PARADIGM SHIFT IN INDIAN FOOD ESTABLISHMENTS: A STUDY OF F&B TRENDS

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ABSTRACT

Over the past few decades, the concerns over the environment and overall health have been increasing in India and across the world. Modern consumers are more aware of the health concerns over processed and unhealthy food choices. Hence, they are looking for more plant-based and organic alternatives, especially in the food and beverages industry. The food establishments in India have seen a drastic change due to ever-changing customer demands. In order to attract customers, these businesses have to look for innovative ways and offer more healthy options at great prices. In this study, we are focusing on the changing food and beverage trends in India and across the world and how these trends are changing typical food establishments and giving birth to new opportunities.

Keywords – *food establishments, food and beverage trends, F&B, food and beverage industry, hospitality industry*

Introduction, Background and Literature Review

Food establishment is a broad term which consists of various operations like storage, packaging, preparation, vending and serving food to the customer directly, or providing the same for consumption, as in a catered location or restaurant. According to the "Department of Public Health", the copy of 590 consists of regulated food establishments like cloud kitchens and catering operations in B&B, food banks, grocery stores, bakeries, food trucks, restaurants, takeout and delivery, catered or satellite feeding areas (with facilities to cook, store, and serve food), vending locations, etc. Some of the unregulated food establishments are food processing plants, homes receiving home-delivered or catered food, foods for service at charitable or religious organizations, donation or distribution, cooking class for educational purposes, home kitchens for family, etc. (Local Public Health; Department of Public Health). The food and beverages sector is poised to have significant growth worldwide. Increased purchasing power and emergence of new economies in developing countries are driving strong hold. Customer demands are changing with higher focus on healthy items having the right ingredients. Governments worldwide are putting emphasis on labeling standards on F&B packaging. Even customers have more concerned with labeling and ingredients. In 2011, standardized "Front of Pack" labeling policy was adopted in Europe. Several countries like the US, Australia, and New Zealand are adopting these policies. Many countries that fall under the Americas like Ecuador, Mexico, Peru, and Chile have adopted mandatory labeling of nutrition (Thornton, 2014).

Governments are looking forward to introducing taxes on fast food and other unhealthy food to combat obesity and encourage healthy food habits. A law was imposed by Mexico in November 2013 on imposing taxes on sugary beverages and junk food and raising prices of unhealthy food. South Africa has also signed a salt reduction law for some foods like imported ones to control the salt levels in fast food items. Customers are concerned over health issues related to sedentary lifestyle sand poor nutrition. Hence, the organic food market is showing positive signs of growth and customers are more willing to pay extra for organic foods. Around 48% of the total food market in North America was accounted for by organic F&B, making it the largest consumer of healthy food in 2013, followed by 45% in Europe. In terms of organic food items, Asia Pacific is also a fastest emerging region as governments are considering organic food demands. US$ 16.7 million has been set aside by the government for developing organic food (Thornton, 2014). Food is the basic need for

the survival of mankind, especially for the balance and growth of life. People's health relies heavily on their diet. Either because of eating unhealthy food or having food with lack of nutrients, food is responsible for declining health. In addition, external contamination may also take place at some point from the maker to the consumer. During the journey, food handlers are responsible to keep the food safe. Considering the surveillance and epidemiological data, faulty practices of food service joints, food processing plants, and homes are responsible for food-borne illnesses and their causal chain. The health condition of food handlers, their knowledge of food safety, their practices and attitude towards hygiene, and their personal hygiene play their part. Several diseases can be transmitted from food handles. Hence, Prabhu& Shah (2012) identified some of the problem areas in food handling. According to them, there is a need to motivate food handlers to improve personal hygiene. They should be trained for food safety and undergo medical checkups.

Due to lack of awareness of food-borne illnesses and their spread and poor personal hygiene, food handlers in food joints could spread several infections of enterogenic pathogens and intestinal helminthes of protozoa. Viruses (Hepatitis A, Norovirus, Rotavirus, Enterovirus, etc.), parasites (Giardia, Cryptosporidiosis, etc.) or bacteria (E.Coli, Clostridium, etc.) cause over 250 food-borne illnesses. Several food-borne illnesses are hepatitis A, botulism, norovirus, diarrhea, typhoid, hookworm, food poisoning, etc. (Park, 2005). Food-borne diseases affect around 30% of the population in developed countries every year, while around 2 million deaths occur in developing nations every year, according to the WHO. In addition, contaminated food causes around 70% of diarrhea cases in developing countries, while 16 million new cases of typhoid and over 600,000 deaths were recorded due to typhoid every year (Abera et al., 2010; Takalkar et al., 2011). A study was conducted on food hygiene awareness and practices among food handlers by Kubde et al. (2016) and found that around 82.5% food handlers did not have food training certification. Even worse, only 27.9% of food handlers claimed that they knew about food-borne illnesses. They knew that food can spread infection due to poor handling. However, 36.8% women were aware while only 25.3% males were aware of this fact. Mass media was found as the prime source of knowledge of most of the food handlers. In this study, the food handlers' attitude for food handling was satisfactory. Majority of food handlers followed all food hygiene practices very well in this study. The concept of food safety management requires food to be consumed as per the intended purpose without any harm (ISO 22000, 2005). In addition, food hygiene refers to the process of keeping food clean and safe which doesn't cause any disease. Providing safe food in global markets is one of the major concerns in this day and age. Food borne chemicals and pathogens causing food borne accidents is the major driving factor for growing concerns over food hygiene. Most of the developing countries still neglect the effects of food-borne diseases due to contamination. In 2008, the "Food Safety and Standards Authority of India (FSSAI) was established as a statutory body under "Food Safety and Standards Act (2006)" for laying scientific standards for food safety. The manufacturing, import, processing, sale and distribution of food have been regulated to ensure the delivery of wholesome and safe food to the consumer (Shukla et al., 2014).

Food & Beverages Trends in Indian Food Establishments: An Overview

The F&B sector is evolving significantly with different restaurant trends. This sector has already conquered the retail establishments with the market share of 31% in India, as compared to 25% in China, 17% in Brazil, and 9% in the US (Cattini, 2017). With the onset of internet revolution, globalization, and population growth, food and beverage trends in Indian food establishments are changing significantly. Due to the current pandemic, everyone started rethinking their business model by structure, size, pricing and location. With unlock guidelines are already in place, most businesses are considering their bottom line while strongly considering the compliance in future. They are constantly working on everything from the very beginning. People are more and more attracted towards local,

homegrown brands, while getting back to the roots. Along with the fine dining, ice cream parlors, casual dining, cloud kitchens, and food trucks, were already in trend in 2017 and 2018. In this day and age, we are going to see some other concepts given below -

Plant Based Foods

According to the WHO, around 74% of plant-based medicines have been used culturally and traditionally. Veterinary science also has its correlation with medieval and ancient India for animals. A lot of works on plant-based food have been mentioned in Tamil, Sanskrit, and other Indian languages. Sanskrit scriptures, such as "Ashwa Ayurveda sarsindhu" and "Asvavaidhyaka" since the Mahabharata times are documented and classified well as per Ayurveda principles. In addition, a lot of veterinary practices have been undocumented but still in trend in rural India. Thousands of recommendations are available in traditional sources for treatment of diseases. Sharma et al. (2005) also discussed the plant-based sources to be used as spices that have several medicinal properties. The international dairy and meat market is going through an unexpected disruption and competition with the development of feasible plant-oriented alternatives in different categories. These days, plant-based food products are not only for niche buyers and limited to only a small shelf space. Companies are heavily investing in new brands and products to attract health-conscious customers. It should be clear that plant-derived alternatives have always been used and available in significant amounts in the F & B industry. Deloitte (2019) has published a study on the growth of plant-based options and alternatives to dairy and meat products, considering the dietary decision-making and shopping behavior of consumers. Several plant-based sources of protein have been identified, such as peas, soy, pulses, tempeh, and seitan. Over 800 brands and companies across the world either focus completely on organic foods that can be the direct alternative to animal products or have product ranges or business units based on those products. With increasing concerns over zero emissions, there has been a great investment and sales opportunity in moving towards eco-friendly and sustainable production. Investors and companies that are more into plant-based innovative products realize its potential to lead the transition of a carbon-neutral food delivery network. According to Gaan (2021), 2020 was truly a groundbreaking year for plant-derived investments and sales that have driven excitement among the consumers for plant-based alternatives.

Single Dish Restaurant

Restaurant industry has taken the term "less is more" to the next level by introducing the concept of dual dish and even single dish restaurants lately. Menus are getting limited with just a few options like shorter wine lists. The question here is whether the concept of a one-dish or two-dish restaurant will work in the real world. Even some restaurants specialize in one ingredient or dish. For example, Soho's spin-off Madd is offering only Mango-based specialties and Clerkenwell's Meatballs serves, as the name suggests, meatballs. In addition, Primo's Gourmet Hotdogs in Leeds offers only hotdogs with around nine sausage themes. A renowned French bistro, Le Relais de Venise, based in London and Manchester, takes it to the extreme with only one dish on their menu. There are some negative sides of limiting the menu though. In a review of Ooze, a risotto bar, Reyner (2006) added that you have to do extremely well if you wish to go the "one dish" route. If there is only one menu at a restaurant, there is literally nothing to hide if it is not going well. The key here is to be excellent in something if you cannot master everything. According to English (2012), having simpler menus has its perks and there is nothing wrong about it. There is less risk of wastage for restaurants. It can also be ideal for the environment and the budget of a restaurateur.

Cloud Kitchen

Cloud Kitchen instantly became a buzzword in this day and age when Gen Y and Gen Z customers simply want their favorite and wholesome meals at their doorstep with one click. This business model works on a "hub and spoke" concept. The hub is a central mega kitchen and spokes are the outlets where food is delivered, which distribute the food to their respective customers. It is basically a takeaway

outlet where a dine-in facility is not available. Some of the popular examples of "Cloud Kitchen" in India are Box8, Faasos, Freshmenu, Innerchef, Holachef, and Kabuliwala. Choudhary (2019) explores the concept of cloud kitchen as a marketing strategy and business model and analyses it in terms of environment, market, customers, and competitors. Considering the intense competition and uncertainties, such businesses have to constantly keep track on market position and adapt to innovative strategies and market changes.

Green Kitchen

Nandini& Kumar (2019) explain a violent incident due to a service delay at a green kitchen restaurant. After a long journey, a group of starving customers visited a restaurant. The steward briefs the delivery time to the customer after noting down the order. In that case, the restaurant had a new steward who forgot to bring the estimated delivery time to the customer. That day had a rush due to peak hour and customers had to wait a bit longer than normal. It elevated their frustration and caused a complaint and negative feedback on Google+ about the restaurant due to its service delay. The founder had to deal with those complaints coming from a customer who is tech-savvy and to know the implications and nature of social media posts. That incident happened in May 2017 in Tamil Nadu at a small and enchanting town named "Theni" beautifully covered by the Western Ghats. This restaurant was located on the way welcoming pilgrims and tourists heading towards Kerala. With this incident, this study suggests that the restaurant must understand the situations due to which customers got angry and left negative feedback. The restaurant should come up with certain measures to avoid such events in future. They should keep track of their service quality regularly and devise the right recovery mechanism to improve their customer relations. Even a single negative feedback can be a negative publicity or worth of mouth which can drastically affect the service providers in future.

Vegan Cuisine

In 2018, the size of the international vegan food market was US$12.69 billion and was estimated to swell at a CAGR of 9.6 percent by 2025 from 2019. Rising awareness of vegan diet and its benefits is important for this market's growth. There is a huge vegan population in Asia Pacific, North America, and Europe.

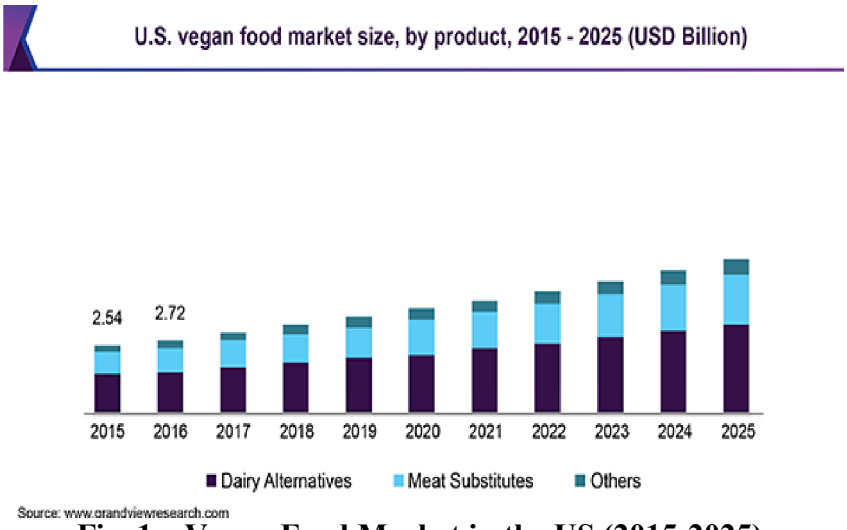

Fig. 1 – Vegan Food Market in the US (2015-2025)

Rising concerns over animal cruelty and health is another major factor in the food industry driving people towards plant-based alternatives. There was an exponential 987% rise in demand for meat-free food from 2012 to 2017, as reported by The Vegan Society (Market Analysis Report, 2019). Rivera &Shani (2013) presented a restaurant operator's perspective on the orientation and attitudes for vegetarian food in the dining industry. The study was focused on real-life implications for San Juan-based restaurants as

well as restaurants based in other places. The need to inform decision makers like managers, chefs, and owners of the restaurants about major issues related to vegetarian food and vegetarian customers is the most important implication here. On the other side, veganism is a different concept which strictly eliminates the use of animals and animal products, especially in diet. Veganism doesn't see animals as commodities. Vegans are the followers of this concept. Gupta and Bhatia (2016) focus on the totality of this trend barring the details of its nutritional value. They also focus on the implications in the hospitality industry towards going vegan along with the vegan lifestyle as a whole.

Gluten Free Diet

India is known to have a highly saturated market for gluten-free products and there are so many medium and small players. Most of them are local businesses offering a huge range of products. Online players are the major distribution channels followed by hypermarkets, supermarkets, and brands like Wholefoods, Gullon, Savorlife, etc. dealing with gluten-free snacks and cookies (Mordor Intelligence, 2019). Masih et al. (2019) conducted a study on gluten-free products in the US and India on the basis of social media and online reviews and found that most consumers anticipated and discussed innovation in food items like fast food (pasta, pizza, noodles, etc.), snacks, and desserts through editorial and social media comments. According to Reilly (2016), the gluten-free diet is also considered as a medical cure for millions of people having an autoimmune disorder celiac disease, which cannot be treated by any other therapy. India has the largest global population with celiac disease as the leading wheat consumer in the world and USA is the largest consumer of gluten-free foods. Hence, Masih et al. (2017) studied a gap between market share and market potential of gluten-free products. They concluded that the USA has around 40% of market share while India has only 10% of their respective market potentials. There are so many gluten-free foods in the US but the consumers over there seek nutrients from healthy gluten-free options like seaweed, legumes, and multi-grains. On the other side, Indian consumers have been highly interested in bakery and snacks, apart from fortified blends and flours. Digital marketing could help both countries to attract more consumers with appealing ads and combos through online mediums.

Homemade products

Antonio Padilla Bravo et al. (2014) analyze the combined impact of information, sensory variables, and attitudes in predicting customer behavior for homemade food. It was a quantitative survey based in Lima, Peru, which suggests that homemade characteristics have no such effect on dependent variables and sensory evaluation. Buying behavior was influenced strongly with overall product likings. It concluded that homemade food manufacturers should highlight the overall appeal of products and their sensory elements. They could capture consumer attention more effectively. For example, tasting sessions in stores or farmers' markets could be more effective.

Homemade craft beverages

Around one-fourth of the total population in the US is millennial. Hence, marketers should study this group and thrive in the market that is almost ruled by millennial. This segment is leading most market segments, including vegetarian, vegan, organic, all-natural, and locally sourced products. Many corporate giants have been forced to adapt as it has impacted the beverages industry. It goes without saying that a lot of manufacturers are coming up with innovative drinks for the customers (Adams, 2016).The hospitality industry in Pune, India is one of the important parts of the tourism sector and it consists of restaurants, hotels, clubs, pubs, self-catering businesses, and guesthouses. Hotels account for the largest share in the hospitality industry and food and beverages is the prime department which brings a lion's share of revenue and plays a vital role in satisfying clients. Modern consumers are well-exposed and educated. They are always in the lookout for creative things that are attractive to them. Customers are more willing to pay extra for getting value than before. They demand innovative food and beverages which are

healthy and cost-effective at the same time. Khulge& Desai (2019) concluded that the F & B sector could grow significantly with the latest and innovative methods and technologies in Pune.

Non Alcoholic Cocktails & Bars

Non-alcoholic beverage is an emerging and ever-growing segment as it is bringing several innovative packaging styles and products. Increasing demand with implications and convenience of drinks are the catalysts of the growth of non-alcoholic drinks in the F & B industry. Beverages have always been considered something to quench the thirst. Finally, this mindset is changing. Customers are now considering them as complete breakfast or other meals. There are so many products to meet diverse needs in the non-alcoholic beverage industry (Suhag, 2017). Most of the studies have been focused on premixed alcoholic drinks which are trending in the Indian market. Hospitality providers like cafés and hotels, distributors, producers, and wholesalers are a part of the alcoholic beverage segment. The trend of premix drinks is growing. Suhag (2015) discusses the benefits of this field for brands and its scope. There are many benefits of globalizing this industry as it may improve the overall alcoholic drinks' quality. Usually, teetotalers are used to consume mocktails at parties and gatherings. These non-alcoholic drinks provide quick energy after having workout or playing outdoor games or sports. Some beverages also help in keeping blood volume in case of excess sweating, heat stroke, vomiting, diarrhea, bleeding, or even dehydration. Food & Beverage Service Foundation (II) Unit 1 focuses on all the commonly-available non-alcoholic beverages which may be mixed and modified for better taste, look, and refreshment or consumed as an individual drink. In addition, it is also observed that milk contains some ingredients that induce sleep, such as the bromine. It improved relaxation and turned body temperature down when it was consumed chilled. Pathak& Sharma (2019) explored the concept of non-alcoholic bar with the feel of a typical lounge and bar. The bar offered 100% non-alcoholic drinks like mocktail and beer, beverages and cocktails with least alcohol percentage, and even sold snacks like peanuts and potato chips. These bars usually have chairs and bar stools at the counters and table for patrons. These bars also had live music for entertainment. The authors concluded that such places should be introduced to help the parents to get their children to the right direction.

Conclusion of the Study

The Food & Beverage sector has become one of the fastest-growing industries in India. The purchasing power of consumers is rising in developing countries and new economies are emerging. These are some of the main factors behind the growth of the food and beverages industry in the hospitality sector. Customer focus is evolving with a great preference for healthy food items and reasonably sourced products. It is very important for food establishments to maintain proper safety and health standards for food and beverage handling in India. In order to keep food safe and hygienic, food handlers also play their role. Especially in the present situation, food establishments should ensure that their staff is taking proper precautions before delivering food to the consumers.

Suggestions and Recommendations

Experts believe that food processing industry in India is one of the most lucrative domains with their huge value potential (Cattini, 2017). Technological advancements, changing customer behavior, and government restrictions have literally made a great change in F&B industry in India. More and more families are discovering new dishes and dining out due to high disposable income. Urban customers are especially discerning with their trust and choices in branded foods for quality assurance. Youths have been more environmental and health conscious generation, resulting in an upsurge in protein-rich, homemade items and foods like nuts, dried fruits, and Trail Mix.Restaurants should also take care of safety, health and security guidelines and leverage on contactless solutions, such as digital menus, in-app ordering, contactless payments, and drone deliveries. The hospitality industry is also using technologies like biometric and facial detection for self-check-ins and check-outs, facial scans to activate

elevators and unlock rooms. It is the right time to invest in technologies to overcome the downtime due to pandemic. In this day and age, customers want convenience. Beverage industry will grow even more with cold brew coffees, readymade lattes, cold-pressed juices, and cold coffees. Introduction of ready-to-drink shots and beverages will definitely meet the demand of grab-and-go culture.

References

1. Local Public Health. What is a Food Establishment? Institute of Massachusetts. Retrieved 25 June 2021, fromhttps://www.masslocalinstitute.info/FoodSafety_Operators/FoodSafety_Operators2.html
2. Department of Public Health. Available at https://www.mass.gov/files/documents/2018/10/09/105cmr590.pdf.
3. Thornton, G. (2014). Indian food & beverage sector the new wave. Confederation of Indian Industries, 16-38.
4. Prabhu, P. M., & Shah, R. S. (2012). A study of food handlers in public food establishments in Maharashtra, India. Age (Yrs), 15(30), 51.
5. Kubde, S. R., Pattankar, J., &Kokiwar, P. R. (2016). Knowledge and food hygiene practices among food handlers in food establishments. Int J Community Med Public Health, 3, 251-6.
6. Park, K. (2005). Park's textbook of preventive and social medicine. Preventive Medicine in Obstet, Paediatrics and Geriatrics.
7. Abera, B., Biadegelgen, F., &Bezabih, B. (2010). Prevalence of Salmonella typhi and intestinal parasites among food handlers in Bahir Dar Town, Northwest Ethiopia. Ethiopian Journal of Health Development, 24(1).
8. Takalkar, A. A., &Kumavat, A. P. (2011). Assessment of personal hygiene of canteen workers of government medical college and hospital, Solapur. National Journal of Community Medicine, 2(3), 448-451.
9. Kubde, S. R., Pattankar, J., &Kokiwar, P. R. (2016). Knowledge and food hygiene practices among food handlers in food establishments. Int J Community Med Public Health, 3, 251-6.
10. ISO 22000. (2005). Food safety management. www.iso.org
11. Shukla, S., Shankar, R., & Singh, S. P. (2014). Food safety regulatory model in India. Food Control, 37, 401-413.
12. Sharma, L. K., Dadhich, N. K., & Kumar, A. (2005). Plant based veterinary medicine from traditional knowledge of India. Nelumbo, 47(1-4), 43-52.
13. Deloitte. (2019). Plant-based alternatives Driving industry M&A. Deloitte. Retrieved from https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/consumer-business/deloitte-uk-plant-based-alternatives.pdf.
14. Gaan, K. (2021). Plant-Based Meat, Eggs, and Dairy. Good Food Institute. Retrieved from https://gfi.org/wp-content/uploads/2021/05/COR-SOTIR-Plant-based-meat-eggs-and-dairy-2021-0504-1.pdf.
15. Jay Rayner reviews Ooze, 62 Goodge St, London, W1. (2006). Retrieved 25 June 2021, from https://www.theguardian.com/lifeandstyle/2006/nov/12/foodanddrink.restaurants.
16. English, A. (2012). Rise of the single dish restaurant. Retrieved 25 June 2021, from https://www.theguardian.com/lifeandstyle/wordofmouth/2012/may/15/rise-of-the-single-dish-restaurant
17. Choudhary, N. (2019). Strategic Analysis of Cloud Kitchen–A Case Study. Strategic Analysis, 9(3).
18. Nandini, A. S., & Kumar, R. G. (2019). Green Kitchen Family Restaurant: Managing the New Age Customer. South Asian Journal of Business and Management Cases, 227797791983376. doi:10.1177/2277977919833768.
19. Market Analysis Report (2019). Share & Trends Analysis Report By Product (Soy

Milk, Almond Milk, Rice Milk), By Formulation (Plain, Flavored), By Application (Food, Beverages), And Segment Forecasts, 2019–2025. URL: https://www. grandviewresearch. com/industry-analysis/dairy-alternatives-market.

20. Rivera, M., &Shani, A. (2013). Attitudes and orientation toward vegetarian food in the restaurant industry. International Journal of Contemporary Hospitality Management, 25(7), 1049–1065. doi:10.1108/ijchm-07-2012-0116.
21. Gupta, S., & Bhatia, S. (2016). A STUDY ON "VEGANISM" - A CHALLENGE IN INDIAN HOSPITALITY INDUSTRY. International Journal Of Research In Engineering And Applied Sciences (IJREAS), 6(7), 206~217. Retrieved 25 June 2021, from http://euroasiapub.org.
22. Mordor Intelligence. (2019). India Gluten-Free Foods & Beverages Market - Growth, Trends and Forecast (2019 - 2024). India: Mordor Intelligence. Retrieved from https://www.researchandmarkets.com/reports/4602381/india-gluten-free-foods-and-beverages-market.
23. Masih, J., Verbeke, W., Deutsch, J., Sharma, A., Sharma, A., Rajkumar, R., &Matharu, P. S. (2019). Big Data Study for Gluten-Free Foods in India and USA Using Online Reviews and Social Media. Agricultural Sciences, 10(3), 302-320.
24. Reilly, N. R. (2016). The gluten-free diet: recognizing fact, fiction, and fad. The Journal of pediatrics, 175, 206-210.
25. Masih, J., Sharma, J., Sharma, A., & Deutsch, J. (2017). Study on gap estimation between market potential and market share of gluten-free market. Int. J. Curr. Microbiol. Appl. Sci, 6, 1954-1961.
26. Adams, K. (2016). Beverage Trends — Foodable Network. Retrieved 25 June 2021, from https://www.foodabletv.com/beverage-trends
27. Khulge, P., & Desai, R. (2019). NEW TRENDS IN FOOD AND BEVERAGE SERVICE SECTOR- PUNE REGION. Pramana Research Journal, 9(3), 626-633. Retrieved 25 June 2021, from https://pramanaresearch.org.
28. Suhag, N. (2017). Functional Non-Alcoholic Beverages: Shifts in the Purchasing Patterns of Non-Alcoholic Beverages. Available at SSRN 2992428.
29. Suhag, N. (2015). Trends of Premix and Flavoured Alcoholic Drinks in India. SSRN Electronic Journal .
30. Food & Beverage Service Foundation –II. (2021). NON ALCOHOLIC BEVERAGES AND MOCKTAILS. Haldwani: Uttarakhand Open University. Retrieved from https://www.uou.ac.in/sites/default/files/slm/BHM-202T.pdf.
31. PATHAK, M., & SHARMA, R. (2019). NON ALCOHOLIC BAR AND ITS IMPORTANCE. International Research Journal Of Engineering And Technology (IRJET), 6(10). Retrieved 25 June 2021, from https://www.irjet.net/archives/V6/i10/IRJET-V6I1079.pdf.
32. Cattini, C. (2017). Food Trends in India. Retrieved 5 July 2021, from https://www.ifis.org/blog/food-trends-in-indi

A SURVEY OF INTERNET OF THINGS ON COMMUNICATION TECHNOLOGIES

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ABSTRACT

The Internet of Things (IoT) is a talented technique that is apt to reform and attach the worldwide by means of various elegant devices in the course of faultless connectivity. The present requirement for Machine Type Communications has the consequence in a diversity of communication techniques with varied service requirements to attain the recent IoT revelation. New current mobile standards such as Long Term Evolution has initiated for phone devices except that are not fine matching set for reduced power as well as small data rate equipments like the IoT devices. To tackle the problem, there is a variety of talented IoT standards. In 5G wireless network, predominantly intends to meet the restriction of earlier mobile standards in addition to be a possible key enabler for further IoT. In the proposed article, the Internet of Things application requisites together with the related communication techniques are analyzed. In addition, the 3GPP mobile based (LWPA) Low Power Wide Area clarifies to sustain as well as facilitate the innovative service condition for hugeto significant IoT cases were argued. This article proposed a complete assessment associated to rising and facilitating techniques with major interest on 5G networks which has envisioned in carrying the increase for facilitating the IoT.

Keywords: *Fifth Generation Networks, IoT, Long Term Evolution, Machine Type Communications.*

Introduction

The upcoming technology of mobile network is an enhancement in the architecture in which the messages has been linked that is available all over the place and at all time to the entire world. In the close proximity, the upcoming Internet of Things will develop into a very significant ingredient of the life. For the improvement of the IoT devices, novel architecture in mobile network is necessary. Away from fourth generation, several significant demands or objectives which are required to concentrate are better security of data, reduced latency, enlarged capacity and improved data rate when communicating. To shift on to a subsequently stage of fifth generation network with ultra bandwidth, it has require a redesigning, restructuring and rethinking of our approach in the direction of wireless architectures.

What presently situation in the method of the Internet of Things is an alienated methods. For instance, we have Blue Tooth, Ultra Wide Band, we have short-range communications systems, Radio Frequency Identification, etc., and this might be a challenging in the upcoming years if we speak about a bigger representation like a elegant city, where a integrated framework for constant link is essential. Fifth generation is a high-quality chance to offer this integrated framework. The earlier mobile generation techniques rely on supposed to be orthogonal multiple access. This technique will be not easy to hold up for upcoming Internet of Things applications. We would have a group of strategies, and we will have to allocate time slots devoted to every of them. However in the ending, this is a comfort that we will not afford, because the amount of obtainable bandwidth resources and time slots has been inadequate. This is because multiple orthogonal access can't work for the fifth generation. Contrast with fourth generation systems, fifth generation mobile network is a skip for larger frequencies which is simpler to attain larger bandwidths.

Existing Research of both IoT and 5G

Internet of Things handles with reduced power devices that interrelate with every other by the means of Internet. The idea [1-6] of the Internet of Things has made the notification of the investigation community with the objective to make sure that smart transportation system, smart-phones, tablets, washing machines, smart appliances, wearable sensors etc., in addition to additional things are related to a general interface with the capability to correspond with everyone. Internet of Things has connects the "Things" along with it facilitate machine to machine

communication [7], that has meant for communication of data among the mixed devices devoid of individual interference. In accordance to this, it will be attainable by means of a medium with flawless communication [8].

