

ERGONOMICS FOR STUDIO APARTMENT: COMFORT AND EFFICIENCY WITHIN THE CONTEXT OF BANGLADESH

Humayra Alam¹ and Md Raihan Khan²

Department of Architecture, Khulna University of Engineering & Technology, Khulna-9203, Bangladesh

Received: 22 September 2018

Accepted: 11 December 2018

ABSTRACT

Furniture manufacturers nowadays follow ergonomics for efficient, productive and comfortable space design. However, most furniture manufacturers of Bangladesh embrace the commonly followed ergonomic rules of design, ignoring the fact that the user group here differs highly in anthropometric measurements from the ones prioritized as main user group internationally. The resulting products are not up to standard for use by all users of Bangladesh and cause health issues related to discomfort, this calls for modified sets of ergonomic guidelines in respect to varying physical structures. At academic level, firsthand experience in designing space, keeping user preference and needs in mind, can prove to be influential in changing the current system. This article can provide the opportunity for rethinking the present ergonomic standards as the study done and design decisions taken by the students give an overview about how a person may function efficiently and comfortably within a small area.

Keywords: *Comfort, Ergonomics, Human Factors, Space Design*

1. INTRODUCTION

An ergonomic approach can provide specific guidelines for design in relation to human factors (Helander, 2006). A major objective of this concerns defining the basic ideas of comfort, efficiency and productivity. In a generalized sense, ergonomics is a scientific field focusing on the persons involved in a specific work environment, maintaining a close observation on the social and psychological aspects of the working situation, in order to ensure a healthy and efficient relationship between the people and the elements utilized in the overall system (Pheasant, 2003). The area of ergonomics implements the physical, cognitive and organizational aspects of design into spatial efficiency in order to meet user needs.

In the case of built environment and space design, ergonomics is the basic unit for initiating the design process. The overall productivity and functionality of a building depend on the smallest details and considerations concerning space arrangement. Human body measurement and postures related to different work activities influence the decisions taken while designing furniture and equipment for specific purposes. This in turn decides whether or not the designated space is the most comfortable to use when those pieces of furniture are used in room arrangement and if they are convenient to use by the users from a specific region or context. When we include the terms region or context into the topic of ergonomics, it generally means designing for users with similar anthropometric dimensions in respect to individual spatial needs. While not all users are similar in physique and do not have the same posture requirements, people from a certain country or within a specific context can be generalized into having a standard for male and female physical structure, which means ergonomic guidelines may vary according to physical differences in different areas. However, in many cases these days, the ergonomic standards in Bangladesh are still at basic level and do not satisfy user needs since most consider ergonomics as a not so feasible system (Ahasan, 2002). Economic benefits have been instrumental in driving manufacturers to produce items for a major user group or for financially developed countries due to feasibility and profit gain. For instance, local furniture brands and shops have adapted internationally followed ergonomic standards in order to reach a vast variety of consumers. The resulting pieces of furniture cannot be used in efficient and comfortable space design and sometimes end up causing health issues. An exception of this would be the Centre for the Rehabilitation of the Paralyzed (CRP), which delivers custom made ergonomic furniture (Sarkar, 2018).

At an international level, the clearly defined field of ergonomics may be conceived as a modern idea, but the initial thought behind the term goes back years. The process of designing equipment emerged from the functional needs of the job involved, which eventually became insufficient in terms of providing a useful and productive outcome. For example, in 1717, Bernardino Ramazzini stated that cumulative trauma disorder was the result of constrained body posture and excessive mental stress (Helander, 2006). Consequently, most furniture and equipment designs delivered neither comfortable usage nor maximum utilization of space. The answer to this problem was found in the introduction of ergonomics into design by paying attention to factors such as body posture and movement, environmental factors, information and operation, as well as work organization (Dul and Weerdmeester, 2001). Presently, the most widely followed ergonomic standards are either

* Corresponding Author: humayra.alam10@gmail.com

developed by International Organization for Standardization (ISO) or the European standardization organization Comité Européen de Normalisation (CEN). In addition to this, national standards are followed in the United States (American National Standards Institute or ANSI) and Britain (British Standards Institution or BSI) (Dul and Weerdmeester, 2001). While these standards have contributed to the production of user friendly and comfortable product manufacturing, the core unit of standardization basically is formed with anthropometry of specific regions. Field study shows that local products follow standards of other contexts, resulting in wastage of space and health issues.

