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INCORPORATING THE USAGE OF 3D MODELLING PROGRAMMING IN TEACHING ARCHITECTURAL HERITAGE DESIGN

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Abstract:

This paper discusses on the integration application of using 3-Dimensional (3D) modelling program in order to teach architectural heritage design. The 3D program mentioned in this paper (3DStudioMax) was used in order to determine the ergonomic properties of traditional Malay furniture that were available inside the selected samples of Traditional Malay Houses (TMH). The anthropometric measurements of the Traditional Malays were calculated and transferred into 3D renderings in order to help visualise the interactions between the users and the furniture. The visualisations included recreation of the environment during which the users were carrying out their daily activities, all into 3D renderings. These visualisations also provided a look of how the furniture of the Traditional Malays were ergonomic towards their users. The samples used in this study consisted of technical drawings of TMH that were archived in the Center for the Study of Built Environment in the Malay Kingdom (KALAM) of Universiti Teknologi Malaysia (UTM). Results showed that the usage of the 3D program helps to give a better understanding of architectural heritage design by providing a visual aid in summarising elements that were no longer available within the environments during site visits.

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Keywords:

Traditional Malay House, Traditional Malay Furniture, 3dstudiomax, 3D Program.

Introduction

In the coming years, the use of visual aid has become a significant factor in teaching and learning. Benefits of visual aid are significant as it helps the students to study more effectively, helps students retain the information that are given for a longer period of time, increases the interest of the students in the topic presented, while also easing the process of teaching for teachers. In the topic of studying built environment, visual aid and visual representations of the subject matter that is being studied helps students to increase their understanding of the whole picture. Evermore, visual aid is important in the process of teaching and learning of architectural heritage, especially when the built environment that is being studied no longer exists. This is where this paper highlights on how the use of 3D renderings and remodelling of the selected sample houses, most of which were Traditional Malay Houses (TMH) that were no longer erected or were partially in ruins, helps to identify the ergonomic properties of traditional Malay furniture that were described in the archived records of the selected samples.

Furniture plays an important role in our everyday life, even in past civilizations until today. Finding and acquiring the most suitable furniture for a specific job or activity can become very beneficial, as a comfortable furniture will inevitably increase productivity as well as reduce stress on the user.

In order to identify the best type of furniture that is to be used, a deep understanding of the measurements of the users as well as the activity carried out is needed. Since this study focuses on the Traditional Malays and how they carry out their daily activities, their anthropometric measurements were calculated and determined. This is where the 3D modelling program comes in as an assistant to help visually compare how the users traditionally interact with the furniture in their daily environments.

Aim and Scope

The aim of this study is to investigate the ergonomic properties of the furniture used by the Traditional Malays in order to help produce a standard of ergonomics in the manufacturing of furniture in Malaysia. The scope of this study encompasses the Traditional Malay furniture that are available inside TMH of selected samples. These samples are selected houses chosen from archived reports from the Center for the Study of Built Environment of the Malay World (KALAM), of Universiti Teknologi Malaysia (UTM), Malaysia. The samples are chosen based on the date of build and are of the oldest houses from each state or region in Malaysia, and were archived.

Limitations and Significance

Limitations of this study is only including the standard of ergonomics of the Traditional Malays of Malaysia only, and does not include standards of ergonomics of other ethnic groups. The significance of this study is providing knowledge of the ergonomic properties of the furniture used by the Traditional Malays of Malaysia. These properties will show that furniture plays an important role in their daily lives and the 3D remodelling will help give a visual aid in order to

