COMPARATIVE STUDY OF CHEFS AND NON-CHEFS USING COGNITIVE ERGONOMICS APPROACH IN THE COMMERCIAL KITCHENS

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Abstract
A commercial kitchen is a space where various activities occur simultaneously. Many studies have been done on commercial kitchens but this pilot study focuses on the comparative analysis between the Chefs and non-chefs (people not working in the kitchen) in terms of work load.For this study, college mess was considered and aquestionnaire was conducted with 5 chefs and 5 non chefs covering five different aspects viz. Thermal comfort, physical, cognitive, Usability and general questions in one place. Further gathering insights, performing Mann-Whitney U test and analyzing the relevant data, discrepanciesin categories between chefs and non-chefs was assessed.

Keywords: Thermal comfort, Physical, Cognitive, SystemUsability, Workload analysis

1. Introduction

Commercial kitchen is a kitchen that is primarily used to prepare meals for visitors in a house, restaurant, hotel, bar, or other establishment.Commercial kitchens are intended tofood which will be made and consumed by others, instead the person or people who are producing it.

Commercial kitchens are made to handle a lot of orders at once. In such kitchens, there is constant use of powerful machinery with high food output. Multiple things needs to be managed at the same point of time, especially during peak hours, including quality and quantity of food, time, usage of right equipment- canmake things easier and complicated at the same time. Few tasks are carried out manually (For example, cutting vegetables for salad,soft items like Indian cottage cheese) and others are mechanized (For example, Chapatti making).

Figure 1- Chefs involved in preparing meals in the Kitchen of College Mess

Moses et al., (2019) describes the protocol that was developed for testing the usability of cook stoves. This protocol is useful for stove designers because it allows them to better understand users and validate design. It includes ethnographic testing, objective measurements and observations, subjective surveys, and questions from semi-structured interviews. Usability criteria are evaluated using Likert scale survey questions. The improved cook stoves, which are intended to reduce risks to humans and the environment, do not satisfy the users' cooking needs.

Usability testing is useful when designers lack a fundamental understanding of what user's need which is defined in Ergonomics of Human System Interaction as a system's ability to meet user needs in.

effectively, efficiently, and completely. The protocol divides all the six key criteria of cook stoveusability which is evaluated with subjective survey, interview-based testing, and objective, quantitative techniques. By testing methods, tests are divided into 4 separate sections that will be carried out parallel in the kitchen while regular cooking activities are taking place.
Usersmust all be clearly identified with the test's objective, administrator, and resulting data, before the development of usability evaluation. A body of research on the usability of cook stoves outlined a few basic user requirements for cook stoves, such as cooking speed, firepower, tending frequency, the capability to use a variety of cooking utensils, fire visibility, and providing light and heat.To better comprehend, 32 participants of the 2016 InStove Stove Summit took part in a survey and compared the practitioners' priorities for cook stoves.Userstend to favor criteria related to usability, such as the capacity to prepare basic foods and use a variety of pots effectively, whereas practitioners give a higher value to technical criteria, including thermal efficiency.

When the user and the evaluator come from different cultural backgrounds, there is a greater risk of misunderstanding and misinterpretation. This is how culture influences the usability testing procedure. Many possible criteria were quantitatively measuredin stovesand the cooking process was observed in order to minimize the possibility of bias. A cook tends to behave normally and provide direct answers if they are more familiar with the test administrator. Laboratory testing collects initial data prior to conducting a field test.

Tan et al., (2021) studied musculoskeletal disorders or MSDs as the second leading cause of disability worldwide and the most common occupational health issues affecting working people today. One occupation that requires movements with repetition, standing for long periods with absent neck, also confinement to one location for extended periods of time is of pastry chefs. They create, decorate and present Desserts such as pastries, cookies, cakes and other confectionery. 104 pastry chefs from Malacca and Malaysia, aged 20 to 50, who worked at least six hours per day and had less than ten years of experience, were recruited using a transverse study design and grab sampling.Dutchmusculoskeletalquestionnaire was used to identifywork-relatedriskfactorsassociatedwith the prevalence of MSD. Reportedly, 92.3% of confectioners in Malacca and Malaysia had MSD in the past 12 months, with ankles (76.9%) showing the highest prevalence, followed by upper back (60.6%) and theshoulder (58.7%). There is a strong correlation between work-related risk factors, such as spending long periods of time in an uncomfortable position, maintaining the same posture,highforcesonthetools,frequentstopsandtwists of the torso, allcauseMSD in pastry chefs.