In accordance to prediction as of Ericsson, it has approximated that concerning 29 billion of elegant equipment has been linked across the worldwide by 2021, by way of greater than 20 billion of the devices has been linked in the course of machine to machine communication and customer electronic equipment [9]. Investigation has also exposed that approximately 8 billion of the equipments has been attached by mobile technologies for instance second generation, third generation and fourth generation that are presently being utilized for Internet of Things however not completely utilized for Internet of Things appliances and LPWA [10] techniques along with an income of approximately 5.4 trillion dollars has been produced through the complete Internet of Things segment internationally [11]. The present requirement for applications of Machine Type Communications like smart water system [23], remote monitoring systems and maintenance [20-22], elegant grid [15-19], smart cities [14], surveillance and smart building [13], and elegant community [12] etc., has bring about enormous associated equipments that create a main examination concerns in requisites of ability for presently organized along with upcoming networks for communication [24].

For example, the LTE standard has visualized primarily for wireless broad band. During this perspective, the IEEE group 802.11ah improved the mobile communication progression to maintain the Machine to Machine applications. In the midst of these are Wi-Fi/IEEE802.11, ZigBee [26] and Bluetooth Low Energy 4.0 [25] to hold up small range communication for Machine Type Communications. LPWA techniques such as LoRa [29], SigFox [28] and Ingenu Random Phase Multiple Access [27] etc., are capable techniques working in the unlicensed ISM spectrum band to supply reduced power as well as extensive range communication as ownership solution.

IoT with new radio 5G enhancement

Existing techniques has revealed that the future fifth generation mobile communication have to supply for the enormous operation of Internet of Things with billions of linked elegant sensors and objects which has been a worldwide illustration of the real world along with to carry the condition of task critical Internet of Things cases, that has need real time reactions and computerization of active procedures across various field of functions such as process control system, vehicle to vehicle, high speed motion, and as well as vehicle to infrastructure.

In fifth generation novel radio network that has presently under concern is anticipated to provide for both enormous and Critical Internet of Things cases as the requirement for equipment communications persist to raise broadly for linking a enormous amount of elegant devices with the reimbursement of utilizing mobile networks. In contrast of this, additional improvements are presently being established in machine to machine communication and Narrowband - Internet of Things systems as mentioned in the present Third Generation Partnership Project Release 14 for mobile Internet of Things, being the initial normative stage for fifth generation standards. Presently, Third Generation Partnership Project equivalence is functioning towards specified that additional improvements of key performance indicators has established into present fourth generation mobile network to make sure that the fifth generation wireless network is intended as of scratch with the intention of provide accommodation to the increasing span of the Internet of Things cases into the marketplace, as well as reducing the price of increasing new mobile networks.

In Third Generation Partnership Project Release 14, a few of the predictable key performance enhancements and features for Machine-to-Machine and Narrowband-Internet of Things systems emphasized for enormous along with Critical Internet of Things applications to be believed for conversation are momentarily commenced as follows

- Market Knowledge Enabler

- Band support for Narrowband-Internet of Things Release 14
- Expansions for Cellular Internet of Things Release 14
- Narrowband-Internet of Things Radio Frequency constraint for co-existence through Code Division Multiple Access networks
- Development of Narrowband-Internet of Things
- Common development to Machine-Type Communications

A. *Expansion in support of Cellular Internet of Things Release 14*

The necessitate to make sure with the purpose of a enormous amount of Machine Type Communications consumer devices are resourcefully maintained and to furthermore deal with interrelated problems to charge critical Machine-Type Communications applications are element of the predictable developments to Fifth Generation Mobile Network radio access techniques. The upcoming model transfer of Machine-Type Communications connectivity clarification in subsequent generation mobile networks has to make sure that task critical Machine-Type Communications applications such as, different range of data throughput, mobile healthcare system, which necessitate tremendously small latency performance as well as ultra high consistency, industrial automation are well maintained. The "moving ambulance" case for example has estimated to make sure that life serious medical care has arranged for the patients though minimizing the delay while moving the patients in the occurrence sight to the hospital for therapeutic consideration. While the case necessitates, where such ambulances have well linked to the hospital with instantaneous broadcast of therapeutic investigation which may comprises of video communications and/or more resolution images. As a result, necessitate for real time process update is significant from the hospital division which afford the medical treatment within the ambulance. For CIoT, Release 14 Third Generation Partnership Project has believed the subsequent ability prerequisites as improvement to Cellular Internet of Things: Inter-RAT mobility to and from Narrowband-Internet of Things, efficient contact service among user device and service ability revelation function , Reprocess of inheritance broadcast/multi cast system, General Packet Radio Service support for Non- Internet Protocol small data by means of services capability exposure function and agreement of make use of coverage improvement. It has obviously studied that in Third Generation Partnership Project previous Release 13, coverage improvement was concentrated, however Release 14 establishes this potential simply to customers who are entirely sign up to this service of coverage improvement in addition to efficient contact among user devices and services capability exposure function as an improvement for acknowledgement of communication send as well as deliver so as to notice the loss of information in the progression of communication.

In finale, a number of developments have been made in the Cellular Internet of Things domain by means of the Long-Term Evolution enrichments of small complication equipments that have been established for Machine-Type Communications applications. Nevertheless, there has a requirement to get on additional investigation and improvement which will begin and improve connectivity solutions that are depends on Fifth Generation Mobile Network for Machine-Type Communications cases. This would definitely help the Internet of Things model and everywhere connectivity for mixed equipments across verticals like electronic commerce, public safety, industrial automation system and smart healthcare system.

B. *Enrichment to Machine-Type Communications*

Although Cellular Internet of Things has a capable technique which maintains the condition of Machine-Type Communications to the customers and assists a chance for wireless service operative in requisites of income generation, there has a necessitate to more develop and improve Long-Term Evolution equipment for Machine-Type

Communications. Considering this, the Third Generation Partnership Project standardization projected an extra complication diminution scheme that has been utilized to attain Machine-Type Communications. In Rel. 14, developments were presently being believed to maintain downlink communications that will enlarge Rel. 13 One CellPoint to Multipoint so as to sustain multicast communication for Enhanced Machine-Type Communications as well as improved coverage region. For a variety of Internet of Things applications, this might be significant that the location of equipment is well-known. Consequently, there has necessitate to estimate and develop MTC interrelated to transmission and reception of measurements in time difference. This would also make sure that the User Equipment complications as well as consumption of power for the experimental difference in time arrival are measured. To advance the high information rates for improved Enhanced Machine-Type Communications, additional contemplation comprises of raising the Transport Block Size, sustain HARQ acknowledge packed and capable of 15 DL HARQ procedures and at last make sure that Voice over Long-Term Evolution enrichment for Enhanced Machine-Type Communications equipments would be attained. The intend of these developments has to make sure that exposure of Voice over Long-Term Evolution for half duplex Frequency Division Duplex along with Time Division Duplex User Equipments are competently improved and maintained.

C. *Enrichment of Narrowband-Internet of Things(NB-IoT)*

NB-IoT has appeared as Third Generation Partnership Project regular based mobile solution in Release 13 for optimized network systems, small device consumption of power, ultra low equipment cost, sustain for huge amount of small throughput equipments, little delay sensitivity and enhanced interior coverage are capable to maintain the non real time voice as well as to assist the ultra low rate for the present requirement of Internet of Things. General cases for Narrowband-Internet of Things contain applications like environment control system, smart cities and constructions and asset tracking etc. This has more enrichments into the Third Generation Partnership Project – Long Term Evolution features for NB-IoT is to enlarge the hold to new power classes, mobility and link variation enrichments, multi cast as well as location positioning that are predictable to be consider in Release 14 for Fifth Generation New Radio network so as to make sure with the intention of market driven requirement of MTC is attained resourcefully.

Multicast: One CellPoint to Multipoint that has measured in Release 13 has to be enlarged so as to facilitate downlink communication (both firmware and software up gradation, delivery of group message) are holded for improved Narrowband-Internet of Things.

Service Continuity and Mobility enrichments: These enrichments to NB-IoT permit linked mode mobility, at the similar time improve service stability and avoid Non-Access Stratum recovery while allowing for the User Plane along with Control Plane solutions devoid of negotiating the consumption of power for the user devices.

New Power Classes: New Classes that may direct to the beginning of New User device through a power level of 15 dBm have to be estimated. According to the last estimation, a signaling method has been expanding for lesser highest power transmits that has been suitable for little form factor battery for wearable. This furthermore proposed to enlarge highest transportation sizes of block by allowing for 1352 downlink bits as well as 1800 uplink bits for which it will facilitate User Equipment into the release to carry highest data rates, decreased delay as well as consumption of power.

D. *Markets Technology Enablers*

The Fifth Generation Mobile Network has been regarded as the upcoming communication models which assure to present the prospect to plan a Third Generation Partnership Project network that has been simply maximized to carry the linked devices as well as services. Third Generation Partnership Project is presently analysis the Release 14 in the direction of potential Fifth Generation service necessities that are

predictable to cover up over 80 cases below the Markets Technology Enablers as talented chance for subsequently generation communication networks. These recently established cases cut across a broad range of new markets from the Internet of Things to vehicular contact along with control, catering for new services like device stealing anticipation as well as revival, industrial automation, tangible internet and drone control system. In some applications the Internet of Things has been sustained by existing systems, there is a necessitate for growth in terms of network slicing, network flexibility, sufficient sustain for dissimilar access technologies and proficient resource deployment which required to be executed into the prospect Fifth Generation radio network that has not voluntarily retrofitted into previously useful and accessible networks. Based on the various manufacturing white papers, the purpose of the prospect Fifth Generation mobile network has an original network model which is anticipated to make sure that various service scopes are competently and successfully maintained.

Table 1. Review of management problems in

Management problems	**Brief explanation**
Management in system configuration	- Network connectivity - Functionality of self-configuration - Devices setting up process - Reconfiguration network
Monitoring of System	It is significant to identify the function and location of related thing in their down-time, sleep condition (mode), running system, etc. so as to recognize their present location of service. - Network topology - Notification of system - Monitoring of network condition
Preservation of linked devices	In view of the heterogeneity of the IoT which engages enormous amount of linked things, this will be significant to observe as well as notice the existence of malfunction. Consequently, this was necessitating to a software defined method which has been utilized for perceiving as well as scheming the occurrence of malfunction in linked things. Additional protection problems to be seemed are revising software, protocol versionrecognition along with updating of patches.
Linked devices performance	It is significant to make sure that suitable examiningsolutions are established for evaluation of system performance as this may avoid the happening of several malfunctions in future. This happens to very vital while allowing for applications that are set up in isolated areas.

Management of energy efficiency	This make sure that the consumption of energy level of the system devices were competently observe includes: - Sufficient information on the level of energy like predictable life span of linked devices. - Energy resources management.
Security and Privacy	In view of the resource inhibited environment of Internet of Things, fundamental protection challenge require to be measured are verification, endorsement, and access control. Additional safety interrelated problems to be deal bymeans of uninterrupted interactions. For instance, taking into consideration the circumstances where linked devices would have to be access by operative applications as well as software devoid of individual interference, as a result, there is require to make sure that severe safety policy are imposed to avoid linked things from enlightening very important and confidential messages to unofficial devices or being utilized impishly. Consequently, severe isolation must be imposed.

Figure 1 shows the projected novel enrichments of service prerequisites for Fifth Generation mobile networks which have competently and successfully carry numerous service dimensions. At last, we conclude with more investigation on the Third Generation Partnership Project New Radio for the rising Internet of Things standards, Fifth Generation mobile network intend at facilitating the fundamental requirements as well as Key Performance Indicator s that are necessary for upcoming Fifth Generation new service necessities to allow the Internet of Things cases.

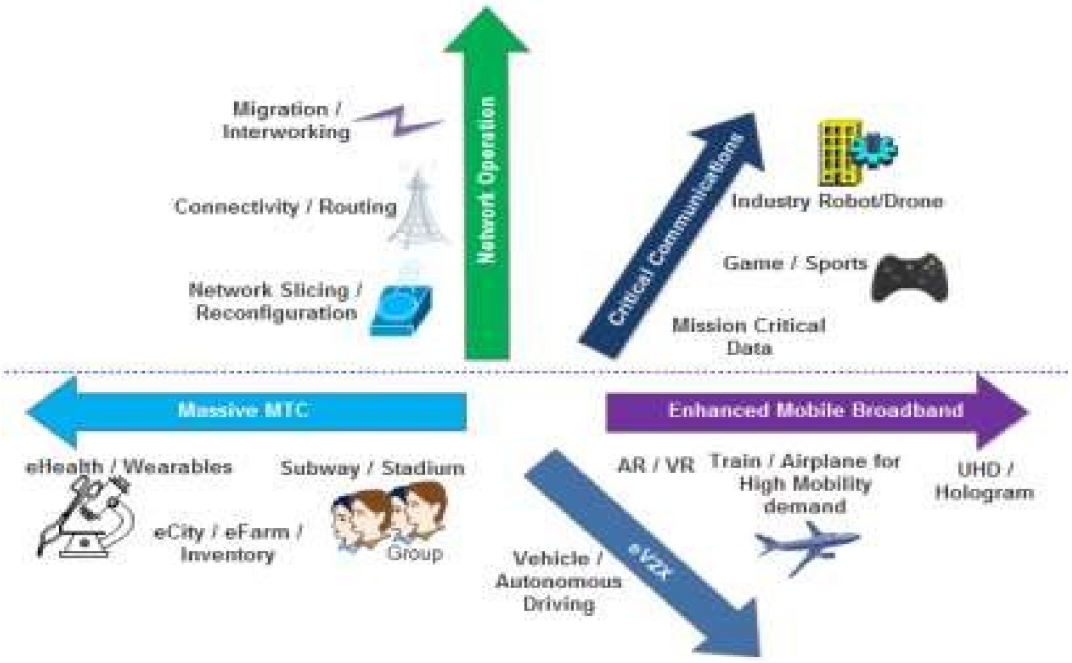

Fig. 1. Markets Technology Enablers - New Service Dimension

Conclusion

The present anticipation and upcoming development of the Internet of Things is capable to facilitate new services as well as quality of experience across the customer society and extremely demanding in the similar time because of the resource controlled environment in the network that was forced the examining group of people to make sure that the necessities for enormous exploitation of Machine-Type Communications applications are attained for worldwide related things. The article have analyzed the distinctive characteristics of the present state-of-the-art of Internet of Things standard communications, together with the cellular-based Low Power Wide Area eMTC, EC GSM IoT, Narrowband-IoT, and non-cellular LPWA technologies with major focus on Fifth Generation Mobile Network. For upcoming development of the Internet of Things, it is thus suggested to extend a context aware congestion control scheme for lightweight Constrained Application Protocol/User Datagram Protocol - based Internet of Things network to maintain the exponential traffic enlargement prototype of the visualized Fifth Generation mobile networks for Machine-Type Communications applications.

References

1. M. R. Palattella et al., "Internet of things in the 5G era: Enablers, architecture, and business models",
2. IEEE Journal on Selected Areas in Communications, vol. 34, no. 3, pp. 510-527, 2016.
3. E. Borgia, "The Internet of Things vision: Key features, applications and open issues", Computer Communications, vol. 54, no. 12, pp. 1-31, 2014.
4. R. Want, B. N. Schilit, and S. Jenson, "Enabling the internet of things", Computer, vol. 48, no. 1, pp. 28- 35, 2015.
5. L. Atzori, A. Iera, and G. Morabito, "The internet of things: A survey", Computer networks, vol. 54, no. 15, pp. 2787-2805, 2010.
6. A. Al-Fuqaha, M. Guizani, M. Mohammadi, M. Aledhari, and M. Ayyash, "Internet of things: A survey on enabling technologies, protocols, and applications", IEEE Communications Surveys & Tutorials, vol. 17, no. 4, pp. 2347-2376, 2015.
7. O. Vermesan et al., "Internet of things strategic research roadmap", Internet of Things-Global Technological and Societal Trends, vol. 1, pp. 9-52, 2011.
8. 3GPP, "Service Requirements for Machine-Type Communications", Sophia-Antipolis Cedex, France, 3GPP TS 22.368 V11.5.0," 2012.
9. J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, "Internet of Things (IoT): A vision, architectural elements, and future directions", Future generation computer systems, vol. 29, no. 7, pp. 1645-1660, 2013.
10. Ericsson, "Cellular Networks for Massive IoT: Enabling Low Power Wide Area Applications", pp. 1-13, 2016.
11. Nokia, "LTE Evolution for IoT Connectivity", Nokia, Tech. Rep., 2016, Nokia White Paper," pp. 1-18, 2016.
12. E. Berthelsen and J. Morrish, "Forecasting the Internet of Things Revenue Opportunity," Machina Research, Tech. Rep.", April, 2015.[Online]. Availability: https://machinaresearch.com/report_pdf/313
13. S. Horten, Vodafone, "Bringing the Smart City to life, M2M Alliance Journal", issue 24, Dec., 2014.
14. S. K. Datta, C. Bonnet, and N. Nikaein, "An IoT gateway centric architecture to provide novel M2M services", in Internet of Things (WF-IoT), 2014 IEEE World Forum on, 2014, pp. 514-519: IEEE.
15. S. Pellicer, G. Santa, A. L. Bleda, R. Maestre, A. J. Jara, and A. G. Skarmeta, "A global perspective of smart cities: A survey", in: IEEE Seventh International Conference on Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS), IEEE, 2013, pp. 439-444.
16. Z. M. Fadlullah, M. M. Fouda, N. Kato, A. Takeuchi, N. Iwasaki, and Y. Nozaki, "Toward intelligent machine-to-machine communications in smart grid," IEEE

Communications Magazine, vol. 49, no. 4, pp.60-65, 2011.
17. Y. Yan, Y. Qian, H. Sharif, and D. Tipper, "A survey on smart grid communication infrastructures: Motivations, requirements and challenges", IEEE communications surveys & tutorials, vol. 15, no. 1, pp. 5-20, 2013.
18. N. Komninos, E. Philippou, and A. Pitsillides, "Survey in smart grid and smart home security: Issues, challenges and countermeasures", IEEE Communications Surveys & Tutorials, vol. 16, no. 4, pp. 1933- 1954, 2014.
19. A. M. Abu-Mahfouz, T. Olwal, A. Kurien, J. Munda, and K. Djouani, "Toward developing a distributedautonomous energy management system (DAEMS)", in AFRICON, 2015, 2015, pp. 1-6: IEEE.
20. P. Dongbaare, S. P. Chowdhury, T. O. Olwal, and A. M. Abu-Mahfouz, , "Smart Energy Management System based on an Automayed Distributed Load Limiting Mechanism and Multi-Power Switching Technique", presented in the 51st International Universities' Power Engineering Conference, Sep. 2016.
21. B. Silva, R. M. Fisher, A. Kumar, and G. P. Hancke, "Experimental link quality characterization of wireless sensor networks for underground monitoring", IEEE Transactions on Industrial Informatics, vol. 11, no. 5, pp. 1099-1110, 2015.
22. B. Cheng, L. Cui, W. Jia, W. Zhao, and P. H. Gerhard, "Multiple Region of Interest Coverage in Camera Sensor Networks for Tele- Intensive Care Units", IEEE Transactions on Industrial Informatics, vol. 12, no. 6, pp. 2331-2341, 2016.
23. K. S. E. Phala, A. Kumar, and G. P. Hancke, "Air quality monitoring system based on ISO/IEC/IEEE 21451 standards", IEEE Sensors Journal, vol. 16, no. 12, pp. 5037-5045, 2016.
24. A. M. Abu-Mahfouz, Y. Hamam, P. R. Page, K. Djouani, and A. Kurien, "Real-time dynamic hydraulic model for potable water loss reduction", Procedia Engineering, vol. 154, no. 8, pp. 99-106, 2016.
25. J. Jermyn, R. P. Jover, I. Murynets, M. Istomin, and S. Stolfo, "Scalability of Machine to Machine systems and the Internet of Things on LTE mobile networks", in: IEEE 16th International Symposium on World of Wireless, Mobile and Multimedia Networks (WoWMoM), IEEE, 2015, pp. 1-9.
26. L. A. Taylor, Zigbee, "Interconnecting Zigbee & M2M Networks, ETSI M2M Workshop, Sophia- Antipolis.", pp. 1-18, Oct., 2011.
27. RPMA, ""RPMA Technology for the Internet of Things", Ingenu, Tech. Rep.," 2016.
28. SigFox, "SigFox", [online]. Availability: htpp://www.sigfox.com.
29. L. Vangelista, A. Zanella, and M. Zorzi, "Long-range IoT technologies: The dawn of LoRa™", in Future Access Enablers of Ubiquitous and Intelligent Infrastructures, 2015, pp. 51-58: Springer

ANTECEDENTS OF EMPLOYEES WORK ENGAGEMENT: A STUDY ON AN ETHIOPIAN UNIVERSITIES IN CASE OF AMHARA REGIONAL STATE

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ABSTRACT

This study aimed to investigate the antecedents influencing employees' engagement at universities in Amhar Reginal state Ethiopia. The study used descriptive and explanatory research designs. A total of 320 academics staffs were taken from ten Amhara Reginal State public Universities as a sample and 282 valid questionnaires collected. Convenience and snowball sampling were used to select the employees from each University. Also, cross sectional survey method applied to collect data via Likert scale questionnaire. Correlation and multiple regression modeling were used to appraisal association and predict the relationships. Initially, a pilot test was a sampled of 30 instructors to check data scale reliability. The study found that all the independent variables (work environment, leadership, reward, organizational support, work motivation) variables had statistically significant correlation with employees' engagement. Morover the study founded that all the studied variables were predictors of workers engagement(R^2= 0.662); but the predictors that had foremost influence were working environment, leadership and work motivation. Remarkable emphasis and devotion is required particularly on variables such as working environment, leadership and work motivation as they have reveled significantly greater influence on employees engagement. Universities shall focus on creating better work environment, working on instructors motivating factors and more work is required to improve the leadership to boost work engagement.

Keywords: *engagement, work environment, leadership, reward, organizational support, work motivation, Universities, Amhara*

Introduction

Employees work engagement is a notion given substantial concern in recent years (Bedarkar & Pandita, 2014). In today's organizations engaged employees are taken as an instrument for competitive advantage in their success. Because, according to Bakker, Albercht and Leiter (2011) in a contemporary world, having highly talented employees is not enough organizations should also enthuse and aid the workers to dedicate their utmost competences to their job. Work engagement is a notion which comprises three dimensions: vigor, dedication and absorption. Employees which are highly engaged are characterized by high level of effort, dedication and vigor. Employees' engagement involves the logical and emotional connection of employees with its firms (Nagesh, Kulenur & Shetty, 2019).

Employees' job engagement is positively and significantly correlated to employees' productivity, creativity, commitment, willingness, innovativeness and customer services and I role and extra role behavior (Belay & Lehal, 2019). As mentioned in the work of Bakker, Albercht and Leiter (2011) workers which are greatly engaged robust, effective person who use impact on actions that influence their endeavors. As a result of their energy level and positive assertiveness, engaged workers create their own positive attitude, recognition and be successful. On the other hand, disengaged workers have a huge loss on organizations. For instance, as mentioned in the work of Osborne and Hammoud (2017) disengaged workers generally caused to incur $ 350 in United States Companies annually. Engaged workers are more probably devoted with increased level of continual energy than those who are disengaged (Arnold. 2011).

Firms across sectors struggle to persist and beat today's fierce competition, mental and physical health of the workers is one of the critical concerns that a human resource managers should focus on. Therefore, workers' engagement is today considered as an influential foundation of competitive advantage in disruptive times (Bedarkar & Pandita, 2014). A review by Robertson-Smith & Markwick, (2009) reveled that engagement is positively associated with productivity, group and organizational success and can lessen absenteeism and turnover levels.

Organizations know that engaged workers are more productive and therefore every employers needs to analyze the antecedents of employees engagement. As the work of Arnold (2011), AbuKhalifeh & Som (2013), Bedarkar & Pandita (2014), Zainol, Hussin, & bintiOthman (2016), Wuttaphan (2016) Fazna Mansoor (2016), Nagesh, Kulenur, & Shetty (2019), there are many antecedents factors influencing employee engagement, namely teamwork, and collaboration, company management, supervisor and coworker relationship, communication, the image of the organization, job role work-life balance, environment, leadership, decision making and policies and procedures, incentives and pay, training and development. The most critical asset which is available to an organization is its workers; hence, having engaged worker is very decisive for any organization (Ngethe, Iravo, & Namusonge, 2012). Employees engagement is becoming a vital issue in the recent body of research as engaged workers not only accomplish better in their jobs but also more satisfied in the workplace and feel happier (MacDongh & Orla. 2017).

As per the finding of Arnold (2011), engaged employees are enthusiastic in their work, bursting with energy and deep in their work activities. Workers who are engaged in their job are completely attached to their job and they will not have the intention to quit their job, performs better, and has a positive emotion and high energy towards their duty (Wuttaphan, 2016; Arnold, 2011).

Ethiopia has a young and quickly expanding higher education system (Abebe, 2015). Ethiopia has been noticeably expanding its higher education institutions over the past two decades simultaneously the number of faculty also increased (Portela & Gebremedhin, 2020). According to Alemayehu & Woldemariam(2020) the faculty's willingness to stay in its respective institution is depending upon the presence of impartial human resource, rules, regulation , policies and practices, the existence of fair reward scheme which is reasonable, better working conditions, academic freedom, and career path. When employees leave their jobs, it is often a sign of disengagement or there is something going wrong (Ngethe, Iravo, & Namusonge, 2012).

Ethiopian Universities expect their faculties to show high initiative, to be proactive, and take responsibility for their own professional development. Moreover, they need staffs who engaged with their work: that feels energetic and dedicated, physically, and emotionally attached to his/her institution. Furthermore, the public at large expects that higher education contributes a lot to a nation's development; but this development is contingent upon competent faculties of the higher education institutions. Nowadays, getting competent and qualified academic staff is becoming tough for higher educational institutions since the potential candidates are choosing for banks, political organizations, and other sectors that are offering better salaries and benefits. Consequently, this would have a negating consequence on country's overall education system.

As far as the researcher's knowledge is concerned, there are not academic research studies which had not been conducted on the antecedents of employee engagement in Ethiopia in general in Amhara regional state in particular. Therefore, the current study tried to investigate antecedents that influenced the work engagement of employees at public universities in Amhara Regional State, Ethiopia.

Literature Review

Theoretical Underpinnings

Kahn (1990) was one of the pioneer thinker theorized work engagement (Arnold, 2011). Kahn considered engaged workers as being wholly connected with their work roles cognitively, emotionally, and physically (Anitha, 2014; Bedarkar & Pandita, 2014; Arnold, 2011). Employees' engagement is a vital paradigm in a body of research as an engaged workers are not only rendering better services but also they are motivated, satisfied, and happier in the work environment (MacDonagh & Orla, 2017).Worldwide, many companies struggle to be the winner of today's stiff competition to this end, the healthiness of the workers is one of the paramount factors that the leaders should know and give due attention. Henceforth, a worker engagement is considered as an influential weapon to gain a competitive advantage in today's competitive

era (Bedarkar, & Pandita, 2014). Work engagement denotes a job related psychological state that comprises absorption, vigor, and dedication to the task and organization (Kahan, 1990; Bakker & Leiter, 2010; Arnold, 2011). Today's implication of job engagement is involvement, commitment, enthusiasm, passion, energy, absorption and focused effort (Bakker & Leiter, 2010).

There are three types of workers in organizations; actively disengaged workers, not engaged workers, and engaged workers. Actively disengaged workers are very dangerous worker who are not only do not execute well but also depress the higher performer in the organization. Engaged employees are builders who persistently struggle to give excellence within their roles. They do what they are told to do. (Gallup., 2002). An employee engaged is aware of his or her responsibility and inspires his coworkers for the organizational goals (Anitha, 2014). The general idea on the concept is that engaged employees give more of what they have to offer and as a result an engaged staff is simply a more productive one (Macey, Schneider, Barbera, & Young, 2009).

Empirical Studies

Significant consideration has been given to association of worker engagement to rewards of organizations (Bedarkar & Pandita, 2014). Studies founded that for attracting candidates' compensation and reward package increasingly becomes important factor (Sange, 2015). Workers expect acknowledgement for their offerings and contribution (AbuKhalifeh & Som, 2013). Many organizations often offer formal rewards and recognition packages in exchange for workers contributions. In addition to this, many workers still expect day-to-day informal praise. The absence of adequate reward has been identified as a key factor for work engagement (Anitha, 2014 & AbuKhalifeh & Som, 2013). Indemnification is a compulsory feature workers engagement that inspires workers to accomplish more and hence focus more on task. Compensation embraces financial and non-financial indemnifications (Anitha, 2014). To have a benefit in attracting and retaining talented employees, organizations should focus on their employee's value (Sange, 2015). As noted by the research findings of Despoina, Arnold, Evangelia, & Wilma (2009), Jane, Mike, & Namusonge (2012), Anitha (2014), Zainol, Hussin, & Bintiothman, (2016) adequate compensation enables the workers to be more engaged, satisfied, and happier in the work environment.

As noted by the research findings of Bedakar Pandita (2014), Anitha (2014), Wuttaphan (2016), Zainol, Hussin, & bintiOthman, (2016) there is a positive e correlation between leader behaviors and follower job engagement. According to Anitha (2014), leadership is one the fundamental factor that influences employee engagement. The contribution of leadership in enlightening workers could not be separated with work engagement (Sugianingrat et al, 2019) Leaders are responsible to a pay a major role in utilizing the workers efforts for overall organization success. When the workers job is considered meaningful and important, it leads obviously to their interest and engagement (Bakker, Albrecht, & Leiter, 2011).

Besides affecting work motivation, work engagement, can also be influenced by interpersonal relationship. Workers felt safer in working environment characterized by supportiveness and openness (Kahn, 1990). Coworker is one of important elements of working environment variables that focuses explicitly on the interpersonal harmony aspect of employees' engagement (Anitha, 2014) According to Kahn (1990) supportive and trusting interpersonal relationship as well as a supportive team promotes employees engagement by creative conducive work environment.