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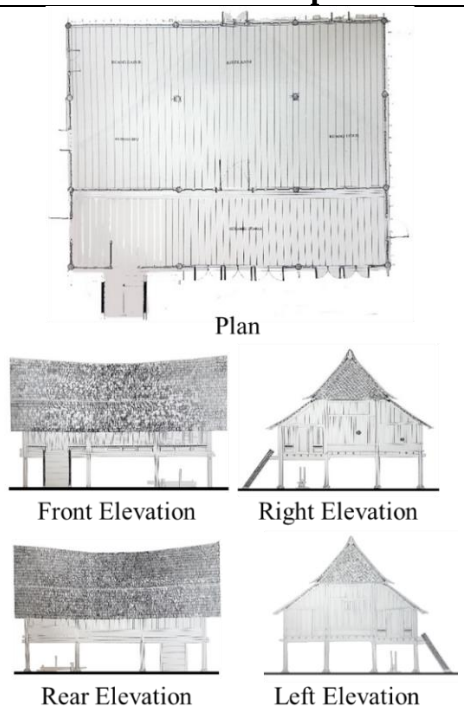
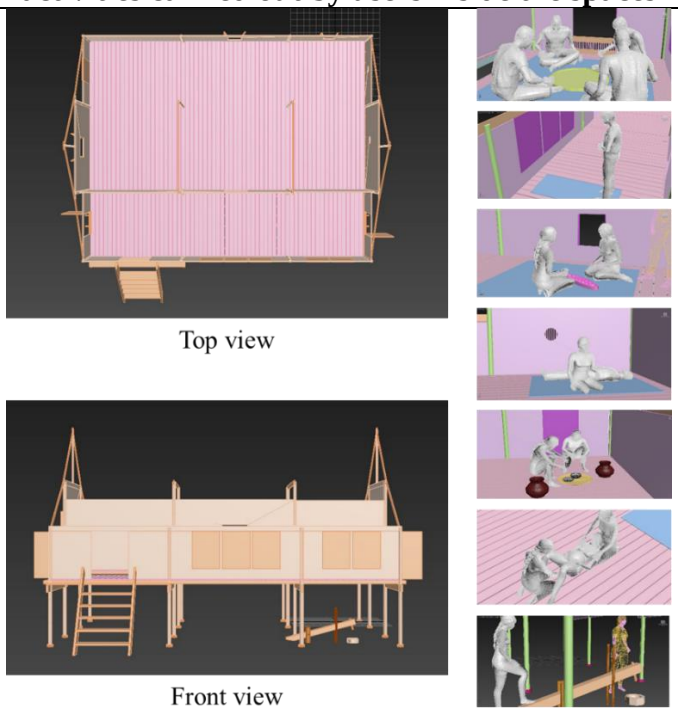
better understand the ergonomic properties of these furniture available inside the selected TMH.

Research Methodology

The main 3D modelling program used in this study was the Autodesk 3D Studio Max, which was used to help illustrate the human interaction between the users and the furniture that were found within the Traditional Malay Houses (TMH). 3D models of the TMH were created based on the measurements and descriptions provided by the technical drawings collected from the archived reports of KALAM, UTM.

Table 1 below shows an example of the technical drawings of one of the selected samples in this study, which a TMH chosen in the state of Negeri Sembilan, that's turned into a 3D recreation model. The first column of the table shows the plan, front elevation, right elevation, rear elevation, as well as the left elevation, which were all taken from the archived reports of KALAM, UTM. From these drawings, based on the measurements stated in the archived reports of the house, a 3D recreation of the house was developed using the 3D modelling program, 3DStudioMax. The 3D recreation example of this house can further be seen in the left column of Table 1 below. The 3D recreation renderings also included the users carrying out their daily activities inside the specific spaces of the TMH. As stated previously, all these information were collected from the archived reports, which included the recollection of what the users did in their daily day to day lives, and were recorded during the interviews when the reports were published.

Table 1: Example Of One Sample Of TMH Taken From Archived Reports And Turned Into 3D Renderings

Technical drawings collected from archived reports	3D recreation of sample house including daily activities carried out by users inside the spaces
	

