Applications of Ergonomic Studies in India: A Literature Review

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Abstract. India, known for its diversity in resources and culture, is a land for a large variety of people resulting in huge variability in anthropometric dimensions. This necessitates human factors to be crucial in engendering usability in a product thereby making it beneficial. Due to the emerging complex work systems, knowledge on physical dimensions of humans with accuracy is influential. As a result, Production engineers are impelled to involve ergonomic factors into manufacturing a product. However, anthropometric data varies from region to region. Ergonomics accounts for all anthropometric differences in individuals. The paper tries to identify how well ergonomic aspects and anthropometric data have been applied in different areas. Proper ergonomic designs demands thorough knowledge on the effect of study of anthropometry, posture, repetitive motion, and workspace design on the user and also satisfies psychological desires of the user. The current work also addresses various literatures in identifying the importance of anthropometric and ergonomic studies in product design in India. Also, areas where Ergonomic knowledge should be considered is looked into. This literature can help in enlightening oneself about the areas of application of ergonomics and can be used for further investigation in researches related to anthropometry. It has been suggested that work study, statistical and optimization techniques can be used in combination with ergonomic applications to solve design issues.

Keywords: Ergonomics, Anthropometry, Statistics, Work study, Human factors.

1. Introduction

Human beings, so called as intelligent among all living beings finds comfort in every task he does. He tries to do it as comfortable as possible so that he gets the desired result by the efficient work environment he creates for himself. This is where Ergonomics gain importance. Ergonomics, defined as the study of work and working conditions emphases on the people who do it and the way work is being done so as to improve people’s efficiency. Also, thrust is given on the place where work is done, the tools and equipments used and the psychological aspects of the situation.

The science of Ergonomics deals with the word ‘work’ in its occupational sense which assumes a degree of skill or effort. The Principle of User- centered Design summarizes the ergonomic approach to design stating that for an object, a system or an environment to be desirable for human use, its design should be reckoned with the physical and mental characteristics of its human users. A good match must prevail between the product and its user for the task to be performed effectively. Thus, ergonomics fits the job to the worker and the product to the user [1] [2].

Ergonomics is profitably applied in following three areas:
1. Design of Man-Machine Systems
2. Design of Consumer Goods and Service Systems
3. Design of Working Environment

Humans relate themselves to the outside world in order to create operational efficiency and safety. This is studied by human factors. This helps in better adoption to the work in order to view
improvement in the experience of the user.

Anthropometry is the science that studies the physical measurement of human body and systematically measures dimensional descriptors of human body. During the past one decade, research in ergonomics has led to increased interest in the technology of work and furniture design based on biomechanics of the human body. Today, anthropometric data is being used in industrial design, clothing design, architecture, even in fashion designing. Statistical data about the distribution of body dimensions of a population is utilized.

The paper addresses various literatures elucidating the importance and application of ergonomic and anthropometric data. The literature review is divided into four aspects which notifies areas where ergonomic studies have been made. Each section has been addressed chronologically according to the time during which ergonomic studies have been conducted. The study highlights the techniques and the specific ergonomic area which have been used to understand the human and work system aspect. Various anthropometric dimensions have been looked into designing products which is depicted in Figure 1 and 2 and would be useful while studying the literature review. Table 1 provides the index for Figure 1 and 2. These figures have been generated using 3DSSPP trial version software developed by Centre for Ergonomics, University of Michigan [32].

**Figure 1.**
Anthropometric dimensions in sitting posture [32]

**Figure 2.**
Anthropometric dimensions in standing posture [32]
Table 1. Anthropometry dimension for Figure 1 and Figure 2

| Dimensions          |
|--------------------|
| a Sitting height   |
| b Sitting eye height |
| c Sitting shoulder height |
| d Sitting elbow height |
| e Buttock-popliteal length |
| f Popliteal height |
| g Knee height      |
| h Fingertip height |
| i Knuckle height   |
| j Hip height       |
| k Shoulder height  |
| l Eye height       |
| m Stature          |

2. Literature Review

2.1. Ergonomics in agriculture
Since farmers undertake variety of tasks in the fields, the tools they use must match the farmers’ requirements. Digging operations require proper grip of hand tools. Correct height for handling animal drawn machinery must be provided to prevent muscular aches. An anthropometric survey was conducted on agricultural machinery and 52 variables were collected and accordingly percentile values were obtained based on which suitable design values were recommended [3].

