.225 for architecture and 2.824 for civil engineering with a significance value of less than 0.05, which reflects a significant difference between the two groups in this dimension for post-pandemic students. In masculinity, means of 3.393 for architecture and 3.479 for civil engineering were collected, slightly entering the masculinity spectrum and with a p-value of 0.279, which with a more conservative study may be a more significant difference between the groups. Finally, in long-term orientation, a mean of 4.229 was obtained for architecture and 4.042 for civil engineering, finding a second significant difference between these study groups in the post-pandemic period.

Individualism

Within the institutional context, individualism represents the students' preferences for work in which each one seeks his or her benefit and does not seek a collective benefit,

thus group work is not liked and there are deficiencies or barriers in teamwork. In the pre-pandemic study, we could observe that both branches of construction have a high level of the individualism which was an expected result due to the type of teaching within the institution, however, there is a significant difference between both university careers, in the case of architecture students are subject to exhibition works that are reviewed and criticized in a public way among them, On the other hand, even though civil engineering students are also evaluated individually, there is a slight group work in subjects that require laboratories, an activity that is reflected in the reduction of the average of individualism as opposed to architecture students.

From the results of table 3, we obtain interesting data since the means between both study groups are close to each other, thus there is no significant difference in terms of individualism and even though both careers are still on the higher side of the spectrum, there is a greater similarity. These results may be due to how these students had their education during the pandemic, being students who had most of their education online, collaborative work was a challenge, so much so that many of them did not even know each other, thus individual work was easier and therefore a cognitive preference was created. However, both pre-pandemic and post-pandemic careers have a high mean within the same dimension, a factor that reflects a preference for individual work. This may suggest that the type of group work is not conducive to fostering collective views or that there is a lack of initiative from team members for task delegation and leadership, however, further research should be conducted to figure out the changes between pre-pandemic and post-pandemic students and the reasons for their inclination towards individualism [1], [34].

Power distance

The power distance refers to the acceptance by the power structures so that a score of 5 on the Hofstede scale means a great acceptance by the power difference and a score of 1 the opposite, in table 2 we obtained results where the means of both careers focused on construction were similar so that there was no significant difference as indicated by the p value, however we see a slight difference between architects with a mean of 2.75 as opposed to engineers with a mean of 2. 66, these results may be due to various factors such as the teacher-student hierarchy that exists within the educational facilities, this is slightly higher in architecture careers where the opinion and criticism of the teacher regarding designs in their projects is very relevant and on which the grade depends entirely, on the other hand in civil engineering the way of evaluation has a slight difference where the correct answers are not to the teacher's liking but are based more on specific indicators that indicate whether the design is functional or not.

On the other hand but with the same trend we have table number 3 which shows practically the same results in post-pandemic, it could be said that the pandemic was not a factor that significantly altered this trend of the power distance, however, there is a slight reduction in the means of both groups and a value closer to the significance limit, this reduction of means may be due mainly to the online class mode where the existence of a figure of power, located in front of a classroom had been lost, the teacher, as well as all others, were behind a screen, reducing the positions of power. As for Architecture, we can observe that there is a slightly higher average, which is to be expected because even though the classes were online, architecture students had the same grading mode where they sought approval for their designs from the teacher.

The results also show that USFQ students have an almost intermediate value within the scale of the Hofstede dimension, which explains that by having a lower score there is greater collaboration between boss and worker in this case teacher and student, by having a value very close to the average we can deduce that the collaboration between teacher and student is appreciated, This is because USFQ has liberal policies where from the first day of classes, trust is sought between the members of the community, a factor that makes the difference with the national average where the distance of power is more accepted.

Uncertainty avoidance

The uncertainty avoidance dimension refers to the acceptance or rejection of the unknown, the higher the score achieved on the scale suggests a tendency to reject uncertainty while the lower the score the higher the risk acceptance. About table 2 we can see that the p-value shows us an insignificant difference that both engineers and architects have similarities within this dimension, however, architecture has a slight increase in the mean which means that they are more reluctant to uncertainty. The study groups with a higher score on this scale are more attached to traditions and structured situations while the groups with a lower score are more likely to accept new ideas and innovative ideas [20]. This result is unusual because it is expected that as architects their creativity and more liberal vision would make them more susceptible to change. This factor goes against the stereotypes of engineers and architects, as architects very often show their dissatisfaction with the lack of innovation in engineers, and vice versa [6], [35].