One of the factors affecting the work engagement is work motivation. There must be a motive for workers to wholly invest their vigor during work time. To have this kind of devotion the degree that works are high on intrinsic motivation that they inspire engagement (Macey, Schneider, Barbera, & Young, 2009).Engaged workers are most likely to prefer to stay with the institution and perform 25% better than their coworkers and act as an advocators of the organization (Gemma & Carl, 2009). According to Kahn (1990) engagement could lead to intrinsic stimulation, creativity, attentiveness,

authenticity and ethical behavior. Engagement helps to have better effort and more productive and happy workers (Gallup, 2006) Engagement could empower the workers to exert themselves wholly in their work, with improved self-efficacy and a positive influence upon the workers' wellbeing which in turn induces better employees support for the organization (Gemma & Carl, 2009) engaged workers are most likely to work better through strengthen level of effort than those who are disconnected (Arnold, 2011)

Empirical studies have found that work engagement and organizational support as a key job resource that enables employees to be adaptable with their job demand (MacDonagh & Orla, 2017). Alike supportive interpersonal relationships organizational support allows the workers to try and to fail without fear of the consequence. Workers also engaged when they had some control over their work (Kahn, 1990). A study conducted by Dai and Qin (2016) shows that there was a positive association between organizational support and work engagement. According to Arnold (2011), organizational feedback, skill variety, autonomy given by the organization and social support from coworkers and supervisors, leads to more work engagement and consequently to higher performance.

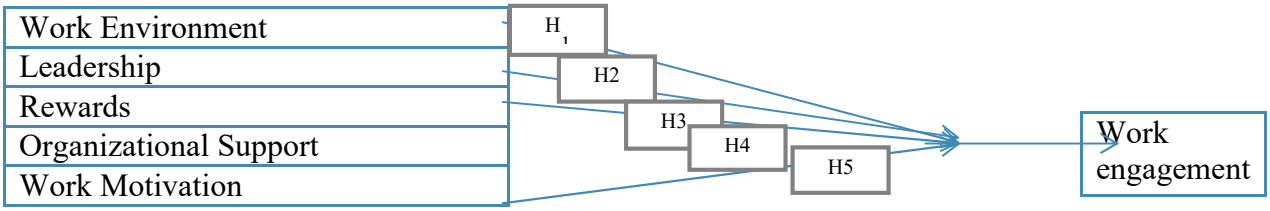

Figure 1: adopted from Conceptual framework of the research

Methods

Research Design: A blend of descriptive and explanatory research designs had been used.

Population and Samples: Population of the study was all academic staffs working in the Amhara regional sate public universities of Ethiopia. There are 10 public Universities in Amhara regional state. To this end, all public Universities were targeted in the current study. A total of 320 survey questionnaires distributed, 282 questionnaires were returned and used for the data analysis purpose representing a response rate of 88%.

Survey Instruments: an online survey questionnaire was developed to this study to investigate the influence of variables such as organizational support, work motivation, leadership, rewards, and work environment on work environment. Work engagement of academic staffs measured by using a standardized questionnaire, called Utrecht work engagement scale

The elements of workers engagement used in this study were dedication (3 questions), vigor (3 questions), and absorption (3 questions). Moreover, the respondents were asked to rate each item on five point likert scale question ranging from strongly agree (1) to strongly disagree (50 in relation to the five variables influencing academic staffs work engagement.

Statistical methods for data analysis: to analyze the collected data both descriptive and inferential statistical tools have been used**.** To test the hypotheses, Pearson correlation analysis used. Regression was also used to analyze the level of influence made by independent variables (organizational support, leadership, work motivation, rewards, and work environment) on dependent variable (work engagement). All the data analysis was done by using Statistical Package for Social Science version 24 (SPSS24).

Reliability Test: Cronbach's alpha is the most commonly used tool for measuring the effeteness of instrument (Zikmund & Babin, 2010). According to Zikmund & Babin, (2010) the range of reliability test that is above 0.7 is Good. Accordingly, the internal consistency of the survey instruments used in this study was reliable in the given population as shown in table1.

Table 1: Cronbach's Alpa result

Item-Total Statistics	
Variable	Cronbach's Alpha
Engagement	.753
Work Environment	.683
Leadership	.701
Reward	.768
Organizational support	.743
Work motivation	.796
Overall	.778

Source: Own survey, 2021

Discussion and Result

Table 2: Education level

What is the highest educational degree you earned?				
Educational level	Frequency	Percent	Valid percent	Cumulative percent
Bachelor's degree	12	4.3	4.3	4.3
Master's degree	265	94.0	94.0	98.2
Doctorate	5	1.8	1.8	100.0
Total	282	100.0	100.0	

Source: Own survey, 2021

Considering the respondents education level (4.3%) of the respondents are bachelor's degree holder, 265(94%) are master's degree holder and the remaining 5 (1.8%) are hold doctor of philosophy. This implies that almost all respondents are master's degree holder.

Table 3: Universities

University	**At which university you are working in?**			
	Frequency	Percent	Valid percent	Cumulative percent
Bahir Dar University	38	13.5	13.5	13.5
University of Gondar	40	14.2	14.2	27.7
Debre Markos University	51	18.1	18.1	45.7
Debre Berhan University	22	7.8	7.8	53.5
Wollo University	21	7.4	7.4	61.0
Debre Tabor University	51	18.1	18.1	79.1
Woldia University	22	7.8	7.8	86.9
Debark University	20	7.1	7.1	94.0
Injibara University	12	4.3	4.3	98.2
Mekdela Amba University	5	1.8	1.8	100.0
Total	282	100.0	100.0	

Source: Own survey, 2021

Regarding participants of the study 51 (18.1%) were from Debre Tabor and similar number of respondents were taken from Debre Markos University. 40 (14.2%) from University of Gondar, 38 (13.5%) Bahir Dar University, and 22 (7.8%) were from Debre Berhan University and similar number of respondents were taken from Woldia University. 21 (7.4%), 20 (7.1%), 12 (4.3%) respondents were from Wollo University, Debark University, Injibara University respectively. Small number of respondents 5 (1.8%) were from Mekdela Amba University.

Table 4: Year of Service

Year of service at university				
	Frequency	Percent	Valid percent	Cumulative percent
Less than 1 year	11	3.9	3.9	3.9
1-3 years	85	30.1	30.1	34.0
4-6 years	81	28.7	28.7	62.8
7-10 years	83	29.4	29.4	92.2
Above 10 years	22	7.8	7.8	100.0
Total	282	100.0	100.0	

Source: Own survey, 2021

Considering the year of experience of the total respondents 85(30.1%) has 1-3 years of experience at a higher institution. 83 (29.4%)

of the respondents has 7-10 years of experience at University. 81(28.7%) of the respondents has 4-6 years of experience a higher institution. 22(7.8%) of the respondents have more than 10 years' work experience and the remaining11 (3.9%) of the respondents have less than 1 year work experience.

As depicted in Table 5 all independent variables such as working environment, leadership, reward, organizational support, and work motivation are positively related to the dependent variable instructors work engagement. Pearson product Correlation of working environment and engagement was found to be statistically significant (r=0.719, p=0.01). Hence, H_1 was supported. This implies when the work environment improved the instructors work engagement also increase. The work of Arnold (2011), Anitha (2014) and Brad, Kobena, Drea, & Kim, (2017) evidenced the significance correlation between working environment and engagement.

Table 5: Pearson Correlations

Correlations							
		Engagement	Working Environment	Leadership	Reward	Organizational	Work Motivation
Engagement	Pearson Correlation	1	.719**	.241**	.185**	.428**	.743**
	Sig.(2-tailed)		0.000	0.000	.002	0.000	0.000
Working Environment	Pearson Correlation	.719**	1	-.050	.032	.326**	.848**
	Sig.(2-tailed)	0.000		.402	.592	0.000	0.000
Leadership	Pearson Correlation	.241**	-.050	1	-.010	.215**	.060
	Sig.(2-tailed)	0.000	.402		.863	0.000	.315
Reward	Pearson Correlation	.185**	.032	-.010	1	.108	.163**
	Sig.(2-tailed)	.002	.592	.863		.071	.006
Organizational support	Pearson Correlation	.428**	.326**	.215**	.108	1	.269**
	Sig.(2-tailed)	0.000	0.000	0.000	.071		0.000
Work Motivation	Pearson Correlation	.743**	.848**	.060	.163**	.269**	1
	Sig.(2-tailed)	0.000	0.000	.315	.006	0.000	
**. Correlation is significant at the 0.01 level (2-tailed)							

Source: Own survey, 2021

Pearson product Correlation engagement and leadership was found to be statistically (r=0.241, p=0.01). Hence, H_2 was supported. This implies when the leadership practice is good, the instructor's work engagement also increase. In this regard, the current finding is in line with the finding of Bedarkar & Pandita, (2014) and Emiko, Reiko, & Kazutomo (2017) that provide evidence for correlation between leadership and instructors work engagement. Pearson product Correlation of reward and engagement was found to be statistically significant (r=0.185, p=0.01). Hence, H_3 was supported. This implies if the reward given to instructors increase, the instructor's work engagement also increase. Studies done by Arnold (2011), Ala`a Nimer & Ahmad, (2013), Anitha (2014) and Sange (2015), and show that rewarded workers are motivated to be engaged at work.

Pearson product Correlation of organizational support and engagement was found to be statistically significant (r= 0.241, 0.01). Hence, H_4 was supported. This implies if the organizational support increase, the instructor's work engagement also increase. The present finding is in line the Kahn, (1990), Kailiang & Xinyu (2016), Ida Ayu Putu, et al (2019) finding which states that a significant correlation between engagement and organizational support. Pearson product Correlation of work motivation and engagement was found to be statistically

significant (r=0. .428, p=0.01). Hence, H5 was supported. This implies if the work motivation increase, the instructor's work engagement also increase. In this regard as the findings of Orla & Joe, (2017) shown that engaged workers not only accomplish better in their works but also more motivated in the workplace.

Table 6: Model Summary

Model Summaryb					
Model	R	R Square	Adjusted R Square	Std.Error of the Estimate	Durbin Watson
1	.817[a]	.668	.662	4.75524	1.768
a. Predictors: (Constant), Work motivation, Leadership, Reward, Organizational support, Working environment					
b. Dependent Variable: Engagement					

Source: Own survey, 2021

Multiple regressions was carried out, it was found all the variables studied were identified as a predictors of employees engagement with an adjusted R^2 value of 66.2% of the variation as depicted in table 6 which is statistically significant. Therefore, 66.2% of the variation in employees' engagement can be explained by five independent variables such as working environment, leadership, reward, organizational support, work motivation in the model. Thus, it can be concluded that the above-mentioned independent variables share 66.2 % of the influence on employee engagement. This means that 33.8% of the influencing factors of employee engagement cannot be explained by this study variable, which may require further investigations by other researches.

Table 7: ANOVA[a] result

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12547.406	5	2509.481	110.979	.000[b]
	Residual	6240.995	276	22.612		
	Total	18788.401	281			
a. Dependent variable: Engagement						
b. Predictors : (Constant), Work motivation, Leadership, Reward, Organizational support, Working environment						

Source: Own survey, 2021

Table 7, reveals the ANOVA result, that reveled a statistically significant probability value (p= 0.000) and shows that all the variables of leadership, working environment, reward, organizational support, work motivation explain significantly employee engagement

Table 8: **Coefficients[a]**

Coefficients[a]								
Model		Unstandardized coefficients		standardized coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	13.922	2.140		6.505	.000		
	Working Environment	.727	.138	.372	5.264	.000	.241	4.151
	Leadership	.437	.078	.206	5.599	.000	.891	1.122
	Reward	.165	.060	.100	2.754	.006	.914	1.094
	Organizational Support	.236	.058	.156	4.076	.000	.822	1.216
	Work motivation	.733	.142	.357	5.143	.000	.249	4.009
a. Dependent Variable: Engagement								

Source: Own survey, 2021

As shown in table 8 the t-values indicates that leadership (t =5.599), working environment (t =5.264), and work motivation (5.143) are the most influential factors on workers engagement as they're statistically significant at 0.01 level of significance. B values also tells that the working environment effects up to 37.2 percent as determinants of workers work engagement and work motivation as about 35.7 percent influence on instructors work engagement. Leadership, reward, organizational supports have 20.6 per cent, 10.0 per cent, 15.6 per cent influence on instructor's work engagement.

Conclusion and Implication

This study focused on examining the antecedents of employees work engagement and also it detects five antecedents that have a significant effect on it. Moreover, this study also discloses all the independent variables have statistically significant correlation with employees work engagement. The multiple regression analysis result predicts that out of several statistically significant factors that have an influence on employees work engagement were working environment and work motivations. Working environment and work motivations were found to have significant *t* value in relation with employees' engagement. This implies that creating a healthy working atmosphere for instructors could help the Universities to have engaged employees. This replicates job motivation that could be leads to vigor, dedication and absorption. Employees would be highly engaged in their work when the Universities give considerable support attention in terms of the determinants being addressed. Therefore, universities are advised to give considerable emphasis on creating sound work place environment, employees' motivation and they have to work to create better leadership.

References

1. Abebe, R. T. (2015). Expanding quality assurance in Ethiopian higher education. Working Papers in Higher Education Studies, 1(2).
2. AbuKhalifeh, A. N., & Som, A. P. (2013). The Antecedents Affecting Employee Engagement and Organizational Performance. Asian Social Science, 9(7).
3. Ala`a Nimer, A., & Ahmad, P. M. (2013). The Antecedents Affecting Employee
6. Abebe, R. T. (2015). Expanding quality assurance in Ethiopian higher education.
7. AbuKhalifeh, A. N., & Som, A. P. (2013). The Antecedents Affecting Employee Engagement and Organizational Performance. Asian Social Science, 9(7).
8. Ala`a Nimer, A., & Ahmad, P. M. (2013). The Antecedents Affecting Employee Engagement and Organizational Performance. Asian Social Science, 9(3).
9. Alemayehu, B. Z., & Woldemariam, G. K. (2020). Academic staff flight from Ethiopian public universities: Causes and possible solutions. Wiley Online Library.
10. Anitha, J. (2014). Determinants of employee engagement and their impact on

Engagement and Organizational Performance. Asian Social Science, 9(3).

4. Alemayehu, B. Z., & Woldemariam, G. K. (2020). Academic staff flight from Ethiopian public universities: Causes and possible solutions. Wiley Online Library.
5. Anitha, J. (2014). Determinants of employee engagement and their impact on employee performance. International Journal of Productivity and Performance Management, 63(2).

Working Papers in Higher Education Studies, 1(2).

employee performance. International Journal of Productivity and Performance Management, 63(2).

11. Arnold, B. B. (2011). An Evidence-Based Model of Work Engagement. Current Directions in Psychological Science, 20(4).
12. Arnold., B. B. (2011). An Evidence-Based Model of Work Engagement. Current Directions in Psychological Science, 20(4).
13. Bakker, A. B., & Leiter, M. P. (2010). Work Engagement: A Handbook of

Essential Theory and Research. Psychology Press.
14. Bakker, A. B., Albrecht, S. L., & Leiter, M. P. (2011). Key questions regarding work engagement. European Journal of Work and Organizational Psychology, 20(1).
15. Bedarkar, M., & Pandita, D. (2014). A study on the drivers of employee engagement impacting employee performance. Procedia - Social and Behavioral Sciences .
16. Belay, D., & Lehal, R. (2019). Fueling Employees Work Engagement through Work Place Support:Evidence from Ethiopian Public University. International Journal of Management Studies, 1(4).
17. Brad, S., Kobena, O., Drea, Z., & Kim, N. (2017). Definitional and Conceptual Muddling: Identifying the Positionality of Employee Engagement and Defining the Construct. Human Resource Development Review, 3.
18. Coetzee, S., & Rothmann, S. (2005). Work engagement of employees at a higher education institution in South Africa. Southern African Business Review, 9(3).
19. Dai, K., & Qin, X. (2016). Perceived Organizational Support and Employee Engagement: Based on the Research of Organizational Identification and Organizational Justice. Open Journal of Social Sciences, 4(46-57).
20. Despoina, X., Arnold, B. B., Evangelia, D., & Wilma, B. S. (2009). Work engagement and financial returns: A diary study on the role of job and personal resources. Journal of Occupational and Organizational Psychology.
21. Emiko, K., R. I., & K. O. (2017). Relationship of High Work Engagement among Staff Midwives with Their Immediate Superiors' urnout on Maternity and Labor Wards in Japan. Open Journal of Nursing, 7(39-49).
22. Fazna Mansoor, Z. H. (2016). Factors influencing Employee Engagement: A study on a elecommunication Network provider in Maldives. International Journal of Accounting & Business Management, 4(1).
23. Gallup. (2006). Gallup study: engaged employees inspire company innovation: national survey finds that passionate workers are most likely todrive organisations forward. The Gallup Management Journal.
24. Gallup. (2002). The high cost of disengaged employees. Gallup Business Journal.
25. Gemma, R.-S., & Carl, M. (2009). Employee Engagement A review of current thinking. Institute for Employment Studies.
26. Ida Ayu Putu, W. S., S. R., i, C. A., M. X., S. D., & W. G. (2019). The employee engagement and OCB as mediating on employee performance", International Journal of Productivityand Performance Management. Emerald Insight.
27. Jane, M. N., Mike, E. I., & Namusonge, G. (2012). Determinants of Academic Staff Retention in Public Universities in Kenya: (Vol. 2). International Journal of Humanities and Social Science.
28. Kahn, W. A. (1990). Psychological Conditions of Personal Engagement and Disengagement at Work. The Academy of Management Journal, 33(4).
29. Kailiang, D., & X. Q. (2016). Perceived Organizational Support and Employee Engagement: Based on port and Employee Engagement: Based on the Research of Organizational Identification and Organizational Justice. Open Journal of Social Sciences, 4(46-57.).
30. MacDonagh, J., & Orla, B. (2017). What's love got to do with it? Employee engagement amongst higher education workers (Vol. 36). Irish Journal of Management.
31. Macey, W. H., Schneider, B., Barbera, K. M., & Young, S. A. (2009). Employee Engagement:Tools for Analysis, Practice, and Competitive Advantage. A John Wiley & Sons, Ltd.
32. Nagesh, P., Kulenur, S., & Shetty, P. (2019). he Study on Factors Affecting Employee Engagement. International Journal of Engineering Research & Technology, 8(6).
33. Ng'ethe, J. M., Iravo, M. E., & Namusonge, G. (2012). Determinants of

Academic Staff Retention in Public Universities in Kenya:Empirical Review. International Journal of Humanities and Social Science, 2(13).

34. Ngethe, J. M., Iravo, M. E., & Namusonge, G. (2012). Determinants of Academic Staff Retention in Public Universities in Kenya:Empirical Review. International Journal of Humanities and Social Science, 2(13).
35. Orla, B., & Joe, M. (2017). What's love got to do with it? Employee engagement amongst higher education workers. Irish Journal of Management, 3.
36. Osborne, S., & Hammoud, M. S. (2017). Effective Employee Engagement in the Workplace. International Journal of Applied Management and Technology, 16(1).
37. Portela, M. J., & Gebremedhin, A. (2020). Prospective evaluation f GPE's country-level support to education:Country Level Evaluation: Ethiopia.
38. Robertson-Smith, G., & Markwick, C. (2009). Employee Engagement: A review of current thinking.
39. Sange, R. T. (2015). Progressive Importance of the Drivers of Employee Engagement. Indian Journal of Science and Technology, 8(4).
40. Wuttaphan, N. (2016). Factors Affecting Faculty Engagement: A Review Literature. HORDJournal, 8(12).
41. Zainol, S. S., Hussin, S. b., & bintiOthman, M. S. (2016). Determinants of Employee Engagement in Hotel Industry in Malaysia.A Theoretical Model. International Journal of Academic Research in Accounting, Finance and Management Sciences, 6(3).
42. Zikmund, W., & Babin, B. J. (2010). Essentials of Marketing Research (4 ed.). Thomson South-Western, Cengage Learning, USA.

AI BASED VOICE BIOMETRIC AUTHENTICATION FOR REMOTE PROCTORING

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ABSTRACT

Right from the evolution of human kind, various new technologies has been invented which makes our daily routine easier. Currently we are in an era, where technology plays a vital role. When talking about online community where all the task can be done virtually, educational sector has its own impact. Last two years is been a great challenge for all of us due to covid-19. This pandemic completely transformed the traditional teaching and learning pedagogy either in terms of content delivery or in assessing the learners during the examination. Due to this, many academic institutions started exploring various learning management system (LMS) software in order to create a bridge between the teacher and the learner. Initially it was hardly accepted by few due to its new interface, but later globally acknowledged by many. At the same time conducting the exams in online platform has brought many advantages. The online mode is preferred as it removes the physical boundaries and makes it easy to write the exam from any part of the world. But as the technology is involved, the security and the authentication becomes a major challenge for the institution to identify the presence of the right candidate during the examination. This paper explains about how biometric authentication can be integrated with the existing proctoring application in order to have a secured login by the right candidate during online examination.

Keywords: *Technology, Education, Online, Authentication, LMS.*

Introduction

In the last decade, many new technologies has been invented which created a great impact in the lives of many people. People started to use these inventions which transformed the way they live. Its influence made their routine simple and ease because various complex and critical tasks has been automated and can be carried out in a more efficient manner. Many domains like Banking, Advertisement, Education, Stock market, Real estate, Medical has been benefitted by this modern technology. In the present scenario, educational sector is affected in a much larger way due to covid-19. Restrictions like social distancing and lockdown completely disturbed the traditional way of teaching. Most of the schools, colleges and universities have temporarily withdrawn the old fashioned classroom coaching. Due to this the teachers started exploring various innovative teaching methods to communicate with the learner's inroder to continue their passion in knowledge transfer. In this situation, e-learning came into existence. It has become one of the efficient and effective alternative mode of teaching. The higher education approved online mode of teaching and learning and mostly all the academic sectors in this global village started integrating it in their curriculum. With the support of learning management system(LMS) they continued to run the institution which was greatly appreciated by the learner's. First time in the history, entertainment gadgets like mobiles, tablets, laptops are used for academic purpose with the support of web. LMS platforms like MOODLE, WHEEBOX, METTLE are playing a vital role in enhancing e-learning approach. Teacher's and the Learners can interact, communicate, share content and discuss in forum using learning management system. The students will have to login using his/her credentials whenever they need to access the content in learning management system.

Objective Of The Study

The main objective of this research is to find a solution for the following questions.

1. How to validate a candidate writing an online examination through biometric authentication.
2. How secured and reliable is this biometric authentication works.
3. In which online examination application we can implement this biometric technology.

Research Methpdology

This research paper used an exploratory research methodology in which a new biometric

voice recognition technology is been integrated with an existing examination management tool software. It is a proposed prototype which can support the academic institutions in conduct of online examination.

Findings

In all these years, the traditional way to permit a candidate for the offline examination is through his/her identity card and hall ticket provided by the institution. These documents will be retained by the candidate throughout the duration of the examination as a proof of his/her identity. But in the current situation we authenticate the candidate through the predefined unique alphanumeric login and password credentials generated by the Online Examination software. But the question we need ask ourself is how far it is secured and reliable in a long term run. In other words this kind of validation has become outdated unless or until it is integrated with the newest tools which makes the application more dependable and secure. This paper focuses on the voice biometric authentication architecture which can be integrated as a plugin for an examination software for making it safeguarded and secured when a candidate logs in the application.

Biometric information can be used to distinguish between different candidate's identity. Normally face is used to recognize someone through their unique features like retina, face iris [1]. But using these face biometrics requires some additional devices like camera, system software. May be not all the exam candidates will have these facilities especially in the rural or developing community sections. Inorder to overcome this problem, a proposed system is been designed which recognizes a person through his voice or acoustic. We all know that every person's voice is different and unique. This can be used for identifying and authenticating a person [2] and this technology is known as Voice Biometric Authentication (VBA). Voice biometric does not require any additional gadgets; a simple microphone can be used. Voice Biometric Authentication (VBA) contains a separate research and development area in biometric architecture. This proposed research creates an environment for communication between human and machine [3]. After the communication, machine will be able to identify and authenticate and give access to the right candidate to write the exam. The table 1 shows a comparison of various biometrics available in the market.

Biometrics	Accuracy	Cost	Size Of Template	Stability	Security Level
Face Recognition	Low	High	large	Low	Low
Iris Scan	High	High	Small	High	Medium
Retina	High	High	Small	Low	Medium
signature	Medium	Low	Medium	Low	Low
Figure print	Average	Low	Small	Low	Low
Voice recognition	Low	Medium	Small	Low	Low
Password	Average	Low	Small	Low	Low

Table 1. The comparative studies of different biometric system [Ref: 4].

We can have a comparison of various biometrics based on accuracy, Cost, Size of template, Stability, Security level. The figure1 shows the graphical representation of comparing various biometrics. In figure I, its clearly shown that biometric used with face recognition has the least accuracy level and at the same time it is very expensive. The reason is even a picture or a video of the same content can unlock the device or in other words, anyone who has your picture can easily login and access you data on the respective device. Iris and retina technology highest level of security. But in terms of cost Iris also is expensive.. Next in the list is voice biometric technology. It has the moderate accuracy level and at the same time inexpensive and easily integrated with the existing system. We need to have only a microphone in the user device which captures the voice command and converts into machine readable format. Others in the lists are finger print technology, digital signature technology which has become an outdated application in this modern era.

Figure 1: Graphical representation of comparing various biometrics. [Ref: 4].

Three Tier Architecture Of Voice Biometric System:

Voice Biometric Authentication (VBA) can be implemented using a three-tier architecture which includes a data tier, Application tier and a Presentation tier. The data tier stored the predefined voice command, application tier contains the business login and the presentation tier is the interface between the user and the software. Figure 2 shows the three-tier architecture of the VBA

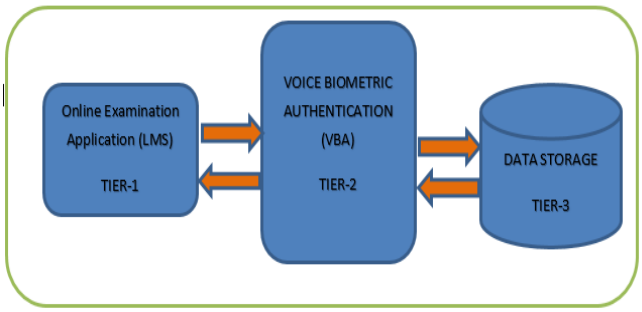

Figure 2: Three-tier architecture of the VBA

In the speech recognition methods, its very important to understand 'who is speaking' and the 'language of the speaker' [5]. Figure 3 shows the block diagram of voice biometric system. Initially a signature sentence (SS) for example "please *authorize my voice for exam*" is setup by the examination board. All the candidates registering for the examination should repeat the signature sentence. this will act as digital voice signature. The voice signatures are stored in the data base once the exam registration process completes. The data base will have voice samples of all the registered candidates.

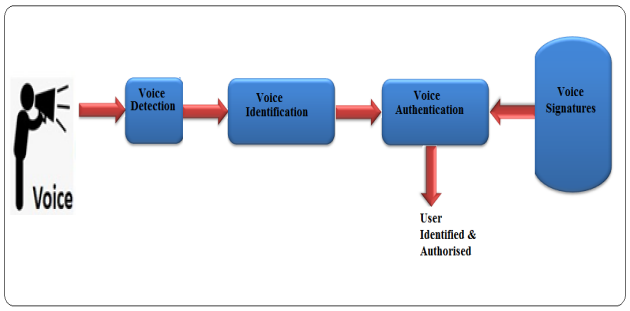

Figure 3: Block diagram of Voice biometric system

During the day of online exam, the registered candidates should login and repeat the signature sentence (SS). The voice of the candidate is detected and then compared with the voice signatures. Only when these two voice signal match with one another, the candidate will be allowed to access the examination portal.

The main advantage of this system is the accessibility and the user interface. Candidate can log in to the application within no time. Another most important quality of VBA is, the candidate need not have to remember the password and username like the traditional system. There is not point in forgetting or resetting the password by the server. Once the voice of the candidate is recognized, he/she can be authorized to take the examination.

Overview Of Voice Biometric Authentication Online Examination Process

A simple procedure has to be adopted by the candidate for using this voice based application technology. Initially the candidates applying for the exam should register along with the login credentials and voice signature sentence. The voice signature along with the login credentials and candidate details will be stored in the database. The information which is already stored in the database in the form of the predefined text can be fetched and validated by the application whenever a candidate log into the system. Once the voice is validated the system opens the respective examination for the candidate. Figure 4 gives an overview of the online examination process using voice recognition authentication.

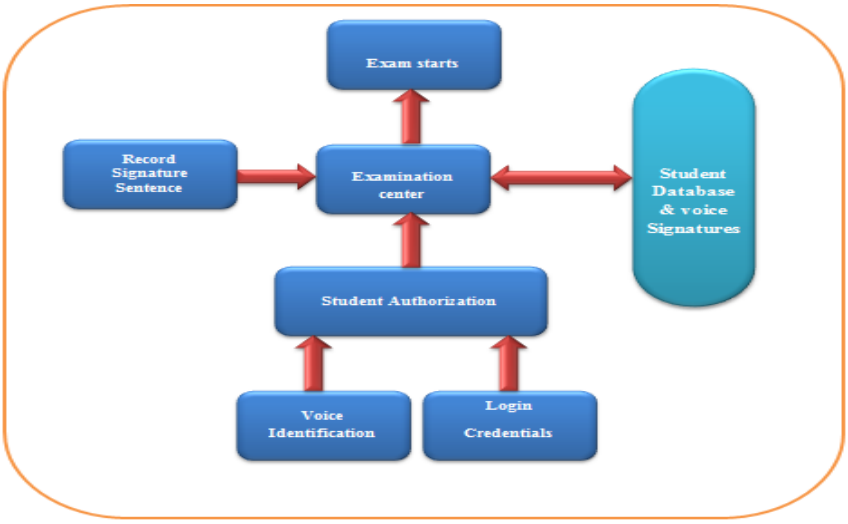

Figure 4: Block diagram of voice biometric

Authentication online examination process

During the time of the online examination, the registered candidates should enter the login credentials and authenticate the right candidature through the voice command. The student authorization section will identify the voice and authenticate it by comparing it with the voice signatures stored in the database. Once the candidate is authenticated then access is given to the exam.