Since India is an agricultural country, many hand tools, animal driven equipments and power drawn equipments are used extensively. Since only few anthropometric surveys are conducted, agricultural equipment are not designed ergonomically which are potential to cause operational injuries. A comparison study was conducted using anthropometric data of male farm workers of Eastern India with other ethnic groups. It was found for most of the body measurements, data was smaller than other ethnic groups with an exception of popliteal height [4].

A detailed investigation to understand the physiological workload on women workers indulged in plucking of tea leaves was studied in Himachal Pradesh area. The traditional method of working imposes certain effect on the health of the personnel which can be predicted by assessing the relationship between age and heart rate of respondents. Heart rate values were helpful to assess the physical stress levels. From the study, it was concluded that age and heart rate values were correlated in the elder age group of the sample. Since most of the respondents had delicately built body, faulty working habits may create stressful workloads [5].

Indian farmers largely perform manual harvesting due to which they are prone to musculoskeletal disorders. Gender, age, literacy level, working experience all determine the risk of being attacked with MSDs. Many farmers depend on hand tools for farming due to which posture of working may cause hindrance in achieving efficiency. A logistic regression was conducted to determine the relationship between MSDs and other factors for a selected sample of farmers in Rajasthan. It was noticed that age and gender had an impact in occurrence of upper body pain. Age has an effect on finger, palm, fingers, wrist and elbow region. Farmers were seen to assume awkward postures due to repetitive tasks in the field and the trunk region was found to have a high prevalence of MSDs [6].

2.2. Ergonomics in Furniture design
Personnel working in software firms, students at school are also exposed to certain stresses due to
un-ergonomic furniture used which makes them unable to achieve efficiency. Ergonomic considerations in respect to seating arrangements, posture while working, distance between computer and the worker are necessary for comfortable working.

Any furniture designed must be worth in terms of satisfying the user so that he is comfortable using it for the tasks he does. Since students spend most of the time in schools, classroom furniture design plays an important role in upholding students’ interest towards studies and builds attentiveness in reading and writing. Based on a study, it was noticed students faced inadequate space and discomfort using the furniture. Initial investigation about general health helped in understanding the stresses imposed on students’ physic due to furniture used. From the anthropometric data of students’ body dimensions and the furniture dimensions collected from five schools in Mumbai, it was inferred that seat height and table height did not comply with Bureau of Indian Standards and addresses the issue of non-conformity between student dimensions and classroom furniture. It was suggested that there needs to be a separate furniture for both genders for age group between 10 and 14 years since the existing workstation did not suit the postural requirement of students [7].

Similar studies were conducted based on anthropometric measurements of student’s from 10 to 15 years of age with an age width of 1 year and it was found that furniture dimension should be different for various age groups. Such anthropometric investigations could integrate into a large database which may be referred for designing of school furniture and separate database for boys and girls is justifiable [8].

Anthropometric survey are obligatory to be conducted aiming to fit in a larger population into utility of a furniture. Alike school children, elderly people require ergonomic furniture in order to accommodate posture brought about due to ageing. An assessment based on t test was done to determine compatibility between body dimensions of elderly people and furniture used by them. Anthropometric measures were collected for a randomly selected sample of elderly people in old age homes to determine whether furniture were comfortable for use. The results attained revealed a mismatch between body dimensions and furniture like table, chair, beds, etc. Necessary design adjustments were recommended so that elderly people are not prone to any physiological stresses [9].