Within the traditional educational environment, architects are subjected to long working days that will be criticized by the teacher, so when receiving criticism they may have a more emotional response, this is related to one of the characteristics of uncertainty avoidance which is that groups with higher scores tend to be more emotional than those groups with lower scores. Civil engineers are not prone to criticism because their designs are based on standards and indicators that show the functionality of the design, thus verifying whether to make changes to the design. This educational environment corroborates the results so that architects see the change of their designs as a rejection or failure, this may be because the way that teachers must correct the hard work of their students is destroying their models, so they are more reluctant to change, on the other hand, civil engineering students do not have this way of classification making them feel more comfortable with the changes.

In table number 3 concerning post-pandemic students we find an interesting significant difference, as we can observe the civil engineers in this period reduced their mean in a way that reduced their avoidance of uncertainty, while on the other hand, the architects slightly increased their mean making them even more reluctant to change.
We can argue that the pandemic increased the gap between architecture and civil engineering students in this dimension. Architecture students, due to the migration to online classes, were forced to learn new computer programs that would allow them to continue their studies, to which we must add that this software requires more sophisticated and more expensive equipment, this factor may have made students slightly more reluctant to the new changes that the pandemic brought about. However, where there was a greater variation with the civil engineering students who reduced

their average to a greater extent, we can argue that this change was because digital tools, such as simulators, allowed students to better understand certain mathematical concepts.

Masculinity

Masculinity suggests that groups with a higher score on the Hofstede scale have more assertive roles focusing on competencies and materiality while groups with a lower score tend to have caring roles focusing on empathy, quality of life, emotions, human interaction among others, each pole of the scale is related to masculinity in the case of tending to 5 scores and to femininity in the case of tending to 1 on the scale [14]. The results in Table 2 show an insignificant difference in the means of both groups, however, the p-value is approaching the limit value to have a significant difference so that performing a more conservative statistical analysis there could be a greater significance, even so, it can be observed that the civil engineering group has a higher mean than architecture students, an expected value based on the nature of both careers. As it is known, civil engineering is a technical career, so the elaboration of their work is colder and objective, a characteristic that makes them more susceptible to the assertive role of masculinity. On the other hand, architects see their designs more emotionally, they look to improve the experience of those around them, and mainly the acceptance and beauty of their work.

In the educational field, architects seek in their designs to supply the best comfort to the user for whom they design it so one of their main functions is to find the spaces well, improve the entrance of light, comfort, and happiness of their future client, a value that is evaluated by their teachers and related to empathy. With civil engineers, the approach is different since they do not seek acceptance or supply comfort, but rather functionality. In table 3 related to post-pandemic students, we do not see a different trend, rather it is quite like pre-pandemic students, this is because the online classes were not a cause of the change of focus of both careers, although it was a new teaching model both architects and civil engineers were still looking for the same objectives that they have been looking for previously. Based on the national average, we can see that civil engineering students even have a higher average than the national average, an interesting fact that could be further investigated to find the causes of these patterns. It is also important to mention that even though the masculinity dimension does not refer to the gender of the groups, there is a larger population of female students in architecture and a larger population of male students in engineering.

Long-term orientation

Long-term orientation refers to activities and virtues oriented to future rewards, making groups with a value tending to 5 on the scale have habits of perseverance and saving, while short-term orientation fosters relationships with the present and past, making groups with values tending to 1 more traditionalist society [24]. In Table 2 we see that there is a significant difference between both study groups in the pre-pandemic period, with an architecture having a higher score, a value that was expected due to the nature and relationship that the architect has with his projects. Architects look to leave meaning in their projects, as discussed in earlier dimensions, the emotions that define an architect generate a link with their designs, a characteristic that makes them think about the future. Likewise in education, teachers look to develop their student's designs that allow them to be functional in the future and not an architectural work that is ephemeral.

On the other hand, civil engineers look for current solutions to their designs, and although they are also oriented to design resistant structures, their focus is more on current problems following specific standards and pre-established methods [36]–[38].