In a time when consumer pressure sometimes leads to the introduction of ergonomic features into design (Pheasant, 2003), a standardized ergonomic system is in demand for the users of Bangladesh. To contribute to this initiative, the undergraduate students of 2nd year 1st term (Department of Architecture, KUET) conducted a study and utilized the gathered knowledge into making design decisions. In the process, students initially studied the various aspects of anthropometrics and made contribution to understand the average size and measurements of users within this context. This involved a detailed study of the postures related to various activities like eating, sleeping, walking, object reaching etc. Later, they focused on an in-depth study of how anthropometrics, added with pieces of furniture and equipment, makes a crucial contribution to the field of ergonomics. The prime objective of this method was to understand the differences between international standards for people from European or American context and those required within the context of Bangladesh, from national and international case studies. The final outcome of the semester-wide study of the students were reflected into the design of a professional's studio apartment for a single user, with the key components being professional needs, body structure and comfort. This study is influential in understanding space, user and ergonomics relation on a small scale.

2. ERGONOMIC APPROACH AND HUMAN FACTORS

As it has been identified time and again, ergonomics is the discipline concerned with understanding human interactions with other factors within a system with the prime objective being achievement of user satisfaction and system efficiency (Attaianese and Duca, 2012). The term “Human Factors” has been intertwined with the field of ergonomics since the beginning of the conception of this idea. Human factors is a general and indistinct term, for it may mean people interfacing with technology, it may be associated with individuals who do work that is concerned with “above the neck” processing as well as “below the neck” processing (Wogalter *et al.*, 2001). In the case of built environment, factors such as user's physiological aspects, activity needs, psychological and physiological comfort, and productive space are most definitely the key concerns in ergonomic design.

2.1 User-centric Ergonomic Design

Ergonomics and human factors are related to the functionality of a system. This system centers on the user, putting the user as the basis to whom the design would then relate. The possibility of ergonomic design is thus concentrated on the active involvement of the user into the system or work environment (Attaianese and Duca, 2012). Ergonomic principles require the design itself to be suited to each user and designers have to acquire knowledge of the potential users, their activities, functions and tasks in order to identify the specific aspects which need ergonomic considerations (Wagner *et al.*, 1996). However, due to variability within populations, most of the designs are found to be suited to 95% of the users, while the remaining 5 percent require special, individual ergonomic measures. In built environment, variability and diversity may be generated due to user's health condition, body size, strength, experience, mobility in the cases of handicapped, elderly or children (Attaianese and Duca, 2012). The significance of these variables can be clearly understood by the study of posture and movement, which refers to the human body adopting a posture in order to carry out a movement (Dul and Weerdmeester, 2001). Poor posture and movement can lead to muscle stress as furniture that are not responsive to user's ergonomics are instrumental to inappropriate usage of space and in turn causes of discomfort, physical and mental stress. A detailed evaluation of factors concerned with different posture is taken into consideration, thereby establishing the features to be highlighted in the ergonomic guidelines.

2.2 Anthropometric Guideline

The significance of user posture can be understood through the reflection of human comfort and a large variety of users may find physical comfort at work by following anthropometric guideline (Helander, 2006), which is closely related to the ergonomic method. Anthropometry generally refers to the measurement of humans, focusing on bodily measurements such as shape and size, body motion, use of space and physical strength (Herron, 2001).

2.3 Ergonomic Methods

Ergonomics may be related to a variety of fields related to body dimensions, measurements, human factors and such; however, a successful implementation of ergonomics into design can only be reflected through strategic methodology. Human factors and ergonomic methods are applied into design through experimental research, descriptive studies, and evaluation research, followed by psychometric properties, practical issues, and descriptive, empirical, and evaluation research methodological processes (Jacko *et al.*, 2012).

2.4 Fallacies and Limitations of Methodology

Built environment design, in recent times, is highly concentrated on the field of ergonomics, user preferences and comfort (Dul and Weerdmeester, 2001). However, the application of the process has not yet been fully utilized in building design, sometimes due to the failure to follow the methodology, or sometimes because architects vary in their opinion about the system from artistic and social viewpoints and sometimes simply because of the unavailability of design data (Attaianese and Duca, 2012). According to Pheasant (2003), five fallacies are involved with the failure of implementing ergonomics in design.