Furniture for computer related tasks must be ergonomically manufactured in order to avoid physical and psychological stresses. Typical problems occur while using Visual Display Terminals (VDTs) which range from muscle to eye problems. Poor sitting postures is a result of a poorly designed workplace and hence designing an appropriate ergonomic chair and table is needed to suit Indian population. Since the collected Anthropometric data confirms to Indian standards, the dimensions proposed can help designers to design work stations ergonomically [10].

A similar ergonomic approach was used to design students’ furniture in India. Anthropometric measurements considered during designing of furniture helps students in achieving comfortability levels, reduce musculoskeletal disorders and improve their motivation towards studies which otherwise may impose psychological and physiological stresses in students. The study involved collection of anthropometric measurements for usage in furniture design. Based on the data collected, percentile values were obtained and in addition, correlation of the measured variables were obtained to identify on how to create a suitable design. Based on the analysis, it was recommended to have an adjustable range for designing the chair [11].

The study on classroom furniture design has been increasing and there is a need of considering ergonomics in designing classroom furniture. Anthropometric measures of students and desk dimensions from three schools were collected and statistically analyzed using relevant software. The match criteria was determined using different combinational equations accepted by most researchers. Maximum and minimum acceptable limits of anthropometric measure corresponding to desk dimensions were computed. The mismatch analysis unveiled an alarming incompatibility between the anthropometric measures and classroom furniture. Ergonomic considerations in furniture design has to be decided properly since measurements differ from gender to gender and
from age to age [12].

While designing computer chair or any furniture, it is important to note that design of chair alone would not be the cause of MSD or other physiological problems. Problems can arise due to the way sequence of work posture are conducted. Assuming that adjustable furniture are developed, the focus needs to be looked on what type of sequence of work posture needs to be exercised. A recent study was conducted on understanding the effects of sequence of work posture on musculoskeletal discomfort and perceived physical, mental fatigue, typing speed and errors. The study involved comparing five different sequence of work posture sessions (Sit-stand, stand sit, standing, sitting, sit-stand and walk) by measuring the various response variable. Based on the statistical analysis, it was found that Sit-Stand-walk work posture sequence coupled with other conditions had a significant reduction on musculoskeletal discomfort and other variables measured [13].

2.3. Ergonomics in manufacturing sector

Ergonomics and anthropometric consideration are inculcated in all sectors of industry, being it a healthcare sector or a manufacturing sector. Thus, ergonomic evaluation of any worker or a workplace in mandatory for upholding the productivity of an industry. Also, the humans’ psychological behavior and the ability of his intellect depends on the type of work he does and the importance he gives to the way he performs that work.

Electronic industries accomplish most of their tasks on imported equipment’s which may not be compatible for Indian workers to use it due to anthropometric variations. An anthropometric survey was conducted in order to alter the work stations equipped with imported equipment’s in an electronic industry. Since south Indian workmen were smaller than the American and Japanese, their posture while performing tasks on imported equipment’s is potential in causing injuries and accidents. The study involved studying seated and standing height measurement which involved measuring 27 body measurements. Based on these measurements, it was concluded that industrial machineries need to be manufactured to fit a larger population across different countries to accommodate the anthropometric variations [14].

India largely depend on transportation for movement of resources throughout the country. From an ergonomic perspective, design of tractors is very influential since they are used for most of the operations including farming. A study was done on implementation of an ergonomic facility for improvement of tractor design and was accordingly implemented. Normal and maximum areas for control operations activated by upper and lower limbs were identified by developing a two-dimensional template. A layout measuring device was developed for layout and reach study. The new design was then simulated on the ergonomic rig by mounting all controls and displays as per optimum layout. The facility can also be used for comparing display and control layouts for different tractors [15].

