Chapter-5

Summary and Conclusions

Introduction

Ergonomics is concerned with the design of systems in which people carry out work. Its name comes from the Greek words *ergon* which means "work" and *nomos* which means "law". All work systems consist of a human component and a machine component embedded in a local environment (Plate 36).

It can readily be seen that even in a simple work system consisting of one human and one machine in an environment, six directional interactions are possible (H>M, H>E, M>H, M>E, E>H, E>M) and four of these involve the human component. When designing any system where humans and machines work together to produce something, we need to know about the characteristics of the people involved and be able to apply this knowledge to the design. This activity is the fundamental function of ergonomics.

**Ergonomics aims to ensure that human needs for safe and efficient working are met in the design of the work systems.**

The ability of people to do their jobs is influenced by both physical design and job content. A major goal of the present text is to describe both the physical and psychological aspects of system design which influence human performance and some of the ways knowledge of human characteristics can be used to optimize the design of systems. (Bridger 1995)

![Simple ergosystems](image-url)
Plate 36 Examples of ergo systems. (A) and (B) are simple work systems. A represents a human alone in an environment, in (B), one machine is added. (C) and (D) are complex work systems. In (C) one human interacts with several machines; in (D) several humans use one machine = local environment, M = machine component = human component (Bridger and Jeros, 1986)

The ergonomist are concerned with nature of work and the physiological processes involved in carrying out the work it is also concerned with energy costs of work, energy demands of different types of work and the effect of environment on the work. The environmental conditions, such as, heat, light, noise, temperature, humidity and air velocity etc. have a decided effort on work output. It also affects the energy costs of work, the nature of fatigue experienced by worker. The aim is to minimize fatigue by appropriate designs of machines, tools, equipment, facilities, techniques and procedures as well as provide conducive environment for work.

The physical environment in which a person works consists of two aspects:
1. Physical space and related facilities, which people use and
2. Various aspects of ambient environment such as illumination, atmospheric conditions and noise.

The nature of man’s environment imposes certain constraints on his behaviour such as restricted movement and field of view. It may also predetermine his behaviour such as stooping to pick up something or moving around the corridors of offices or looking for the edge of road while driving.

Apart from physical environment certain personal and protective items also are part of worker’s work environment such as personal apparel and handbags or protective equipment and accessories such as safety shoes, hats, helmets, glasses, gloves etc.
These are a variety of manual material handling (MMH) activities that increase a worker’s risk of developing a musculoskeletal injury,(MSI) including jobs that involve a significant amount of manual lifting, pushing pulling or carrying and jobs requiring awkward postures, prolonged sitting or exposure to cyclic loading (whole body or vibration). There are a variety of personal and environmental factors that may increase a worker's risk of developing MSI.

A large proportion of the accidents, which occur in industry, involve the manual handling of goods. The problems occur worldwide. According to a recent consultative document by the British Health and Safety Commission, more than 25 percentages of accidents involve handling goods in one way or the other (Health and Safety Commission, 1991). It was estimated that about 30 percentages of the physical hazards in America are associated with manual material handling. Frequent bending and/ or unaided lifting, hand/ wrist manipulations, arm movement, noise and vibrations leads to physical hazards and lifting services/ activities are one of the most frequently identified ergonomic exposure hazards.

**Justification of the study**

Ergonomic research is performed by those who study human capabilities in relationship to their work demands. Information derived from these studies contributes to the design and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of people. Present research would be helpful to the professionals, Interior Designers, Home Scientists, Architects, Family Resources Management Students, Ergonomist, and Physiotherapist for planning workspace of any commercial area as well as to plan out outreach programs, intervention programs to enhance awareness of common mass regarding work and work environment and humanizing the work.