Alam et al., (2020) studied the Thermal comfort inrelation to pantrychef's working conditions in non-air-conditioned and air-conditioned kitchen types ofIndianrailwaypantrycars. Despite being similar in terms of design and structure, the indoor thermal environment in both the kitchens is quite differentbecause of the usage of various cooking equipment and heating appliances during the cooking process. Twenty-ninechefs, including 10 from two AC trains and 19 from four non-AC trains,participatedandanalyzed the statistical data ofrespondents from both types of pantrycars. The comfort temperature of the respondents in this study was found to be 23.5°CTa, and the comfort temperature range to be between20and27.02°C Ta for both non-air-conditioned and air-conditionedcookingtrolleytypes. Although there are differences in insulation values forclothing,clothingestimatesforair-conditionedpantrycarswere0.77cloandnon-air-

conditioneddiningcarswere0.5clo.However,neithertype of pantry hadan effect on the comfort temperature of the respondents.

While each of these five factors—thermal, physical, cognitive, and usability—has been the subject of much research, no study of chefs and non-chefs in a commercial kitchen that included all five factors together has been conducted. Hence, thepurpose of this study is to compare the workload of chefs and non-chefs and Aim is to collect the relevant data from chefs and non-chefs via a questionnaire.

2. Methodology

2.1. Participants

A questionnaire was conducted with 10 employees working in the mess—five chefs and five non-chefs. All were males, aged between 18-58. All the participants worea uniform with white shirt,trousers, black apron, bouffant cap to work provided by the institution. Working from 6 am to 10 am seven days a week with one day off.

2.2. Data Collection

The study was conducted at the college mess to gain insights into functioning, work flowmanagement, performance pressure, etc in the kitchen environment. Ten employees working in the mess—five chefs and five non-chefs—were questioned, and a standardized questionnaire was prepared to assess thermal comfort, the prevalence of musculoskeletal disorders (MSD), usability testing, cognitive load, and general cook stove questions.

First set of questionnaire was applied to assess thermal comfort by ASHRAE-55 which outlines the conditions under which a certainpercentage of residentsconsiders the environment tobe thermally acceptable. Parameters being addressed in this questionnaire were thermal sensation, thermal comfort, thermal preference, thermal acceptability and other environmental factors (indoor and outdoor) include air temperature, air velocity and humidity. The ASHRAE ThermalSensitivityScalewithascoreof0 : neutral (neither cold nor hot), - 1: slightly cold, +1: slightly warm, -2: cool, +2: warm, - 3: cold, +3: hot, was used to assessthermalsensitivity and thermalcomfort. This procedure took about 15 to 20 minutes.

The second set of questionnairehad information on musculoskeletal symptoms in differentpartsofthe body which was collected based on the standardized Nordic questionnaireonmusculoskeletaldisorders.Body parts with neck, shoulders, upper back, elbows, wrists/hands, upper back, low back, hips/thighs/buttocks, ankles/feet and knees was covered in the questionnaire. Respondents were asked to listthemost recent pain or discomfort over the past7days in aspecified body part. In addition, participants were asked to rate the intensity of pain they felt in that body area on a scale of 0 to 5 (where 0 : no pain, 1: very low pain, 2: low pain, 3: moderate pain, 4: high pain and 5: very high pain) in that body part. This procedure took about 15 to 20 minutes.

Thirdly, the System Usability Scale (SUS), had series of qualitative responses over a scale of 5 ranging from Strongly Disagree to Strongly Agree, was applied to check the usability of cook stoves. Evaluation criteria included frequent usage, complexity, ease of use, assistance, functions integration, awkwardness, confidence, etc.