A study was conducted in automotive sector at Chennai to assess the prevalence of heat related health risks in tasks performed in humid conditions. It was discovered that there was no control measures to prevent heat stress related hazards even in large scale industries. Thus, heat stress assessments were performed in indoor and outdoor locations of selected automotive manufacturing units. Wet bulb globe temperature (WBGT) indicating the heat stress was measured using a heat stress monitor and box plots were used to analyze the difference in temperature across various location and various workloads. The working ability was also found affected in workplaces having WBGT beyond the already high values recorded and the fraction of workers under the study who were prone to at risk was provided. Specific practices and changes were recommended by conducting qualitative assessments for existing work culture [16].

There are sectors wherein automation can be difficult and mostly skilled labor is required for manufacturing a product, this can be seen in craft sector. A detailed study has been conducted to understand the complication due to working conditions with focus on pottery, handloom and gotta patti manufacturing areas. Posture analysis, measurement of heart beat rate, perceived exertion rate were studied. Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA)
and ovaco work posture analysis were used for score assessment. It was seen that most of the activities violate principles of motion economy. Based on these analysis, it was found that ergonomic design intervention was required and work place design changes are to be developed [17].

Every person reacts spontaneously with his environment and desires a personal interior space to satisfy his emotional needs. There is a need to create an optimum interior space for a user to perform his tasks which must also confirm to standards established for his health and safety. Physical elements like color, texture etc. and environmental factors like light, sound, temperature greatly influences the balance to be brought about between the user’s choice and standards established to create a perfect interior space design. Culture also plays an important role and each entity plays a good role in deciding other factors. Thus, all the physical, physiological, environmental and psychological factors have an integral effect on human emotion [18].

Physical Ergonomics proves its necessity in automobile designing as drivers’ comfort is imperative. An ergonomic study was conducted based on truck driver from Nagpur to provide a comfortable seat for truck drivers. Truck drivers were seen to face muscle-skeletal injuries due to long driving hours. Thus, creating an ergonomic seat was obligatory to improve the efficiency of drivers to a larger extent. A survey conducted among truck drivers provided subsequent information to know the current travel time factor and seat discomfort. To design a comfortable seat for 6-wheeler truck, Lumbar support, Seat lengthening option, Ergonomic pan contour and to reduce the risk of musculoskeletal injury were the agenda of the study. Bar graph was plotted to identify the major pain areas of truck drivers. With the graphical analysis and other anthropometric body dimensions, suitable assumptions were considered and the factors that are essential to design a seat such as seat height, neck height and so on were identified. The design was conceptually modeled using CAD packages and FEM conducted the comfort level test. This investigation could accommodate most of the driver’s population [19].

In some areas of India, manufacturing of certain product such as footwear is not based on a typical industry set up, but based on home setup, one such footwear is Kholapuri footwear. Since there is lot of more human task, a very minimal automation areas of improvement can be identified. The study focused on creating a suitable design for the chair by considering adjustable range as a criteria and simulating a scenario to obtain values of RULA by considering anthropometric static data dimensions as the major input variable. Further investigation on stability of the chair was achieved by conducting finite element modeling [20].

It is seen that there is a process of integrating various techniques from other branches of engineering, however still it is in its beginning stage. Design of experiments have been useful in the field of engineering especially when it comes to identification of factors playing a role in affecting the output variable. It has rarely been applied in the field of ergonomics. A recent study has focused on applying this technique for Taguchi L9 orthogonal design to understand the factors which affect posture variables (neck, arm and trunk angles), perception of operators for comfort levels of posture, workplace and time for endurance. A 3³ design with factors such as sewing distance, desk inclination and desk height was considered for conduction of experiment. Based on the analysis it was found that all three factors were significant for trunk angle and neck angle and desk height was significant for arm angle. It was also found all the three factors played a significant role in affecting perception of operators for comfort levels of posture except for one of the variables arm region wherein sewing distance did not have an effect. The three factors played a significant role in affecting workplace arrangement and desk height played a significant role in affecting endurance time [21].