- i. This design is satisfactory for me, it will, therefore, be satisfactory for everybody else.
- ii. This design is satisfactory for the average person, it will, therefore, be satisfactory for everybody else.
- iii. The variability of human beings is so great that it cannot possibly be catered for in any design, but since people are wonderfully adaptable it doesn't matter anyway.
- iv. Ergonomics is expensive and since products are actually purchased on appearance and styling, ergonomic considerations may conveniently be ignored.
- v. Ergonomics is an excellent idea. I always design things with ergonomics in mind, but I do it intuitively and rely on my common sense so I don't need table of data or empirical studies.

As noted in Table 1, the misconceptions about ergonomic design are those which cause the limitations in the adaptation of the approach. Not only designers, but also manufacturers who play a major role in distributing products and items, often ignore the significance of consideration for all users, resulting in the production of furniture or equipment not suited for comfortable usage. Designers in Bangladesh often tend to ignore the variables involved in the study of ergonomics, and sometimes the limitations of handicapped users. In the case of manufacturers, the lack of research and finance that are needed in background study and the temptation of financial profit gain often play key roles to overlook the importance of ergonomics in design.

2.5 National and International Standardizations

Standardization in general is the act of formulating, issuing and implementing guidelines for common and repeated use, keeping the actual and potential problems in mind, all the while with the objective of achieving the suitability of products, processes and services for their intended purposes (ISO/IEC Guide 2, 2004). According to ISO (International Organization for Standardization)/IEC (International Electrotechnical Commission) Guide 2 (2004), standards can be classified into four groups: international, regional, national and provincial. An example of internationally followed standard system may be ISO, whereas Europe consists of three major regional standardization bodies: the European Committee for Standardization (CEN), European Committee for Electrotechnical Standardization (CENELEC), and European Telecommunications Standards Institute (ETSI) (Rodrick *et al.*, 2012). In building design, the CEN standards are applied in Europe with regards to body size, measurements and posture requirements for users from that specific region. The prime concerns of these standards are to ensure safety and productivity in design and the minimization of waste, which make these elemental to the field of ergonomics.

2.6 Ergonomic Standards in Bangladesh and Limitations

Compared to national and international level standards, the present condition in Bangladesh is still not at a developed level due to lack of field study and background research. Most of the furniture manufacturing companies rely on the internationally followed standards, and some do not even adapt those in the design to fit in the local context. Small entrepreneurs involved in furniture production do not have the exact data about the ergonomic guidelines. As they carry on with the traditional practice of furniture design followed by their ancestors and rely on their general perception of body measurements, the comfort and usability aspects often go unnoticed. Proprietor Mr. Shahid says, "It's our family business and by legacy I got the ownership of this furniture shop". He added, "We are ensuring best quality and innovative design. In case of measurements, we have followed the high-end manufacturers and international standards since the start. Now a day, people are conscious about the products and modify the shape, size, etc. according to their comfort ability".

However, the need to adopt a specific standard system for the context of Bangladesh is now more crucial than ever, and a number of reasons are responsible for that. The major cause behind this is the global problem of population explosion and with the increasing number of people in Bangladesh, the need for livable space is also increasing. As a result of this, people are being forced to choose more confined and small spaces as residence due to lack of enough space. On the other hand, sedentary lifestyle leads to health problems, such as, back pain, disc displacement of spinal cord which is directly connected with furniture related with daily activities. However, the term “proper utilization” is still non-existent within this context due to the lack of relevant design schemes that fully comprehend the average body sizes and shapes of users from Bangladesh. For example, factory owners and employers association in Bangladesh, lacking money, resource and other elements, generally consider ergonomics to be financially draining and tend to avoid it in workspace design (Ahasan, 2002). If a strategically designed guideline is not established for the users here, the economic system may suffer even more due to lack of productivity and worker involvement, not to mention comfortable living spaces that may decrease in amount. A comprehensive study is therefore on the demand for establishing a standard system of ergonomics in Bangladesh. The study attempted to focus on the problem that is currently on rise by concentrating on the physical attributes of users within this context and using the data acquired and eventually providing a propositional guideline for ergonomic design.

3. METHODOLOGY

The study involved an academic exercise by the students for the design of a studio apartment with respect to physical measurements of an average sized user from Bangladesh. It was done as part of design studio work at 2nd year 1st term, session 2017-18, undergraduate program in the Department of Architecture of Khulna University of Engineering & Technology (KUET), Bangladesh. The method involved anthropometric study and survey and application of gathered data in designing studio apartments for two professionals, a writer and a doctor, all the while attempting to develop a standard system of ergonomics for users within the context of Bangladesh.