NASATLX questionnaire was used to judgethe workload of chefswhilecooking and non chefswhile serving food. It consisted of six subscales: mental demand (how mentally demanding the taskwas), physical demand (how physically demanding the taskwas),and temporal demand (how pacedthetaskwas,wereyouinahurry),performance (how successful were you in accomplishing what you were asked to do),effort(howmuchefforthadtobeput in to reachtheperformancelevel),andfrustration(How insecure, discourage, irritated, stressed, and annoyed you were) on a 5-point scale Fromvery low to very high.

The last step was a questionnaire presented on how to improve traditional cook stoves that included general questions like the number of family members, occupation, type of material used to construct the stove, type of fuel and daily consumption, number of pots, type of wood, maintenance, age of the stove, location, and preference for wood over LPG.

Cognitive task analysis (CTA) for the preparation of an Indian snack(samosa)was also accurately analysed and a diagram for the same was made.The chef arrives the kitchen and gets ready by wearing the uniform at 8.15am.

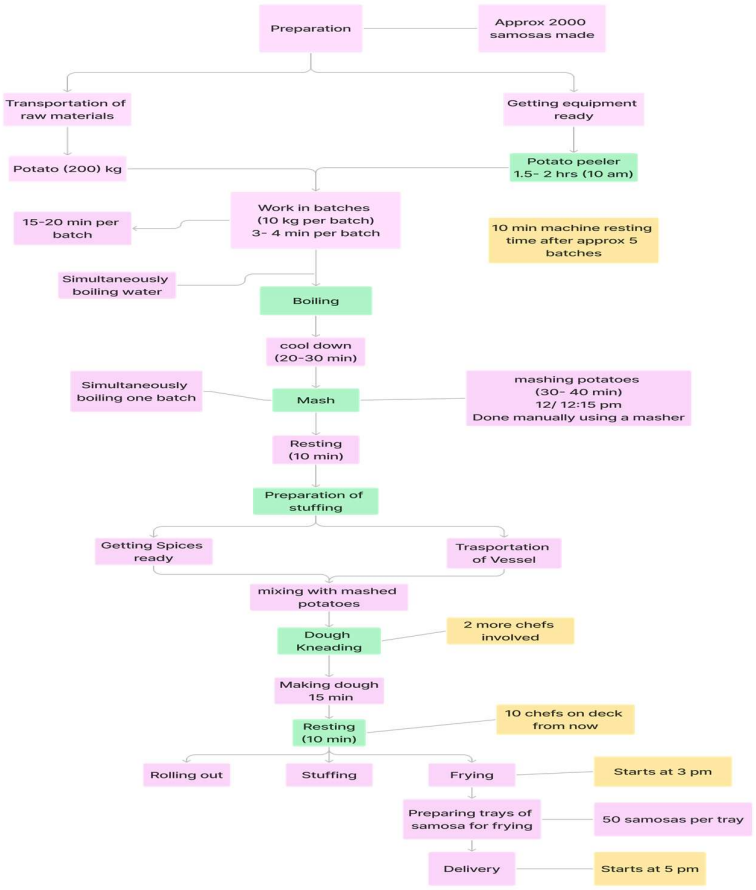

Figure 2CTA diagram outlines the steps for making samosa, a popular Indian snack, for evening meal

3. Result

Mann-Whitney U test was used to perform the statistical analysis of the data using IBM SPSS Statistics version 28.0.Inside Air temperature and humidity was determined to be 40 deg C and 93 percent respectively and outside Air Temperature as 30 deg C.

With 3-6 family members, respondents work as cooks and non-chefs. They use stainless steel, Earthenware (MittiChulha), induction, LPG, PNG, or wood (Neem, Babool) or cow dung as fuel and require, on average, 10 kg of wood and 0.25 kg of LPG each day. A few of them preferred wood stoves over LPG due to Acquaintance, taste, and economics.

The ranks table provides information about the results of the Mann-Whitney U test by showing the mean rank and the sum of ranks for the two groups tested. i.e. chefs and non chefs.