Conclusion

As we are all aware how the pandemic covid-19 has brought a temporary halt to the traditional education system in the last two years. Even though the educational system is trying to find a solution to educate the wards, still it is a challenging task for most of the institutions to convince its stakeholders which includes the parents , students and the teachers. These institutions have to explore and find a solution to the above stated problem and continue their services to the society without any kind of barriers which affects them. One innovative pedagogy is to teach online through learning management system (LMS). But LMS is for content and knowledge sharing platform. When it comes to evaluate a candidate examination is the only way. But the problem is how to proctor and validate a student who is not physically present in the premises of the institution?. The solution is to implement VBA in the LMS and authenticate the candidate before the commencement of the examination. Still it is a part of the examination features. When it comes to proctoring we need to have a better application to monitor the student taking the examination. When this task is achieved then we will have an efficient flexible client server application which integrate all the modules and supports a the academic institution in a better way.

References

1. Nilu Singh (2014), A study on speech and speaker recognition technology and its challenges, proceedings of national Conference on Information Security Challenges. Lucknow: DIT, BBAU, 34-37.
2. M. Kockmann, L. Burget, Contour Modeling of Prosodic and Acoustic Features for Speaker Recognition, Speech@ FIT, Brno University, Czech Republic, 1-4.
3. Nilu Singh, Alka Agrawal, Raees Ahmad Khan. (2015), A Critical Review on Automatic Speaker Recognition, Science Journal of Circuits, Systems and Signal Processing. Vol. 4, No. 2, 2015, pp. 14-17. doi: 10.11648/j.cssp.20150402.12
4. Dr. Rajinder Singh, Shakti Kumar(2014), Comparison of Various Biometric Methods, International Journal of Emerging Technologies in Computational and Applied Sciences(IJETCAS) ISSN (Online): 2279-0055.
5. Gregory G, Jean-Luc G (2018), Optimization of RNN-Based Speech Activity Detection, IEEE/ACM Transactions on Audio, Speech, and Language Processing, 26 (3), 8-12.
6. Bhagyashri Kaiche, Samiksha Kalan, Sneha More, Lekha Shelukar (2014), Online Descriptive Examination and Assessment System, International Journal of Emerging Technology and Advanced Engineering, Certified Journal, Volume 4, Issue 3 , March 2014.
7. Z. M. Yuan, L. Zhang, G. H. Zhan (2013), A novel web-based online examination system for computer Science education, In proceeding of the 33rd Annual Frontiers in Education, S3F7-10.
8. B.Persis Urbana Ivy, A.shalini, A. Yamuna (2012), Web Based online Secured Exam, International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 2, Issue 1,Jassn-Feb 2012, pp.943- 944943.
9. Zhang, et al (2013), Online Descriptive Examination and Assessment System. Development of Standard Examination System of Special Course for Remote Education, Journal of Donghua University (English Edition), 2013, Vol. 19, NO.1, 99-102.

THE SILENT SUFFERINGS OF OPPRESSED MASSES: A NEW HISTORIC STUDY OF GERADLINE BROOKS' *YEAR OF WONDERS*

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ABSTRACT

The silent sufferings of the oppressed masses in Geradline Brook's novels especially Year of Wonders may easily attract the attention of avid readers as these sufferings of the oppressed are so common, human and contemporary. The Year Of Wonders shows the journey of sufferings with all kinds of oppressions leading to tragic episodes. The protagonist Anna Frith serves in the house of Mr. Michael Mompellion, the rector and ultimately faces more terrors and abuse. Hence, the present research paper questions the longstanding prototype of oppression in Geradline Brook's Year Of Wonders.

The remote facts of history are brought into daylight by an eminent American journalist and writer Geraldine Brooks. One of her works March honored her with attaining Pulitzer Prize.

Year of Wonders, a fictional work is inspired by the true story of the villagers of Eyam, summer of 1990. Generously, she spent some time with Eyam's local historian, John. G. Clifford, author of the informative Eyam Plague (1665-1666). She visited the small museum and skimmed the books which were greatly about Eyam, but the lore remains scant. She rendered her efforts to reveal the forbidden incidents to the spectators. Brooks says about her villagers as: "The account was so touching and terrible that it took root in my imagination" (Afterword 305).

New Historicism, a form of literary theory perceives intellectual history through literature and literature is understood through its cultural contexts. Harold Aram Vaseer in his anthology of essays," that every act of unmasking, critique and opposition uses the tools it condemns and risks falling prey to the practice it exposes" (The New Historicism).

The entire story is seen through the eyes of Anna Frith, the narrator, protagonist and "a woman who faced more terrors than many warriors" (15). She serves in the house of Mr. Michael Mompellion, the rector. Though she is an illiterate, she shapes herself as a midwife, herbalist and a socialist. She is locked down and abused by Michael that results in the birth of a girl child. Gayatri Chakrovorthy Spivak says in, "Can the Subaltern Speak?", " the subaltern is very often, though not quiet always, gendered female in my work… because women the word over are still structurally subordinated to men" (15) When Anna voluntarily renders to reads him the Bible, Michael rejects her readily by saying, "You cannot read Anna"(Year Of Wonders 4).

Anna has lost her comfort and safest side of life because, she is a widow and two of her sons are dead. Her father Josiah Bont, grave digger, never cares Anna. Her step-mother Aphra, had Anna in her house in order to take care and nurse her children. She is turned away by Aphra telling, "…Better she be wedded early to Frith than bedded untimely by some youth with a prick more upright than his morals" (7). Her words ached Anna and she comes out. She is treated as a mere object, which Simone De Beaviour maintains that, "Woman is to man " a sexual being", a female by virtue of a certain lack of qualities, ' a natural defectiveness,' ' an incidental being' above all she is ' the others,' she is woman in virtue of her anatomy and physiology" (12). Brooks focused on the fragility of servants in the Hall. When the Bradfords are about to set out of the Hall, they left their servants helpless. They wandered along the streets. Maggie Cantwell, Brand, the pantry boy and the maid Jane felt very sad. They screamed in agony. Maggie cries, "Anna, they have turned me off! Eighteen years, and ordered out on a second's notice!" (107). She continues to grieve, "…now they put us out without a roof or a way to earn our bread!" (107). Anna too experienced the same, when Elizabeth yelled

her saying, "How dare you smirk at me, you insolent slattern!" (15).

The seventeenth century marks the survival of herbalists. This novel entails the chapters of two herbal women namely MemGowdie and AnysGowdie. They grew medicinal plants and extract medicines from barks, leaves, flowers and fruits. These medicinal women make concoction and decoction to cure the sick. Their service to the society and they are put to death in order to end the curse of the village. They are charged as witchcrafts. Stanley called Mem as witch. He debases her as, "She defined God's will in telling folk that they could prevent illness with her teas and sachets and simples" (39). Once, Mem was asked by the villagers to "swim her" (90) in order to find out whether she is a witch who brought plague to village. This drove Mem to catch up in the depth and could not come back. Anys helped her resuscitate conscious. The village drunkards took this as a sign to accuse Anys as a witch. They hung a noose around the neck of Anys. The people of the village proved their savage consciousness towards the poor medicine women.

The victims of the plague and their near and dear ones are treated illegally. Maggie and Brand faced severe insults while their way towards Stoney Middleton. The people of the village left a parcel of catcake and a flask alone at the milestone. A farmer, who saw them, permitted them both to spend the night among his cattle. When they reached the larger town of Bakewell, it was market day. Poor Maggie and Brand has no place to escape. Someone from the crowd recognized Maggie and shouted: "A woman from the plague village! Beware! Beware!" (126).

Children started to peck stones at them. Both of them were treated as mere barbarians.

Nearly half of the entire population of Eyam works in mine factories. Accidently, Anna lost her husband Sam Frith in mine. People who work here have to strife hard from dawn to dusk. In some families, the situation becomes very pathetic. Merry Wickford, a small girl of George and Cleath Wickford lost her parents in plague. Already the entire family has undertaken the mine but they could not succeed in getting the one. Anna and Elinor came forward to help Merry Wickford because, if she cannot take a dish of one before the particular day, the mine will be taken over and owned by someone else. People at mine are dark and their safety is questioned. Brook's usage of diction in narrating the task of Anna in taking one is excellent.

The segregation of classes is vividly exemplified by the sriptor while she talks about the congregation. People are given separate places to be seated. Their seats differ: "the yeomen and miners toward the front, then the artisans, then the crofters and the hands" (19). The poor villagers placed themselves three yards away separated from each family, believed to avoid the passing of infection. Michael took religion in his hand and he attacked people not to leave the village. He asks the people to repent their superficial beliefs and turn towards God. Especially, when the Bradfords decided to leave the village, he rebuked them and speaks in favour of himself. His prejudiced notion make the readers to look him as a stone hearted man, as he fails to help Mrs. Bradford though he is good to many other souls.

Josiah Bont, a grave digger, is yet another man who pays no care to the poor and the needy. He charges hike for digging graves. Even at the courage of death, people are ablazed with ill-spoken words. On Sundays, he did not attend the congregation, instead, knocks at the doors of the ill and say, if he wants to make a grave, he will dig it "then and there or not at all" (191). His filthy words make the sick more panic. If the relatives of the dead ones have no money to pay, they have to give some objects. Once, a widow Brown paid him pewter for the graves of her man and boy. While we read Thomas Gray's "Elegy written in a country churchyard," we find the inspirational expression of human grief, Gray addresses the buried with all dignity and feels sad that they are bereft all contact with the members of their families.

The analysis and skimming of the text gives us denied yet unbelievable myths. Brooks succeeded in giving the remnants of the neglected scars. Brook's painting efforts brought her works an instant success. She is honored and can be applauded for unwrapping the emotions of trails of the periphery and make them to be in centre.

References

1. Brooks, Geraldine. Year of Wonders. New York: Penguin Books, 2001. Print.
2. Brooks, Geraldine. Afterword, Year of Wonders, By Geraldine Brooks. New York: Penguin Books, 2001. 305. Print.
3. Chakravorthy Spivak, Gayatri. "Can the Subaltern Speak?" Web. 1 Ap.2018., <shmoop.com>.
4. Aram Veeser, Harold. The New Historicism. London: Taylor and Francis Ltd., 1994. Print.
5. Beauvior, Simone de. The Second Sex. Trans. And Ed. Am. Oarshely. Harmondsworth: Penguin, 1983. Print.

OPPONENT COLOR MODEL IN NO-REFERENCE QUALITY ANALYSIS OF IMAGES

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ABSTRACT

Image processing has a very promising role in the present digital world. The internet is overwhelmed with images and videos being transmitted from one end to another. Users are selective and they are interested in collecting and watching images and videos that are of good quality. Normally, quality check of images and videos are done subjectively due to varied reasons and due to practical difficulties. This paper explains the implementation of a method that helps in improving the quality score prediction of color images. This paper aims at the use of Opponent color model in describing the content in the image. This emerging color image representation has found its profound application in quality analysis computation and quality score prediction in images. The result of the proposed quality score computation in images is promising and has outperformed other existing methods in terms of correctness of result. The results are verified with subjective analysis and has proven to be accurate.

Keywords: *Opponent color space, NSS images, Quality Assessment, Subjective Analysis*

Introduction

According to the overviews and perceptions, the measure of computerized picture content in the web and web-based media is expanding overwhelmingly. Image processing has been widely popular from the time humans start creating and capturing images. Precisely speaking, an image is a representation of a signal. A digital image contains pixels that has values in numerical representation indicating variations of red, green, and blue colors at a location. Image quality assessment is a significant problem due to the addition of unwanted noises and distortion introduced in the signal. Image quality measures the perceived image degradation..

Mean Squared Error (MSE) compares image with its noisy or distorted counterpart. Likewise, Peak Signal to Noise Ratio (PSNR) is also a customary quality check mechanism to measure degradation occurred in the image[1]. It is impossible to construct the MSE value if the original image is unavailable. PSNR computation generally compares the signal value with noise component. In the majority of situations, getting the pristine quality reference picture or quality score of the picture is not generally feasible. Hence, having an Image assessment algorithm that can compute the quality value of the given image without any reference image is the demand of the image, video and multimedia research industry. Through this paper, we are trying to explore the possibility of predicting the quality value of a Natural Scene Statistics Image by extracting features from the image.

State of the art methods

One way of quality prediction examines the 2D geometrical relationships between local edge elements extracted from natural scenes[2]. These statistics can be used to characterize the information available to support performance of certain simple tasks, such as the contour completion and contour grouping. NSS images are proven to possess some statistical structures that are in the image. In the absence of any kind of degradation of quality in image, these property values remain unchanged and are common for all NSS images[3]. Once if the image is affected by any quality degradation by the addition of noise or distortion, this basic innate properties gets disturbed. Thus the quality of NSS image can be obtained by in fact measuring the amount of degradation happened to the image.

Quality Assessment Based on DCT: Michele Saad, et al in 2010 developed BLIINDS [4] to compute quality value. In this paper the authors have mentioned that without any prior training, human visual system can distinguish high contrast and good quality images from low contrast reduced quality images. Like the way human visual system distinguishes good portions in specific parts of low quality image, it is possible to distinguish distorted sections in images from comparatively good quality

natural images. The approach taken by the authors quantifies the un-naturalness from the usual environment. The local DCT contrast value is calculated and it is used for quantifying distortions and noises.

A K Moorthy and Alan C. Bovik [5] in 2011 proposed a BIQA method relying on wavelet transform coefficients called DIIVINE. In this paper the authors have followed the underlying strong mechanism of quality prediction by means of statistical information collected from the image. It works in a two stage approach. First stage is a distortion identification phase and the second stage is a quality prediction phase by checking the edges or boundaries. This method has a limitation. High computational power is needed as it uses DWT transform.

In 2012, a statistic-based NR IQA model, BRISQUE was suggested and implemented by Mittal which works in spatial domain, [8]. The scientists and researchers have realized that the result of evaluation of image quality ultimately depends on the sensitivity and response of the active viewers. Hence the final image evaluation for perfect and more suitable image in the search of best quality must be based on human response and it has to combine the subjective and objective evaluation methods. A varied set of research studies have revealed that it is necessary to consider the response of Human Visual System (HVS) in evaluation criteria and it will result in better evaluation methods.

In 2016, Sebastian Bosse et al. [9] have developed a Blind IQA method established on self -learning Convolutional Neural network (CNN). The CNN takes as un-pre-processed image patches as input and evaluates the quality without using any domain information. This method divides the images into patches of size 32 × 32 and it is given as input to the training. For training, a quality label is attached with each image patch and it is treated as an independent sample. All the hidden layers in the CNN is activated through ReLU activation function. Zero padding is applied for all the convolutions for maintaining the dimension. 2×2 kernels are used with all max-pool layers and a dropout regularization of ratio 0.5 is given to the fully connected layers. The highlight of this method is that compared to other image quality assessment method, it is not specific to Blind Image Quality Assessment. This technique can be applied to Full Reference or Reduced Reference method.

Observations from the Literature Review

The existing research contributions in this area converts the domain from spatial to another domain to analyse the image. This research work mainly does process in spatial domain, since as per the survey conducted, it is understood that the visual cortex of human beings respond well in spatial domain. The normalized luminance value of the image offers a good knowledge about the amount of distortion happened to the image and the amount of naturalness presented in the image under consideration. In this work, the quality of an NSS image is examined by inspecting the opponent color coefficient value along with normalized luminance value, to compute the quality score [5]. Subjective observations are not needed for opinion-unaware methods for training and hence the practical applicability of such methods are more compared to opinion aware quality assessment methods. Also, the outcome is an independent value which do not rely on training values.

Opponent Color Model

RGB model is the standard way of representation of colors, but it is not the excellent way of representation of color. A better model of perception of Human Visual System towards color can be achieved by *opponent color model*. It is a color theory which states that the human visual system interprets information about color by processing signals from cone cells and rod cells in an opposed manner [11]. It is easy and effective for the human eye to record differences between the responses of cones, than recording each cone's response. This color space has three components: *O1* is called as luminance component, *O2* is the red-green channel and *O3* is the blue-yellow channel. When human beings stare at a bright color for a long while, for example, red, and looking away at a white plain background will perceive them a green color. i.e. activation of one member of the pair inhibits activity in the other.

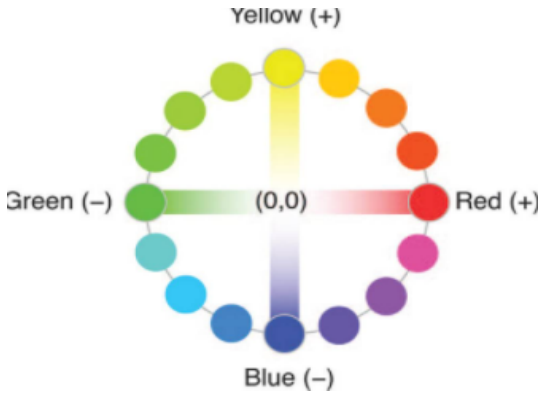

Figure 1: The opponent Color space

This color model describes color vision as a neural interconnection of photoreceptors as shown in Figure 1. This opponent process theory is applicable to various stages of the nervous system. Once the neural system response passes beyond the retina to the brain, the nature of the cell changes and the cell responds in an opponent fashion. This nature of human brain is detailed perfectly by opponent model of color representation [10] and hence the color image in RGB space can be converted to opponent color space. This concept is derived from recordings of retinal and thalamic cells, which were excited by one color and suppressed by another. Based on these oppositions, the cells were called "Blue-yellow", "Green-red" and "black-white" opponent cells. The general conversion matrix followed is as follows:

$$\begin{bmatrix} o1 \\ o2 \\ o3 \end{bmatrix} = \begin{bmatrix} 0.06 & +0.63 & +0.27 \\ 0.30 & +0.04 & -0.35 \\ 0.34 & -0.60 & +0.17 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad \text{-- (1)}$$

This conversion can be alternatively represented using equations as

Red-green : $O1=(R-G)/\sqrt{2}$ -- (2)

yellow-blue : $O2=((R+G)-2B)/\sqrt{6}$ -- (3)

luminance : $O3=(R+G+B)/\sqrt{3}$, -- (4)

for normalized R, G and B values in the range [0,1].

This color space developed by Ruderman et al. has proven to minimize the correlation between the R, G and B color channels in Natural images. This color space is termed as '*Opponent space'* which is based on the fact-driven perception that human visual system is the best suited environment for processing and evaluating natural scenes. In this color space there is no correlation between the axes and hence, cross channel artifacts in the image is negligible. Another advantage in this color space is that the uniform change in intensity of the image pixel is also detectable uniformly in all the affected pixels. Hence, in order to completely capture the color statistical properties, the image can the diagnosed by converting RGB Channels to opponent signals. In this model, as shown in Figure 2, blue-yellow channel and red-green information are denoted by two parallel channels in the visual system that combine cone signals differently. The science behind human vision system states that cones, the color photo receptors in the human retina are sensitive to long (L-cone), middle (M-cone) and short (S-cone) wavelengths. As the neural system travels beyond the retina to the brain, the behavior of the cell changes and it depicts an opponent kind of nature. Thus, L, M and S belong to first layer of the retina whereas luminance and opponent colors belong to second layer, forming the basis of chromatic input to the primary visual cortex. Thus, the RGB space is best in representing digital images in devices and the LMS space represents images better in the first layer of human retina.

Figure 3 shows a set of 4 images where one is an average quality original image and the remaining three are the output given by Equation (2) to Equation (4) when applied on the original image. With naked eyes, by observing the resultant image, the users cannot extract any information, but the beauty of the opponent color space becomes exposed when analysis of the histogram distributions of these coefficients are done.

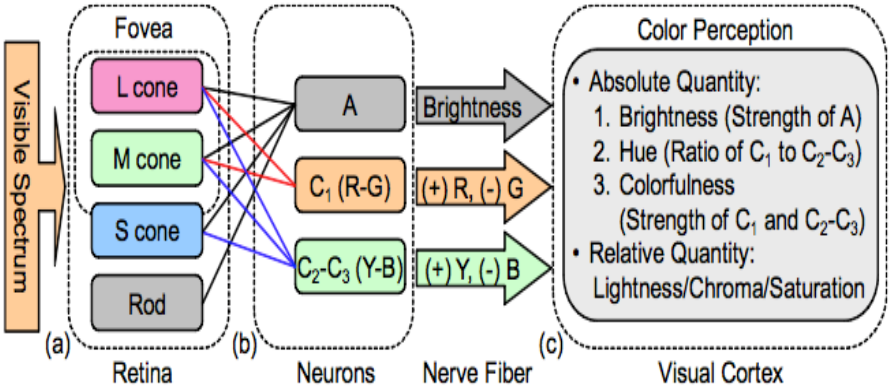

Figure 2: Opponent color space representation

Figure 3: The O1, O2 and O3 components of the given pristine image. *O1* is called as luminance component, *O2* is the red-green channel and *O3* is the blue-yellow channel.

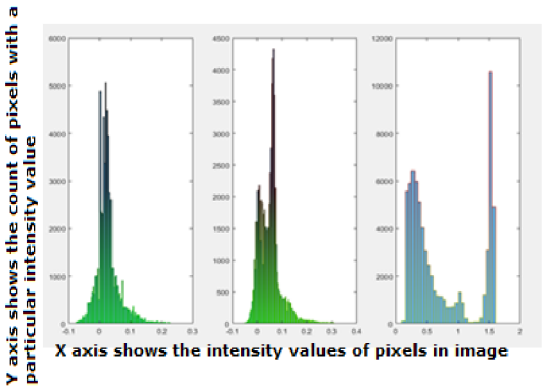

Figure 4: The histogram pattern shown by the computed O1, O2 and O3 channels

It is observed that the opponent color space values follow a Gaussian probability pattern for natural undistorted images [5]. Hence, an outline curve is fitted for the histogram channels O_1, O_2, and O_3 and that is compared with a Gaussian function as expressed in Equation (5), and the model parameters are extracted from these representation.

$$f(x;\zeta,\rho^2) = \frac{1}{\rho\sqrt{2\Pi}} \exp\left(\frac{-(x-\zeta)^2}{2\,\rho^2}\right) \quad \text{-- (5)}$$

The histogram of values O_1, O_2, *and* O_3 are plotted separately. These feature coefficients depict a Gaussian distribution for a good quality image. Nonconformities with Gaussian nature indicate the presence of noise or distortion in the image.

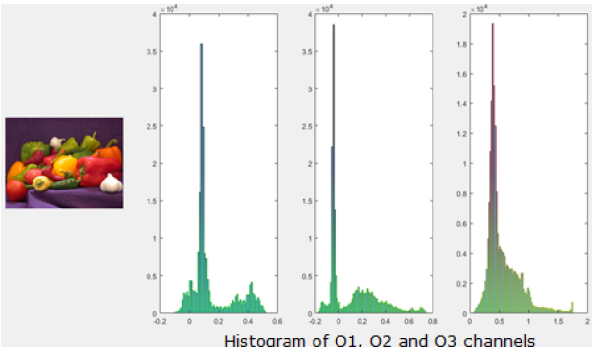

Figure 5: The histogram pattern shown by the computed O1, O2 and O3 channels of another good quality image

Figure 5 shows the histogram pattern shown by another good quality image. Here, these histogram outline curve representations can be compared with the Generalized Gaussian Distribution representation to extract the model parameters.

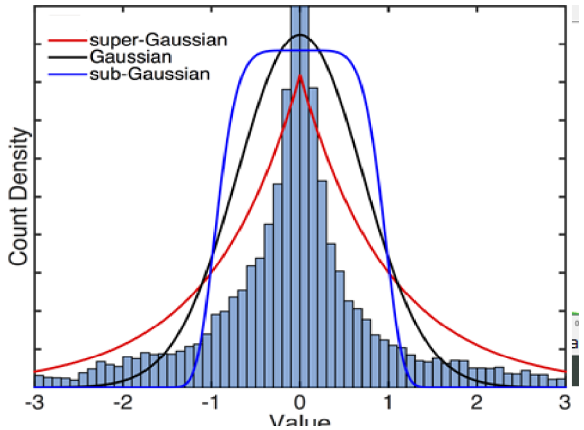

Figure 6: Outline Curve fitting of histogram provided by O1, O2 and O3 channels

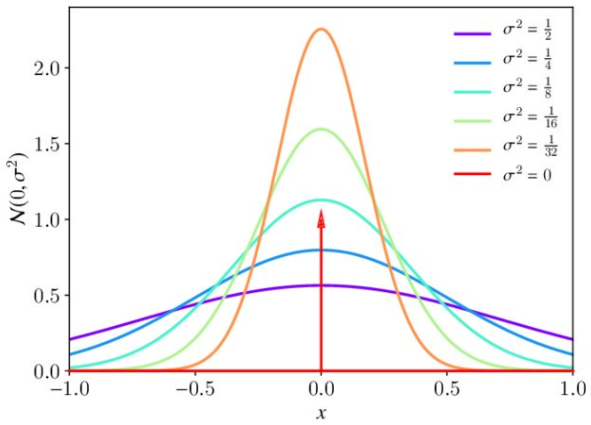

Figure 7: The various GGD curve patterns for various deviation σ^2 values and for mean = 0

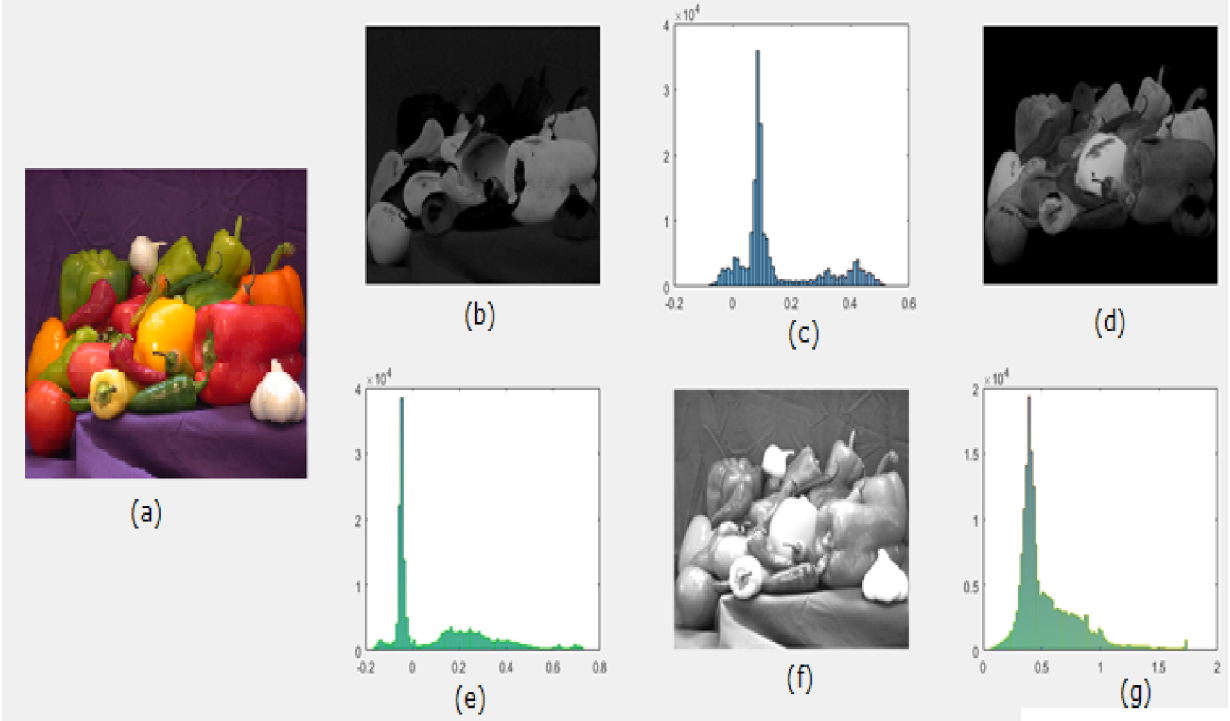

Figure 8: (a) shows a good quality image, (b), (d) and (f) depicts the O1,O2 and O3 components extracted from the image and (c),€ and (g) its corresponding histograms.

It is observed that pristine images exhibits a similar behavioural pattern by having the histogram representations following a GGD pattern. The shape parameters extracted from the GGD curve of pristine images falls under a definite set. For noisy images, the pattern does not follow a GGD curve and hence the values extracted will not fit for a GGD representation. This concept will be better understood by comparing the various noisy versions of the same image as shown in Figure (9) to Figure (12).

As the noise component in the image increases, the histogram pattern properly detects the noise component and shows the variation in the plotted histogram. Thus we have successfully proved the versatility of using the opponent color model for predicting quality value of images. The accuracy of any quality assessment algorithm is done by its comparison with subjective analysis. The opponent color model is able to provide a result exactly as seen by a human observer[12]. Thus this model is the most

suitable color representation for image quality analysis.

Quality analysis of Natural Scene Statistics Images

In 2012, Alan C Bovik and Mittal [6] develop the concept of BRISQUE , which is blind/referenceless image spatial quality evaluator. This method evolved as a well accepted method to analyse quality of NSS images. This method uses the Normalized Luminance Coefficients extracted from images for computing the quality score. The Luminance coefficients were also termed as Mean Subtracted Contrast Normalized (MSCN) values. A set of 36 features that belong to the category of MSCN values were extracted from the image and quality score was predicted with the help of these features.

In the previous section, it was stated that opponent color model and its extracted coefficients can help in quality prediction.