For this reason, answers can be given to the limited working relationship between engineer and architect, since while the architect looks for future-oriented work, the engineer focuses on the current solution, so that the designs are counterbalanced. In Table 3 we see that the difference between these two groups is still significant, which is interesting data that allows us to argue that the pandemic is not a cause of this gap between civil engineering and architecture students. On the other hand, we find that the means in both groups decreased in this period and even if they are still in the high spectrum of long-term orientation, some factors in the pandemic may have caused these scores to decrease. We infer that due to the restrictions, and the difficulties that the pandemic caused in aspects of education, the students may have perceived a reduction in motivation as well as being subjected to fatigue from long hours in front of the screen, these factors may handle the reduction in forward thinking that the students experienced. However, more studies are needed to focus on the mental and health effects of the pandemic on engineering and architecture students in the context of Ecuador.

Conclusions

The purpose of the research was to understand the cultural differences that exist between the construction careers offered by the Universidad San Francisco de Quito, a university of book arts located in Ecuador. The study was based on Hofstede's theory of cultural dimensions and the modifications proposed by Sharma, in this way it was possible to assess the gaps within the five cultural dimensions between civil engineering students and architecture students. Also, as a preliminary study, it was intended to understand how the new remote teaching system caused by the COVID 2019 pandemic, could generate variations in the cultural dimensions in these two study groups. Based on the results, we found statistically significant differences in students who had traditional studies, i.e., pre-pandemic students and post-pandemic students who conducted their studies remotely or online due to the restrictions that COVID 2019 required to safeguard the lives of the students. These variations between post-pandemic and pre-pandemic students lead us to the conclusion that the teaching methods at the facility could be one of the causes for the creation of this cultural gap between both construction careers.

The statistically significant differences were concentrated in two cultural dimensions, these were individualism and a long-term orientation, being architecture the one who surpassed civil engineering students on average. However, in conclusion, both groups are in the zone of high individuality within the spectrum, making us understand that collaborative work is not their forte, creating possibilities of lack of communication between them, and generating a not-so-favorable work environment. Based on the study it was found that architecture students seek to give their works a meaning that lasts over time, a characteristic that makes them more emotional, while on the other hand, engineers focus on immediate and performance-driven solutions. These characteristics generate a clash between the vision of the architect and the engineer when it comes to translating their ideas into a project.

The statistically significant differences in the post-pandemic group were concentrated in the dimensions of uncertainty avoidance and long-term orientation. So, we can conclude that the pandemic closed the gap between civil engineering and architecture students in terms of individualism, but created differences in uncertainty avoidance in both groups, making civil engineering students more accepting of change and innovation than architecture students who increased their rejection of uncertainty. It was also found that due to the pandemic, the level of incentive for future thinking decreased in both groups, however, the pandemic could not alter the already existing significant difference in the long-term orientation of both construction careers, thus corroborating the conclusion that the type of education is one of the main causes of the cultural gaps between these study groups.

Within the educational establishment of study, the interaction between architecture students and civil engineering students is quite reduced, to such an extent that even though they are careers related to construction, they belong to different schools or departments, this generates that students finish their studies without having been able to relate to each other, an activity that they will have to learn in their professional life. For this reason, it is important to open the way for collaborative work between engineers and architects from the beginning, so that by interacting and understanding each other's vision, they can have better working environments in their professional lives. It is advisable to create spaces as a contest where the work of both parties is required to move forward a project in this case real estate where both branches of construction work hand in hand, in addition to fostering skills such as leadership, communication, and empathy. On the other hand, based on the results obtained from the pre-pandemic and post-pandemic students, we can observe that the education methods are the direct cause of the gap that has been widening between engineers and architects; therefore, courses are recommended where a greater relationship between both careers is sought; however, further research is needed regarding the curricula and courses required by each career within the establishment.

The research opens the door to new studies where cultural dimensions can be further explored, taking into account the latest studies of Hofstede in which he adds a sixth cultural dimension, focusing on construction students in comparison with other countries or universities that share the same university careers, in addition, more information can be obtained for further research about the consequences or benefits that the COVID 2019 pandemic could generate in the students who were affected, and what changes generated in the cultural dimensions of each study group.

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