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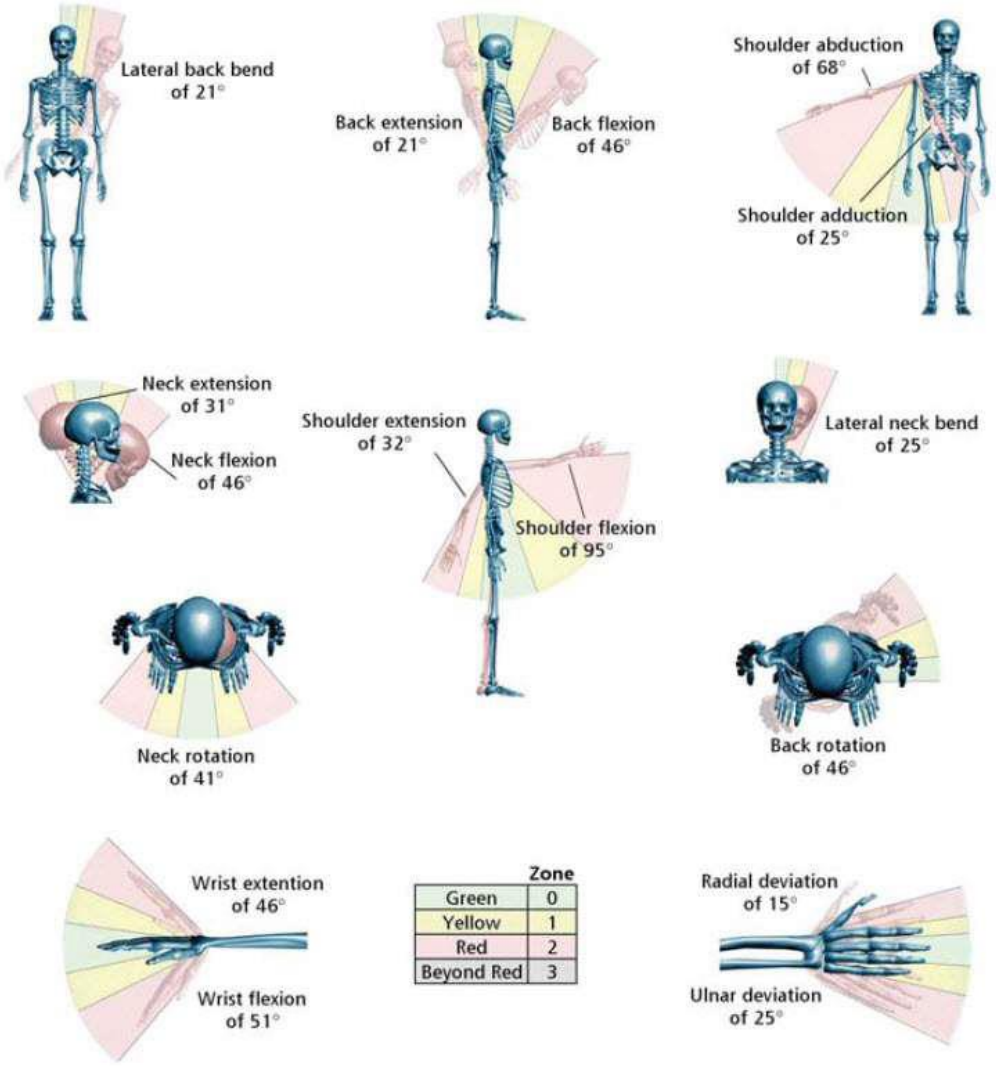

Figure 1: Four Zones of Range of Movement (ROM)

Source: Openshaw & Taylor (2006)

Recreation of Human Models and Activities in 3D Modelling

Within these 3D recreations, a human model was made based on the anthropometrics of the Traditional Malays that were calculated within the study. These human models were used in order to analyse the Range of Movements (ROM) of the users in the TMH between their interactions with the surrounding space as well as the furniture, while carrying out their daily activities. Figure 1 illustrates the four zones of ROM that was used as basis in this study.

The Four Zones are parameters that promote better blood circulation and flexibility which could lead to a more comfortable work and higher productivity. The Four Zones include; Zone 0 (Green Zone) and Zone 1 (Yellow Zone) which is the preferred zone for most movements and puts minimal stress on muscle and joints, Zone 2 (Red Zone) which is a more extreme position for limbs and puts greater strain on muscles and joints, and lastly Zone 3 (Beyond Red Zone) which is the most extreme positions for limbs and should be avoided if possible.