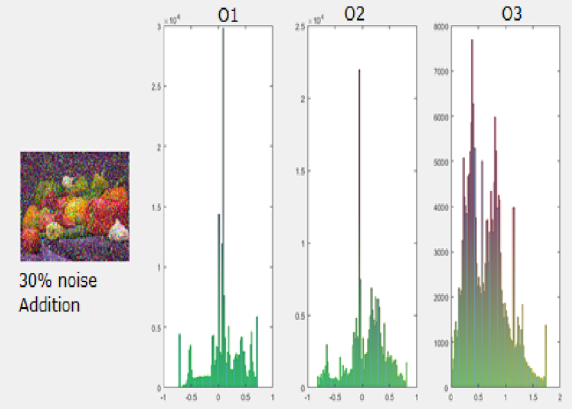

Figure 9: 30% noisy image and histogram of its O1,O2 and O3 channel

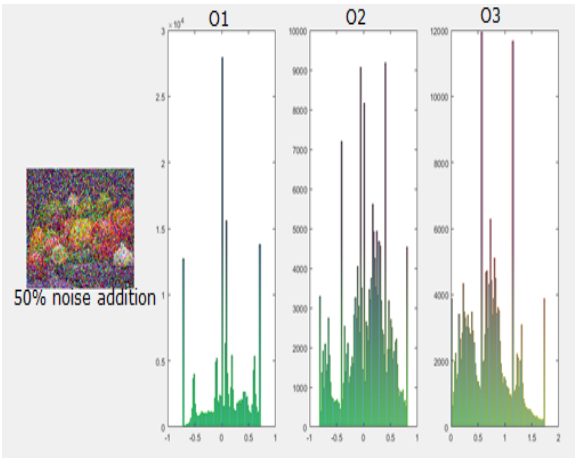

Figure 10: 50% noisy image and histogram of its O1,O2 and O3 channel

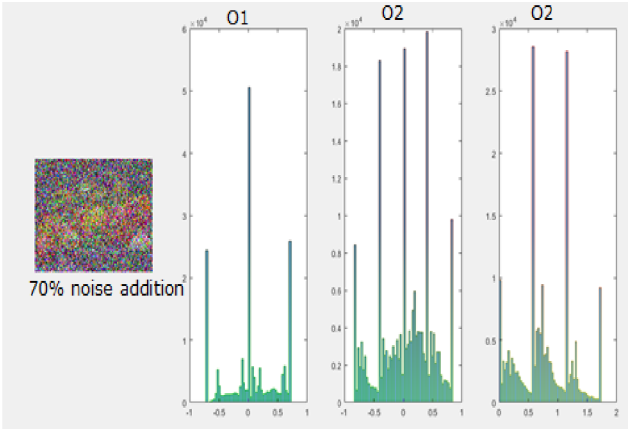

Figure 11: 70% noisy image and histogram of its O1,O2 and O3 channel

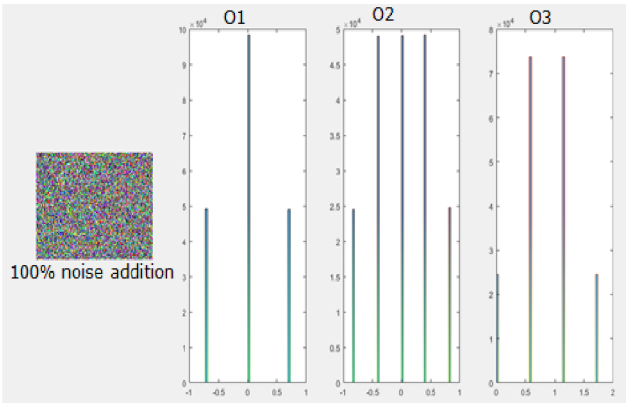

Figure 12: 100% noisy image and histogram of its O1,O2 and O3 channel

Hence the shape and variance parameter extracted from the GGD curve fitting of histogram pattern of color images are also combined along with the existing 36 features provided by BRISQUE. Hence the feature vector size is extended to 42. This features values are combined in the form of a consolidated numerical quality score value. The input image is divided into a collection of patches, each of size 16 ×16 pixels. The mentioned 42 feature values are computed and extracted from the image. It is then entered into a vector. This vector is compared against a pre computed and stored model feature set value corresponding to the mean of a set of all 29 pristine images available in LIVE Dataset 2008. For each feature value in a patch, the amount of deviation of the feature value from the corresponding feature value of pristine images is noted. Sum of deviation is computed

for each patch by Bhattacharyya distance computing method. It is repeated for all the patches and the mean of all the deviations are calculated to get the final numerical Quality score value of the image.

Let f1 to f42 be the vector corresponding to feature values of a patch of size 16 x16 in the input image and let p1 to p42 be the vector of mean feature value of the set of pristine images in the LIVE dataset.

Quality value of each patch,

$$q_i = \sum_{i=1}^{4\ 2} abs(f_i - p_i) \qquad (6)$$

where the difference or the distance measure between the feature value f_i and p_i is calculated using a modified form of Bhattacharyya distance given by,

$$X_1 - X_{2=} \frac{}{\sqrt{(\mu_1 - \mu_2)^T * 2/(\sum_1 + \sum_2)(\mu_1 - \mu_2)}} \qquad (7)$$

Here, f_i represents a particular feature value of the image taken for testing and p_i represents the same feature's value in the already computed pristine image set. In Equation (7) μ and ∑ are the means and covariances of the distributions taken for distance computation.

Bhattacharyya distance calculation is used to measure the separability of two statistical samples falling in the same category. This method works best in the MVG or multivariate Gaussian distribution. It is more reliable than many of the other existing distance computation methods like Mahalanobis distance, Hellinger distance etc. Finally, the 'Quality score' of the image is computed as

$$\textit{Quality score, } Q = \sum(q_i) \text{ / Number of patches} \qquad (8)$$

It is predictable that, as the variation from the pristine image increases, the computed Quality Score will be obviously a larger value. Thus, if the quality of the test image is poor, the computed numerical *'Qaulity' score* value tends to be relatively high and if the quality is good, variation of test image with pristine image is very low and hence, *Quality score* tends to be relatively lower value

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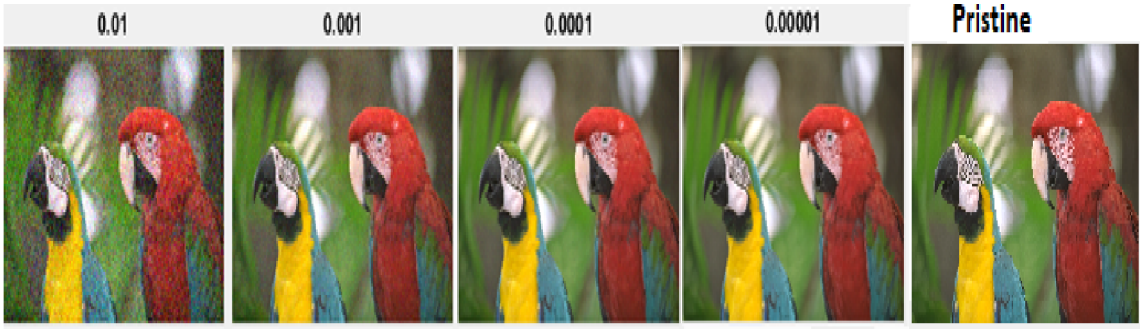


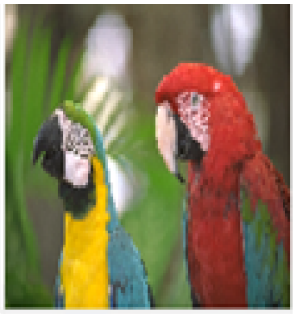
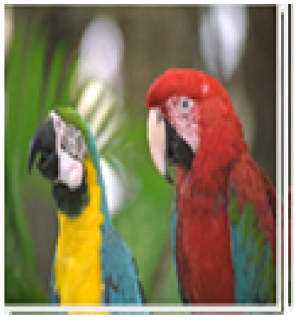
26.246179 12.5938 11.8437 11.3909 11.04303

Figure 13: Pristine and noisy versions of the same image taken under 4 different variance conditions and its corresponding 'Quality Score' values

Table 1 : Numerical 'Quality' Score obtained or various variance values

Image names as in LIVE dataset	***Numerical 'Quality Score' obtained through proposed method for different variance (v) values for noise components.***				
	v = 0.01	**v = 0.001**	**v = 0.0001**	**v= 0.00001**	**Pristine image**
Bikes	19.538376	11.5372	10.6058	10.4811	10.48012
building2	17.892432	10.9921	10.8576	10.8258	10.82479
Buildings	19.802774	10.4115	9.7652	9.7092	9.706779
Caps	20.890929	12.8286	10.8576	12.3179	12.09109
carnival doll	20.69812	12.3958	11.3149	11.1451	11.08224
Cemetery	21.243379	10.2054	9.0426	8.9154	8.915381
church of capitol	25.400959	10.6879	9.401	9.2283	9.197774
Coinsinfountain	24.698573	12.1766	11.1223	11.0724	11.03547
Dancers	20.758983	11.8165	10.465	10.3094	10.24344
Flowers	16.890153	9.3054	9.0634	9.0498	9.087626
House	23.80608	13.5159	13.1877	13.1701	13.19779
Lighthouse	21.013433	9.4612	8.8039	8.7731	8.77806
lighthouse2	24.459319	12.5349	11.7282	11.6543	11.64919
Manfishing	31.231749	12.4604	10.7318	10.5569	10.51352
Monarch	17.448513	9.6532	9.1064	9.0263	9.033111
Ocean	27.301145	16.205	13.2758	12.9948	12.95598

Table 2 : Comparison of Proposed method with Existing methods

Images taken for comparison			**Scores**	**Q scores**
Image1 (Better quality)	**Image2 (Noisy versions)**	**Name**		
		Fountain.jpg	SSIM = 0.45396 MS-SSIM = 0.52 FSIM = 0.5432	Image1 - 11.03547 image2 - 24.698573
		Parrots.jpg	SSIM = 0. 7479 MS-SSIM = 0.752 FSIM = 0.7989	Image1- 11.04303 and image2 - 11.8437

Testing and Evaluation

LIVEDatabaseRelease2 is the repository taken for the implementation and testing of the proposed method. The dataset consists of pristine reference images and its different levels of distorted versions under the domains Gaussian blur, Fast-Fading noise, White noise, Jpeg, Jpeg2k etc.

Firstly, a collection of noisy image set is constructed from each and every pristine image available in the data set. Noisy image set is constructed by adding varying noise content. A value of 0.00001 variance noisy image contains very less amount of noise content, 0.0001variance is slightly more noisy, 0.001 is still a little higher noisy and 0.01 is the maximum noisy image that is considered for testing to predict the accuracy of the proposed method. Thus a collection of images, segregated according to the value of noise content is prepared for testing. The response given by the image parrots.jpg is illustrated in Figure 13. The image shows that as the variance in the added noise component increases, the image becomes low quality. As per human visual system, on looking into the image, it is observed that the image with 0.00001 variance in noise is highly similar to pristine and the one with 0.01 variance of noise is very poor in quality.

When the proposed method is executed for 5 variants of the same basic image, it is observed that for pristine image, the numeric 'Quality ' Score obtained is 11.04303. And for the image affected with more noise, the numeric 'Qaulity' Score is 26.246179. Other values range in between from low to high based on the variation of noise content. The response produced by the all the images in the set is given in Table 1. The response clearly depicts that for low quality images, score values are higher than its other versions. Thus, the proposed method is capable of collecting and representing noise content in the obtained NSS image in the most effective way. The results obtained from the proposed method compared with the results obtained from the traditional SSIM. Table 2 depicts that the proposed method is at par with SSIM. Features Similarity Index Matrix (FSIM) maps the features and measures the similarities between two images. An advanced version of SSIM is Multi Scale Structural Similarity Index Method (MS-SSIM) that evaluates various structural similarity images at different image scale.

Although SSIM is fully reference model and this paper explores 'No reference' model, still it is important to compare both to investigate the performance. Here Image2 refers to low quality image and it is compared with Image1 which is available in the better quality set in the database. The variation in quality is captured well in SSIM and also in the proposed method. In the first image pair, 'Fountain.jpg', image2 is a noisy version and the SSIM similarity between both is 0.453. The proposed method measures the variations of the images as 11.035 and 24.698 respectively from their ideal characteristics. This large variation in score indicated a major difference in quality. For the second image pair, Parrots.jpg, image2 is a very low blurred version of image1. Thus SSIM gives a similarity measure of 0.7479. MS-SSIM and FSIM gives an improved quality score than SSIM since it captures more detail from image. The proposed method scores also does not show much variation in values, thus signifying images with less variation.

Conclusion

In this research work, an objective image quality assessment attempt is made on the development of an algorithm that computes the numerical Quality Score of NSS images by depending on the feature values extracted from the input image. Focus is given on BLIND estimation of quality, where information about the pristine version of the image to be checked is unavailable. More focus is given on the use of opponent color model and its applicability in image analysis. Among the 1000 variations of NSS images that were taken for the proposed Experiment, the method was able to get accurate result for 984 samples which shows an accuracy of 98.4%; thus outperforming other existing methods. The result is verified with subjective analysis and it is proven as accurate

References

1. Horé & D. Ziou, (2010), Image Quality Metrics: PSNR vs. SSIM, IEEE, 20th International Conference on Pattern Recognition, Istanbul, 2366 - 2369
2. V. Bhateja, et al(2014), Reduced reference IQA based on structural dissimilarity, International Conference on Signal Processing and Integrated Networks (SPIN), Noida, 63-68.
3. X. Gao et al (2009), mage quality assessment based on multiscale geometric analysis, IEEE Transactions on Image Processing, 18:1409-423.
4. Michele Saad, et al (2010), A DCT Statistics-Based Blind Image Quality Index, IEEE Signal Processing Letters, Institute of Electrical and Electronics Engineers , 17 (6) :583-586.
5. K. Moorthy & A. C. Bovik, (2011), Blind image quality assessment: From natural scene statistics to perceptual quality, IEEE Trans. Image Process., 20(12):3350-3364.
6. P. Ye &D. Doermann, (2011), No-reference image quality assessment using visual codebooks, Proc. IEEE Int. Conf. Image Processing, 3129–3138.
7. P. Ye, et al (2012) Unsupervised feature learning framework for no-reference image quality assessment, Proc. IEEE Conf. Comput. Vis. Pattern Recognit., 1098-1105.
8. Mittal, A.; et al (2012), No-reference image quality assessment in the spatial domain, IEEE Trans. Image Process., 2(1):4695-4708.
9. S. Bosse et al (2016), A deep neural network for image quality assessment, IEEE International Conference on Image Processing (ICIP), Phoenix, AZ, 3773-3777.
10. Richard Mooney et al (1996), Thalamic Relay of Spontaneous Retinal Activity Prior to Vision, Neuron, 17: 863-874,
11. Wang, Bo et al (2008), HVS-based structural similarity for image quality assessment, Signal Processing,1194- 1197.
12. R. V. Babu &A. Perkis, (2005), An HVS-based no-reference perceptual quality assessment of JPEG coded images using neural networks, IEEE International Conference on Image Processing 2005, Genova, 1(1), : 433–436.

MEASURING TIME USED IN UNPAID HOUSEHOLD WORK: STUDY BASED ON SURVEY OF TIME USE IN INDIA

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ABSTRACT

Over the past decades, progress in gender equality has been observed but still inequality linked to gender norms, unequal distribution of household work and child care responsibilities still persists. In this paper study has been made to updates the findings of Time Use Survey of India, 2019. Results from information on time use was collected from each member of age 6 years and above of the selected households, that is 4,47,250 persons of age 6 years and above consisting 2,73,195 in rural and 1,74,055 in urban has been presented. In this paper in addition, the author had analyzed the mean differences for various activities gender wise, education, age and location. The study suggests that there is huge gender gap in participation and time use in activities like unpaid domestic services for household members, participation in production of goods for own final use, participation in unpaid caregiving services for household members, where female participation and average time use are more than male counterpart. It is also seen that in unpaid activity the participation of female is higher than male counterpart by 40.1per cent but lower by 37.7 percent in case of paid activity.

Keywords: *Gender, time, work*

Introduction

Studies on time use were first used in the early twentieth century to understand people's lifestyle based on their time use patterns (Rubiano, E and Viollaz, 2019*)*. Back in the 1930s, feminist scholars inquired into time use and the need to measure the "invisible" unpaid work of men and women (Reid, 1934). Moreover in the 1960s, countries like Canada and the United Kingdom had conducted time surveys, and were followed by Norway, Japan, Finland and Austria in the 1970s and 1980s (Ironmonger, 1999). Developing countries started carrying out time use surveys and the instruments acquired a new focus by the end of the 1990s.

For better understanding of individual decisions to work as well as decisions on how to allocate time to different activities, survey on time use had been used and is necessary. Time use information could be effectively used to better understand the factors leading to gender inequalities in access to economic opportunities, well-being as well as the implications for policy making (Rubiano, E and Viollaz, M 2019). Across the countries there has been evidence that women are specialize in household work and care activities, while men focus on market work (Apps, 2004; Berniell and Sánchez-Páramo, 2011; Ferrant et al., 2014; Campaña et al., 2015). Women work more hours in total than men when productive activities such as market work, housework and care are considered altogether (Haddad et al., 1995; Ilahi, 1999; Berniell and Sánchez-Páramo, 2011).

This study updates and reinforce the findings of time use in India (2019) reported by Ministry of Statistics and programme implementation, National Statistical office by analyzing gender differences in allocation of time among various types of activities. In this paper the study had focus on three aggregate categories i) How time use pattern vary according to gender in paid and unpaid activities ii) Time use by age iii) Time use by educational level.

Definition of paid and unpaid work

Unpaid household work refers to those unpaid services that are produced for immediate consumption by one's own household, and for which market substitutes exist. For example, fixing leaky faucets rather than hiring plumbers, grocery shop instead of using a grocery delivery service, and preparing meals rather than eating at restaurants etc. The unpaid household work are less frequently quantified and do not have timely statistical measurement about person employed, hours worked, earning generated and others unlike work that is done for pay (Kent, R. K, 2009). Unpaid activities in Survey of Time Use in India , 2019 includes care for children, sick, elderly, differently-abled persons in own households**,** production

of services for own consumption, production of goods for own consumption, voluntary work for production of goods in households, voluntary work for production of services in households, voluntary work for production of goods in market/non-market units, voluntary work for production of services in market/non-market units, unpaid trainee work for production of goods, unpaid trainee work for production of services, other unpaid work for production of goods, other unpaid work for production of services. Paid activities are self-employment for production of goods, self-employment for production of services, regular wage/ salary for production of goods, regular wage/ salary for production of services, casual labour for production of goods, casual labour for production of service.

Data collection

The "Time Use Survey" (TUS) is the first survey of its kind conducted by the National Statistical Office (NSO) during the period January 2019 to December 2019. Time use data can be used to gain knowledge about the activities that are performed by the population about the duration of time used for paid and unpaid activities. The time use survey provides information of time use in both rural and urban areas with different level of disaggregation like gender, age, education etc. that can be used for planning, formulation and decision support.

The survey on Time use in India was spread over 9,945 First Stage Units (villages/urban frame survey (UFS) blocks/sub-units (SUs) as per the situation) consisting 5,947 villages and 3,998 urban blocks. The ultimate stage units (USU) were households in both the sectors covering 1,38,799 households, 82,897 rural household and 55,902 urban household. Information on time use was collected from each member of age 6 years and above of the selected households, that is 4,47,250 persons of age 6 years and above consisting 2,73,195 in rural and 1,74,055 in urban. The survey covered the whole of the Indian Union except the villages in Andaman and Nicobar Islands. Information on activity particulars was collected with a reference period of 24 hours starting from 4:00 AM on the day before the date of interview to 4:00 AM on the day of the interview.

In Time Use Survey (TUS) the participation rate in a day in any activity is defined as the percentage of persons performing that activity during the 24 hours of the reference period.

Participation rate in activity 'A'= (number of person participating in activity 'A'/ total number of person) x 100

Average time spent in a day per participant is calculated by

Average time spent in a day per participant in activity 'A'= Total time spent by the participant in activity 'A' / total number of person participating in activity 'A'.

In this study the mean differences, standard deviation and standard deviation for various activities for gender, education level, age and location are also calculated.

Discussions and Results

How do time use patterns vary according to gender in unpaid household work?

To analyze gender differences in time use patterns according to gender in unpaid household work, it is focus on participation rate and average time spent in a day by participant in both rural and urban areas in unpaid household work.

Table1 Participation rate and Time spent in unpaid household work

	Participation Rate (in rural areas)in percentage	Participation Rate (in urban areas)	Average time spent in a day per participant in rural areas)in minutes	Average time spent in a day per participant in urban areas	India's participation rate (in percentage)	India Average time spent in a day per(in minute)
Participation in production of goods for own final use and time spent per participant of age 6 and above in a day						
Male	19.1	3.4	203	134	17.1	151
Female	25	8.3	123	64		

Total	22	5.8	158	85		
Differences(male-female)	-5.9	-4.9	80	70		
Participation in unpaid domestic services for household members and time spent per participant of age 6 and above in a day						
Male	27.7	22.6	98	94	53.2	248
Female	82.1	79.2	301	293		
Total	54.6	50.1	249	247		
Differences (male-female)	-54.4	-56.6	-203	-199		
Participation in unpaid caregiving services for household members and time spent per participant of age 6 and above in a day						
Male	14.4	13.2	77	75	20.7	114
Female	28.2	26.3	132	138		
Total	21.2	19.5	113	116		
Differences (male-female)	-13.8	-13.1	-55	-63		
Participation in unpaid volunteer, trainee and other unpaid work and time spent per participant of age 6 and above in a day						
Male	2.8	2.5	99	111	2.4	101
Female	2	2.2	98	101		
Total	2.4	2.3	98	106		
Differences (male-female)	0.8	0.3	1	10		
Participation in socializing and communication, community participation and religious practice and time spent per participant of age 6 and above in a day						
Male	91.7	90.6	151	138	91.3	143
Female	91.2	91.4	139	138		
Total	91.5	91.0	145	138		
Differences (Male-female)	0.5	-0.8	12	0		
Participation in culture, leisure, mass-media and sports practices and time spent per participant of age 6 and above in a day						
Male	87.0	92.1	162	171	86.9	165
Female	82.2	92.7	157	181		
Total	84.6	92.4	159	176		
Differences (Male-female)	4.8	-0.6	5	-10		
Participation in self-care and maintenance and time spent per participant of age 6 and above in a day						
Male	100	100	737	711	100	726
Female	100	100	724	720		
Total	100	100	731	715		
Differences (Male - female)	0	0	13	-9		
Participation in learning and time spent per participant of age 6-14 years in learning activities in a day						
Male	86.4	85.1	427	441	85.9	430
Female	85.4	86.4	427	437		
Total	85.9	85.7	427	439		
Differences (Male-female)	1	-1.3	0	4		
Participation in learning and time spent per participant of age 15-29 years in learning activities in a day						
male	31.2	36.6	425	448	29.2	430
Female	22.6	32.0	423	429		
Total	26.9	34.4	424	440		
	8.6	4.6	2	19		
Participation in unpaid and time spent per participant of age 6 years and above in these activities in a day						
Male	47.8	35.1	167	110	63.6	289
Female	85.0	81.7	373	337		

Total	66.4	58.4	270	223.5		
Differences (Male-female)	-37.2	-46.6	-206	-227		
Participation in paid and time spent per participant of age 6 years and above in these activities in a day						
Male	53.4	58.1	415	486	36.2	413
Female	17.7	15.5	313	367		
Total	35.55	36.8	364	426.5		
Differences(Male-female)	35.7	42.6	102	119		

Source: Compiled from survey "Time Use in India", 2019, Ministry of statistics and programme implementation, National statistical office

Female participation in production of goods for own final use in both rural and urban areas is more than male counterpart by 5.9 and 4.9 per cent respectively. However the time spent per participant for the same is higher for male both in rural and urban areas by 80 and 70 minutes respectively. This is because the production of goods for own final use includes agriculture, forestry, fishing and mining for own final use, making and processing goods, construction activities for final use, travelling, moving, transporting or accompanying goods or persons related to own use production of goods (Details of the activities are given in appendix, Table no.1). In case of unpaid domestic services for household members, female participation in rural areas is 82.1 percent which is more than male participation rate by 54.4 per cent. In urban area too female participation for the same is more by 56.6 per cent than male participation rate. It is also observed that there is huge gap between male and female time spent per participant for the unpaid domestics services for the household members. Participation rate and time spent per participant for unpaid caregiving services for household members is also found to be more for female than male counterpart. It is clear from the table that female participation rate and time spent for unpaid activities is more for female than male. In case of participation rate in unpaid activity there is a gap of 37.2 per cent in rural area and 46.6 per cent in urban area, also in case of time spent for unpaid activities in rural and urban area, there is huge gap of 206 and 227 minutes respectively.

However there is very little gap between male and female participation rate and time spent per participant in case of unpaid volunteer, trainee and in socializing and communication, community participation and religious practice, participation in cultural activities, leisure, mass media and sports. It is also evidence from above table that both male and female takes equal responsible for participation in self -care, maintenance and learning.

Table 2 Percentage share of total time in different activities in a day per person of age 6 years and above (All India)

Description of the activity	Rural			urban			Rural+urban		
	Male	female	person	male	female	person	male	female	person
Employment and related activities	16.9	4.2	10.6	21.3	4.3	13.1	18.3	4.2	11.4
Production of goods for own final use	2.7	2.2	2.4	0.3	0.3	0.3	1.9	1.6	1.8
Unpaid domestic services for household members	1.9	17.2	9.4	1.5	16.1	8.6	1.7	16.9	9.2
Unpaid caregiving services for household members	0.8	2.6	1.7	.7	2.5	1.6	0.8	2.6	1.7
Unpaid volunteer, trainee and other unpaid work	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1
Learning	7.1	5.7	6.4	7	6.1	6.6	7.1	5.8	6.5
Socializing and communication, community participation and religious Practice	9.6	8.8	9.2	8.7	8.8	8.8	9.3	8.8	9.0

Culture, leisure, mass-media and sports practices	9.7	9.0	9.4	10.9	11.7	11.3	10.1	9.8	9.9
Self-care and maintenance	51.2	50.3	50.8	49.4	50.0	49.7	50.6	50.2	50.4
Total	100	100	100	100	100	100	100	100	100

Source: Time Use in India", 2019, Ministry of statistics and programme implementation, National statistical office

When we observed the percentage share of total time spent in different activities in a day, it is seen that most of the time in India (both rural and urban) has been spent in self-care and maintenance (50.4 per cent) followed by Employment and related activities (11.4 per cent), culture, leisure, mass media and sport practices (9.9 per cent), unpaid domestics services for household (9.2 per cent), socializing and communication, community participation and religious practice (9.0 per cent) respectively and the least time spent has been observed in unpaid volunteer, trainee and other unpaid work (0.1 per cent).

Now when we observed the differences in percentage share of total time spent among gender, we have observed that there is a gap of 12.7 per cent (rural areas) and 8.8per cent (urban) in employment and related activities, 15.3 per cent (rural) and in unpaid domestics' services for household members, 1.8 per cent in unpaid caregiving services for household etc. However, in case of activities like production of goods for own final use, unpaid volunteer, trainee and other unpaid work, learning, socializing and communication, community participation and religious practice, culture, leisure, mass media and sport practices, self care and maintenance, a gap is observed to be very less.

Unpaid caregiving services for household members and other unpaid domestic work

Unpaid caregiving services for household members are important for the purpose of understanding the needs of care within the households. The different categories of unpaid caregiving services for household members includes Childcare and instruction, care for dependent adults, help to non-dependent adult household members, other activities related to unpaid caregiving services for household members, travelling and accompanying goods or persons related to unpaid caregiving, services for household members and all care activities.

Table 3 Percentage of persons participating in a day in different unpaid caregiving services for household member (All India)

Descriptive of unpaid caregiving services	Male	female	Person
Rural			
Child care and instruction	13.8	27.2	20.4
Care for dependent adults	0.2	0.5	0.3
Help to non-dependent adult household members	0.2	0.3	0.2
Travelling and accompanying goods or persons related to unpaid caregiving services for household members	0.4	0.4	0.4
Other activities related to unpaid caregiving services for household Members	0.2	0.4	0.3
All care activities	14.4	28.2	21.2
Urban			
Child care and instruction	12.3	25.2	18.5
Care for dependent adults	0.2	0.6	0.4
Help to non-dependent adult household members	0.2	0.4	0.3
Travelling and accompanying goods or persons related to unpaid caregiving services for household members	0.9	1.1	1.0
Other activities related to unpaid caregiving services for household Members	0.1	0.3	0.2
All care activities	13.2	26.3	19.5

Urban + rural			
Child care and instruction	13.3	26.6	19.8
Care for dependent adults	0.2	0.5	0.4
Help to non-dependent adult household members	0.2	0.3	0.2
Travelling and accompanying goods or persons related to unpaid caregiving services for household members	0.5	0.6	0.6
Other activities related to unpaid caregiving services for household Members	0.1	0.4	0.3
All care activities	14.0	27.6	20.7

Source: Time Use in India, 2019, Ministry of statistics and programme implementation, National statistical office

When we observed the percentage of person participating in different unpaid caregiving services for household members, it is observed that in rural area, total person participating in all caregiving activities is 21.2 per cent of which 14.4 per cent is participated by male and 28.2 per cent by female. Of all the unpaid caregiving services, services given for child care and instruction are found to be highest, where the total person participation is 20.4 per cent, of which 13.8 per cent is participated by male and 27.2 per cent by female.

In urban area too, the same scenario is observed where the highest unpaid caregiving services is for child care and instruction. Taking all the care activities it is observed that total person participated in unpaid care activities is 19.5per cent of which 26.3 per cent is participated by female and 13.2 per cent by male.

When we observe all India (both rural and urban) it is observed that total person participation in all care activities is 20.7 per cent of which 14 per cent is participated by Male and 17.6 per cent by female

Table 4 Average time (in minutes) spent in a day per participant in unpaid caregiving services for household members

Descriptive of unpaid caregiving services	Male	female	Person
	Rural		
Child care and instruction	75	132	113
Care for dependent adults	96	85	88
Help to non-dependent adult household members	79	76	77
Travelling and accompanying goods or persons related to unpaid caregiving services for household members	86	77	82
Other activities related to unpaid caregiving services for household members	84	75	78
All care activities	77	132	113
Urban			
Child care and instruction	71	137	115
Care for dependent adults	119	97	104
Help to non-dependent adult household members	95	77	84
Travelling and accompanying goods or persons related to unpaid caregiving services for household members	61	67	64
Other activities related to unpaid caregiving services for household members	77	76	76
All care activities	75	138	116
Urban + rural			
Child care and instruction	74	134	113
Care for dependent adults	104	89	94
Help to non-dependent adult household members	85	76	79
Travelling and accompanying goods or persons related to unpaid caregiving services for household members	74	71	73
Other activities related to unpaid caregiving services for household Members	82	75	77
All care activities	76	134	114

Source: Time Use in India, 2019, Ministry of statistics and programme implementation, National statistical office.