It would also be helpful to the entrepreneurs who want to start his/her own business. The findings would be helpful to the workers of the food unit in performing activity without any obstruction and hazards. Learners and teachers would be benefited by knowing the finding and would be encouraged to plan extension activity to improve working postures. With work efficiency increase, more profit with good health at work will result.
So there is a need to identify occupational health hazards faced by the food unit workers that have direct effect on their physical and psychological cost of their work and to evaluate the work/worker/and working environment for developing guidelines for safe work surface for reducing occupational health hazards. With this background the present study was conducted to find out occupational health hazards of the unorganised food unit workers. The main purpose of the study was to ergonomically assess the activities carried out in unorganised food units.

**Objectives**

**General Objective:** To assess ergonomically the selected activities carried out in food units and suggest ways to improve health and safety.

**Specific Objectives:**

1. To study the different activities carried out by workers in selected food units.
2. To assess the work environment of the workers.
3. To study the postures adopted by the workers in selected food units.
4. To assess the feelings of fatigue (using Body Map) experienced by the workers in selected activities.
5. To study the effect of age, height, weight and work experience of the workers and the feeling of fatigue in performing selected activities.
6. To suggest remedies to increase safety at work place.

**Limitations of the study**

1. The guidelines developed would be applicable to the workers working in unorganized food units

**Delimitations of the study**

1) The study was limited to the Anand and kheda district.
2) The study was limited to the workers engaged in unorganized food units.
3) The study was limited to the food units which were not registered.
4) The study was limited to 120 farsan workers, 60 bakery and sweet workers for the general survey.
5) The study was limited to 30 workers each from farsan, bakery and sweet unit for experimental study.
Hypotheses of the study:

HO₁: There is no significant effect of age of the respondents on feeling of fatigue while carrying out the work.

HO₂: There is no significant effect of BMI of the respondents on feeling of fatigue while carrying out the work.

HO₃: There is no significant effect of work experience of the respondents on feeling of fatigue while carrying out the work.

Methodology

The study "An ergonomic assessment of the selected activities carried out in unorganised food units" adopts the following section:

Research Design

In order to achieve the objectives of the study both the descriptive and experimental design was planned to find out the nature of work carried out by the unorganised food unit workers. The experimental study was designed to analyse the posture adopted by the workers while carrying out the work through ergo master software.

Development of the tool:

1. Observation sheet for preliminary information- Observation technique was used to collect the information of the subjects regarding working pattern, postures adopted and work environment.

2. Interview schedule for general survey- The close end questionnaire was formulated. It was divided into different parts:

   Part-A- Personal Detail: Name, age, gender, education, height, weight, working hours etc.

   Part-B - General Health -this part included information regarding the status of health of respondents. It covered the details about the habits, feeling of fatigue through body map and universal pain assessment tool. Low back pain, neck and/or shoulder pain.
Part-C- Work Environment Assessment- it includes ambient temperature, noise level, illumination level, types of safety apparel worn, housekeeping of food unit etc.

3. Signs and symptoms interview schedule for experimental study-
   
   Section -A-Personal Detail: Age, gender, height, weight, working hours etc.
   
   Section -B - General Health - It covered the feeling of fatigue, severity of pain, area of pain through body map and universal pain assessment tool
   
   Section-C- Work Environment Assessment- it included ambient temperature, noise level, illumination level, types of safety apparel worn, housekeeping of food unit etc.

4. Videography for experimental study- Videography was used for collecting technical data and collecting data pertaining to the posture adopted by the workers while working.

Selection of sample

1. Selection of universe

   The unorganized food units selected were of Anand, Nadiad, Dakor and Vanakbori. The sample selected was workers of unorganized food units.

2. Locale of the study.

   The survey was conducted on workers of the food units i.e. farsan, sweet and Bakeries.

3. Sampling Procedure:

   Snowball Sampling method:

   Snowball sampling method was used in the present study.

   Selection of food units:

   For this study the workers selected were from an unorganized food units producing farsan (sev, chavanu, tam tam, fafda, gathia, samosa, batatavada, papdietc), Bakery(cakes, khari, pastry, buns, sweet khari, puff, pizza rotla) and sweets (jalebi, kajukatri, ladu, peda, halwasan etc.)
Selection of activity:
In unorganized food units numbers of activities were carried out. The preparation of various types of snacks, sweets, bakery items and relevant food items carried out in food units were selected for the study.