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As stated previously, all these 3D recreations were recreated based on the measured drawings of the selected samples in the archived reports of KALAM. These models helps the researcher in order to give a concrete visualisation to the environment of the past, as most photographic evidence of the Traditional Malays interacting with their furniture are not easy to come by, and most of the reports give a description based on what the user of the house describes of the past.

These data from the archives provided the information needed in order to produce the 3D models needed for the research. By these visual illustrations, and the interactions of the 3D models inside the recreated surroundings, ergonomic properties of the furniture were identified, and analysed using research methods commonly used in researches pertaining to ergonomics and human factors (E/HF). Figure 2 and Figure 3 illustrates the examples of recreated rendering models used in the 3D program.

Figure 2: Recreated 3D Model Renderings of the Activity (Last Burial Rites) and Environment based on the Archived Reports

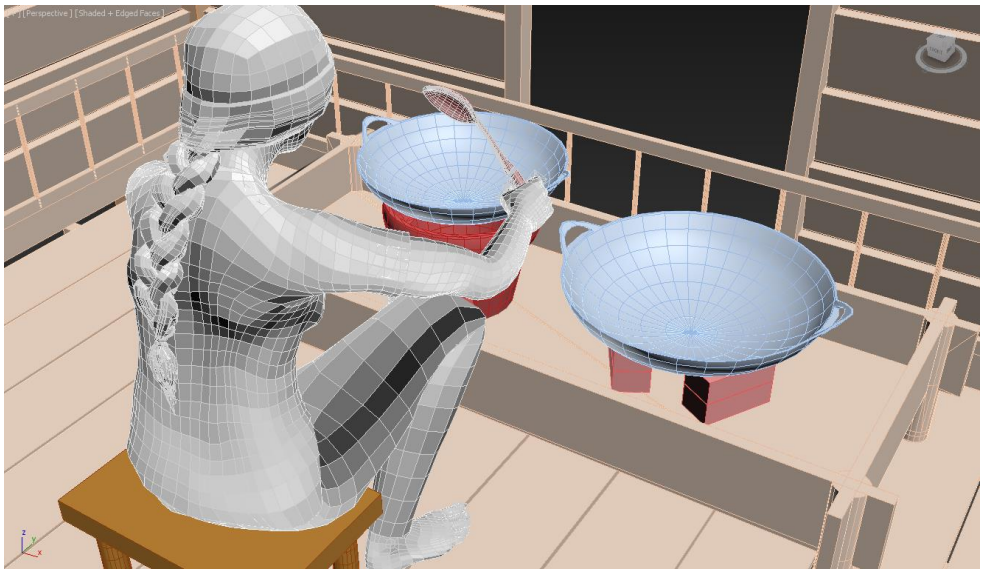

Figure 3: Recreated 3D Model Rendering of the Activity (Cooking on the Floor Stove Kitchen) and Environment Based on the Archived Reports

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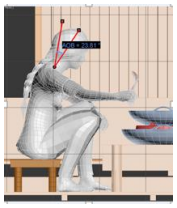
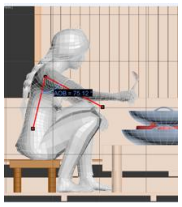
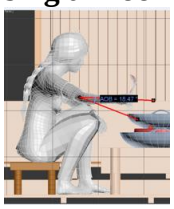
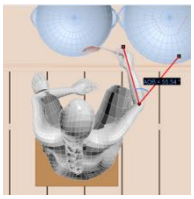
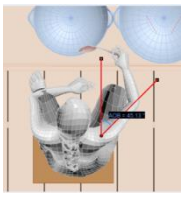
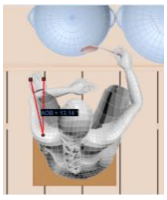
Brief Analysis

The models were then analysed using research methods that are commonly used in researches pertaining to E/HF, in this case the Rapid Entire Body Assessment (REBA). In order to analysis using REBA, the models were calculated based on their ROM and Zones. This was done by determining the angles of each limb that was required for the analysis. This included limbs, upper bodies as well as lower bodies. Table 2 below states one example of this data.