When we observed the average time (in minutes) spent in a day in unpaid caregiving services for household members, it is observed that the time spent in all care activities for all India (rural and urban) is 114 minutes of which 134 minutes is spent by female and 76 by male which indicate a gap of 58 minutes. When we observed gender wise gap in time spent for different activities, it is observed that in case of child care and instruction the time spent by female is more than male by 60 minutes in a day. However in case of activities like care of dependent adults, help to non-dependent adults household members, travelling and accompanying goods or person related to unpaid caregiving services for household members male spent more than female by 15 minutes, 9 minutes,3 minute and 7 minutes respectively.

Table 5 Means differences in participation rate and average time spent (in minutes**)** by gender and location for all unpaid caregiving activities

	Mean	Standard deviation	Standard error
Participation Rate			
male	4.71	6.925	2.826
female	9.35	13.792	5.630
Rural	6.65	9.575	3.909
urban	7.13	10.589	4.323
Average time spent			
male	82.8182	15.689	4.73
female	97.4167	28.506	8.22
Rural	90.000	21.702	6.54
urban	90.833	26.81	7.74

Source: Author calculation

The table above shows the mean differences in participation rate and average time spent (in minutes) by gender and location for all unpaid caregiving activities. It is evidence from the table that means participation rate for female is higher than the male counterpart by (4.64 per cent) and in urban it is more by (0.48 per cent). For average time spent, again the mean of female is higher than male counterpart by 14.6 minutes in all unpaid caregiving activities. However the difference in mean for location (rural and urban) is too small.

Table 6 Percentage of persons participating in different unpaid domestic service activities for household members

Descriptive of unpaid domestics services	Male	female	Person
	Rural		
Food and meals management and preparation	4.9	75.7	39.9
Cleaning and maintaining of own dwelling and surroundings	8.4	67.1	37.4
Do-it-yourself decoration, maintenance and repair	1.1	1.0	1.0
Care and maintenance of textiles and footwear	2.7	43.8	23.0
Household management for own final use	1.4	2.1	1.7
Pet care	6.1	5.7	5.9
shopping for own household members	9.1	3.4	6.2
Travelling, moving, transporting or accompanying goods or persons related to unpaid domestic services for household members	3.4	1.3	2.3
Other unpaid domestic services for household members	2.1	5.1	3.6
All unpaid domestic services for household members	27.7	82.1	54.6
Urban			
Food and meals management and preparation	7.2	73.9	39.6
Cleaning and maintaining of own dwelling and surroundings	5.2	59.5	31.6
Do-it-yourself decoration, maintenance and repair	0.8	0.7	0.8
Care and maintenance of textiles and footwear	2.8	44.5	23.0

Household management for own final use	1.1	2.1	1.6
Pet care	0.7	0.8	0.8
shopping for own household members	10.6	9.3	10.0
Travelling, moving, transporting or accompanying goods or persons related to unpaid domestic services for household members	3.7	2.7	3.2
Other unpaid domestic services for household members	1.2	3.7	2.4
All unpaid domestic services for household members	22.6	79.2	50.1
Urban + rural			
Food and meals management and preparation	5.6	75.2	39.8
Cleaning and maintaining of own dwelling and surroundings	7.4	64.8	35.6
Do-it-yourself decoration, maintenance and repair	1.0	0.9	0.9
Care and maintenance of textiles and footwear	2.7	44.0	23.0
Household management for own final use	1.3	2.1	1.7
Pet care	4.5	4.2	4.3
shopping for own household members	9.5	5.1	7.4
Travelling, moving, transporting or accompanying goods or persons related to unpaid domestic services for household members	3.5	1.7	2.6
Other unpaid domestic services for household members	1.8	4.7	3.2
All unpaid domestic services for household members	26.1	81.2	53.2

Source: Time Use in India, 2019, Ministry of statistics and programme implementation, National statistical office

The table clearly depicts the percentage of person participating in different unpaid domestic services for household member in both rural and urban. The total participation rate (both rural+urban) for all unpaid domestic services for household member is 53.2 per cent, of which 81.2 per cent is participated by female and 26.1 per cent by male. In unpaid activities like food and meals management and preparation, cleaning and maintaining of own dwelling and surrounding, care and maintenance of textile and footwear, a huge gender gap participation of 69.6 per cent, 57.4 per cent and 41.3 per cent respectively is being observed.

Table 7 Average time (in minutes) spent in a day per participant in unpaid domestic services activities for household member

Descriptive of unpaid domestics services	Male	female	Person
	Rural		
Food and meals management and preparation	97	207	200
Cleaning and maintaining of own dwelling and surroundings	53	72	70
Do-it-yourself decoration, maintenance and repair	80	80	80
Care and maintenance of textiles and footwear	40	63	61
Household management for own final use	54	66	61
Pet care	97	89	93
shopping for own household members	61	62	61
Travelling, moving, transporting or accompanying goods or persons related to unpaid domestic services for household members	66	61	65
Other unpaid domestic services for household members	71	92	85
All unpaid domestic services for household members	98	301	249
Urban			
Food and meals management and preparation	88	199	188
Cleaning and maintaining of own dwelling and surroundings	54	71	69
Do-it-yourself decoration, maintenance and repair	62	63	63
Care and maintenance of textiles and footwear	44	67	66
Household management for own final use	58	70	66
Pet care	81	76	78
shopping for own household members	60	62	61
Travelling, moving, transporting or accompanying goods or persons related to unpaid domestic services for household members	58	57	58
Other unpaid domestic services for household members	71	87	83

All unpaid domestic services for household members	94	293	247
Urban + rural			
Food and meals management and preparation	94	204	197
Cleaning and maintaining of own dwelling and surroundings	53	72	70
Do-it-yourself decoration, maintenance and repair	75	76	75
Care and maintenance of textiles and footwear	41	64	63
Household management for own final use	55	67	63
Pet care	97	88	93
shopping for own household members	61	62	61
Travelling, moving, transporting or accompanying goods or persons related to unpaid domestic services for household members	64	59	62
Other unpaid domestic services for household members	71	90	85
All unpaid domestic services for household members	97	299	248

Source: Time Use in India, 2019, Ministry of statistics and programme implementation, National statistical office.

When we observed the average time spent (rural+urban) in a day in unpaid domestic service activities for household member, it is seen that time spent for all unpaid domestic services for a household member is 248 minutes of which 299 minutes is spent by female and 97minutes by male. Of all the unpaid domestic service activities, time spent is highest for food and meals management and preparation (197 minutes) followed by pet care (93 minutes), Other unpaid domestic services for household members (85 minutes), decoration, maintenance and repair(75 minutes) respectively.

Now, when we observed the gender gap in different activities (rural+ urban), it is observed a gap of 110 minutes in time spent for food and meals management and preparation, 19 minutes in cleaning and maintenance of own dwelling and surrounding,23 minutes in Care and maintenance of textiles and footwear and 12minutes in Household management for own final use.

Table 8 Mean difference for participation and time use in different unpaid domestic service activities for household members

Gender/location	Mean	Standard deviation	Standard error	t	sig
Participation rate					
Male	4.3556	2.9640	.98800	2.207	0.41
female	28.6364	32.734	9.86995		
Rural	17.2100	26.753	26.753	0.72	0.943
Urban	16.6150	25.724	25.274		
Time use					
Male	67.8500	17.845	3.990	2.296	0.27
female	108.2	76.554	17.11		
Rural	90.5000	60.161	13.452	0.380	0.706
Urban	83.2500	60.516	13.531		

Source: Author calculation

It is evident from the table that there is significant mean difference between male and female for participation rate and time use. The mean for both the participation rate and time use for unpaid domestic service activities is higher for female than their male counterpart by 24.3per cent and 40.35 per cent respectively. However in case of urban and rural the mean differences are statistically insignificant.

Table 9 Average time (in minutes) spent and participation rate in unpaid activities, paid activities in a day

Description of the activity	Percentage of persons participating in unpaid activities, paid activities in a day			
	male	female	Gap (male-female)	person
	Rural			
Unpaid activity	47.8	85.0	-37.2	66.2
Paid activity	53.4	17.7	35.7	35.7
	Urban			
Unpaid activity	35.1	81.7	-46.6	57.8
Paid activity	58.1	15.5	42.6	37.4
	Rural +Urban			
Unpaid activity	43.9	84.0	-40.1	63.6
Paid activity	54.8	17.1	37.7	36.2
Description of the activity	Average time (in minutes) spent in a day per participant in unpaid activities, paid activities			
	male	female		person
	Rural			
Unpaid activity	167	373	-206	298
Paid activity	415	313	102	390
	Urban			
Unpaid activity	110	337	-227	266
Paid activity	486	367	119	462
	Rural +Urban			
Unpaid activity	153	363	-210	289
Paid activity	438	328	110	413

Source: Time Use in India, 2019, Ministry of statistics and programme implementation, National statistical office.

Table 9 shows the average time (in minutes) spent and percentage of person participating in paid and unpaid activities. In rural 53.4 per cent male had participated in paid activities and 47.8 per cent in unpaid activity. However 85.0 per cent female had participated in unpaid activity and only 17.7 in paid activity. In urban 58.1per cent of male had participated in paid activity and 33 per cent in unpaid activity whereas 81.7 per cent of female had participated in unpaid activity and 15.5 in paid activity. When we take into account both rural and urban 54.8 per cent of male had participated in paid activity whereas female participation in paid activity is only 17 percent. This shows gender disparity in participation of paid and unpaid activity. Same scenario can be observed in case of average time (in minutes) spent in a day per participant in unpaid activities and paid activities.

When the gap (male-female) both rural and urban in participation of paid and unpaid activity in a day is observed, it is seen that in unpaid activity the participation of female is higher than male counterpart by 40.1per cent but lower by 37.7 percent in case of paid activity. The gap is also observed in case of time use, where female time use in unpaid activity is more than their male counterpart by 210 minutes but lower by 110 minutes in case of paid activity.

Time use by Age groups

Age is one of the important factor determining the participation rate and use of time for different activities. The average amount of time spent in a day in different activities per participant of age groups 15-29 years, 15-59 years and 60 years and above and participation rates in various activities are presented in table below.. It is observed that the participation rate and time use in employment and related activities is highest in age group15-59 years. In this age group male participation for the same is 70.9 percent and time use is 470 minutes and female participation is 21.8 per cent and time use is 343 minutes, however this shows a gender gap of 49.7 and 127 minutes respectively.

For production of goods for own final use the participation rate and time use (male) is highest for age group 60 years and above (21.4 per cent and 213 minutes) but in case of female the participation for the same activity, it is highest

in age group 15-59 years (22.7 percent) whereas for age group 60 years and above the participation rate is 20.8 per cent. In case of unpaid domestic services for household members, the age group 60 years and above has the highest participation rate i.e. 16.2 per cent for male but for female age group 15-59 years has highest participation rate (92.3per cent).

In case of unpaid care giving services for household members, female participation in age group 15-29, 15-59 and 60 years above is 39.8 per cent, 32.8 percent and 17.1per cent respectively. In case of male, age group15-59 years of age has the highest participation rate i.e.16.2 per cent. In learning activities the participation rate and time use for both male and female is highest in age group15-59years age. For socializing and communication participation and religious practice age group 60 years and above has the highest participation rate for both male and female.

Table 10 Participation rates and time use in the activities by persons in different age groups (All India, rural+urban)

	15-29 years		15-59 years		60 years and above	
Description of the activity	Male					
	Participation rate	Time use	Participation rate	Time use	Participation rate	Time use
Employment and related activities	53.9	463	70.9	470	43.5	397
Production of goods for own final use	11	176	15.6	198	21.4	213
Unpaid domestic services for household members	24.2	94	28.9	95	34.7	112
Unpaid caregiving services for household members	11.5	75	16.2	73	11.1	90
Unpaid volunteer, trainee and other unpaid work	2.6	116	2.9	103	3.2	109
Learning	32.9	433	14.3	421	0.6	102
Socializing and communication, community participation and religious practice	91.9	145	93.4	146	96.7	202
Culture, leisure, mass-media and sports practices	88.3	163	86.9	144	88	211
Self-care and maintenance	100	717	100	711	100	788
Female						
Employment and related activities	14.2	328	21.8	343	13.8	304
Production of goods for own final use	18.1	97	22.7	115	20.8	127
Unpaid domestic services for household members	85.8	291	92.3	315	78.3	245
Unpaid caregiving services for household members	39.8	154	32.8	137	17.1	1181
Unpaid volunteer, trainee and other unpaid work	2.1	94	2.2	100	2	106
Learning	25.4	425	10.9	414	0.3	149
Socializing and communication, community participation and religious practice	91.3	129	92.6	136	96.2	192
Culture, leisure, mass-media and sports practices	84.2	153	83.8	151	84.9	207
Self-care and maintenance	100	709	100	704	100	797
Person						
Employment and related activities	34.1	435	46.4	440	29	375
Production of goods for own final use	14.6	127	19.2	149	21.1	172
Unpaid domestic services for household members	55	247	60.6	262	56.0	202
Unpaid caregiving services for household members	25.6	136	24.5	116	14.1	107

Unpaid volunteer, trainee and other unpaid work	2.4	106	2.5	102	2.6	108
Learning	29.2	430	12.6	418	0.5	118
Socializing and communication, community participation and religious practice	91.6	137	93	141	96.6	197
Culture, leisure, mass-media and sports practices	86.3	158	85.3	147	86.6	209
Self-care and maintenance	100	713	100	707	100	792

Source: Time Use in India, 2019, Ministry of statistics and programme implementation, National statistical office

Table 11 Mean difference in participation rates and time use in the activities by persons in different age groups (All India, rural+urban)

	Mean	Standard deviation	Standard error
Participation rates			
15-29 years	48.7222	37.453	8.827
15-59 years	49.3444	38.604	9.099
60 years above	45.1389	40.3055	9.500
Time use			
15-29 years	2.645	205.82	48.513
15-59 years	2.652	204.38	48.173
60 years above	3.073	303.263	71.479

Source: Author calculation

Table 11 depicts the mean difference in participation rates and time use in different activities by persons in different age group. The mean of different age group in case of participation in different activities shows no statistical significance because the gap of differences is too small. However still we observed that participation rate for different activities is highest for age group 15-59 years of age and lowest of age 60 and above. In case of time use also no statistical significant of mean is observed for different age group. But the means is highest for age group 60 and above.

Table 12 Percentage of persons of different age groups participating in a day in unpaid activities, paid activities

Description of the activity	Percentage of persons and average time (in minutes) spent in a day of different age groups participating in a day in unpaid activities, paid activities								
	15-29 years			15-59 years			60 years and above		
	Male	female	person	Male	female	person	Male	female	person
	Rural								
Unpaid activity	43.4	90.2	67.2	53.7	95.1	74.6	57.3	84.8	70.6
Paid activity	50.9	12.3	31.3	67.1	21.3	44.0	44.0	14.8	29.9
	Urban								
Unpaid activity	30.8	81.0	55.0	37.8	90.9	63.7	44.6	81.3	62.8
Paid activity	51.2	13.5	33.1	71.5	18.9	45.8	34.1	8.0	21.2
	Rural+Urban								
Unpaid activity	39.4	87.5	63.4	48.6	93.8	71.2	53.6	83.8	68.3
Paid activity	51.0	12.7	31.9	68.5	20.6	44.6	41.1	12.8	27.3
Description of the activity	average time (in minutes) spent in a day of different age groups participating in a day in unpaid activities, paid activities								
	15-29 years			15-59 years			60 years and above		
	Male	female	person	Male	female	person	Male	female	person
	Rural								
Unpaid activity	147	394	316	166	400	317	200	299	257
Paid activity	424	306	400	422	317	397	364	293	347

	Urban								
Unpaid activity	105	333	267	108	357	282	130	259	213
Paid activity	491	394	472	490	371	466	442	327	420
	Rural+Urban								
Unpaid activity	137	378	303	151	388	307	183	287	245
Paid activity	445	333	423	445	332	419	383	300	364

Source: Time Use in India, 2019, Ministry of statistics and programme implementation, National statistical office

When we observed the participation rate in paid activities according to age group, it is observed that the participation rate for male (rural +urban), it is observed that in age group 15-29,15-59and 60 years above, the participation rate in paid activity is 51per cent, 68.5per cent and 41.1 per cent respectively. When we observed the same in case of female, the participation rate is 12.7 percent, 20.6 per cent, 12.8 per cent showing a gap of 38.3per cent, 47.9 percent and 28.3percent respectively. Again when the participation rate in unpaid activity is concern, it is seen for age group15-29, 15-59 and 60 years above, the participation rate is 39.4per cent, 48.6 per cent, 53.6 per cent respectively for male and for female it is 87.5 per cent, 93.8 percent, 83.8 percent showing a gap of 48.1 per cent, 45.2 per cent and 30.2 percent respectively.

In case of unpaid activity in different age group15-29, 15-59and 60 years above, time use by female is more by 228 minutes, 249 minutes, and 129 minutes respectively. However in case of paid activity the time use by male for different age group that is group15-29, 15-59and 60 years above, is higher by 112 minutes, 113 minutes, 83 minutes respectively.

Time use by educational level

Education level also plays an important role in participation of different activities. Percentages of persons participating in different activities are presented for different levels of education. The level of education according to time used survey means the highest level of education that a person has successfully completed.

Table 13 Percentage of persons participating in different activities in a day for different levels of education (rural + urban, all India)

Description of the activity	not literate	literate and level of education				all
		below primary	primary	upper primary/ middle	secondary and above	
Male						
Employment and related activities	66.6	33.6	52.1	59.3	62.7	57.3
Production of goods for own final use	23.1	10.2	14.4	15.7	11.3	14.3
Unpaid domestic services for household members	31.7	17.5	24.9	27.0	26.9	26.1
Unpaid caregiving services for household members	14.3	11.7	13.0	14.1	15.2	14.0
Unpaid volunteer, trainee and other unpaid work	2.7	1.9	2.2	2.9	3.0	2.7
Learning	3.5	50.3	30.9	23.1	20.6	23.9
Socializing and communication, community participation and religious practice	94.7	83.7	90.1	91.7	93.0	91.4
Culture, leisure, mass-media and sports practices	80.4	91.2	88.0	88.1	91.3	88.5
Self-care and maintenance	100.0	100.0	100.0	100.0	100.0	100.0
Female						
Employment and related activities	24.6	12.2	16.1	15.9	17.3	18.4
Production of goods for own final use	28.9	15.1	19.3	19.8	13.5	20.0
Unpaid domestic services for household members	88.9	52.6	75.3	83.0	87.7	81.2
Unpaid caregiving services for household members	25.9 20.8	20.8	26.7	29.2	31.9	27.6 0
Unpaid volunteer, trainee and other unpaid work	2.1	1.6	2.1	2.0	2.2	2.0
Learning	1.7	44.5	28.0	24.0	21.0	19.8

Socializing and communication, community participation and religious practice	93.7	85.0	90.0	91.7	92.0	91.3
Culture, leisure, mass-media and sports practices	77.9	88.3	85.4	86.0	91.1	85.3
Self-care and maintenance	100.0	100.0	100.0	100.0	100.0	100.0
Person						
Employment and related activities	39.5	23.4	34.9	39.9	43.5	38.2
Production of goods for own final use	26.9	12.6	16.7	17.6	12.3	17.1
Unpaid domestic services for household members	68.6	34.3	48.9	52.1	52.7	53.2
Unpaid caregiving services for household members	21.7	16.0	19.5	20.8	22.3	20.7
Unpaid volunteer, trainee and other unpaid work	2.3	1.8	2.2	2.5	2.6	2.4
Learning	2.3	47.6	29.5	23.6	20.8	21.9
Socializing and communication, community participation and religious practice	94.1	84.3	90.1	91.7	92.6	91.3
Culture, leisure, mass-media and sports practices	78.8	89.8	86.8	87.1	91.2	86.9
Self-care and maintenance	100.0	100.0	100.0	100.0	100.0	100.0

Source: Time Use in India, 2019, Ministry of statistics and programme implementation, National statistical office

When we considered the participation rate (all India) according to their educational level, it is observed that for employment and related activities, the total rate is 38.2 per cent. When the level of education is taken into account, the participation rate for the same is highest for the educational level secondary and above with 43.5 per cent. For production of goods for own final use, the total person participation rate is 17.1per cent and participated highest by not illiterate (26.9 per cent). For unpaid domestic services for household members, the total person participated rate is 53.2 per cent and participated highest by not literate (68.6 per cent).

The person participated for unpaid caregiving services for a household member is 20.7 per cent, participated highest by educational level secondary and above with 22.3 per cent. For learning activity, the total person participated is 21.9 per cent and highest participation is for educational level below primary.

Again for socializing and communication, community participation and religious practice, the total person participated is 91.3 per cent and for culture, leisure, mass-media and sports practices, it is 86.9 per cent. Among all the activities, the participation rate is 100 per cent for self-care, and maintenance. Self care and maintenance includes sleep and related activities, eating and drinking, receiving personal and health/medical care for others, travelling time related to self care and maintenance activities and other self-care and maintenance.

Table 14 Average time (in minutes) spent in a day per participant by different levels of education (rural + urban, all India)

Description of the activity	not literate	literate and level of education				All
		below primary	primary	upper primary/ middle	secondary and above	
Male						
Employment and related activities	447	430	449	464	471	459
Production of goods for own final use	217	196	197	198	184	198
Unpaid domestic services for household members	108	93	95	94	95	97
Unpaid caregiving services for household members	77	84	75	73	76	76
Unpaid volunteer, trainee and other unpaid work	92	87	94	102	111	102
Learning	366	416	438	450	417	426
Socializing and communication, community participation and religious practice	169	125	140	91.7	149	147

Culture, leisure, mass-media and sports practices	150	190	166	88.1	164	164
Self-care and maintenance	751	760	734	100.0	710	729
Female						
Employment and related activities	342	303	315	305	349	333
Production of goods for own final use	140	107	108	98	89	116
Unpaid domestic services for household members	296	301	304	308	295	299
Unpaid caregiving services for household members	126	126	131	131	146	134
Unpaid volunteer, trainee and other unpaid work	103	90	98	91	102	99
Learning	355	411	440	453	410	423
Socializing and communication, community participation and religious practice	159	122	130	131	132	139
Culture, leisure, mass-media and sports practices	159	186	165	157	165	165
Self-care and maintenance	738	749	721	713	702	723
Person						
Employment and related activities	405	398	420	435	450	429
Production of goods for own final use	163	144	148	148	139	151
Unpaid domestic services for household members	265	245	248	247	236	248
Unpaid caregiving services for household members	114	110	112	109	119	114
Unpaid volunteer, trainee and other unpaid work	99	88	96	98	108	101
Learning	361	414	439	452	414	424
Socializing and communication, community participation and religious practice	163	124	135	137	142	143
Culture, leisure, mass-media and sports practices	156	189	166	157	164	165
Self-care and maintenance	743	755	728	718	706	726

Source: Time Use in India, 2019, Ministry of statistics and programme implementation, National statistical office

The table above clearly depicts the average time (in minutes) spent in a day per participant by different level of education. It is observed that for employment and related activities, the average time spent (person) is 429 minutes and according to educational level, the time is spent highest by secondary and above. For production of goods for own final use, the average time spent (person) is 151 minutes and in the same the average time is spent highest by not literate. The average time spent for unpaid domestic services for household members is 248 minutes and is spent highest by not illiterate.

For unpaid caregiving services for household members, the average time spent is 114 minutes in a day and spent highest by secondary and above. For learning activity the average time spent is 424 minutes and highest time is spent by upper primary level.

Again the average time spent for socializing and communication, community participation and religious practice is 143 minutes and spent highest by not illiterate. Of all the activities, the highest time in a day has been spent for self-care and maintenance.

Table 15 Means difference in participation rates and time use in different activities by level of education

	Mean	Standard deviation	Standard error
Participation rates			
Not literate	41.77	34.99	12.37
Below primary	38.72	32.90	11.63
Primary	41.07	32.28	11.41
Upper primary/ middle	35.45	29.49	11.14
Secondary and above	42.25	34.57	12.22
Average time spent	2.98	114.92	40.63
Not literate	1.91	225.51	79.73
Below primary	3.00	225.46	79.71
Primary	2.81	226.01	85.42
upper primary/ middle	2.98	219.78	77.70
Secondary and above			

Source: Author calculation

In case of participation in different activities by level of education, the mean is found to be highest for secondary and above and lowest for upper primary, but statistically we have not observed significant differences in mean by different levels of education. For average time spent in different activities the mean is observed to be highest for primary level and lowest for below primary but the mean differences for different level of education are statistically insignificant.

Conclusion

From above discussion, it is clear that there is huge gender gap in participation and time use in activities like unpaid domestic services for household members, participation in production of goods for own final use, participation in unpaid caregiving services for household members, where in these activities female participation and average time use are more than male counterpart.

However there is very little gap between male and female participation rate and time spent per participant in case of unpaid volunteer, trainee and in socializing and communication, community participation and religious practice, participation in cultural activities, leisure, mass media and sports. It is also evidence from above discussion that both male and female takes equal responsible for participation in self -care, maintenance and learning.

It is also seen that in unpaid activity the participation of female is higher than male counterpart by 40.1per cent but lower by 37.7 percent in case of paid activity. The gap is also observed in case of average time use, where female time use in unpaid activity is more than their male counterpart by 210 minutes but lower by 110 minutes in case of paid activity

The mean of different age group in case of participation in different activities shows no statistical significance because the gap of differences is too small. However still we observed that participation rate for different activities is highest for age group 15-59 years of age and lowest of age 60 and above. In case of time use also no statistical significant of mean difference is observed for different age group. But the means is highest for age group 60 and above

In case of participation in different activities by level of education, the mean is found to be highest for secondary and above and lowest for upper primary, but statistically we have not observed significant differences in mean by different levels of education.