Sample size:
All the workers those who were working in selected food units were included as sample for general survey (n = 240 workers) from farsan units -120 workers, bakery units-60 workers and sweets units -60 workers and for experimental work 90 workers were selected from Farsan units - 30, Bakery units -30 and sweets units -30 each.

Analysis of data
The data was coded according to code numbers assigned. It was further analysed employing descriptive as well as relational statistics. frequency, percentage, mean, standard deviations, coefficient of correlation, one way ANOVA test was used for analysis of data and testing of hypothesis.

Major Findings
Major findings of the present study are presented here.

Activities carried out in unorganized food Units
Farsan Unit:
- Fafda – dough making, dough flattening, cutting and frying
- Papdi-dough making, frying
- Palaksev- dough making, frying
- Tam tam- dough making, frying
- Gathia- dough making, frying
- Batatavada-frying
- Samosa-making balls, rolling, filling and frying.
- Masala Dal-frying, mixing.
- Sing bhujia-batter making and frying
- Dal vada-frying
Bakery Unit:

- **Khari**- dough making, rolling, cutting, greasing, tray stacking and baking.
- **Sweet layered biscuit**- dough making, cutting, rolling, tray stacking and baking.
- **Puff**- dough making, rolling, cutting, stuff filling, greasing, tray stacking and baking.
- **Cake**- cream making, applying cream.
- **Bread** – dough making, weighing and portioning, beating dough, greasing and tray stacking and baking.
- **Bun**- dough making, rolling, tray stacking and baking.

Sweets Unit:

- **Barfi** (pistabarfi and malaibarfi)- preparation of barfi mixture from mava, tray filling, cutting.
- **Jalebi**- dough making, making sugar syrup, pouring in mould / cloth, frying, dipping in sugar syrup.
- **Gulabjamun**- dough making, making sugar syrup, rolling, frying, and dipping in sugar syrup.
- **Bundiladdu**- batter making, making sugar syrup, frying with mould, dipping in sugar syrup and rolling ladoo.
- **Motichurladdu**- batter making, making sugar syrup, frying with mould, dipping in sugar syrup and rolling ladoo.
- **Milk cake**- preparation of barfi mixture from mava, tray filling and cutting.

❖ General survey of the respondents

**Background information of the respondents.**

- Majority (85.8 percentages) of the respondents were male; 66.66 percentages of respondents had education up to secondary, 95 percentages of the respondents were workers at shop, 77.5 percentage of them had 1-10 years of experience, almost half of the respondents worked for 8-11 hours and 82.91 percentages of them were right handed workers.
In the present study majority (76.7% and 66.7%) of the respondents from bakery and sweet shops were young whereas in farsan shop the respondents had less difference between young and middle age. Regardless of the food unit it was observed that percentage of the old respondents was less.

Majority of the respondents had normal weight whereas 17.5 percent were underweight, 15.4 percent respondents were overweight and only 4.58 percent respondents were obese.

It has been observed in many occupational situations that workers take enough rest as and when they feel tired or fatigued, which are not usually included in the normal work schedule, and are not scientifically organized.

It was found that regardless of the type of unit the investigator's observation was that almost all the workers used to take 5-15 minutes break unofficially at the end of every two hours or when the work cycle completes.

Regardless of the type of activity, meal pattern observed was also uniform among all the workers. They used to bring meal from home and had nashta and tea during work breaks.

It was found that workers working at sweets unit spent more time in comparison to the workers working at bakery and farsan unit. All the workers in sweets unit worked overtime regularly.

From the attendance register the investigator came to know that regardless of type of unit majority (66.7 percent) of the workers had cent percent attendance whereas remaining 33.33 percent had low attendance in a month. None of them were engaged in other paid or unpaid job.

It was found that majority of workers walk down to the workplace or used hired auto vehicle.

General health status of the respondents.