3.1 Sampling and measuring procedure

For the initial study purpose, both male and female students were selected from second year level of the Department of Architecture and obtained their anthropometric measurements in the order of tallest, average and shortest. The ages of the students ranged between 20-22 years. Anthropometric measurements of the forty students divided into three categories were taken by three groups of students in the classroom. The purpose of defining various categories was to understand how height and physique can make impact on the design considerations. The anthropometric measurements of the students were taken in two postures: standing and sitting on a chair. Heights of the students were measured when standing barefoot. At sitting position, the students' legs were at right angle with the seat and their feet were flat on the floor. Students surveyed local furniture shops using random sampling method as part of the initial study using standard measuring tape, so as to find out the locally followed measurement of different furniture. Students studied how international standards may vary from the standardization requirements for local average sized user.

3.2 Anthropometric Measurements

Anthropometrics relates to the measurement of physical postures and has been utilized as a system of data collection in the methodology. The physical measurements of the six students and their related postural measurements have been taken by applying the system. In order to design a studio apartment, students collected the measurement data as shown in Figure 1 in relation to assigned activities to develop comparative analysis and identify limitations of currently practiced ergonomic standards.

Standing

1. Stature 2. Forward grip reach 3. Chest depth 4. Vertical grip reach 5. Eye height 6. Shoulder height 7. Elbow height 8. Knuckle height

Sitting

11. Sitting height 12. Sitting eye height 13. Sitting elbow height 14. Popliteal height 15. Elbow-grip length 16. Buttock-popliteal length 17. Buttock-knee length

Anthropometric measurements were studied in an attempt to understand the differences in body structure of national and international users. Figure 2 and 3 below show comparison of anthropometric measurements between British and Bangladeshi adults.

