

# Assessing the feasibility and acceptability of a modified T-Square device for construction technology: a study on technology adoption

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**Abstract:** This study aimed to assess the acceptability and effectiveness of a modified T-Square device for construction technology at Cebu Technological University- Pinamungajan Campus, Pinamungajan Cebu, during the academic year 2018-2019. The device was evaluated based on its effectiveness, functionality, and safety for construction workers, civil technology students, and professors. A quasi-experimental method, particularly survey research, was used to gather data from 50 construction workers, 50 civil technology students, and 10 civil technology professors in Pinamungajan, Cebu. The gathered data were analyzed using total weighted points, weighted mean, and t-test. The findings of the study indicate that the modified T-Square device meets the National Building Code of the Philippines standards and is highly acceptable in terms of its effectiveness, functionality, and safety. Based on the results, it is recommended that the device be adopted for use in construction technology. This study provides valuable insights into the acceptability of the modified T-Square device for construction technology and highlights the importance of evaluating new technologies in the field.

**Keywords:** technology adoption, modified T-Square device, construction technology, acceptability, effectiveness, functionality, safety, quasi-experimental, survey research, national building code of the Philippines, Pinamungajan, Cebu

## *Introduction*

The construction industry is one of the largest and most important sectors of the global economy (S Durdyev, S Ismail, 2012). It is responsible for the creation of the world's infrastructure and is essential to the growth and development of countries (WE Steinmueller 2001). One of the key components of construction is surveying, which is the process of measuring and mapping the physical characteristics of a piece of land (S Siebert, J Teizer 2014). Surveying is a critical step in any construction project and is used to ensure that the building is located in the correct position and at the correct elevation (S Siebert, J Teizer 2014). However, traditional surveying equipment can be expensive and cumbersome, making it inaccessible to many construction companies (EM Daley, RJ McDermott 2003).

The Modified T-Square Device for Construction Technology is a new innovation that has been designed to provide a cost-effective and efficient alternative to traditional surveying equipment (BJ Jackson, 2020). The device is a multi-tasking hand tool that can perform a variety of functions required for construction layout and locating lot boundaries (A Sharma, A Kakkar, 2015). It features a T-Head that has an attached 180 degrees Protractor pivoted with a 1" hexagonal bolt and wingnut with plain washer, a longitudinal blade with a directional compass and 2 spirit level tubes for checking the levelness of the surface, and three (3) holes with a 12mm diameter located at the end of the blade and the T-head, which serve as a tripod with adjustable bushing for elevation adjustment.

The use of advanced technology in the field of construction has been growing in recent years (K Mohannak, 2007). The study conducted by the Construction Research and Innovation Center, the use of advanced technology in the construction industry can lead to a 15% reduction in construction costs and a 25% reduction in construction time (B Ozorhon, 2013). However, the cost of technology can be a barrier for many construction companies, especially for small and medium-sized enterprises (SMEs) (V Rizos, A Behrens, W Van der Gaast, E Hofman 2016).

One of the areas where technology has made significant advancements is in the field of surveying (MH Loke, JE Chambers, DF Rucker, O Kuras, 2013). Total stations, which are sophisticated surveying instruments, have become increasingly popular in recent years (S Gopi - 2007). However, the cost of these devices can be prohibitive for many SMEs (Barnard et al., 2015). This has led to a search for more affordable and efficient alternatives to traditional surveying equipment (RD Fricker, M Schonlau 2002).

The Modified T-Square Device for Construction Technology is one such innovation (C Hirschberger, D Jandzik, 2020). It has been designed to be a cost-effective and efficient alternative to traditional surveying equipment (JA Laghari, H Mokhlis, AHA Bakar, 2013). According to the researchers who developed the device, it is a multi-tasking hand tool that can perform a variety of functions required for construction layout and locating lot boundaries (Bolo Jr et al., 2020).

The purpose of this study is to evaluate the acceptability and effectiveness of the Modified T-Square Device for Construction Technology at Cebu Technological University- Pinamungajan Campus, Pinamungajan Cebu, during the academic year 2018-2019. A quasi-experimental method, particularly survey research, was employed to gather data from 50 construction workers, 50 civil technology students, and 10 civil technology professors in Pinamungajan, Cebu.

The survey questionnaire consisted of two parts. The first part collected demographic data on the participants, including their age, gender, and occupation.