Health status of the worker as perceived by the respondents. Nearly three fourth of the respondents had good health whereas 22 percent had fair health and only 4 percent respondents had poor health.

It was found that chewing pan masala and chewing tobacco were the prevailing bad habits among the selected workers which may affect their overall health status in long run.
It was revealed from that respondents frequently experienced fatigue, back pain, and headache after work; whereas one third of them rarely experienced pain in joints.

It was observed that majority of bakery workers experienced fatigue frequently, headache sometimes and back pain rarely whereas disturbed vision, lack of concentration, leg pain and joint pain were not experienced by majority of them.

It was revealed from the study that among the workers from the sweets unit fatigue was experienced frequently by 60 percent, 63 percent experienced headache sometime and 73 percent experienced back pain rarely. Disturbed vision, lack of concentration, skin problem, leg and joint pain were never experienced by majority of the respondents.

It could be concluded from the study that more than half of the respondents (56.25 %) suffered from upper back pain were the severity of the pain ranged from mild to severe.

The study revealed that maximum percentages (46.25) of the respondents had mild pain, nearly 31.63 percent of the respondents suffered from moderate pain which interferes the task and the concentration. Severe and worst pain did not persist in any of the respondents and only 0.4 percent had no pain.

**Low back pain occurrence among the respondents.**

- It could be concluded that the major cause for low back pain among the respondents was due to lifting heavy load, sudden movement and bad posture during work.
- The association of low back pain with work was present among majority (87.08 percent) of the respondents.
- It could be concluded that the majority of the respondents had little problem while moving heavy loads.
- Majority (58.33%) percent of respondent’s pain did not radiate into the arm while sneezing and coughing.
- The medical treatment of low back pain among the respondents show that majority (93.91 %) percent of respondents had not treated low back pain medically, as they did not take it seriously.
It was observed that occurrence of lower back pain among the workers was felt less frequently may be because the workers got used to the work and the pain associated with the work and thus they were not conscious of the occurrence of the pain.

It was revealed that workers change the type of work every day and because of that the lower back pain does not last for more than one day or maximum for seven days among majority of the respondents. From the selected food units the respondents who worked in sweets and bakery units were not entirely cured from the condition of low back pain as compared to the respondents who worked in farsan unit.

It could be concluded that nearly more than half of the respondents did not remain absent from work.

From the selected food units back pain was present among the farsan workers compared to bakery and sweet workers.

Majority (79.58 %) of the respondents did not make any adjustment in work due to low back pain and continued to work.

From the study it could be concluded that there was no association of low back pain with leisure time activities among the respondents

Majority (50.83 %) respondents’ sleep was hindered due to low back pain.

It was observed that majority (86.25%) respondents felt stiff in the morning due to low back pain.

**Neck and shoulder pain occurrence among the respondents.**

- Cause for low back pain among the respondents was due to lifting heavy load and sudden movement.
- Majority (69.58%) of the respondents felt that there was association of neck and shoulder pain with work.
- From the study it could be concluded from the study that majority (89.16 %) of the respondents felt that there was no association of neck and shoulder pain with leisure time activities.
- Majority (67.08%) of the respondents suffered once from spell of neck and shoulder pain.
• It could be concluded from the study that majority (75.83 %) of the respondents had not taken sick leave in past 12 months.
• Majority (61.25) of the respondents had suffered for less than one day from neck and shoulder pain.
• From the selected food units the respondents who worked in Farsan units got cured completely as compared to sweets and bakery units.
• It could be concluded from the study that majority (59.58 %) respondents sleep do not hindered due to neck and shoulder pain.
• Majority (90%) of the respondents from bakery and sweets unit experience neck and shoulder pain on holidays as compared to respondents from farsan unit.
• It could be concluded that majority (90%) of the respondents from bakery units experience the stiffness in the morning as compared to the respondents from farsan and sweets units.
• It could be concluded from the table that majority (59%) percentage of respondent’s pain did not radiate into the arm while sneezing and coughing.
• It could be concluded that the large percent of respondents had not treated the low back pain as they did not take it seriously.
• It could be concluded from the study that maximum number of respondents had no trouble caused by neck and shoulder pain whereas 28.33 percent respondents had little trouble while moving heavy loads (more than 20 kg).