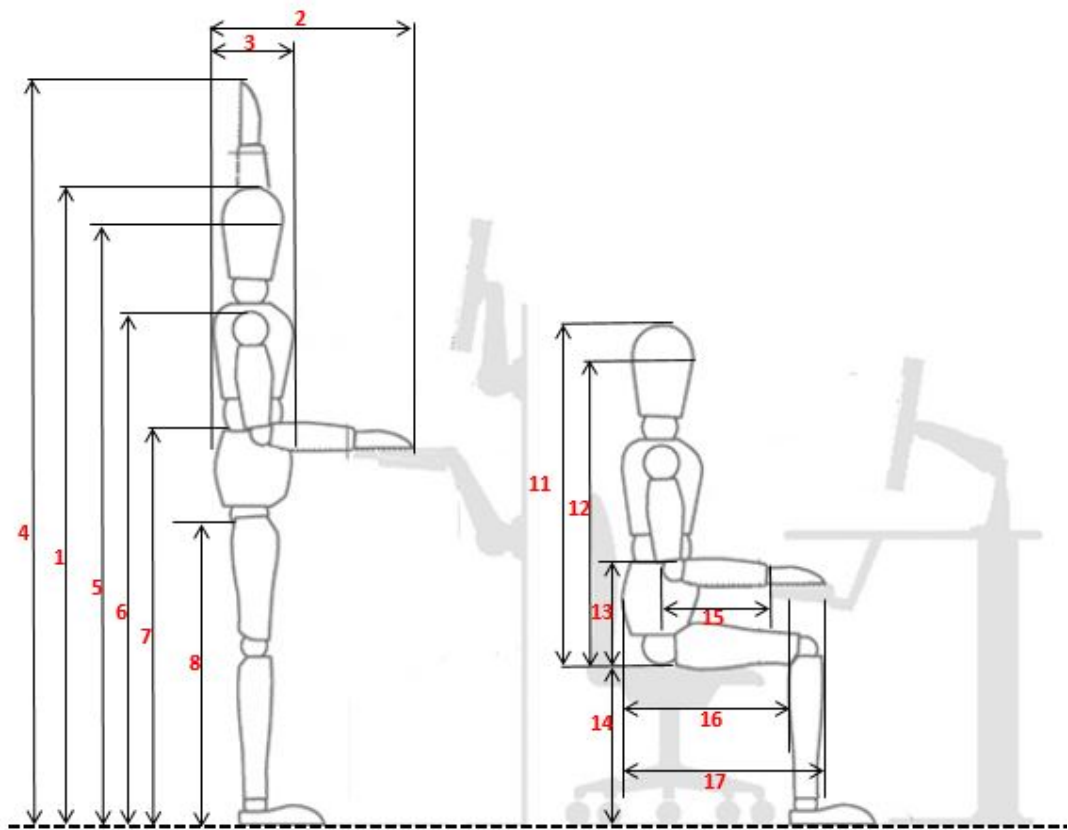


Figure 1: Illustration of anthropometric postures and measurement areas. Reprinted from *Ergonomics for Beginners A quick reference guide* (p. 12), by Dul and Weerdmeester, (2001), Taylor & Francis Inc. Reprinted with permission

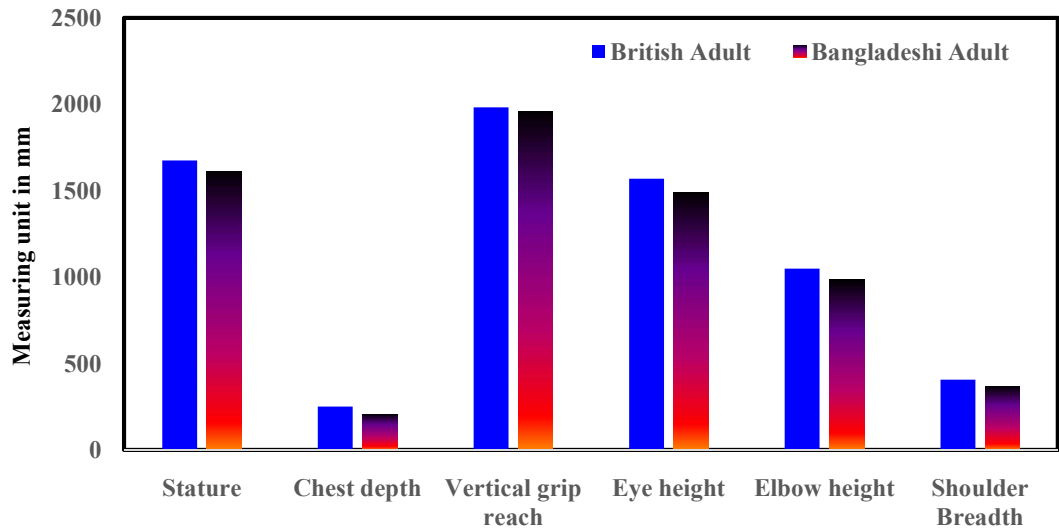


Figure 2: Comparison of standing postures

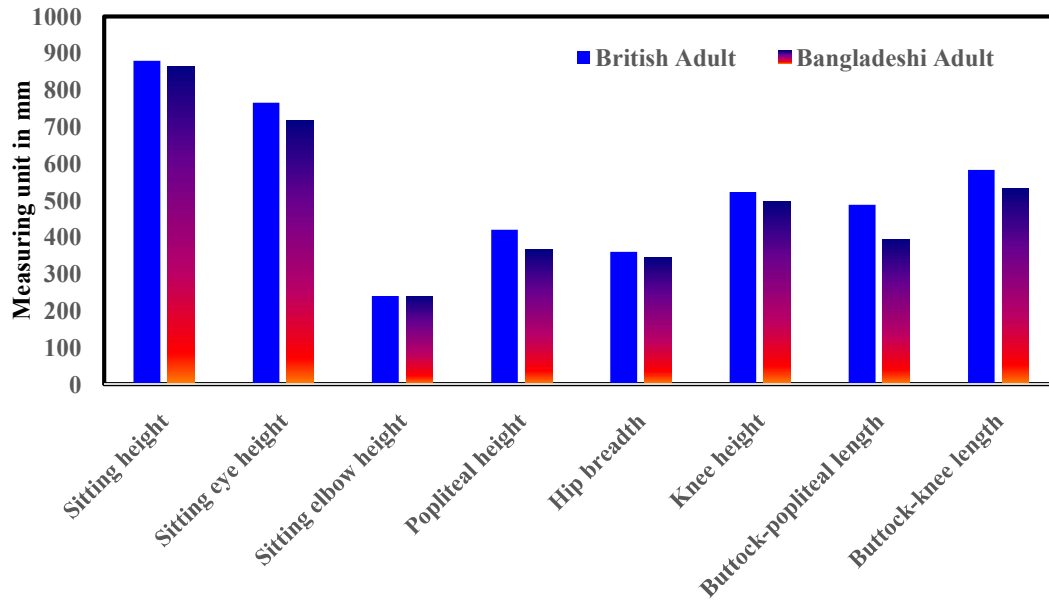


Figure 3: Comparison of sitting postures

Charts A and B represent the comparison of Anthropometric dimensions (all measurements are in mm) between the British and Bangladeshi adults. Source: ISO (International Organization for Standardization)