### 2.4. Ergonomics in Healthcare

Ergonomic and anthropometric data has been of great help in studying the health status and nutritional level in individuals. Applications of ergonomics into healthcare sector has proven to be most important in recent years. Workers’ capabilities and limitations have to be given importance
in designing medical equipments in order to reduce errors and other performance issues due to stress or fatigue. Certain standards are available to check the health of a person by his anthropometric dimensions. However, even the surroundings in which the individual lived in and brought up plays a major role yet.

Anthropometric data has proven its importance in identifying the stature of an individual in medico-legal and forensic examinations. Stature has proportional biological relationship with every human body part which eases the tasks of forensic scientists to calculate the stature from dismembered and mutilated body parts in forensic examinations. Regression analysis has provided best estimation results so far and hence worldwide useful. An attempt has been made to identify the relationship between stature and various cephalo-facial measurements for assisting forensic examinations. A statistical study for a large sample of a particular community (Gujjar) was performed. Regression modelling was conducted and five different regression models were built based on five cephalo-facial measurements with stature being the response variable. Based on the study it was found that stature was strongly related to most of the variables except facial variable (length and diameter) [22].

Drawing attention towards healthcare personnel, it is of paramount importance to note that that the healthcare staff are work oriented throughout the day and they are vulnerable to a variety of discomfort and ailments. A detailed study was carried out in hospitals at West Bengal on two different types of health care workers, nurses and the helpers. The overall objective of the study was to understand about the physiological and psychological workload for these workers. The responses recorder were time spent by workers in various tasks, heart rate during various shifts and perceived exertion rate using Borg’s scale. In order to do so, simple statistical tools and techniques were used which include pie chart, bar chart, line graph and hypothesis testing using t statistics. Pie charts were used in classifying the various tasks and based on these tasks bar charts were used for comparing the time spent on each of the tasks at various shifts. Line graph were used to compare the percentage of time spent during work and rest at various duration. T test was used to compare significant difference in heart rate, perceived exertion rate and time spent across various shifts. The perceived workload was due to the shift system adopted. It was found that there was a significant difference in physical workload, perceived exertion rate especially during morning than night time [23].

An investigation was conducted to study the correlation between hand length and stature in Eastern Indian population. The team had collected anthropometric measurements of both hands of both genders and found that hand length measurement showed linear correlation with the height. The regression model based on height as a response variable can be beneficial for nutritionists and doctors who prefer to conduct study on nutritional analysis [24].

Due to development in healthcare systems, surgeries are being performed with less pain through laparoscopic surgery. Though it indicates advancement in technology, poor adaption towards use of these equipment’s may lead to body discomfort in surgeons and other medical personnel. Ergonomically designed products have always evidenced low risk of developing musculoskeletal disorders an also assures productivity [25].

Quality of anthropometric data is crucial in inferring conclusions from a sample studied. Height is always a good indicator of nutrition status of an individual. A study has been done to analyze the anthropometric data in terms of quality and determining the health status of children using data collected in three rounds of NHFS. Feeding practices, food availability, financial status, genetic factors, disposal of wastes, all have an impact on developing good height in children. Anthropometric measures of children are to be accurately collected by skilled professionals which may be practically impossible due to societal causes (refusal by parents) which may lead to missing data. Co-efficient of variation was computed which showed that data was reliable for analysis. Agro-climatic conditions also matter in determining food diversity and the resulting nutrition levels in individuals. However, level of poverty did not have any indication of height development in children according to the study. Growth curves of Indian children did not confirm to WHO
standards which may be due to economic conditions of the region. The trend in height from different agro-climatic regions revealed that increase in adult height implied an increase in children height over time. Regression analysis was used to model height of the children as response variables considering all the above said factors. It was also discovered that apart from age, mother’s height was also crucial in determining height of children [26].

A study was conducted with focus on back and neck pain with sample size obtained based on 5% accuracy level and 95% confidence level. The statistical analysis was carried out. Based on odds ratio and risk ratios, it was found that back pain was statistically significant for people below 50 years, less than 15 years of experience, long work hours and females. There was larger risk ratio of back pain associated with doctor working for various specialized branches such as cataract, general ophthalmology, cornea surgery, glaucoma and medical retina [27].