Table 2: ROM Dataset of User in the Kitchen Using a Floor Stove

Position of Body					
Angle	Back flexion: 13.32°	Neck flexion: 23.81°	Shoulder flexion: 75.12°	Elbow Flexion: 18.47°	Hip Flexion: 135.56°
Position of Body					
Angle	Knee flexion: 23.25°	Ankle adduction: 85.20°	Elbow adduction: 55.54°	Right shoulder adduction: 45.13°	Left shoulder adduction: 13.14°

Base on the datasets provided and calculated such as those that can be found in Table 2, the REBA analysis can be carried out using the worksheet provided. This will result in a REBA score that shows whether the furniture and activity of the user is ergonomic, or whether there should be changes that has to be made to the furniture. This REBA analysis has been commonly used by E/HF researches to analyse ergonomics of furniture, and such organisations that use this analysis includes the National Institute of Occupational Safety and Health (NIOSH). REBA scores are calculated based on the positions and ROM of the users which include the neck, trunk, legs, upper and lower arms, and wrists. These positions are then tallied with amount of force or load the user has to bear while carrying out the activity, coupled with the amount of time or how long the user has to keep being in the position mentioned previously. Calculations of the REBA score can be further illustrated in Figure 4. Figure 5 states how the calculations were carried for one of the analysis example.

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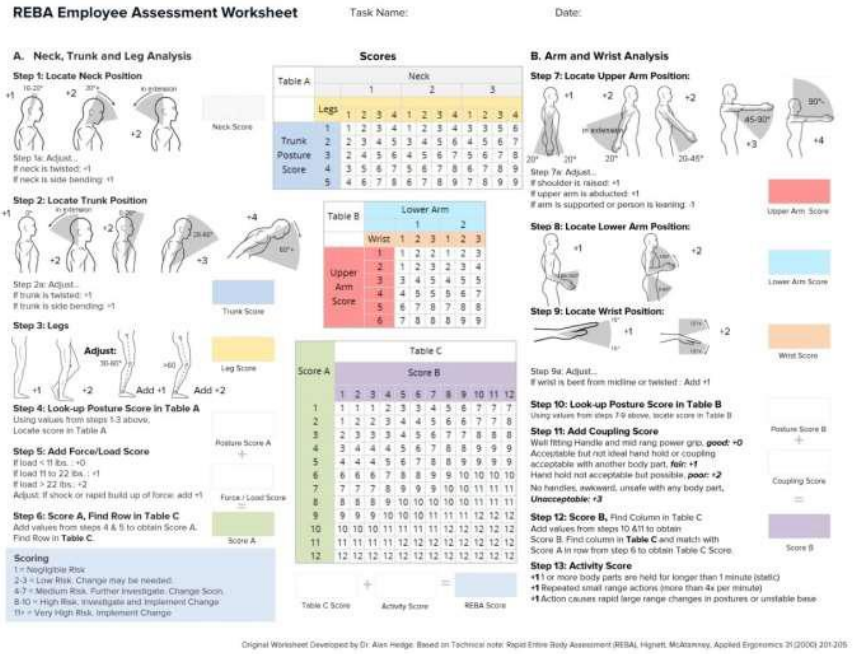

Figure 4: Rapid Entire Body Assessment (REBA)

Source: National Institute of Occupational Safety and Health (NIOSH)