3.3 Furniture Measurements

In order to understand how furniture dimensions influence the arrangement of spaces and how these may vary according to functional or professional needs, students conducted a study based on existing local furniture and internationally standardized ones. Furniture associated with residential and chosen professional activity spaces, such as living, dining, bedroom, kitchen, toilet and professional workstation were taken for ergonomic analysis. In association with these activities, the following furniture (Table 1) were selected to study measurements focusing different activities of a studio apartment.

Table1: Furniture associated with different activities

Space	Associated Activities	Related Furniture
Living	watching TV	shelves
	talking	TV furniture
	visiting (if any)	sofa
	handcrafts space (if any)	table (center or corner)
Dining	taking meals	dining table
	washing	wash basin
Kitchen	preparing / cooking food	countertop sink
	dishwashing	suspended cabinets (high)
		pantry cupboard (wall)
		refrigerator
Bedroom	sleeping	stove
	reading	wardrobe
		bed
Toilet		reading table
Workstation for professional		WC, wash Basin
1. Doctor	maintaining personal hygiene	
	waiting area	chairs
2. Writer	patient consultation	doctor's table and chair
	treatment/examination	patient bed
	reading	reading table
	writing	bookshelf
	book storage	

3.4 Ergonomics Study

While surveying the local small scale furniture shops and large scale furniture brands of Bangladesh, students noticed that the ergonomic measurements are significantly similar with the standards that are followed internationally and a lack of any specific context oriented standardization system. Even though local brands such as Hatil, Regal etc. follow a measurement system of ergonomic furniture design, which is neither suitable to the context of Bangladesh or blind copy of internationally accepted standardization systems without any local or regional modification. Otobi, a large scale local furniture producing brand, has recently introduced a number of products, which are designed with respect to local ergonomic requirements, even though most of their furniture products are based on European standards.

As per the conducted study, a two seater sofa from a local brand (Figure 4) usually measures 825-900 mm in height, which is similar to the one designed with international standards. On the other hand, the international standard for a two seater sofa of the Sheraton type (De Chiara and Callender, 1980) includes 762 mm width and a height of 914 mm (Figure 4). The dimensions of a two seater sofa may vary according to typology, usually within a range of 1828-2133 mm in length and 762-914 mm in width (De Chiara and Callender, 1980). The apparent difference is seen in the length of the local example and international standard.

- (a) Height 800 mm, Width 825 mm, Length 1225 mm
- (b) Height 900 mm, Width 750 mm, Length 1800 mm

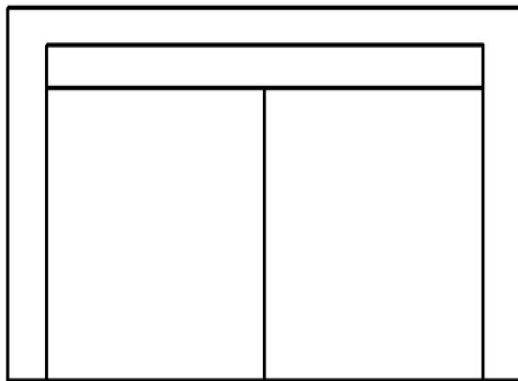


Figure 4: Sofa measurement in terms of national and international standards

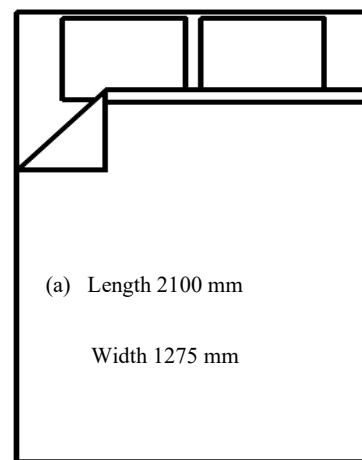


Figure 5: Bed measurement in terms of national and international standards

As seen in Figure 5, the ergonomic measurements of a double bed in Bangladesh features a length of 2133 mm and a width of 1295 mm in general, while the international standard of a double bed is 2082 mm length and 1371 mm width (Figure 5).