Table 1–The ranks table displaysresults of Mann-Whitney U test, for chefs and non-chefs

		Cooking_staff	Mean Rank
Cognitive	Mental_Demand	Chef	5.70
		Non-chef	5.30
	Physical_Demand	Chef	5.20
		Non-chef	5.80
	Temporal_Demand	Chef	3.50
		Non-chef	7.50
	Performance	Chef	5.50
		Non-chef	5.50
	Effort	Chef	6.30
		Non-chef	4.70
	Frustration	Chef	5.10
		Non-chef	5.90
Physical (MSD)	Neck	Chef	6.00
		Non-chef	5.00
	Shoulder	Chef	5.50
		Non-chef	5.50
	Elbows	Chef	5.50
		Non-chef	5.50
	Wrist_Hand	Chef	5.50
		Non-chef	5.50
	Upper_Back	Chef	5.00
		Non-chef	6.00
	Lower_Back	Chef	4.50
		Non-chef	6.50
	Both_hips	Chef	5.50
		Non-chef	5.50
	Both_ankles	Chef	7.00
		Non-chef	4.00
	Both_knee	Chef	5.50
		Non-chef	5.50
	Neck_scale	Chef	6.00
		Non-chef	5.00
	Shoulder_scale	Chef	5.40
		Non-chef	5.60
	Elbow_scale	Chef	5.50
		Non-chef	5.50
	Hand_scale	Chef	5.50
		Non-chef	5.50
	Upperback_scale	Chef	5.00
		Non-chef	6.00
	Lowerback_scale	Chef	5.10

		Non-chef	5.90
	bothhip_scale	Chef	5.00
		Non-chef	6.00
	Bothfeet_scale	Chef	6.80
		Non-chef	4.20
System Usability	Cookstove_frequently	Chef	5.80
		Non-chef	5.20
	Unnecessarily_compl ex	Chef	3.00
		Non-chef	8.00
	easy_to_use	Chef	6.80
		Non-chef	4.20
	assistance	Chef	4.00
		Non-chef	7.00
	function_integrated	Chef	6.50
		Non-chef	4.50
	awkward	Chef	3.00
		Non-chef	8.00
	feel_confident	Chef	8.00
		Non-chef	3.00
	lot_to_learn	Chef	3.00
		Non-chef	8.00
	Quickly_learn	Chef	5.90
		Non-chef	5.10
Thermal Comfort	TSV	Chef	8.00
		Non-chef	3.00
	TCV	Chef	3.60
		Non-chef	7.40
	TP	Chef	7.00
		Non-chef	4.00
	TA	Chef	4.50
		Non-chef	6.50

The data in the table indicates that cooks had the highest mental demand; as a result, they can be regarded as belonging to the category with the highest value, or with highest mean rank.Test statistic, *U* statistic, as well as the asymptotic significance (2-tailed) *p*-value is included inthe Test Statistics table.

Table 2 - Test Statistics table

	User attributes	Mann-Whitney U	Wilcoxon signed rank test	Z	Asymp. Sig. (2-tailed)	Exact Sig. [2*(1-tailed Sig.)]
Cognitive	Mental_Demand	11.500	26.500	-0.231	0.817	.841[b]
	Physical_Demand	11.000	26.000	-0.346	0.729	.841[b]