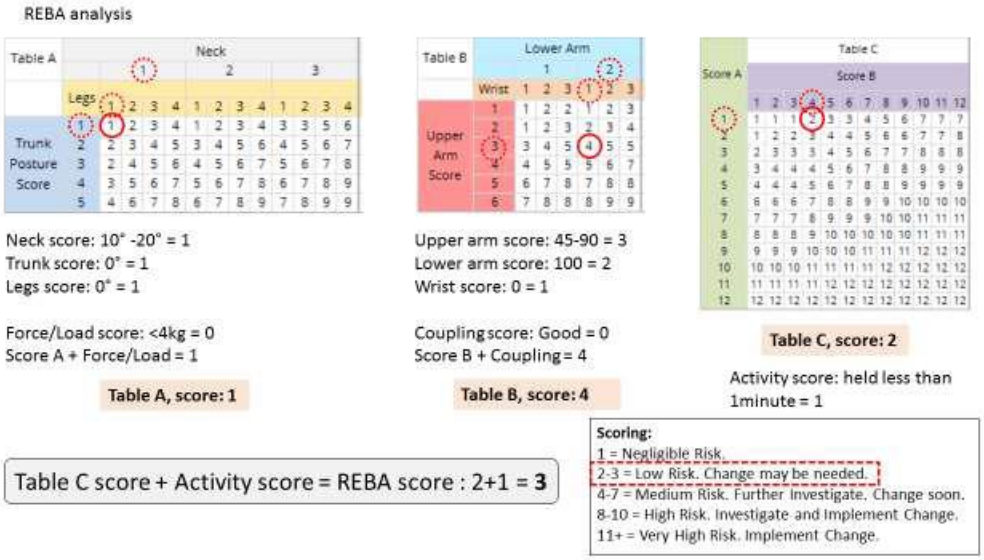

Figure 5: Example of REBA Score Calculations Made in the Study

Findings

Findings show that a majority of Traditional Malay furniture has a low REBA score, while few furniture that involves squatting has a middle range REBA score, these results indicate that Traditional Malay furniture have very user friendly features and are considered very ergonomic towards its users. These findings show that visual aids and renderings helped give a better understanding of the historical built environment that can longer, or seldom be found in todays' day and age, which is due to a majority of the architectural heritage selected in the samples being no longer available, or in ruins. For example, looking at Figure 6 and 7 below, the 3D recreation models and renderings help students in order to better visualise how the environment

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looked like back in the days and how the users interacted with the furniture available inside the houses. These visual aid further helps in identifying and solidifying the ergonomic properties of the Traditional Malay furniture that can be found in these sample houses.

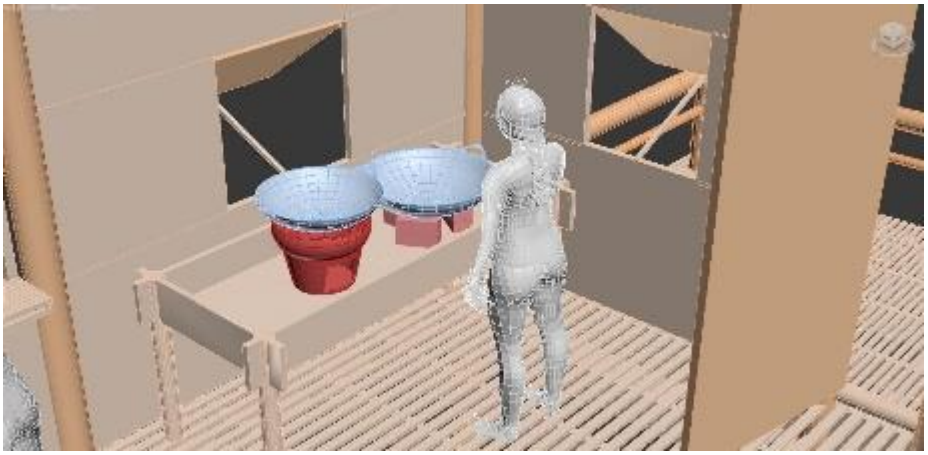

Figure 6: 3D Model of How a Standing Fire Kitchen Stove Looked Like With the Interaction of the User