3.5 Ergonomic Considerations in Student Projects:

Students worked on the studio project, studio apartment for a professional, by dividing up into two groups. Each group studied apartment typology based on two professions, one for a writer and one for a doctor. While the functions such as living room, kitchen, bedroom, toilet etc. are similar in arrangement scheme, the main differences are derived from the space and arrangement requirements of the professional's workstation or work studio.

Figure 4 shows a studio apartment designed for a writer, the prime design consideration being the visual separation between the semiprivate and private spaces. As a writer spends a major part of his day in his workspace, writing is a profession in need of enough privacy and calm atmosphere for the writer to be able to concentrate fully on the task. The major pieces of furniture required in this case are the reading table and the bookshelf. The design emphasizes a workstation featuring a connection to the sleeping area, with a thoroughly designed space consisting of a writer's worktable, with two spaces of book stacking, one beside the table and another being the shelved stacking system. The height, length and width of both the table and the shelf were selected after studying detail ergonomics and local ergonomic requirements. The total workspace has been arranged to accommodate required functions within an ergonomically designed compact space.

Figure 6 illustrates a studio apartment designed for a doctor and features a significant difference with the one for the writer, reflected in the arrangement of the workstation. The difference is highly influenced by the professional's work type, as can be seen in the zoning of the doctor's chamber in a more public setting than the writer's reading and writing station. A doctor's chamber requires a public setting as it needs to accommodate a

patient waiting area attached to it. The prime challenge in this case was to design an ergonomic living space which can accommodate an attached chamber for patient inspection and treatment in addition to the waiting space. In this design (Figure 6), the doctor's living room and chamber are accessible from the entry in a way so that the living room may also act as a waiting room for the visiting patients. The major furniture of concern in this case was the patient bed which required a detail study of ergonomics to understand how it can be designed to be accommodated within a small space while also ensuring patient comfort. The patient bed is designed by following local anthropometric measurements and is set with a shelf opposite it. The focus in this case was on the height, length and width measurements of the bed.



Figure 6: The model shows a compact design solution considering all anthropometric and ergonomic factors of Writer. Source: Model and design are prepared by Md Abdul Kayum, Student ID 1625018, Student of Department of Architecture, KUET



Figure 7: The model shows a compact design solution considering all anthropometric and ergonomic factors of Writer. Source: Model and design are prepared by Mir Mohammad Akbar, Student ID 1625025, Student of Department of Architecture, KUET

The designs turned out to be accommodating required functions within less area than those designed with furniture of international standard. This certainly provides an insight into how excessive space is being wasted by using presently manufactured furniture within Bangladesh. As less space for pieces of furniture means less space for the overall apartment and in turn, site area, a significant area can be saved by establishing national ergonomic standards and follow through the process in design as well.

4. LIMITATIONS AND POSSIBILITIES OF ERGONOMIC DESIGN

From the field study on the local furniture market, students achieved a comprehension of how a lack of local standards has a significant impact on user comfort. The problem is rooted into the basic ergonomic approach that most furniture companies follow. As described before, the top-ranked brands in Bangladesh implement a system of ergonomics designed around international standards. However, the physique of users from this region varies largely from those considered as being of standard physique for the establishment of international ergonomic systems of design. One of the prominent disadvantages of this practice is clearly the improper

utilization of space. As the international standards are based around of those physically different than the ones from this region, the market-oriented designs often take up too much space and cause discomfort. In a time when compact and suitable use of space is in the demand, such practice can often be the cause of lack of sufficient space.

The project worked as an opportunity for the students to understand how ergonomics may influence the design of furniture and in turn the comfort factors of local users. During the initial study phase, students attempted to find the human factors responsible for changes in standards of ergonomic design and utilized that knowledge into detail design. As the project itself involved designing for a professional in a small scale, it provided the scope to think in detail about user comfort while also keeping in mind the ergonomic factors of design.