Work environment assessment.

• From the selected food units mean body temperature of the workers was 38°C.
• From the selected food units mean ambient temperature of the workplace was more compare to “The Gujarat Factories Rules, 1963” in farsan unit (42.48°C), 37.15 °C in sweets unit whereas in bakeries it was 36.8°C.
• From the selected food units mean illumination level was more 218 lux in sweets unit, whereas 175.8 lux in farsan unit that is appropriate and in bakeries very bright illumination 603.3 lux, was observed.
• Noise level in the food units was under the limit of 90 dB.
• Safety devices were not supplied and therefore nobody was using safety devices at workplace.
• Majority (95%) of the bakeries units had first aid facility.

❖ Experimental survey

Background information and general health status of the respondents

• It was observed that majority (90%) of the respondents worked in rotating shift whereas only 10 percentages of the respondents did not work in rotating shift.

• It could be concluded 47.7 percentage of the respondents were working for 71-80 hours per week whereas half (51.11%) of the respondents worked for 60-70 hours and in both the cases, it was revealed that all the respondents worked for more than prescribed number of hours.

• It can be concluded that regardless of the units nearly half (46.66 percentages) of the respondents worked for 6-10 hours overtime in a month. This may affect the worker adversely health wise if worker adopts wrong posture at work.

• It could be concluded that majority of workers walk down to the workplace or used bicycle.

• Majority of the respondents (70%) suffered from wrist pain and the severity of the pain ranged from mild to moderate. Two third of the respondents suffered from lower back pain and severity of pain varied between mild to moderate, 60 percentage of the respondents suffered from shoulder pain and the severity ranged from very mild to moderate and 30 percent of the respondents suffered from mild neck pain. 26.66 percent and 23.33 percentage of the respondents suffered from very mild and moderate knee pain and elbow pain.

• It can be concluded that majority of the respondents suffered from elbow, lower back, knees, and shoulder and wrist pain. This may because most of the activities in bakeries were done by leaning forward while rolling puff, khari, dough beating and baking also required squatting and leaning forward in bhattis.

• It could be concluded that majority of the respondents suffered from mild to moderate pain in wrist, lower back, shoulders, neck and elbows pain whereas nobody suffered from severe pain.
- It could be concluded that regardless of the type of food units major areas of pain experienced by the respondents were low back, shoulders, hand/wrist, Elbow/forearm and thigh/knees.
- It could be concluded from the table that majority of the respondents suffered from mild pain in farsan units, bakeries and in sweets units.
- Majority (23%) of the respondents from bakery unit experienced problem in last seven days whereas only 13.3 percentages of the respondents experienced problem from farsan and sweets unit. Very few of the respondents had medical treatment for this problem. Cent percent respondents from Bakery unit experienced pain during the last year whereas 90 percentages of the respondents from farsan and sweets unit experienced pain during the last year.

**Posture assessment of the selected respondents using ergo master software.**

Using ergo master software posture assessment was carried out and it was observed that in Farsan units nearly half of the respondent were in the score category of 5 and 6 which means investigate further and changes are required soon changes were required to overcome the problems associated with working conditions, 33.33 percentages of the respondents scores 3 or 4 that is investigate further whereas 20 percentages of the respondents score 7 that is investigate and changes are required immediately.

In bakeries majority of the respondents were in the score categories of 5 and 6 which means investigate further and changes are required soon, 23.3 percentage score 7 indicates that investigation and changes are require immediately.

In Sweets unit more than half of the respondent were in the score category of 5 and 6 which means investigate further and changes are required soon, 36.6 percentages of the respondents’ scores 3 or 4 that is investigate further.