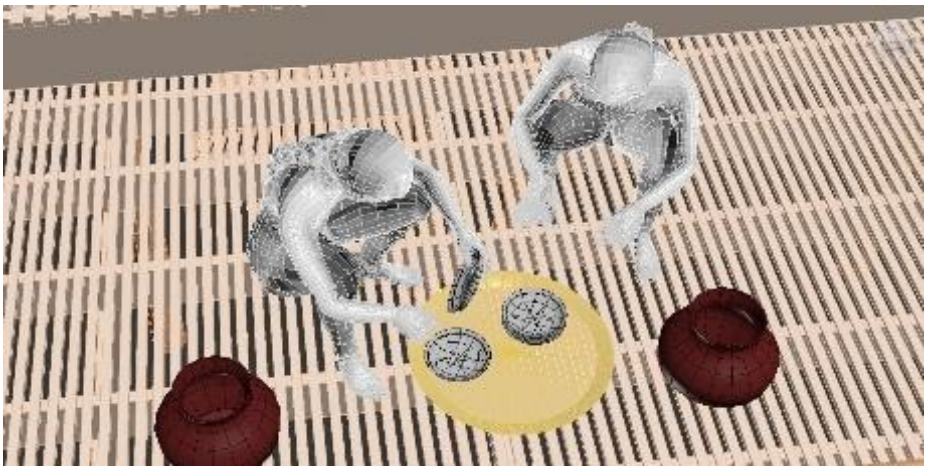

Figure 7: 3D Model of How Users in the Sample TMH Carried Out Their Daily Food Preparations

Conclusion

In conclusion, in order to provide an engaging academic session to the younger generation of today, visual computing can be applied to further enhance and encourage students of the technology era to learn and better understand architectural heritage designs.

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References

Business and Institutional Furniture Manufacturer's Association (BIFMA) (2002). BIFMA G1-2002. *Ergonomics Guideline for VDT (Virtual Display Terminal) Furniture Used in Office Work Spaces*. Grand Rapids, Michigan.

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DOI: 10.35631/JISTM.7250056

Campbell, M., Holdaway, S., & Macready, S (2013). *Introduction: An archaeology for the modern world*.

Chignell, M. H., & Hancock, P. A. (1992). *Design Orientation and Ergonomics.* Proceedings of the IEEE International Conference on Systems, Man, and Cybernetics, Chicago.

Frank, S. (1997). *History of Physical Anthropology*. New York and London, England.

Gibbs, P. (1987). *Building A Malay House*. Singapore.

Gritai A, Shah M. (2006). *Tracking of Human Body Joints Using Anthropometry*. Florida.

Handwerker, W. P. (2002). *The Construct Validity of Cultures: Cultural Diversity, Culture Theory, and a Method for Ethnography*. American Anthropologist. 104(1), 106-122.

Heidebrecht, M. A. (2007). *Target the Problem, Not the Symptom. Choosing The Correct Ergonomic Analysis Tool*. Ergo Methods.

Herskovits, M. J. (1948). *Man and his Works: The Science of Cultural Anthropology*. New York: Knopf.

Jastrzebowski, W. (1957). *Outline of Ergonomics, or the Science of Work Based Upon Truths Drawn from Science of Nature*. California, USA.

Jurgens H. W., Matzdorff, I., & Windberg, J. (1998). *International Anthropometric Data for Work-Place and Machinery Design*. Germany.

Khayal, O. (2019). *Human Factors and Ergonomics*, Atbara, Sudan.

Litchfield F. (1893). *Illustrated History of Furniture: From the Earliest to the Present Time*.

Ma T, Zhang S. (2011). The integrality of architecture and Furniture Design—Analysis of famous architects' furniture works, *2011 International Conference on Multimedia Technology*, pp. 1311-1313, doi: 10.1109/ICMT.2011.6002594.

Malaysian Standard. (2013). *Ergonomics – General Approach, Principles and Concepts (MS ISO 26800:2013)*. Department of Standards Malaysia.

Mohamad, D., Deros B., Ismail A. R., Daruis, D. D. I. (2010). Development of a Malaysian anthropometric database. *World Engineering Congress, Conference on Manufacturing Technology and Management*, 2nd-5th August 2010, Kuching, Sarawak, Malaysia.

Mohd Yusuff, R, Baba, Z, MD. Dawal, S.Z., Tan E. (2016). *Malaysian Ergonomics Standards-Its Development, Awareness and Implementation- A Review Article*. Iran J Public Health.

Openshaw, C., Taylor, E. (2006). *Ergonomics and Design A Reference Guide*. Allsteel Inc.

Whitfield D. Ergonomics: Designing for the User. IEE Proceedings A (Physical Science, Measurement and Instrumentation, Management and Education, Reviews), (1983).