References

1. Apps, P. (2004) Gender, Time Use, ands Models of the Household. Policy Research Working Paper Series 3233, The World Bank
2. Al-Ani, Wajeha. (2017) "Methodological analyses and applications to determine and maximize the added value of volunteer work in Oman", International Journal of Humanities and Social Sciences vol 6(2) Pp 53-64
3. Berniell, M.I., and C. Sánchez-Páramo.(2011) Overview of Time Use Data Used for the Analysis of Gender Differences in Time Use Patterns. Background paper for the WDR 2012
4. Campaña, J.C., J.I. Gimenez-Nadal, and J.A. Molina. (2015) Gender Differences in the Distribution of Total Work-Time of Latin-American Families: The Importance of Social Norms. IZA Discussion Paper 8933, Institute for the Study of Labor, Bonn
5. Government of India (2019) Time Use in India, 2019, Ministry of Statistics and Programme Implementation, National statistical office
6. Ferrant, G., L.M Pesando, and K. Nowacka. (2014) Unpaid Care Work: The Missing Link in the Analysis of Gender Gaps in Labour Outcomes, OECD Development Centre.
7. Ironmonger, D. (1999) "An Overview of Time Use Surveys", paper presented in International Seminar on Time Use Studies, Center for Development Alternatives, Ahmedabad, India.
8. Ilahi, N. (1999) Gender and the Allocation of Adult Time: Evidence from the Peru LSMS Panel Data. Policy Research Working Paper Series 2744, World Bank, Washington, DC
9. Kent, R.K (2009) "Measuring time spent in unpaid household work: Results from the American Time Use Survey", Monthly Labor Review
10. Mallikarjuna, K. G., and N. T. K. Naik. (2014) "Indicators of Women Economic Empowerment" International Journal of Humanities and Social Sciences (IJHSS) vol 3(3) Pp 67-74
11. Rubiano, E and Viollaz, M (2019) Gender Differences in Time Use Allocating Time between the Market and the Household. Policy Research Working Paper 8981
12. Reid, M. G. (1934) Economics of Household Production. New York: John Wiley and Sons, Inc

Appendix

Table 1TUS activity classification as per International Classification of Activities for Time Use Statistics 2016 (ICATUS 2016

1. **Production of goods for own final use**	*a. Agriculture, forestry, fishing and mining for own final use* Growing crops and kitchen gardening, for own final use Farming of animals and production of animal products for own final use Hunting, trapping and production of animal skins for own final use Forestry and logging for own final use Gathering wild products for own final use Fishing for own final use Aquaculture for own final use Mining and quarrying for own final use *b. Making and processing goods for own final use* Making, processing food products, beverages and tobacco for own final use Making, processing textiles, wearing apparel, leather and related products for own final use Making, processing of wood and bark products for own final use Making, processing bricks, concrete slabs, hollow

	blocks, tiles for own final use Making, processing herbal and medicinal preparations for own final use Making, processing metals and metal products for own final use Making, processing of products using other materials for own final use Acquiring supplies and disposing of products and other activities related to making and processing goods for own final use *c. Construction activities for own final use* Construction activities for own final use *d. Supplying water and fuel for own final use* Gathering firewood and other natural products used as fuel for own final use Fetching water from natural and other sources for own final use *e. Travelling, moving, transporting or accompanying goods or persons related to own-use production of goods* Travelling, moving, transporting or accompanying goods or persons related to own-use production of goods
Unpaid domestic services for household members	*a. Food and meals management and preparation* Preparing Serving meals/snacks Cleaning up after food preparation/meals/snacks Storing, arranging, preserving food stocks Other activities related to food and meals management and preparation. *b. Cleaning and maintaining of own dwelling and surroundings* Indoor cleaning Outdoor cleaning Recycling and disposal of garbage Upkeep of indoor/outdoor plants, hedges, garden, grounds, landscape, etc. Tending furnace, boiler, fireplace for heating and water supply Other activities related to cleaning and upkeep of dwelling and surroundings *c. Do-it-yourself decoration, maintenance and repair* Do-it-yourself improvement, maintenance and repair of own dwelling Installation, servicing and repair of personal and household goods including ICT equipment Vehicle maintenance and repairs Other activities related to do-it-yourself decoration, maintenance and repair *d. Care and maintenance of textiles and footwear* Hand/machine-washing Drying textiles and clothing Ironing/pressing/folding Mending/repairing and care of clothes and shoes; cleaning and polishing shoes Other activities related to care of textiles and footwear *e. Household management for own final use* Paying household bills Budgeting, planning, organizing duties and activities in the household Other activities related to household management *f. Pet care* Daily pet care Using veterinary care or other pet care services (grooming, stabling, holiday or day care) Other activities related to pet care *g. Shopping for own household members*

	Shopping for/purchasing of goods and related activities Shopping for/availing of services and related activity *h. Travelling, moving, transporting or accompanying goods or persons related to unpaid domestic services for household members* Travelling, moving, transporting or accompanying goods or persons related to unpaid domestic services for household members
Unpaid caregiving services for household members	*a. Child care and instruction* Caring for children including feeding, cleaning, physical Care Providing medical care to children Instructing, teaching, training, helping children Talking with and reading to children Playing and sports with children Minding children (passive care) Meetings and arrangements with schools and child care service providers Other activities related to childcare and instruction *b. Care for dependent adults* Assisting dependent adults with tasks of daily living Assisting dependent adults with medical care Assisting dependent adults with forms, administration, accounts Affective/emotional support for dependent adults Passive care of dependent adult Meetings and arrangements with adult care service providers Other activities related to care for dependent adults *c. Help to non-dependent adult household members* Feeding, cleaning, physical care for non dependent adult household members including for temporary illness Affective/emotional support for non-dependent adult household members Other activities related to care for non-dependent adult household members *d. Travelling and accompanying goods or persons related to unpaid caregiving services for household members* Travelling related to care-giving services for household members Accompanying own children Accompanying dependent adults Accompanying non-dependent adult household members *d. Other activities related to unpaid caregiving services for household members* Other activities related to unpaid caregiving services for household members
Unpaid volunteer, trainee and other unpaid work	*a. Unpaid direct volunteering for other households* Unpaid volunteer household maintenance, management, *a.* construction, renovation and repair Unpaid volunteer shopping/purchasing goods and services Unpaid volunteer childcare and instruction Unpaid volunteer care for adults Unpaid volunteer activities in enterprises owned by other households Other activities related to direct unpaid volunteering for other households *b. Unpaid community- and organization-based volunteering* Unpaid volunteer work on road/building repair, clearing and preparing land, cleaning (streets, markets, etc.), and construction Unpaid volunteer preparing/serving meals, cleaning up Unpaid volunteer cultural activities, recreation and sports activities Unpaid volunteer office/administrative work Other activities related to community- and organization based unpaid volunteering *c. Unpaid trainee work and related activities* Unpaid trainee work and related activities *d. Travelling time related to unpaid volunteer, trainee and other unpaid work* Travelling time related to unpaid volunteer, trainee and other unpaid work *e. Other unpaid work activities*

	Other unpaid work activities
Learning	*a. Formal education* School/university attendance Extra-curricular activities Breaks at place of formal education Self-study for distance education course work (video, audio, online) Other activities related to formal education *b. Homework, being tutored, course review, research and activities related to formal education* Homework, being tutored, course review, research and activities related to formal education *c. Additional study, non-formal education and courses* Additional study, non-formal education and courses *d. Travelling time related to learning* Travelling time related to learning *e. Other activities related to learning* Other activities related to learning
Socializing and communication, community participation and religious practice	*a. Socializing and communication* Talking, conversing, chatting Socializing/getting together/gathering activities Reading and writing mail (including email) Other activities related to socializing and communication *b. Participating in community cultural/social events* Participating in community celebrations of cultural/historic events Participating in community rites/events (non-religious) of weddings, funerals, births and similar rites-of passage Participating in community social functions (music, dance, etc.) Other activities related to community participation *c. Involvement in civic and related responsibilities* Involvement in civic and related responsibilities *d. Religious practices* Private prayer, meditation and other spiritual activities Participating in collective religious practice Other activities related to religious practice *e. Travelling time related to socializing and communication, community participation and religious practice* Travelling time related to socializing and communication, community participation and religious practice Other activities related to socializing and communication *f. Participating in community cultural/social events* Participating in community celebrations of cultural/historic events Participating in community rites/events (non-religious) of weddings, funerals, births and similar rites-of passage Participating in community social functions (music, dance, etc.) Other activities related to community participation *g. Involvement in civic and related responsibilities* Involvement in civic and related responsibilities *h. Religious practices* Private prayer, meditation and other spiritual activities Participating in collective religious practice Other activities related to religious practice *i. Travelling time related to socializing and communication, community participation and religious practice* Travelling time related to socializing and communication, community participation and religious practice

	j.Other activities related to socializing and communication, community participation and religious practice Other activities related to socializing and communication, community participation and religious practice
Culture, leisure, mass-media and sports practices	*a. Attending/visiting cultural, entertainment and sports events/venues* Attendance at organized/mass cultural events and shows Attendance at parks/gardens Attendance at sports events Other activities related to attendance at cultural, entertainment and sports events *b. Cultural participation, hobbies, games and other pastime activities* Visual, literary and performing arts (as hobby) Hobbies Playing games and other pastime activities Other activities related to cultural participation, hobbies, games *c. Sports participation and exercise and related activities* Participating in sports Exercising *d. Mass media use* Reading for leisure Watching/listening to television and video Listening to radio and audio devices Other activities related to mass media use *Activities associated with reflecting, resting, relaxing* Activities associated with reflecting, resting, relaxing *e. Travelling time related to culture, leisure, mass-media and sports practices* Travelling time related to culture, leisure, mass-media and sports practices *f. Other activities related to culture, leisure, mass-media and sports practices* Other activities related to culture, leisure, mass-media and sports practices
Self-care and maintenance	*a. Sleep and related activities* Night sleep/essential sleep Incidental sleep/naps Sleeplessness Other sleep and related activities *b. Eating and drinking* Eating meals/snack Drinking other than with meal or snack *Personal hygiene and care* Personal hygiene and care Health/medical care to oneself Other activities related to personal hygiene and care *c. Receiving personal and health/medical care from others* Receiving personal care from others Receiving health/medical care from others Other activities related to receiving personal and health/medical care *d. Travelling time related to self-care and maintenance activities* Travelling time related to self-care and maintenance activities *e. Other self-care and maintenance activities* Other self-care and maintenance activities

AN ENHANCED CONVERGENT KEY GENERATION ALGORITHM FOR SECURING DATA IN HYBRID CLOUD

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ABSTRACT

End-user needs for data storage, use of various cloud services, and resource sharing are all made easier with cloud computing. It's a key component that requires proper security to be put into the cloud for data storage. Because it combines public and private clouds, the hybrid cloud is very flexible. In a hybrid cloud environment, a company will prefer to employ private cloud for internal data storage while relying on public cloud for sharable data. As a result, a strong key generation process is critical for preventing data from being hacked. Encryption is a cryptographic measure that necessitates a key for symmetric encryption and two keys for asymmetric encryption. In most circumstances, symmetric encryption, also known as conventional encryption, is faster than asymmetric encryption. It has the capability of storing vast volumes of data. ECEKG: An enhanced convergent encryption key generation methodology is employed in this research to create keys for symmetric encryption in the hybrid cloud.

Keywords: *Cloud Computing, Data Security, Cryptography, Encryption, Hybrid Cloud*

Introduction

For secure data storage in the cloud, cryptography techniques necessitate encryption and decryption processes. Plain text is converted into incomprehensible Cipher text as part of the encryption process. Symmetric encryption requires the creation of a key that can be safely shared between the sender and recipient. The process of encryption can be given as

McEt → Ec(Ot, k) where

McEt → MAG Cipher Encrypted text

Ec → Encryption

Ot, → Original text

K → Key

The MAG Cipher [1] is a symmetric encryption method that uses a key to encrypt and decrypt data. For the success of an encryption technique, it is critical to produce keys effectively. The key generation process must be able to produce keys rapidly and demonstrate that the algorithm's speed is not hampered.

Stream ciphers and block ciphers can both be used in symmetric key cryptography. The Vigenere Cipher is an example of a stream cipher. These ciphers encrypt a message's letters or numbers (usually bytes) one at a time, whereas block ciphers take a group of bits and encrypt them all at once.

Many symmetric data encryption techniques have been proposed up to this point. Some of them encrypt text using traditional methods [2].The process of producing keys for cryptography is known as key generation. Keys are sometimes created at random using a truly random number generator (RNG) or a pseudo random number generator (PRNG). A pseudo random number generator (PRNG) is a computer technique that generates random data. To seed data, PRNGs utilize system entropy. It generates better results since it makes it considerably more difficult for an attacker to determine the PRNG's beginning circumstances. [3]

Key security strength:

The security strength that a key can provide is determined by the following factors:

a) The methodology utilized, b) The size of the key, c) The method used to generate the key, and d) How the key will be managed.[4].The technique of protecting and administering cryptographic keys and their related data throughout the key life cycle is known as key management.

For security, cryptographic keys must be carefully handled. A vault's password is the

same as the combination of keys. The Strongest Lock offers no protection against penetration if an attacker knows a secure sequence. In the same way, poor key management can put even the most powerful algorithms in jeopardy .Finally, the strength of the keys, the efficacy of procedures and protocols linked with the keys, and the keys preservation all play a role in the security of information assured by cryptography.[5]

Related Work

DES, 3DES, AES, IDEA, RC4, and RC5 are among the symmetric algorithms compared by Shancang Li et al. [6]. Symmetric key algorithms are more secure than asymmetric key algorithms, according to the report. Some symmetric key algorithms are thought to be virtually unbreakable. In addition, symmetric key algorithms are exceedingly quick.

B. Seetharamulu et al. [7] discussed a convergent encryption system in which a file is hashed with the sha256 method [8] to produce a hash value that may be used as a key for file encryption. The result of sha256 is 256 bits, which can be used as a key in the AES technique to encrypt files.

Ms. Madhuri A. Kavade et al. [9] offered Convergent encryption as a way to implement data secrecy while achieving deduplication. It encrypts and decrypts data using a convergent key produced by computing the cryptographic hash value in the data copy's content.

M. Guru Vimal Kumar et al [10] compared DES, 3DES, AES, RSA, Diffie-Hellman, and DSA, as well as other symmetric and asymmetric methods. It has been discovered that a short length single key is incapable of providing a secure secure cryptographic model, whereas a long length key could. A suitable key arrangement is required to achieve a secure cryptographic model.

A crypto system for a Telemetry was devised by Lewin A.R.W. Edwards et al. [11]. It had a transmitter that used a symmetric-key technique with a rather difficult-to-crack key width. A physical connection to the device can be used to read the serial number on each transmitter. When a unit is placed on the charging station, it is loaded with a fresh random key.

Cheolhee Park et al. [12] discussed a deduplicatable proof of storage approach that is both secure and efficient. Sec-DPoS is based on symmetric key cryptography. It protects data from brute-force attacks while allowing for integrity auditing using symmetric key cryptography.

Mazhar Islam et al. [13] went into greater detail concerning the use of images as secret keys. Message letters are translated to their 8-bit binary equivalents. The image pixel values are scanned using these 8-bit codes. Rather than saving pixel positions as (x, y) coordinates, they are saved as a single column value. Pixel positions are communicated as cipher text when all matches have been found. The receiver side will scan the same image for all the points and select the values that represent message codes at those points.

Shafali Agarwal et al. [14] described a cryptosystem that encrypts a simple image with a key based on a fractal image. The main benefit of employing a fractal key is that it requires less key storage and is more resistant to attacks. To calculate an encryption key in the suggested approach, the distance parameter must be carefully adjusted so that the algorithm can produce a secure encrypted image. It can't be too close, and it can't be too big (such as the size of an image).

Interactive Message-Locked Encryption with Convergent Encryption was studied by Jayapandian N et.al [15]. (iMLEwCE). The data is first encrypted, followed by the cipher text. The storage space is reduced using block-level deduplication. The encryption keys are created from the chunk data in a regular setup of data dependencies. The cipher text will always be the same if the chunks are identical. The hacker will not be able to derive the keys arrangement from the encrypted chunk data.

Junbeom Hur et al. [16] suggested a solution that uses randomized convergent encryption and secure ownership group key distribution to allow the cloud server to restrict access to outsourced data even when ownership changes dynamically. This stops data from being leaked not only to revoked users, but also to a trustworthy but suspicious cloud storage server.

Problem Definition

The current era is described as an information era and a period of digitization. The digital information is generated in terabytes daily through various sources like smart phones, social networks, user generated content. This digitization has raised several issues with respect to data storage on cloud .The Cloud service provider's responsibility is to ensure security in the data stored in the cloud. The end user must be assured of confidence. It requires the selection of appropriate methods to enhance data protection. The user chooses either the public as well as a private cloud to store their data.

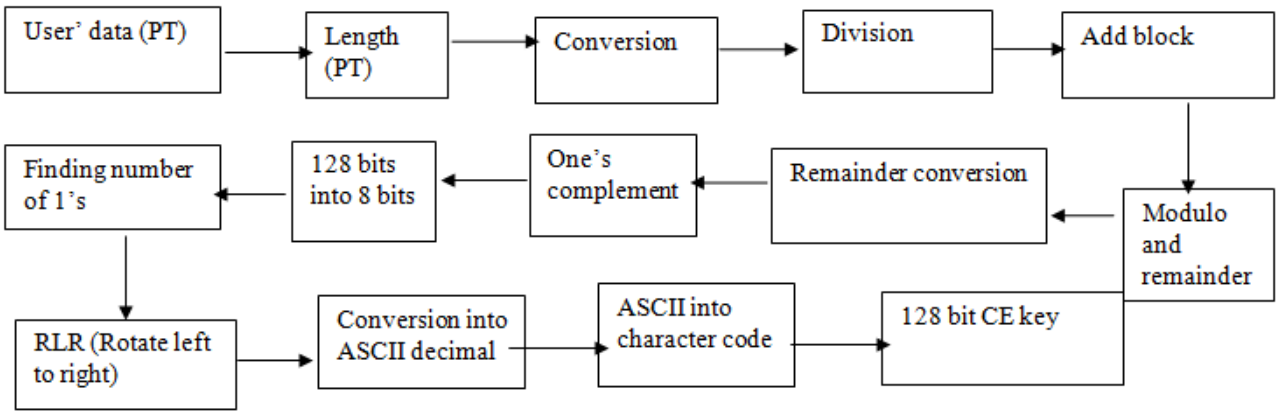
The secrecy of the key involved is critical to perform encryption and decryption operations .For symmetric encryptions, the success of the algorithm applied always rely on how robust the key is. A key generation procedure must be unambiguous and must be deduced effectively. There are different techniques in key generation. This paper discusses the usage of Convergent encryption key generation tchnique in hybrid cloud.

Proposed Enhanced Convergent Encrypted Key Generation .ECEKG Features

- The proposed key generation(ECEKG) is used to geneate keys for perfoming encryption before moving data into the cloud.
- It also protects against deduplication of encrypted content.
- The key is produced from the data that is uploaded to the cloud.
- The generated key will be the same for the same data submitted to the cloud at all times .
- The encrypted data produced upon encryption will aso be similar.
- As a result, replication authentication safeguards the same encrypted data stored in both public and private clouds.
- In a hybrid cloud environment, the proposed convergent encryption key generation effectively preserves data protection and data deduplication.

Block diagram of ECEKG

Block diagram of ECEKG



Steps to be involved in the generation of Convergent key

Step 1. Users' data is input PT.

Step 2. Find the length of the PT.

Step 3. The characters in the PT are converted into decimal code.

Step 4. Divide the PT into 16 characters' length of blocks.

Step 5. Add each block decimal with the following 16 block decimal values.

Step 6. Find the modules by dividing each decimal value by 256, note the reminder value

Step 7. The derived 16 reminder values are converted into binaries 0's and 1's.

Step 8. Finds the one's complement of the 128 bits binary.
Step 9. Divide the 128 bits into 8 bits.
Step 10. Count the number of 1's in each 8 bits block.
Step 11. Rotate left to right each 8bits at the number of times the occurrence of 1's in every8bits.
Step 12. Convert the 8bits into the ASCII decimal code.
Step 13. Convert the decimal into the character code.
Step 14. The converted character code is the 128 bit CE key.

Experiment with original sample text

Input: The Hybrid Cloud
The Key for the PT is,

Key: µq↓▒aΩπΓIáë Hë╨î)

Simulation Results

The proposed convergent key generation is compared with a similar cryptographic key-based hash function, such as HMAC [17] and PMAC [18]. The performance of proposed and existing hash algorithms are calculated based on time is taken for processing the data at a different size. Table 1and figure 1 shows the time comparison of existing and proposed techniques.

Table 1 Performance Comparison based on Time

Data Size	Techniques		
	HMAC		PMAC
	ECEKG		
	Milliseconds		
1 MB	1228	1024	614
2 MB	2150	1945	1126
3 MB	3788	2969	1843
4 MB	4710	4198	2355
5 MB	6041	5120	3276

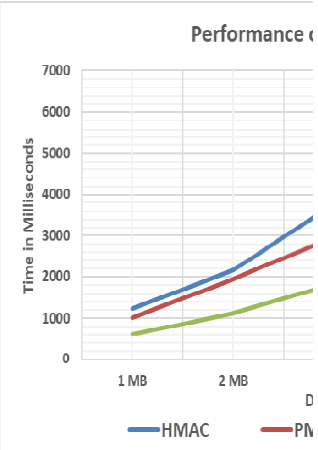


Figure 1 Performance comparison of existing and proposed techniques.

It is observed that the proposed convergent encryption key generation algorithm has taken minimum time for processing the data compared with the existing techniques.

Conclusion

The secrecy of the keys, not the cipher, is what determines the security of any cryptosystem. Data could be encrypted using AES-256 or RSA-2048, making the cipher text hard to crack. But that plays no role if the keys are lost or are compromised. In Cryptography, entropy is the measure of uncertainty or randomness in a system. Entropy refers to the randomness of the cipher and of the encryption key. The higher the entropy, the more random the results and the more secure the cipher text. This paper deals with Enhanced Convergent Encrypted key generation which creates key from the user plain text itself. For different inputs, this algorithm creates different key which can be used for encryption either in the public cloud or in the private cloud. For same plain text given as input, this algorithm produces the same key. The same encrypted data will be produced using the same key and encryption procedures. As a result, duplicate verification safeguards the same encrypted data stored in both public and private clouds. In a hybrid cloud context, the suggested convergent encryption key generation successfully ensures data security and data deduplication.

References

1. Dr. D.I. George Amalarethinam, Madhupriya, ”MAGcipher: An Enhanced Cryptography Encryption for securing the Data in Hybrid Cloud” International Journal of Advanced Science and Technology , Vol. 29, No. 5s, (2020), pp. 585-590
2. Borislav Stoyanov, article “Symmetric Key Encryption Based on Rotation-Translation Equation” Symmetry, MDPI 2 January 2020)
3. Dr. S. Arul Jothi, “ Evaluation of Symmetric Key Cryptosystem Based On Randomized Key Block Cipher Algorithm to Cryptanalytic Attacks” IOSR Journal of Engineering (IOSRJEN) ISSN (e): 2250-3021, ISSN (p): 2278-8719 Vol. 09, Issue 2 (February. 2019), ||V (I) || PP 01-04
4. Elaine Barker, “ NIST Special Publication 800-133 Revision 2 Recommendation for Cryptographic Key Generation, June (2020)
5. Article on ”Selecting The Right Key Management System”www.Cryptomathic.com,
6. Shancang Li,“IoT Node Authentication”, Science Direct (2017).
7. B. Seetharamulu, ”Cloud Storage Using Convergent Encryption Technique”,International Journal of Applied Engineering Research, ISSN 0973-4562 Vol.10No.79 (2015) © Research India Publications
8. Movable Type Scripts , SHA-256Cryptographic Hash Algorithm, https://www.movable-type.co.uk › scripts › sha256
9. Ms. Madhuri A. Kavade, ” A Literature Survey On Secure De-Duplication Using Convergent Encryption Key Management”, International Journal Of Engineering And Computer Science ISSN:2319-7242,Volume 3 Issue 11 November, (2014) Page No. 9201-920
10. M. Guru Vimal Kumar, ”A Survey on Current Key Issues and Status in Cryptography”, 978-1-4673-9338-6/16/$31.00_c (2016) IEEE
11. Lewin A.R.W. Edwards, ” Encryption and Data Security Primer”, Open-Source Robotics and Process Control Cookbook (2005)
12. Cheolhee Park,”A Symmetric Key Based Deduplicatable Proof of Storage for Encrypted Data in Cloud Storage Environments” Hindawi Security and Communication, Networks Volume (2018), Article ID 2193897.
13. Mazhar Islam,”A New Symmetric Key Encryption Algorithm using Images as Secret Keys”,978-1-4673-9666-0/15 $31.00 © (2015) IEEE DOI 10.1109/FIT.2015.12
14. Shafali Agarwal**,** **”**Symmetric Key Encryption using Iterated Fractal Functions”, **I**. J. Computer Network and Information Security, (2017)**,** 4, 1-9 Published Online April 2017 in MECS (http://www.mecs-press.org/)
15. Jayapandian N, ”Secure Deduplication for Cloud Storage Using Interactive Message -Locked Encryption with Convergent Encryption To Reduce Storage Space”, Vol.61: e18160609, (2018) http: //dx.doi.org/10.1590/1678-4324 - 2018160609 ISSN 1678-4324 Online Edition
16. Junbeom Hur, ”Secure Data Deduplication with Dynamic Ownership Management in cloud Storage”, DOI 10.1109/TKDE.(2016).2580139, IEEE Transactions on Knowledge and Data Engineering.
17. HMAC algorithm in Computer Network, Geeks for Geeks-HTML document
18. PMAC (cryptography) - HandWiki-HTML document

DETECTION AND ANALYSIS OF COLON CANCER USING ASSOCIATION RULE MINING BASED CLASSIFICATION

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ABSTRACT

Colon cancer is one of the most threatening diseases affected by the majority of people in India. Recommending an IT-enabled diagnosis for colon cancer can improve the present status of this disease in India. A promising approach is to use association rule mining to build an expert classification system for identifying and diagnosing colon cancer at its early stage. In this paper, we proposed an effective classification method for mining important association rules based on utility and weight. Initially, we calculate information gain and set threshold empirically for selecting all those attributes in the dataset which have a gain value greater than the threshold for mining. An Apriori algorithm is then applied in the selected attributes to form a group of association rules from the dataset. On each such association rule, a combination of UW-score is computed and a specific threshold value for UW-score is estimated empirically. The rules that possess UW-score greater than the threshold being selected for the classification. We implemented five different classification models such as K-Nearest Neighbor (KNN), Naïve Bayes, Decision Tree, Artificial Neural Network and Support Vector Machine (SVM), then evaluated the performance of the proposed work against the conventional classification model.

Keywords: *Association Rule Mining (ARM), Colon Cancer, F-Score, Gain, Utility, UW-Score.*

Introduction

Several years ago, Colon cancer was very few in numbers. Now, this is very predominant in western countries which causes a 10 % rate of cancer-related death. This change even in developed countries is due to population aging, unhealthy dietary habits, obesity, smoking, and low physical exercise, etc. New treatments emerged for primary and metastatic colon cancer diagnosis. It provides additional treatment options for patients such as laparoscopic surgeries, more-aggressive resection, radiotherapy, palliative, and neoadjuvant chemotherapies. But long term survival and cure rates are affected by these treatments. So, a risk prediction system can provide more important information for treatment. Such systems are very useful in the medical field.[1]

A final part of the digestive system of the human body is known as the colon. Uncontrolled growth of the colon is known as colon cancer that starts from the digestive system of the human body. Colon cancer usually affects older people but there may possibility to happen at any age of human life. At the initial stage, small polyps inside the colon are developed and later it leads to colon cancers. Regular checkup helps to prevent this cancer at the earlier stage and remove polyps before it became more dangerous. Different treatment methods are now available to handle this disease after the detection. It includes radiation therapy, drug treatments, and surgery. Drug treatment consists of techniques such as immunotherapy, chemotherapy, and targeted therapy. A persistent change in bowel habits including constipation or diarrhea may be due to this disease. A change in the consistency change in stool, stool containing blood or bleeding in rectum, weakness or fatigue and weight loss, discomfort in the abdomen (gas or pain, cramps) are symptoms of colon cancer. In the early stage of this, disease some people find no symptoms at all. [2][3][4]. According to the size of cancer and its position in the large intestine symptoms may vary. Factors that may increase the risk of colon cancer include, the race which is African-American, older age, colorectal cancer history, condition of inflammatory intestine, Low-fiber/high-fat diet, syndromes that are inherited, diabetes, a sedentary lifestyle, smoking, obesity, alcohol, etc. [2][3][4].

Agrawal proposed the association rule mining concept in 1994. According to the association rule mining concept, the rules are generated based on the two parameters such as support and confidence. To form the association rules a specific threshold value that is derived empirically is used. All items in that dataset possess support and a confidence value greater than the threshold is chosen for generating the rules. Finding those rules which satisfy the condition is the procedure for association rule mining. Association rule discovers interesting

relations between variables in the large databases. Every such rule has two parts that are an antecedent and consequent part. For example, a rule is of the form: An **if** (antecedent) and a **then** (consequent)part.[5][6][7]

A *rule* has the following form:

$$X \rightarrow Y$$

Here antecedent part is X and consequent part is Y

The two constraints such as support and confidence are used to find the interesting rules from the large dataset. Support is a measure that identifies how frequently the item set appears in the dataset. Confidence evaluates how often the rule is true.[5][6][7]

Different approaches are therein the association rule mining concept such as fuzzy weighted frequent pattern (FWFP) growth, fuzzy weighted association rule mining, utility-based association rule mining, etc. All of these approaches are used in many areas like financial analysis, retail industry, and business. Association rule mining is two steps procedure. Initially, it finds out the frequent items and then generates association rules from this. Various algorithms are already available in the literature to find the frequent items. One of the disadvantages of these algorithms is that they all treat items equally well. In reality, each item has a different significance. To overcome this demerit, new approaches have to been evolved. It includes utility mining model, weighted association rule mining, etc. [5][6][7].

Literature Review

Last two decades, different efficient algorithms have been developed for association rule mining. For mining efficient association rules between the set items in a large database, mining algorithms make use of buffer management and pruning technique. These two techniques propose two measures namely support and confidence with minimum transactional support. In a rule, the percentage of itemset which contains both items in the antecedent and consequent part is known as support. Confidence is the percentage of transactions that satisfy both the antecedent of the rule and the consequent of the rule. if in a single pass all itemset in the transaction that may be unfit to the memory then this algorithm makes use of buffer management to handle this situation. The Certain itemset is deleted in such a situation and all those items are measured again in the next iteration to maintain completeness. It shows high accuracy in testing [8].

Agrawal [9] presented an improved algorithm named Apriori and aprioriHybrid. Large database of a sales transaction, this algorithm is implemented to discover the rules between items in such transactions. In the above algorithms, itemset found in a previous pass is used to generate new candidate items for the current pass. AprioriTid uses a coding of candidate itemset of the previous pass. They compared these two algorithms with AIS [Artificial immune system] and SETM (Set-oriented mining) algorithm. The experiment results show that the proposed algorithm is far better than these algorithms. The performance gap also increased with the problem size [9].

Christian Hidber [10] introduced Continuous Association Rule Mining Algorithm (CARMA) which is a new method to compute large item sets online. During the first pass, the user can change the threshold of support at any time by scanning the transaction sequences. All large itemset superset is maintained by this algorithm. After two scans this algorithm terminates with the precise support for each large itemset. An interesting aspect of this algorithm is that a second scan result is not needed so it will shrink the support intervals. This paper compares the algorithm with Apriori. It is not faster in general but outperforms Apriori on a low support threshold.[10]

Rapid Association Rule Mining (RARM) [11] is an algorithm for association rule mining. An efficient tree structure is used by this algorithm to represent the original data base. In association rule, many algorithms have been proposed to speed up the mining process. Here the authors propose an innovative algorithm to break the speed barrier. This algorithm does not use candidate 2-itemset generation. Finding 2-itemsets candidate is a time-consuming process in the Apriori algorithm which is solved by this algorithm by eliminating the process of generating candidate 2 itemset that increases the speed of the mining process. While comparing RARM and Apriori algorithm, RARM outperforms with Apriori 100 times higher [11]

Traditionally association rule mining uses a single support value in rule mining, which is not an efficient method. Weights are associated with each item that has varying significance. But frequency is not considering in that case. In this paper, multiple-level association rule mining is used to mine both positive and negative weighted association rules with multiple minimum support. Support count is different for each item in multiple support models. Over different levels, this algorithm identifies different associations, such associations form rules in mining. [12]

Weighted utility association rule mining deals with item weight and frequency of items. The Traditional approach only uses a weighted association rule where the frequency is not considered. This causes loss of information. Thus, in recent research, researchers include factors that influence such as utility and weight parameters. In this paper [28] for effective mining of significant association rules, they proposed a novel approach based on weight and utility parameters. During the first phase, this method uses a traditional Apriori algorithm to find the rules. Then some measures are calculated for the mined rules such as u- gain and w-gain. Finally, rules are pruned based on a threshold of uw-score. This algorithm is very efficient in generating high utility rules. [13]

In this paper, to mine high utility association rules, an efficient approach based on utility and weight factors is used. During the first phase, proposed an approach to find the gain of each attribute. Then attribute with the gain below the threshold is eliminated and then using Apriori algorithm is used on those attributes to generate association rules. The rules that are mined are subjected to two factors: weightage and utility. For every rule, a UW score is calculated. A set of rules that are taken by pruning is based on the threshold value which is computed empirically.

Materials and Methods

Classification

Classification processes in data mining are categorized into two: predictive and descriptive classification. In both of these techniques, hidden patterns are extracted from bulk data and classified into different classes to which the pattern matches. Classification is the process of converting the actual data into a set of classes based on the features or pattern extracted from it. In classification either supervised or unsupervised classification methods are used. In the supervised learning method, data are classified into previously known classes whereas, in the case of unsupervised classification, the set of cases in the data are unknown, and then it is formed as different cluster units. In clustering, a user is classifying the data by giving a name to these classes through some assumption. Based on the given input the outcome is predicting in clustering. To make a prediction, there is a need of accessing the available data. Records are classified based on this data. In classification, the data sources used for classification can be of two types. The first one is training data. The Building classification model is done by using training data. Later this model is used for evaluating the classification model built. For evaluating the model, another set of data known as test data is given to the model built during the training stage for predicting the outcome of a new sample in the dataset [14][15][16].