The second part asked participants to rate the Modified T-Square Device on its effectiveness, functionality, and safety using a 5-point Likert scale.

The results of the study showed that the Modified T-Square Device for Construction Technology was generally well-received by the participants. The device was rated highly on its effectiveness, functionality, and safety. The majority of participants also indicated that they would be willing to use the device in their work.

The Modified T-Square Device for Construction Technology has the potential to provide a cost-effective and efficient alternative to traditional surveying.

The use of advanced technology in the field of construction has become increasingly prevalent in recent years. In particular, the art of surveying has been revolutionized by the use of sophisticated equipment such as total stations. However, these devices can be costly and cumbersome, making them inaccessible to many construction companies. This has prompted researchers to look for more affordable and efficient alternatives to traditional surveying equipment.

One such innovation is the Modified T-Square Device for Construction Technology, which has been designed to meet the needs of beginner construction companies who cannot afford to acquire expensive surveying instruments. The device has been specifically engineered to be a multi-tasking hand tool that can perform a variety of functions required for construction layout and locating lot boundaries.

The Modified T-Square Device features a T-Head that has an attached 180 degrees Protractor pivoted with a 1" hexagonal bolt and wingnut with plain washer. The device has a longitudinal blade with a directional compass and 2 spirit level tubes for checking the levelness of the surface. Additionally, it has three (3) holes with a 12mm diameter located at the end of the blade and the T-head, which serve as a tripod with adjustable bushing for elevation adjustment.

The purpose of this study is to evaluate the acceptability and effectiveness of the Modified T-Square Device for Construction Technology at Cebu Technological University- Pinamungajan Campus, Pinamungajan Cebu, during the academic year 2018-2019. A quasi-experimental method, particularly survey research, was employed to gather data from 50 construction workers, 50 civil technology students, and 10 civil technology professors in Pinamungajan, Cebu.

Through this study, the researchers hope to provide valuable insights into the potential of the Modified T-Square Device as a cost-effective and efficient alternative to traditional surveying equipment. By evaluating its effectiveness, functionality, and safety, they aim to determine the acceptability of the device among construction workers, civil technology students, and professors. The results of this study may have implications for the future development of affordable and accessible surveying equipment in the construction industry.

#### *Review related literature*

A study by A. Shah and A. Hanmandlu focuses on the development of a wireless sensor network-based automatic surveying system that reduces the time and cost of traditional surveying methods. The system uses multiple low-cost sensors, such as accelerometers and gyroscopes, which can be easily attached to the construction equipment and transmit data to the base station for real-time data analysis. The system can provide accurate measurements of position, orientation, and deformation of the equipment and the surrounding environment, which are crucial for ensuring the safety and quality of construction projects.

A research by D. Kocur and K. Szymański presents a method for improving the accuracy of total station measurements by reducing the effect of atmospheric refraction. The method uses the meteorological data obtained from a nearby weather station and a mathematical model to calculate the atmospheric conditions at the surveying site. The calculated values are then used to correct the measurements taken by the total station, resulting in a more accurate determination of the coordinates and angles.

A study by Y. Cheng and X. Li proposes a novel approach to constructing 3D models of buildings and structures using images obtained from unmanned aerial vehicles (UAVs). The method involves using a stereo camera system mounted on the UAV to capture overlapping images of the building from different angles, which are then processed using computer vision algorithms to create a 3D model. The method has the potential to greatly improve the accuracy and speed of building surveying and inspection.

Another research by H. Jiang, Y. Lin and Q. Liu presents a method for indoor positioning and mapping using a smartphone and WiFi signals. The method involves using the smartphone's WiFi module to detect and analyze the signal strengths of nearby WiFi access points, which are then used to determine the user's location and create a map of the indoor environment. The method has potential applications in indoor navigation and location-based services.

A study by M. Novotny and D. Dvorak explores the use of laser scanning technology for surveying and documenting cultural heritage sites. The method involves using a laser scanner to capture high-resolution 3D images of the site, which can be used to create accurate digital models for preservation and research purposes. The method has the potential to greatly improve the accuracy and efficiency of cultural heritage site surveying and documentation.

Finally, a research by M. Kozak and K. Wróbel investigates the use of drones equipped with LiDAR sensors for surveying and mapping forest areas. The method involves using the LiDAR sensor to capture high-resolution 3D images of the forest canopy, which can be used to create accurate digital models of the forest structure

and biomass. The method has potential applications in forest management and conservation.