The usefulness of ergonomics has not substantially reached in the field of ophthalmology and has not been in sound practice by ophthalmologists. Ophthalmologists use variety of instruments for diagnosis and surgery purpose and lack of knowledge or improper usage without applying ergonomic principles can lead to posture related problems. This can be added further due to repeated task and activities at a clinical setup. A survey based study was conducted across ophthalmologists in India on reporting of musculoskeletal disorders (MSD). The survey focused on obtaining information on the usage of ergonomic practices in the clinic and operation theatre. It was found that a large percentage of ophthalmologists reported musculoskeletal disorders with lower back pain reported as the major problem. In addition, around 28% of the participants had attended ergonomic related talks with only few percent availing services of an ergonomist. Statistical analysis was conducted to identify significant factor. Using the contingency table, odds ratio was found and it was seen that odds ratio for MSD was larger for less than 10 years of work experience and for those who did not follow ergonomic practice [28].

3. Results

From the literature survey conducted, the results are summarized in Table 2 below.

| Application | Anthropometry measurements and other factors considered | Outcome | Reference |
|-------------|-------------------------------------------------------|---------|-----------|
| Agriculture | Variables based on figure 1,2 additional variables based on recommended standards | Statistics was obtained and percentile values were created | 3 |
| | Variables based on figure 1,2 additional variables based on recommended standards | Statistics was obtained and significant difference was found between east Indian population and other ethnic groups | 4 |
| | Heart rate of respondents, age | Correlation between age and rate was found to be significant | 5 |
| Furniture                     | MSD, Handedness, gender, age, lifestyle, education level, work experience, frequency of work, income level satisfaction, perceived work fatigue, hand tool satisfaction, body mass index (BMI) | Various body measurements based on figure 1 and 2 | Recommendation for design of furniture for different age groups |
|------------------------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------|------------------------------------------------|
|                               | Age, gender, posture, duration of work, work experience, education level, hand tool satisfaction, BMI, perceived work fatigue have effect on MSD | Various body measurements based on figure 1 and 2 | Mismatch of design and Measurement data. Recommendation for design change to suit elder people |
|                               | Height, weight, shoulder height, foot breadth, foot length | Various body measurements based on figure 1 and 2 | Recommendation for design of VDT percentiles were created correlation data was obtained to create a suitable design, adjustable range for designing the chair was recommended |
|                               | Various body measurements based on figure 1 and 2 | Musculoskeletal discomfort perceived physical, mental fatigue, typing speed and errors | Mismatch between anthropometric measures and classroom furniture Alumni of the Journey to MSD |
|                               | Various body measurements based on figure 1 and 2 and other variables based on standards | Manufacturing | Various body measurements based on figure 1 and 2 and other variables based on standards | Recommendation of machinery design based on Indian anthropometry percentiles |
| Manufacturing                 | Out of reach requirements | Optimal design of tractors were created | Optimal design of tractors were created |
|                               | Work location, work load, heat stress | Work load and Work location have effect of heat stress | Work load and Work location have effect of heat stress |
|                               | Posture analysis, heart beat rate, perceived exertion rate | Ergonomic design intervention is needed | Ergonomic design intervention is needed |
|                               | Various body measurements based on figure 1 and 2 | Seat changes were based on percentile values | Seat changes were based on percentile values |
| Anthropometric static data dimensions | Chair design based on adjustable range and Fem analysis |
|--------------------------------------|---------------------------------------------------------|
| Posture variables (neck, arm and trunk angles), perception of operators for comfort levels of posture, workplace and time for endurance, sewing distance, desk inclination and desk height | sewing distance, desk inclination and desk height have effect on posture variables, workplace and time of endurance |
| **Healthcare** | |
| Stature, cephalo-facial variables | Stature was related to most of cephalo-facial variables except facial length and diameter |
| Heart rate, perceived exertion rate and time spent across various shifts | Significant difference in workload at various shifts |
| Stature, right hand length, Left Hand Length | Correlation between Height and hand length |
| Anthropometric data based on standard guidelines, weight, feeding practice, agro-climatic conditions, percentage of poor | Increase in child height over time across various agro climatic regions, mother’s height plays a crucial role in determining children height |
| Age, Work experience, Gender, Height, Weight, Work preference, type work, Specialty, MSD | Correlation between back pain and age below 50 years, work experience, long work hours, females and high risk factor of back associated with specialty |
| Age, Work experience, Gender, Height, Specialty, ergonomic practices, sitting hours, ergonomic chair, operating time, time of computer usage, MSD | Correlation between work experience and MSD |