	Temporal_Demand	2.500	17.500	-2.228	0.026	*.032*[b]
	Performance	12.500	27.500	0.000	1.000	1.000[b]
	Effort	8.500	23.500	-0.876	0.381	.421[b]
	Frustration	10.500	25.500	-0.472	0.637	.690[b]
Physical (MSD)	Neck	10.000	25.000	-1.000	0.317	.690[b]
	Shoulder	12.500	27.500	0.000	1.000	1.000[b]
	Elbows	12.500	27.500	0.000	1.000	1.000[b]
	WristHand	12.500	27.500	0.000	1.000	1.000[b]
	UpperBack	10.000	25.000	-1.000	0.317	.690[b]
	LowerBack	7.500	22.500	-1.225	0.221	.310[b]
	Bothhips	12.500	27.500	0.000	1.000	1.000[b]
	Bothankles	5.000	20.000	-1.800	0.072	.151[b]
	Both knee	12.500	27.500	0.000	1.000	1.000[b]
	Neckscale	10.000	25.000	-1.000	0.317	.690[b]
	Shoulderscale	12.000	27.000	-0.118	0.906	1.000[b]
	Elbowscale	12.500	27.500	0.000	1.000	1.000[b]
	Handscale	12.500	27.500	0.000	1.000	1.000[b]
	Upper back scale	10.000	25.000	-1.000	0.317	.690[b]
	Lower back scale	10.500	25.500	-0.454	0.650	.690[b]
	Bothhipscale	10.000	25.000	-1.000	0.317	.690[b]
	Bothfeetscale	6.000	21.000	-1.536	0.125	.222[b]
System Usability	Cook stove frequently	11.000	26.000	-0.340	0.734	.841[b]
	Unnecessarilycomplex	0.000	15.000	-2.887	0.004	*.008*[b]
	Easy-to-use	6.000	21.000	-1.396	0.163	.222[b]
	assistance	5.000	20.000	-1.671	0.095	.151[b]
	Functionintegrated	7.500	22.500	-1.500	0.134	.310[b]
	awkward	0.000	15.000	-2.835	0.005	*.008*[b]
	Feelconfident	0.000	15.000	-2.887	0.004	*.008*[b]
	Lottolearn	0.000	15.000	-2.887	0.004	*.008*[b]
	Quicklylearn	10.500	25.500	-0.516	0.606	.690[b]
Thermal Comfort	TSV	0.000	15.000	-3.000	0.003	*.008*[b]
	TCV	3.000	18.000	-2.124	0.034	.056[b]
	TP	5.000	20.000	-1.800	0.072	.151[b]
	TA	7.500	22.500	-1.225	0.221	.310[b]

In this data, there is a difference between chefs and non-chefs in these five categories since the p value for the following variables in this data is less than 0.05 ($p<0.05$): Temporal Demand, Unnecessarily Complex, Awkward, Feel confident, Lot to learn, TSV values

4. Discussion

This study is an attempt to do a comparative analysis covering all the aspects at one place. Given that chef's mental demand and efforts are higher, cognitive analysis suggests that a variety of mental processes are taking place that are directly or indirectly in related to the efforts he makes to finish the task at hand. These processes range from making efforts to finishing the task on time.

As per the study by Tan et al., (2021), 92.3% of pastry chefs in Malacca and Malaysia had MSD within the previous 12 months, with ankles (76.9%) showing the highest prevalence, followed by upper back (60.6%) and the shoulder (58.7%). However, in this study, highest prevalence of pain has been observed in neck and ankle region among chefs and upper back and lower back region for non chefs.

In usability testing of the two groups (chefs and non chefs), the usage patterns for cook tops, feelings of awkwardness, complexity, and confidence all differ. Regardless of being chefs or non-chefs, the majorities of them feel confident and are comfortable using the cook stove. They are aware when and how to use it.

In accordance with the difference in thermal sensation found, cooks in that atmosphere felt warmer in comparison to non-chefs. The chefs were more uncomfortable inside due to the increased humidity and eventually preferred a colder environment.By Changing the position of cook stoves can also create an impact for the same.

5. Conclusion

In closing, this study highlights the prevalence of workload among chefs and non-chefs and the potential risks associated with it. Through the analysis of the current work pattern, it is inferred that an excessive workload can result in major mental and physical health problems.The insights gained from this study can help individuals to better understand their working environment and take proactive measures to address workload-related issues. It is important to note that high workloads are not only a concern for chefs, but also for non-chefs who work in commercial kitchens. The study highlights the need for both groups to be aware of the potential risks and take appropriate measures to reduce their workload and improve their working conditions. The findings of this study are relevant to anyone who works in a commercial kitchen and can be used to promote better working conditions and employee well-being.

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