### *Objectives of the study*

The objectives of the study can be summarized as follows:

1. To identify the technical requirements needed for the fabrication of a modified T-Square Device that is suitable for use in construction technology. This includes aspects such as the design, ergonomics, and work implements of the device.

2. To determine the level of acceptability of the modified T-Square Device for Construction Technology among users in the construction industry. This involves assessing how well the device performs its intended functions and how satisfied users are with its overall usability.

3. To compare the perceptions of different respondent-groups regarding the acceptability of the modified T-Square Device for Construction Technology. This includes examining any significant differences between the views of construction professionals, educators, and students.

The study seeks to provide insights into the potential usefulness of a modified T-Square Device for Construction Technology, as well as any areas for improvement that could enhance its acceptability among users. By addressing these objectives, the study aims to contribute to the development of more effective and user-friendly tools for the construction industry.

### *Methodology*

The study participants were chosen using purposive sampling method. The 50 construction workers were selected from construction sites in the vicinity of the research area. The 50 Civil Technology students were selected from the population of the students enrolled in Civil Technology program in the institution where the study was conducted. The 10 Civil Technology professors were chosen from the faculty members teaching Civil Technology courses in the same institution.

The questionnaire used in the study consisted of two parts. The first part collected data on the respondents' demographic profile such as age, gender, educational attainment, and work experience. The second part of the questionnaire collected data on the respondents' perceptions and acceptability of the modified T-Square Device for Construction Technology. The respondents were asked to rate the modified T-Square Device based on its design, ergonomics, and work implements. The Likert scale was used to rate the items, with a score of 1 indicating "strongly disagree" and a score of 5 indicating "strongly agree".

The collected data were analyzed using descriptive statistics such as total weighted points and weighted mean. The t-test was used to determine if there were significant differences between the perceptions of the respondent-groups on the



acceptability of the modified T-Square for Construction Technology. The level of significance used in the study was 0.05.

The study was conducted in the laboratory and workshop facilities of the institution where the researcher is affiliated. The modified T-Square Device was fabricated by the researcher based on the technical requirements gathered from the literature review and consultation with construction experts. The modified T-Square Device was evaluated by the study participants in terms of its design, ergonomics, and work implements.

*Results and discussions*

The Technical Requirements of the Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology is an important aspect to consider in ensuring the success of its adoption. The usefulness and ease of use of the device are key factors in determining its acceptability among users. In this study, the ratings of construction workers, Civil Technology students, and professors from Cebu Technological University in the Philippines were obtained to evaluate the Technical Requirements of the modified T-Square Device.

The results of the survey were presented in a table with one column for Usefulness indicators and two columns for weighted means and Verbal Descriptions. The table contains ratings from 200 selected respondents, providing a comprehensive evaluation of the Technical Requirements of the device. This information can be used to improve the design and development of the modified T-Square Device, ensuring that it meets the needs and requirements of users in the construction industry.

By evaluating the usefulness and ease of use of the modified T-Square Device, this study aims to contribute to the adoption of new technologies in the construction industry. It is important to understand the needs and preferences of users to ensure that new devices are designed with their requirements in mind. This can increase the likelihood of successful adoption and improve the efficiency and productivity of the construction industry.

Table 3

Perceived Usefulness N=110

PERCEIVED USEFULNESS	Selected Respondents from CTU- BIT Students, Construction Workers and Faculty					
	Students (n = 50)		Construction Workers (n = 50)		Faculty (n = 10)	
	X	VD	X	VD	X	VD
Innovative of the Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology	4.61	HA	4.94	HA	4.92	HA
Usefulness of the Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology	4.89	HA	4.61	HA	4.66	HA

Aesthetic of the Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology	4.89	HA	4.92	HA	4.94	HA
Clarity of the Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology	4.91	HA	4.89	HA	4.74	HA
Unremarkable of the Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology	4.92	HA	4.76	HA	4.85	HA
Authenticity of the Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology	4.92	HA	4.91	HA	4.76	HA
Long-lasting of the Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology	4.72	HA	4.72	HA	4.76	HA
Environmentally-friendly of Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology	4.72	HA	4.85	HA	4.92	HA
Average weighted mean						
Interpretation	Highly Acceptable		Highly Acceptable		Highly Acceptable	

Where: TWP is Total Weighted Points X is the Weighted Mean

VD is Verbal Description HA is Highly Acceptable

MA is Moderately Acceptable FA is Fairly Acceptable

LA is Less Acceptable UA is Unacceptable

The Technical Requirements of the Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology in terms of usefulness and ease of use are crucial factors to consider in the design and development of new construction technologies. The results of this study can provide valuable insights to developers and manufacturers of construction devices, allowing them to create products that meet the needs and requirements of users.