- **Case study of the selected respondents.**

All the activities carried out in food units are physically demanding due to poor design of workplace workers have to adopt awkward posture and wrong habits of workers while sitting, standing and working suffer from most prevalent health hazards like low back pain, upper back pain and shoulder pain.
Therefore the detail study of the individual workers was carried out with few workers who cooperated with the investigator to carry out the research work in detail in which some changes were done with the height of the stool, table and size of the equipment which helps to reduce the awkwardness of posture adopted while working.

❖ Testing of Hypotheses

- From the correlation test in Farsan units it was found that age and experience were highly correlated, age and BMI had significant correlation; whereas age and feeling of fatigue showed negative correlation which was highly significant.
- From the correlation test in Bakery units it was found that the age of the workers and experience of the workers had positive correlation. There was negative correlation between age and fatigue which was highly significant.
- From the correlation test in Sweet units it was found that age and BMI of the respondents and age and fatigue as well as age and experience and fatigue had significant correlation.
- F- Test carried out between the workers age and fatigue experienced. It could be concluded that there is highly significant relationship between fatigue and age of the selected farsan and bakery workers whereas insignificant relationship was found in sweets unit workers.
- F- test carried out between the workers BMI and fatigue experienced. It could be concluded that there is no relationship between fatigue and BMI of the selected workers working in the unorganized food units.
- F- test carried out between the workers BMI and fatigue experienced. It could be concluded that there is significant relationship between fatigue and work experience of the selected workers working in the unorganized food units.

Conclusions of the study

1) It could be concluded that different types of activities were carried out in these unorganized food units which are as follows:
   In Farsan unit activities like dough making, dough flattening, cutting and frying were carried out.
   In Bakeries activities like dough making, rolling, cutting, stuff filling, greasing, tray stacking, cream making, applying cream and baking were carried out.
   In Sweets unit activities like preparation of barfi mixture from mava, tray
filling, cutting. Dough making, making sugar syrup, pouring in mould / cloth, frying, dipping in sugar syrup and batter making were carried out.

2) Body temperature of the workers were 38°C, mean ambient temperature was more than 30°C in farsan unit, mean illumination level was more (218 lux) in all units, Noise level in the food units was under the limit of 90 dB.

3) Using ergo master software posture assessment was carried out and it was observed that in Farsan units nearly half of the respondent were in the score category of 5 and 6 which means investigate further and changes are required soon changes were required to overcome the problems associated with working conditions, in bakeries majority (93.3%) of the respondents were in the score categories of 5 and 6 which means investigate further and changes are required soon whereas in Sweets unit more than half of the respondent were in the score category of 5 and 6 which means investigate further and changes are required soon.

4) Feelings of fatigue (using Borg scale) experienced by the workers in selected activities.

For General survey:
More than half of the respondents (56.25 %) suffered from upper back pain were the severity of the pain ranged from mild to severe.

For Experimental survey:

More than half (62.68%) of the respondents suffer from lower back pain, 61 percentages of the respondents had shoulder pain whereas nearly half of the respondents had wrist pain.

5) From the correlation test among bakery workers it was observed that as the age of the worker increases experience also increases but feeling of fatigue does not increase with the age of the worker.
From the correlation test among Sweet unit workers it revealed that as the age increase BMI of the respondents also get affected, age and fatigue as well as age and work experience had correlation.
From the correlation test among as the age increases, the experience increases and with increasing age and experience, the workers got used to the work and did not feel tired. Even BMI of the workers was increasing with increasing age
From one-way ANOVA test it was observed that there is highly significant relationship between fatigue and age farsan and bakery unit workers whereas in sweets unit there is no relationship between fatigue and age of the selected workers.

From one-way ANOVA test it was observed that in farsan, bakery and sweets unit there is no relationship between fatigue and BMI of the selected workers.

From one-way ANOVA test it was observed that in farsan, bakery and sweets unit there is significant relationship between fatigue and work experience of the selected workers.

**Recommendations for further study**

The identified thrust areas are:

1) A similar study can be carried out on workers of organized food units
2) Considering several other variables/ factors a similar study can be conducted on the same population as well as other population and area.
3) A detailed study can be conducted on the same population by adopting any one specific activity.