5. CONCLUSION

Designing a studio apartment for a professional within a limited space in respect of comfort and workstation needs provided an opportunity for the students to explore how the anthropometric measurements of users from Bangladesh differ from other regions. This enabled them to study in detail how the standard measurements for furniture can be determined specifically for users from this context and design according to these standards. Human factors such as body height, age, gender, nationality etc. influence the design considerations of furniture and space. But due to manufacturers targeting large scale furniture market by following current trend and not following through with the concept of contextual ergonomic standards, especially in Bangladesh, wastage of functional space occurs. This practice in turn causes lack of sufficient space in a broader perspective as more space is taken up by profit oriented designs. As far as comfort is concerned, the resulting products are definitely not up to comfort standard for local users and cause physical and mental stress, ultimately affecting productivity.

As the sole comfort of the user is the main concern here, an approach of ergonomic design turned out to be the process to follow. Anthropometric measurements act as the starting point of the method and even though this attitude toward design is internationally recognized, the lack of emphasis toward standardization decisions has negative impact on the concept of comfort in Bangladesh. As a result, further study into how contextual and regional human factors influence the sizes of furniture and space in turn is required to ensure efficient and comfortable implementation of ergonomic design.

The article brings attention to the need for proper measures in order to establish a standard ergonomic system for the users of Bangladesh. A study into anthropometrics and ergonomics at undergraduate level can certainly help establish a general idea of how ergonomic standards designed specifically for Bangladesh may influence space utilization. The study can help concerned body to conduct further study into the field and provide scope for national standards. The article emphasizes the need to rethink ergonomic furniture dimensions in respect of the context of Bangladesh.

ACKNOWLEDGEMENT

The authors would like to thank the students of 2nd year 1st term, Department of Architecture, KUET for providing study reports and design decisions of studio project for the article.

REFERENCES

- Ahasan, R., 2002. Occupational Health, Safety and Ergonomic Issues in Small and Medium-Sized Enterprises in a Developing Country, Academic Dissertation, University of Oulu, pp. 23.
- Attaianese, E., and Duca G., 2012. Human factors and ergonomic principles in building design for life and work activities: an applied methodology. *Theoretical Issues in Ergonomics Science*, [Online], 13(2), 187–202.
- De Chiara, J., and Callender J., 1980. *Time-Saver Standards for Building Types*, 2nd ed. Singapore: McGraw-Hill Inc., 7, 22.
- Dul, J., and Weerdmeester B., 2001. *Ergonomics for Beginners*, E-Library version, 2nd ed. USA and Canada: Taylor & Francis, pp. 2-5.
- Helander, M., 2006. *A Guide to Human Factors and Ergonomics*, E-Library version, 2nd ed., Florida: Taylor & Francis, 3(7), 147.
- Herron, E. R., 2001. Anthropometric Databases, In: *International Encyclopedia of Ergonomics and Human Factors*, 1st ed., Vol. 1. Karwowsky W. (ed.). London: Taylor & Francis, 191-192.
- International Organization for Standardization & International Electrotechnical Commission. ISO/ IEC Guide 2: Standardization and related activities General vocabulary. 8th ed. Geneva: International Organization for Standardization & International Electrotechnical Commission. 2004.

- Jacko, A. J., Yi J. S., Sainfort F., and McClellan M., 2012. Human Factors and Ergonomic Methods, In: Handbook of Human Factors and Ergonomics. 4th ed., Salvendy G. (ed.). New Jersey: Taylor & Francis, pp. 298-329.
- Pheasant, S., 2003. Bodyspace: Anthropometry, Ergonomics and the Design of Work, [E-Library version] 2nded. London: Taylor & Francis, 4(11), 188-189.
- Rodrick, D., Karwowsky W., and Sherehiy B., 2012. Human Factors and Ergonomics Standards, In: Handbook of Human Factors and Ergonomics. 4th ed., Salvendy G. (ed.). New Jersey: Taylor & Francis; 2012, pp.1511-1549.
- Sarkar S. Blame the chair not the person for being a pain in the neck! The Daily Star, [Online] January 16 2018. Available from: <https://www.thedailystar.net/lifestyle/spotlight/blame-the-chair-not-the-person-being-pain-the-neck-1520242> [Accessed 24th June, 2018].
- Wagner, D., Birt A. J., Snyder M., Duncanson P. J., 1996. Human Factors Design Guide, U.S. Department of Transportation, Report Number: DOT/FAA/CT-96/1.
- Wogalter, S. M., Dempsey G. P., and Hancock A. P., 2001. Defining Ergonomics/ Human Factors, In: International Encyclopedia of Ergonomics and Human Factors, 1st ed., Vol. 1. Karwowsky W. (ed.). London: Taylor & Francis, 35-37.