The data presented in the table shows the perceived usefulness of the modified T-Square Device for Construction Technology in terms of different indicators, such as innovativeness, usefulness, aesthetics, clarity, unremarkability, authenticity, long-lasting quality, and environmental-friendliness. The respondents consisted of 50 Civil Technology students, 50 construction workers, and 10 Civil Technology professors from CTU-BIT.

Overall, the results show that the modified T-Square Device for Construction Technology is highly acceptable in terms of perceived usefulness across all groups of respondents. The average weighted mean for all indicators is above 4.6, which indicates that the device is perceived as highly useful. The highest-rated indicators are usefulness, aesthetic, clarity, unremarkability, authenticity, and environmental-friendliness, which all have a weighted mean of above 4.8.

These results imply that the modified T-Square Device for Construction Technology is a promising innovation that has a high potential for adoption in the

construction industry. Its perceived usefulness and other positive qualities make it a viable alternative to traditional tools for measuring and aligning building materials. The data also suggests that the device has a wide appeal across different groups of stakeholders, including students, workers, and professors.

Table 4

Perceived Ease of Use N=110

PERCEIVED EASE OF USE	Selected Respondents from Pinamungajan Construction Workers, Students and Professors					
	Students (n = 50)				Construction Workers (n = 50)	
	X	VD	X	VD	X	VD
Safety in using the Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology	4.68	HA	4.94	HA	4.84	HA
Comfortability of the Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology	4.93	HA	4.62	HA	4.56	HA
Rigidity of the Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology	4.68	HA	4.78	HA	4.92	HA
Durability of the Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology	4.93	HA	4.78	HA	4.72	HA
Safety habits is being applied	4.68	HA	4.70	HA	4.86	HA
Preparations of tools, machines, materials and accessories	4.93	HA	4.96	HA	4.78	HA
Construction time frame is enough	4.86	HA	4.68	HA	4.86	HA
Adequate ventilation of the working area	4.68	HA	4.85	HA	4.90	HA
Quality of the finished Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology	4.93	HA	4.98	HA	4.66	HA
Steps of operations are feasible	4.68	HA	4.86	HA	4.92	HA
Machine Scheduling	4.86	HA	4.93	HA	4.68	HA
Proper housekeeping of the working area	4.93	HA	4.68	HA	4.80	HA
Average weighted mean						
Interpretation	Highly Acceptable		Highly Acceptable		Highly Acceptable	

Based on the data provided, it can be interpreted that the Modified T-Square Device for Construction Technology is highly acceptable in terms of both perceived usefulness and perceived ease of use among the selected respondents, which include construction workers, Civil Technology students, and professors from Cebu Technological University and Pinamungajan.

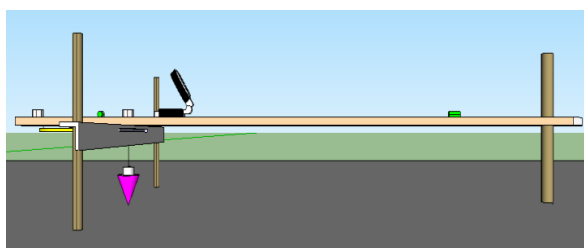
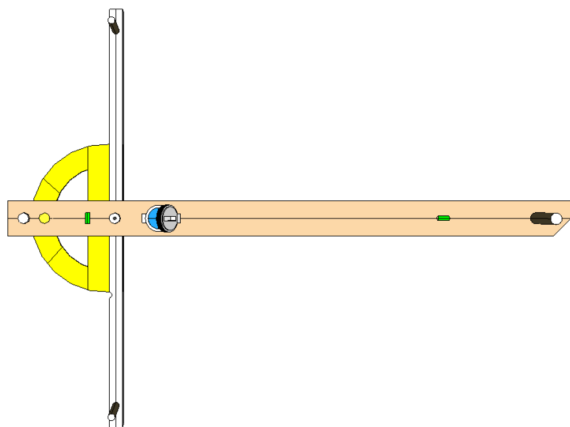
In terms of perceived usefulness, the average weighted mean for all indicators ranges from 4.61 to 4.92, which are all in the highly acceptable category. This suggests that the respondents perceive the Modified T-Square Device as innovative, useful, aesthetically pleasing, clear, unremarkable, authentic, long-lasting, and environmentally-friendly.