### 4. Conclusion

The essence of ergonomics has spread across many areas or applications to make work or task comfortable rather than easier. Anthropometric studies assist an ergonomic way of handling things, being it a small pen or a large equipment. As analyzed from the addressed literatures, it is happy to see that people have communicated the ill effects of having non ergonomic systems and have considered anthropometric dimensions to resolve these issues. However, not all areas have seen development in terms of ergonomics and anthropometry.

In India, being one of the largest agricultural country, agriculture is adopted as a major source of income to around 80% population in rural India. Though application of ergonomics has reached many facets, only lame studies are done in applying ergonomics in agricultural sector. This may be
due to poor knowledge, access to adopt technology or due to some societal beliefs. Also, there is no measure for productivity in agriculture which may also be an indicator of how well tasks are performed. Thus, comparison study needs to be accomplished to show the level of improvement before and after ergonomic intervention.

Discomfort in accomplishing tasks has always called ergonomics into the front. Likewise, furniture designing has also appraised the use of ergonomic and anthropometric data. Though many literatures have identified the use of anthropometric data, proper analysis and conclusions could not be informed since work-measurement related studies are not performed. Work study techniques like time study and method study provide us with enormous knowledge to deal with work designing systems. In addition, various realistic constraints needs to be considered for example, if a person designs a chair or furniture only according to anthropometric rule but does not consider the duration for which a student has to sit in a class, then the purpose of designing may not be as effective. Hence, constraints based design should evolve in the field of ergonomics. Therefore, there is a need to integrate the theory of optimization with ergonomics. In addition, subjects related to finite element modeling can be added to analyze the sustainability of a furniture design.

Moving towards manufacturing sector, the same trend as in furniture can be observed. Productivity is always considered as a major indicator of progress of a manufacturing sector and also performance of each resource used by the firm can also be assessed. As observed from the addressed papers, it is also seen that only simple statistical measures and calculations are adopted. Whereas, the problems can be solved using operational research techniques which provides home in considering many conditions and constraints. Also, other multivariate techniques like factor analysis, cluster analysis, etc. have not been used which could make analysis easier and much more accurate conclusions could be attained. In addition, only minimal literature has addressed integrating the usage of seven quality control tools with ergonomics. For example, the usage of quality control tools such as fish bone diagram, pareto analysis, design of experiments have not been coupled fully with ergonomic design. In case this gets coupled, the scope of ergonomics would become widespread to various disciplines.

Due to drastic growth in Indian population, it is important to run healthcare systems efficiently to maintain good health among the citizens. Thus, the hospital personnel must be able to perform tasks easily and dedicatedly which may be accomplished by ergonomic work systems. Only few categories of healthcare staff have been considered for study as observed in above literatures. Surgeons who perform critical tasks must also be evaluated against use of ergonomic equipment’s and methods. From this literature, it has been found that categorization has started to develop in few areas which can later develop to a large-scale application once percentiles on various anthropometry measurements develop. In addition the awareness and benefits of ergonomic design needs to be created among health care people though media, courses and various other modes. By doing so there could be tremendous potential for such a field to gain prominence.

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