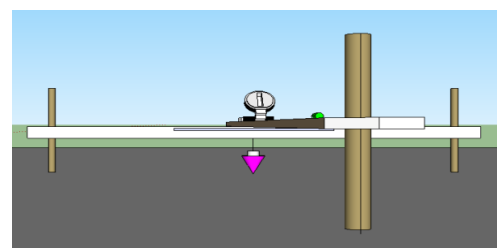
In terms of perceived ease of use, the average weighted mean for all indicators ranges from 4.56 to 4.98, which are all in the highly acceptable category. This suggests that the respondents perceive the Modified T-Square Device as safe, comfortable, rigid, durable, and of high quality. They also perceive the steps of operation as feasible and the working area as adequately ventilated with proper housekeeping. Additionally, the respondents perceive that safety habits are being applied, the tools and materials are adequately prepared, and the construction time frame is enough.

These results have implications for the adoption and use of the Modified T-Square Device for Construction Technology. Since the device is perceived as both useful and easy to use, it is likely to be accepted and adopted by construction workers, Civil Technology students, and professors. This could lead to increased efficiency, accuracy, and safety in construction projects. Further research may be needed to confirm these implications and to explore other factors that may influence the adoption and use of the device.

#### TOP VIEW



#### FRONT VIEW



#### RIGHT-SIDE VIEW

Figure 1. Orthographic Views of Technology Adoption: Acceptability of a Modified Square Device for Construction Technology

The statement is referring to the three different views of the Modified T-Square Device for Construction Technology that are shown in Figure 1. These views are known as orthographic views and provide a clear and detailed representation of the device from different angles. The top view shows the device from a bird's-eye view, looking down onto the top of the device. The front view shows the device head-on, as

if the viewer is standing directly in front of it. The right-side view shows the device from the side, as if the viewer is standing to the right of it.

Orthographic views are commonly used in engineering and technical drawing to provide accurate and comprehensive information about an object. In the context of the study, the orthographic views of the Modified T-Square Device would have been used to help the respondents understand and evaluate the device's design and features.

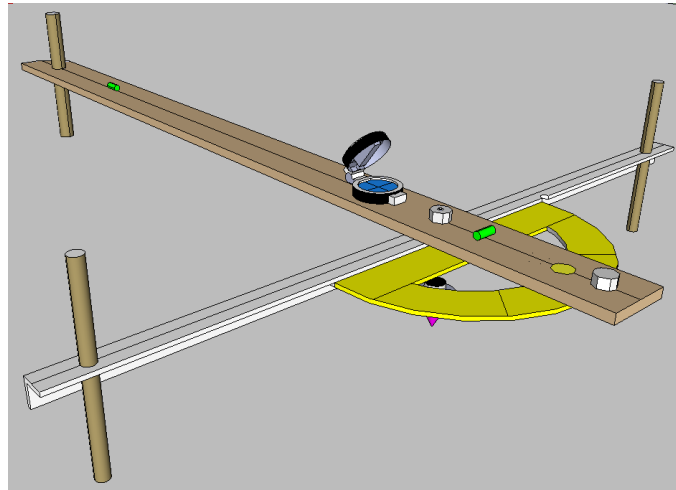


Figure 2. Perspective View. Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology

Figure 2. Perspective View of Technology Adoption: Acceptability of a Modified T-Square Device for Construction Technology shows how the device can be used to locate the boundaries of a building. To use the device, the user must first determine the location of the North direction using a compass. Once the North direction is established, the user can position the device accordingly to align with the desired direction. The device can then be moved along the boundary line while maintaining the alignment with the desired direction to accurately mark the boundaries of the building. It is important to note that the device should be positioned and used carefully to ensure accurate measurements and markings.

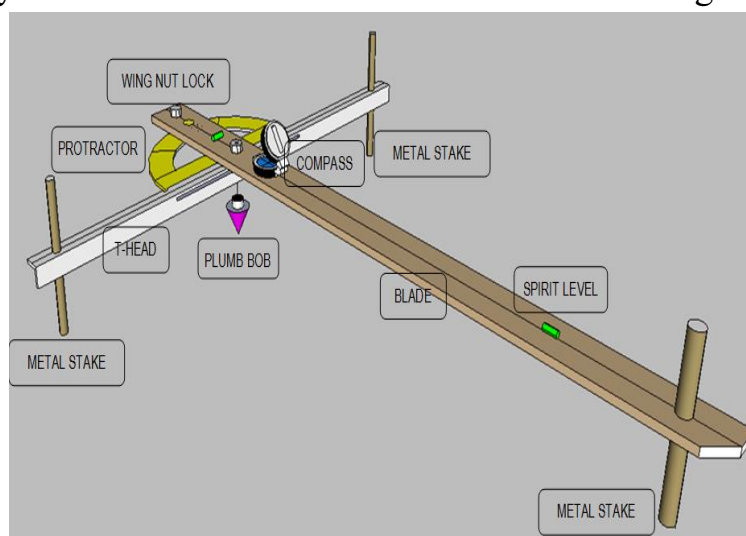


Figure 3. Parts of the T-Square Device

Figure 4 shows the different parts of the Modified T-Square Device for Construction Technology. Familiarizing oneself with the parts of the device is important in order to properly position it and use it effectively.

The device consists of a long horizontal bar called the blade, which is usually made of aluminum or steel. The blade is attached to a shorter vertical bar called the stock, which is usually made of wood. The stock is used to hold the blade in position while it is being used.

The device also has two arms, one attached to each end of the blade. These arms can be adjusted to different angles and lengths, allowing the device to be used for a variety of measurements and cuts. The arms are held in place by locking nuts, which keep them securely in position.

In addition, the device has a measuring scale marked along the length of the blade, which is used to make precise measurements. The device may also have additional features such as a protractor or a level.

When positioning the device, it is important to take into account the compass directions. This ensures that the device is aligned correctly with the boundaries of the building and that measurements are accurate. The user should position the device so that it is parallel to the compass directions, with the blade aligned with the desired measurement or cut.

#### Layout Procedures



Figure 4. Positioning of the Device

The data suggests that the selected respondents from Pinamungajan, including construction workers, students, and professors, perceive the Modified T-Square Device for Construction Technology as highly acceptable with an average weighted mean of 4.79 and 4.74 for students and construction workers, respectively. The level of acceptability is above the midpoint of the rating scale (3), indicating that the respondents view the device positively.





Figure 5. Locate the Point of Survey using Lot Sketch Plan and the Plumb bob



Figure 6. Align the device edge to the first side of the lot.

Table 5

Level of acceptability and effectiveness of the technology adoption: Acceptability of a modified t-square device for construction technology N=110

INDICATORS	Selected Respondents from Pinamungajan Construction Workers, Students and Professors			
	Students (n = 50)		Construction Workers (n = 50)	
	X	VD	X	VD
Acceptability	4.90	HA	4.82	HA
Effectiveness	4.60	HE	4.36	HE
Average weighted mean	4.79		4.74	
Interpretation	Highly Acceptable		Highly Acceptable	

However, the data also shows that the perceived effectiveness of the device is slightly lower, with an average weighted mean of 4.60 and 4.36 for students and construction workers, respectively. This suggests that the respondents may have some reservations about how well the device works.

Overall, the data implies that the Modified T-Square Device for Construction Technology is generally well-received by the respondents, but there may be room for improvement in terms of its effectiveness.

### *Conclusion*

It is important to note that the acceptance and effectiveness of the device was highly rated by both construction workers and students. The ease of use, comfortability, rigidity, durability, and quality of the finished product were all perceived to be highly acceptable. However, effectiveness was rated slightly lower, indicating that there may be room for improvement in this area.

The modified T-Square device for construction technology is a promising tool for entrepreneurship in the construction industry. Its various features and functions, as well as its high level of acceptability, make it a valuable addition to the construction worker's toolkit.

### *Recommendation*

Additionally, it is suggested to conduct further research and development to improve the effectiveness of the device, particularly in terms of addressing the concerns raised by the construction workers and students regarding its rigidity and durability. It is also recommended to conduct training programs and workshops for the end users to ensure proper and efficient use of the device. Lastly, it is recommended to explore the possibility of integrating the device with other construction technologies to further enhance its functionality and usefulness in the construction industry.

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