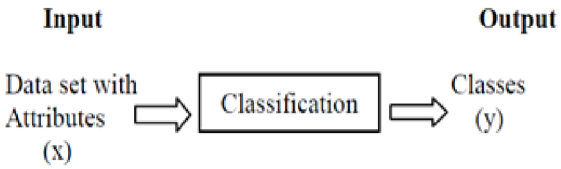

Figure 1: Classification from x to y

The most commonly available classification algorithms include: Decision Tree (DT), Naïve Bayes (NB), Artificial Neural Networks (ANN), K-Nearest Neighbour (KNN), and Support Vector Machine (SVM)

Decision Tree

Divide and conquer methodology is used here. This is a widely used classification technique. The procedure is starting by dividing the data into sub-data.

A Decision tree is organized in a way with a root at the top of the tree. The internal nodes represent branches of the tree and leaf node that pointing to the class in which the data is classified. Such leaf node cannot make further division or classification [14][15][16][17][18][19].

Constructing a decision Tree is an NP-complete problem. Thus, research has been going on to find an efficient method for constructing an optimal Decision Tree. A top-down approach is used in Hunt's algorithm. Here one attribute split the data into subsets and the data contains more than one class. Attribute test is done through a greedy method. The greedy method is used to select the attribute for best split and stop the process. This algorithm makes use of both numeric and categorical data sets [14]. Hunt algorithm does the work as follows. If all record belongs to the same class, then it is a leaf node. If it contains no record, then also it is the default class. Other ways (containing more than one class), split the data into smaller groups. This process repeats for all subsets until the subset belongs to the same class. [15][16].

For the best split, considers some factor such as Entropy, Gini index, misclassification error, etc. Information gain as selection criteria for selecting attribute in ID3 algorithm. Given a set of examples D, the first is to compute its entropy.

Entropy (D) = $P_i \log P_i$ (1) Where p (c_j) is the probability c_j in D. Here c_j is the class and D is the dataset. Impurity or disorder is measured by Entropy. For selecting attribute Ai the information gain is

Gain (D, A) =Entropy(D) − Entropy Ai (D) (2)

Naive Bayes Classifier

A hypothesis is made for the set of classes and assumes the classes are independent. This classification is based on the Bayes theorem. For example, A fruit is predicted as oranges based on its color and shape that possess. Color and shape feature makes the prediction that the given fruit is orange and therefore these two features that makes an independent model for the prediction. Conditional probability serves as an important point in Naive Bayes algorithm. [15][16].

$$P(A|B) = \frac{P(B|A)*P(A)}{P(B)} \quad (3)$$

P (A|B) is the conditional probability or posterior probability of target class A, given predictor class B. posterior probability means A is derived from B. P (A) - prior probability of A. It counts only the occurrences of A. P (B|A) - the conditional probability of B, given a P (B) is the prior probability of A.

A Bayesian Network (BN) is a graphical representation of probability relationships between variable features. A Bayesian Network (BN) is represented by a directed acyclic graph (DAG). In such network *M,* the nodes denote the features *X.* Feature's casual influences are denoted by an arc. Conditional independencies in M are indicated by the absence of arc. A node (feature) is conditionally independent of its non-descendants that are given by its parents [14][16].

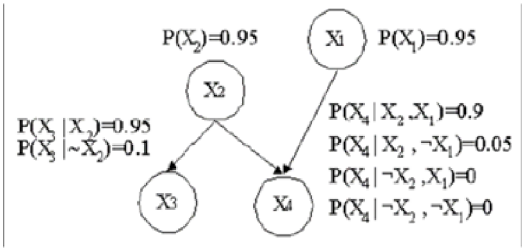

Figure 2: The structure of Bayes network

This classification also has some limitations. Unknown networks are difficult to explore. The most interesting feature of The Bayesian network is the possibility of considering the prior information about the problem. This prior information is structural relationships of its features. A disadvantage of BN is that they are not suitable for inputs with many features. Because of building a very large network is not easy and feasible.[15][16][17][18][19]

Artificial Neural Networks (ANN)

ANN is inspired by a biological neuron. Neuron (node) is the basic building block of such a system. Communication of neurons is done through sending signals. The structure of an Artificial Neural Network consists of two types of networks. One is Feed Forward and the other is feedback network. The data flows only in one direction in the feed-forward network. Acknowledgment is not possible in this kind of network. Errors cannot be acknowledged. Example: recognition of images or identification of the Fingerprint patterns. It is possible to provide feedback in the feedback network. A Feedback network is efficient because it can identify the occurrence of errors. Image recognition is a classic example of a neural network. Other examples are Medical

diagnostics, Detective tools, Quality assurance, etc. [16] [18] [19]

Back-propagation (a supervised learning algorithm) in multilayer perceptron (MLP) is famous for ANN architecture. For prediction and classification, this is more powerful. It is the most studied ANN architecture. It is a collection of a perceptron. It consists of a feed-forward structure with multiple layers. MLP network consists of more than three layers. They are the output layer, hidden layers, and input layer.

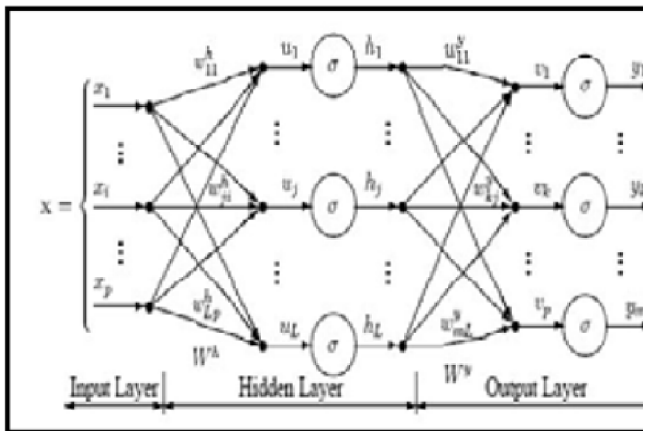

Figure 3: MLP

Figure 3 shows the architecture of MLP. A neuron j in the hidden layer adds its input xi multiply the weight w_{ji} to and all these inputs are then fed to the output layer [15][16].

$$Y_j=f(\Sigma WjiXi) \quad (4)$$

To train neural networks, a back propagation algorithm can be used. The network consists of three different types of layers as mentioned above. These layers comprise connected neurons that form a network. Weights on the connections indicate the strength of the signal. Weights of the connection are updated by the hidden layer. The algorithm works as follows. First, data samples are given to the input layer for training. Here the classes are predefined. This step is known as the training phase. The second phase is the testing phase in which a set of test data is given to the input layer for the prediction of classes. If the output does not match the desired outcome, the error is propagated back to the previous layer. Weights are then adjusted to reduce the difference in errors. The process is continued until the error becomes small. This algorithm is simple to use and implement [16] [18] [19].

K-Nearest Neighbour (KNN)

In KNN data are classified on closest training samples given in the feature space. The computing decision boundary is the core role of KNN. Boundary complexity's function determines the complexity of KNN. The algorithm is working purely on the data given to it. k = 1 is a special case called the nearest neighbor algorithm. The data set determines the value of k. Classification error can be reduced by a larger value of k where it causes less distinct boundaries among classes. There are different techniques for selecting K. results of KNN are seemed to be consistent. Misclassification error occurs when we choose a small value for k. It is easy to implement but the computational cost is high for a large dataset. It requires more space for keeping its local structure of the model build during the building of model [14][16][19]

Support Vector Machine (SVM)

Support Vector Machine (SVM) makes use of the concept of decision-plane. SVM is proposed by Vapnik in his machine learning algorithm in 1960. This model is trained to predict classes of samples. Support vectors are those classes whose decision boundaries are defined. There are two ways to use the SVM technique. The first method is mathematical programming. The second method is to use the function. In SVM, data points are separated by a hyper plane. These are in high dimensional and point belongs to different classes. For example two-class problem. The classes being Q and N. It is for Y_n = 1,-1, and by which we can extend to K class classification by using K into 2 class of the classifiers [17].In linear SVM data is linearly separable. Let W is the weight vector, X_n is the nearest data point.

$W^T + b \geq 1$ For $x_n \in$ Q and

$W^T X_n + b \leq -1$ for $x_n \in$N (5)

For optimization it minimizes the

$1/2[W^T W]$ Subject to $Y_n(W^T W + b) \geq 1$ for n=1 to N

(6)

The Lagrangian formula for this problem is

$L(W, b, \alpha) = 1/2||W||^2 - \alpha_n y_n(W^T X_n + b) - 1$ (7)

Where α is the Lagrange multiplier. For the quadratic program α is maximized to α≥0 and minimize with respect to w, b

$$\Delta wL = w \quad - \alpha_n y_n X_n = 0 \qquad (8)$$

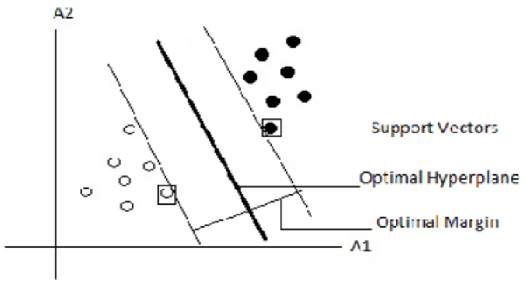

Figure 4: Linear SVC

$$\frac{\partial L}{\partial b} = - \sum_{n=1}^{N} y\, \alpha_n \qquad (9)$$

So, the above equation become

$$L(\alpha) = \sum_{n=1}^{N} \alpha_n \frac{1}{2} \sum_{n=1}^{N} \alpha \quad {}_m y_n Y_n W^T W \qquad (10)$$

In Non –linear SVM, this can be used to learn. Non-linear decision function can also learned from this. Mapping function space represented by

$$X -> H \text{ And } x -> \varphi \qquad (11)$$

Mapping is time consuming. Here, use a function to give the inner product value, called the kernel function.

$$K(x, z) = \varphi(X)^T \varphi(z) \qquad (12)$$

In a Non-separable case, data points can be misclassified due to noise. Here use a vector of slack variable ε = (ε1, ε2…) ^{T}. Advantages of SVM are: while considering all classification technique, it has efficient methods and it avoids over fitting. Disadvantages are: It is very expensive; it needs more time for training and it needs more storage. [15][16][19]

Performance Measures

Classification algorithms are evaluated against their performance. Based on these evaluations, one selects it suitable for a particular classification problem. The different classification method is evaluated using the following parameters. It is used to evaluate how accurate a classifier is: [20]. The following parameters were used for evaluating the performance of the classifiers.

1. Confusion matrix
2. Accuracy
3. Sensitivity and specificity
4. Precision and recall
5. F score

Confusion Matrix

Classifier's inaccurate and accurate predictions are depicted in the confusion matrix. After prediction, training data is compared with test data. There are two attributes for a confusion matrix: True and False. [20]

True positives *TP*: The number of samples that are positive and correctly classified.

True negatives *TN*: The number of samples that are negative and correctly classified.

False positives *FP*: The number of samples that are positive and incorrectly classified.

False negatives *FN*: The number of tuples that are negative and incorrectly classified.

3.2.2 Accuracy

The accuracy of a classification model is defined as the number of correctly classified instances divided by the total number of instances present in the dataset. [18][19]

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \qquad (13)$$

Sensitivity and Specificity

Class imbalance problem can be solved by sensitivity (rate of true positive) and specificity (rate of true negative) measures. Class imbalance is the problem of data set distribution. The class imbalance problem is the majority in negative class and minority in positive class. These measures are calculated by as [19][21]

$$\text{Sensitivity} = \frac{TP}{P} \qquad (14)$$

$$\text{Specificity} = \frac{TN}{N} \qquad (15)$$

Precision and Recall

These are also widely used as measures for the evaluation of the classification model. Precision can be thought of as a measure of *exactness* (what percentage of samples are labeled as positive). A recall is a measure of *completeness* (what percentage of positive samples are labeled as positive. The recall is similar to sensitivity.

It is also called true positive rate. These measures are:[19][20]

$$\text{Precision} = \frac{TP}{TP+FP} \quad (16)$$

$$\text{Recall} = \frac{TP}{TP+FN} \quad (17)$$

F Score

Test's accuracy is measured in F-score. It is calculated from the precision and recall of the test. The F score is the harmonic mean of the precision and recall. [21]

$$\text{F score} = \frac{2*\text{precision}*\text{recall}}{\text{precision}+\text{recall}} \quad (18)$$

Dataset

The Monica dataset consists of 3000 colon cancer patient details with 12 attributes that comprise the information and their outcome. It contains basic information about a patient such as age, sex, year of onset, etc. There is a column called outcome which shows whether a patient is alive or dead.

This data set has the following columns:

Table1: *Different columns of the dataset*

Column name	Description
Outcome	The patient is alive or not
Age	age of the patient
Sex	Male or female
Hosp	Hospitalized or not
Yronset	onsets year

Proposed Method

In this paper, we implemented a classification algorithm based on Association Rule Mining (ARM). It consists of two stages. In the first stage of the algorithm, it calculates information gain and then the attributes in the dataset are selected based on the information gain value greater than the specific threshold value derived empirically. Once the attributes are selected, in the second phase, applying the Apriori algorithm on those attributes to generate a set of association rules among these attributes. Once the rules are mined, then calculate the u-gain and w-gain of all such rules. From these two parameters finally, UW Score is computed. Using this UW score final rules for the classification of the dataset is done by pruning all such rules which have UW score less than the threshold. Once the rules are pruned, the dataset can be classified by using these rules. Finally, the performance of classification based on association rule mining is compared with standard classification algorithms such as KNN, Naïve Base, Decision Tree, ANN and SVM with pruned attributes in the dataset generated during the computation of UW score of the ARM algorithm.

In the proposed CBA (Classification Based Association rule) algorithm, initially calculates the information gain as follows:

Here D is a database with n number of transactions and m number of classes to which the transaction belongs to. The attribute are selected using Information gain. The entropy H (D) of a dataset D is a measure of the disorder/variation/information in it. The entropy of a dataset D with m classes having probabilities p1, p2 …pm is calculated by:

$$H(D) = -\sum p_i \log p_i \quad (19)$$

For a dataset D is that divided into D_1, D_2, D_3……, D_n the information gain of the split is computed.

$$\text{Gain} = H(D) - \sum p(D_i)) \log p(D_i) \quad (20)$$

Once the gain is computed, then it eliminates the attributes which have gain lesser than the threshold. The remaining attributes are selected for the next level iteration and this will reduce the test cases needed for classifying the object.

For example, Table 2 shows the total number of attributes in the database, and after eliminating the attribute based on the gain value of the threshold is shown in table 3.

Table 2: Original attribute list in the dataset

Sl.No	Attribute
1	outcome
2	sex
3	Age
4	Yronset
5	Premi
6	Smstat
7	Diabetes
8	Highbp
9	Hichol
10	Angina
11	stroke
12	Hosp

Weights are assigned to each attribute based on information gain. Medical field applications require more accuracy which can be obtained by using these weights. In a practical case, for any application, the significance of different attributes is different, especially in classification models. By considering information gain, different weights are assigned to different attributes. Usually in a database contains a count of attributes that shows the quantity of an item in numeric. But many traditional algorithms (Example: Apriori) did not consider this fact while mining the rule. It only considers the presence and absence of the data item in the database. So, weightage is not important in such cases. Mostly in transaction attributes have more weightage even though they are infrequent. In our proposed work this fact is taken into consideration. Here we use w-gain for this.

The utility is the second measure that we used in our method. A Utility is a profit or risk associated with an item. This measure is used to improve the efficiency of our method. Two additional parameters such as u-gain and w-gain are also computed from the above parameters for improving the performance of our method.

In the second stage, from the database D association rules are mined with n transactions.

The Database D contains following T transactions represented as follows

$$D = [T_1, T_2, \ldots, T_n] \qquad (21)$$

Every transaction contains attributes that are 'm' in number ([I1, I2,....., Im]). Every attribute i is associated by its weights Wi.

Table 3: Selected attribute based on gain value

Sl.No	Selected attribute
1	Yronset
2	age_class
3	Premi
4	Diabetes
5	Angina
6	Highbp
7	Stroke

To find frequent item set, we use a standard algorithm called the Apriori algorithm. Classical Apriori generally processes on a binary mapped database that consists of binary values 0 and 1 that denote the non-existence and existence of the attributes in the transactions. There is no point of weight in this approach.

Generally, the process of association rule mining using Apriori that consist of two steps namely,

1. **Frequent itemset generation:** Generate all possible sets of attributes that have support value greater than min-support (threshold).

2. **Association rule generation:** Generate association rules from the generated frequent itemset that have confidence greater than the minimum confidence. A standard association rule is of the form: A→B, where A (the antecedent) and B (the consequent) is a subset of items, such that, A ⊂ I, B ⊂ I, and A ∩ B=φ.

Support (A→B) = P (AUB) (22)

Confidence (A→B) = P (B|A) = support (AUB)/ support (A) (23)

The pseudo code for the Apriori algorithm is shown below:

I_1= l arg e 1- itemset};
for (k = I $_2$; $_{1\,k-1} \neq 0$, k+ +)do begin
C_k= apriori-gen (I_{k-1}); // New candidates
forall transactions T ∈ do D begin
C_T = subset (C_k ,T); // Candidates contained in
T candidates c ∈ C do//
c.count ++;
end
end

***I* = {*c* ∈*C* | *c.count* ≥ *min sup*}**
end
Answer = $U_k I_k$

This algorithm generates a k number of association rules R = {R_1, R_2,....., R_k }. The set of association rules R is fed to the next phase of the proposed method. Weightage and utility gain is calculated for every attribute present in every association rule of R. For example, in an association rule Ri of the form, (A, B) ⇒ C. Here, A, B, and C are the attributes in the rule Ri. Then, measures such as U-gain, W-gain, and UW-score are calculated for every attribute A, B, and C individually. Initially, all the k association rules generated are first sorted in descending order based on their support. The sorted list of association rules is given by S = {R1, R2 ....., Rk}, S ∈ R, where sup (R1) ≥ sup (R2) ≥ sup (R3)….. ≥ sup (Rk) so on [9].

Once the set of rules are generated, calculate u-gain, w-gain, and UW-score for each rule. For this, choose the first rule R1 from the sorted list of S and the individual attributes of R1 are determined and then calculated W-gain for each attribute in the rule R1.

Item weight is the quantitative measure of the attribute contained in the transaction. Wi is a non-negative integer. Weighted gain (W-gain) is defined as the sum of item weights Wi of an attribute contained in every transaction of the database D. [9]

$$\text{W-gain} = \sum_{i=1}^{|T|} w_i \quad (24)$$

where Wi is the item weight of an attribute. |T |is the number of transactions in the database D.

Similarly, for U-gain computation, the first rule R1 from the sorted list S is selected. Then the individual attributes of R1 are considered. The U-gain measure is calculated for every individual attribute present in rule R1 based on the U-factor and the utility value Ui of the attribute. The item utility Ui is generally defined as the margins of profit or risk associated with that particular attribute.

$$\text{Utility factor (U-factor)} = 1/\sum_{i=1}^{m} U_i \quad (25)$$

Utility gain refers to the measure of an attribute's actual utility based on the U-factor.[9]

$$\text{U-gain} = \text{Ui} * \text{U} - \text{factor} \quad (26)$$

The measure U-gain is computed for every attribute in the association rule R1. After calculating W-gain and U-gain, a single consolidated value termed UW-score is computed for every individual association rule. UW-score is defined as the ratio between the sum of products of W-gain and U-gain for every attribute in the association rule to the number of attributes present in the rule.

$$\text{UW-score} = \sum_{i=0}^{|R|} (w - gain * u\_gain)/|\text{R} \quad (27)$$

Where R represents the numbers of attributes in the association rule. These processes calculating W-gain, U-gain, and UW-score are repeated for the rest of the association rules R2 to Rk present in the sorted list of S. Now, all *k* association rules in the sorted list S possess a UW-Score. Later, the association rules in the sorted list S are sorted based on the UW-score. This will leads to S = {R1, R2,....., Rk}. Here UW-score (R1) ≥ UW-score (R2) ≥ UW-score (R3),… ≥ UW-score (Rk). The rules that have a uw-score more than the threshold are selected as the weighted utility association rule. This rule is given by {RWU}= {RWU1, RWU 2, RWUl}, where, k ≥ l and RWU ⊆ S.

Once the weighted utility association rules are formed as explained above, they can be used for classifying all the transactions in the database for predicting the respective outcome class. To compare the performance of the weighted utility association rule mining classification, different classification models are built using KNN, Naïve-Bayesian, decision tree, Backpropagation, and SVM with the attribute generated during the first phase of the algorithm are used as the input features. Further, our dataset mostly contains categorical values, therefore it is necessary to convert categorical values to numerical ones.

Result and Discussion

In this paper, we implemented a weighted utility association rule mining classification for classifying the Monica dataset comprised of 3000 colon cancer patients for predicting the outcome as dead or alive by using the most frequent itemset generated out of the 12 attributes in the original database. The dataset

comprised 1324 dead cases and 1676 alive cases. For the classification purpose, initially, we have done some sort of data preprocessing steps to fill all the unknown values with most occurring cases of that attribute to the outcome. Finally, we have chosen a sample size of 1250 from each outcome class for the classification purpose to avoid class imbalance problems. Therefore, the final sample set comprises 2500 entities out of which 1250 samples belong to both outcome classes. For training and testing purposes, we used a 10-fold cross-validation method. The algorithm initially calculates the information gain of each attribute and then selects all those attributes which possess a gain value less than the threshold. Once the attributes are selected, association rules are mined using the Apriori algorithm. The u-gain, w-gain of each mined rule are then calculated and from these, a new parameter called UW-score for each rule is further computed. Finally, all the mined rules are selected for the classification purpose based on the UW score greater than the threshold value set by the user empirically. To compare the performance of the above UW-score-based classification algorithm, standard classification models are built using KNN, Naïve Bayes, Decision Tree, ANN, and SVM with the pruned attributes in the dataset as its input. After comparing the performance in terms of accuracy, speed, and other parameters, the proposed method stands in the top of all other classification algorithms.

In addition to the UW score-based model, we have formed five different models such as KNN, Naïve Bayes, Decision Tree, ANN, and SVM. All these models have been built with selected attributes based on information gain. All other attributes were eliminated. This approach reduces the number of test cases. Different models are built using training data. Performance is evaluated using test data. Results are taken for all those models implemented. By analyzing the accuracy of the rules, it becomes consistent when the UW-Score value equals 0.1.

The performance evaluation of all these methods is evaluated based on the confusion matrix obtained in the classification. The performance of each model is assessed using parameters like accuracy, Sensitivity, Specificity, and finally the F-Score value. It is found that the accuracy of the model using the uw-score method has the highest percentage (94.40 %) while comparing the performance of KNN (50.40%), Naïve Bayesian (67.20%), Decision Tree (76.80 %), ANN (93.60%) and SVM (94 %) respectively.

The specificity and sensitivity value obtained for the proposed uw-score method is 92.80% and 96% respectively. Comparing with all other classification models built, the proposed method also achieved better specificity (92.80 %) and sensitivity (96 %) except SVM that achieved 96 % sensitivity and 92 % of sensitivity. Finally comparing the F-Score value of all models built during the classification, it is found that the proposed uw-score method achieved the highest UW-score value (0.944) which is followed by SVM (0.939). The detailed performance evaluation assessed with different parameters of all these models built during the implementation is shown in Table 5 and the graphical representation of the performance of all these methods is further shown in figure 5.

Conclusion

For effective mining high utility association rules, in this paper, we proposed an efficient data mining approach that is based on weight factor and utility. The proposed algorithm initially calculates information gain based on which some attributes are selected on the empirically calculated threshold value and then applying the Apriori algorithm on those attributes in the dataset. To generate a set of association rules from the original data set the proposed approach initially uses a classical Apriori algorithm. A combined Utility-Weight (UW Score) score is calculated for each association rule mined from the classical Apriori algorithm based on weightage, W-gain, utility, and U-gain. Finally, we identified a subset of major association rules from the combined UW score. The experimental result shows that the proposed approach is effective in producing high utility association rules that can be utilized for effective mining approaches in medical diagnosis.

The performance of the proposed work based on different classification techniques is evaluated. Since the proposed method eliminates attributes at the beginning, so the performance of the algorithm will be high and more accurate. We

have formed six different models such as KNN, Naïve Bayes, Decision Tree, ANN, SVM, and UW-Score based classification. The model based on UW-Score and SVM achieved high accuracy which is 94.40 % and 94% respectively. Further achieved specificity and sensitivity as UW=Score as 92.80% and 96% and 96% and 92% respectively. Finally in conclusion, our proposed method has 94.40% accuracy, specificity, and sensitivity 92% and 96 %, which is higher with all other models implemented.

Even though the model performs well compared to all of the conventional classification methods. It wants to improve the accuracy and another parameter of the model by adjusting certain parameters that we calculated during the generation of association rules. That will be the future enhancement that to be incorporated with the proposed method for obtaining much more accuracy in the detection and analysis of colon cancer.

References

1. Ernst J. Kuipers, William M Grady, David Lieberman,Thomas Seufferlein (2015),colorectal cancer, Nature Reviews Disease Primer
2. https://www.mayoclinic.org/diseases-conditions/colon-ancer/symptoms-causes/syc20353669#:~:text=Colon%20cancer%20is%20a%20type,can%20happen%20at%20any%20age.
3. https://www.cancer.gov/publications/dictionaries/cancer-erms/def/colon-cancer
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4874655/
5. Guangzhu Y, Shihuang S, Xianhui Z (2008), Mining long high utility itemset in transactional database, WSEAS Trans.inf.sci.Appl.
6. Yao, Hong, Howard J. Hamilton, and Cory J. Butz (2004). A foundational approach to mining itemset utilities from databases. Proceedings of the 2004 SIAM International Conference on Data Mining. Society for Industrial and Applied Mathematics.
7. Rahman, AMJ Md Zubair, and P. Balasubramanie (2009). Weighted support association rule mining using closed itemset lattices in parallel. IJCSNS 9.3 (2009): 247-253.
8. Kavitha, D.(2012) Improved Strategies for Session Identification and Frequent Pattern Generation in Web Usage Mining.
9. Agrawal, Rakesh, and Ramakrishnan Srikant (1994). Fast algorithms for mining association rules. Proc. 20th int. conf. very large data bases, VLDB. Vol. 1215.
10. Hidber, Christian (1999) Online association rule mining. ACM Sigmod Record 28.2: 145-156.
11. Das, Amitabha, Wee-Keong Ng, and Yew-Kwong Woon (2001). Rapid association rule mining. Proceedings of the tenth international conference on Information and knowledge management.
12. Jiang, He (2008) et al. Mining both positive and negative weighted association rules with multiple minimum supports.2008 International Conference on Computer Science and Software Engineering. Vol. 4. IEEE.
13. Dhaliwal, Dalvinder S (2011). Mining utility-oriented association rules: An efficient approach based on profit and quantity. International Journal of Physical Sciences 6.2 (2011): 301-307.
14. Jayanthi (2011), B. Recommended system based on non redundant multi level association rules.
15. Phyu, Thair Nu (2009). Survey of classification techniques in data mining. Proceedings of the international multiconference of engineers and computer scientists. Vol. 1. No. 5.
16. Gorade, Sudhir M., Ankit Deo, and Preetesh Purohit (2017). A study of some data mining classification techniques. International Research J. of Engineering and Technology (IRJET) 4.
17. Chakarverti, Mohini, Nikhil Sharma, and Rajiva Ranjan Divivedi (2019). Prediction analysis techniques of data mining: a review. Proceedings of 2nd International

Conference on Advanced Computing and Software Engineering (ICACSE).
18. Kumari, Milan, and Sunila Godara (2011) .Comparative study of data mining classification methods in cardiovascular disease prediction 1.
19. Sharma, Seema (2013), et al. Machine learning techniques for data mining: A survey. 2013 IEEE International Conference on Computational Intelligence and Computing Research. IEEE.
20. Han, Jiawei, Micheline Kamber, and Jian Pei (2011). Data mining concepts and techniques third edition. The Morgan Kaufmann Series in Data Management Systems 5.4: 83-124.
21. Umadevi, S., and KS Jeen Marseline (2017). A survey on data mining classification algorithms. International Conference on Signal Processing and Communication (ICSPC). IEEE.

Column name	Description
Outcome	The patient is alive or not
Age	age of the patient
Sex	Male or female
Hosp	Hospitalized or not
Yronset	onsets year
Premi	Is there any history of myocardial infarction values are y, n, nk not known
Smstat	Status of smoking. Values ex-smoker, non-smoker, not known, current.
Diabetes	Values indicating yes, no, not known
Highbp	Implies blood pressure, values are yes, no, not known
Hichol	Indicating cholesterol patient or not. values are yes, no and not known..
Angina	Values includes yes, no, not known
Stroke	Values includes yes, no, not known

Name of the Classifier	Confusion Matrix			ACC	SP	SN	PR	RC	F-Sc
K-Nearest Neighbourhood (KNN)		Dead	Alive	50.40	81.60	19.20	0.511	0.192	0.279
	Dead	24	101						
	Alive	23	102						
Naïve Bayes		Dead	Alive	67.20	82.40	52.00	0.747	0.520	0.613
	Dead	65	60						
	Alive	22	103						
Decision Tree		Dead	Alive	76.80	88.00	65.60	0.845	0.656	0.739
	Dead	82	43						
	Alive	15	110						
Artificial Neural Network (ANN)		Dead	Alive	93.60	92.00	95.20	0.922	0.952	0.937
	Dead	119	06						
	Alive	10	115						
Support Vector Machine (SVM)		Dead	Alive	94.00	96.00	92.00	0.958	0.920	0.939
	Dead	115	10						
	Alive	05	120						
Proposed Method		Dead	Alive	94.40	92.80	96.00	0.930	0.960	0.944
	Dead	120	05						
	Alive	09	116						

Table1: *Different columns of the dataset*

Figure 5: Performance of the different classification model

ACC: Accuracy SP: Specificity SN: Sensitivity PR: Precision RC: Recall F-Sc: F-Score

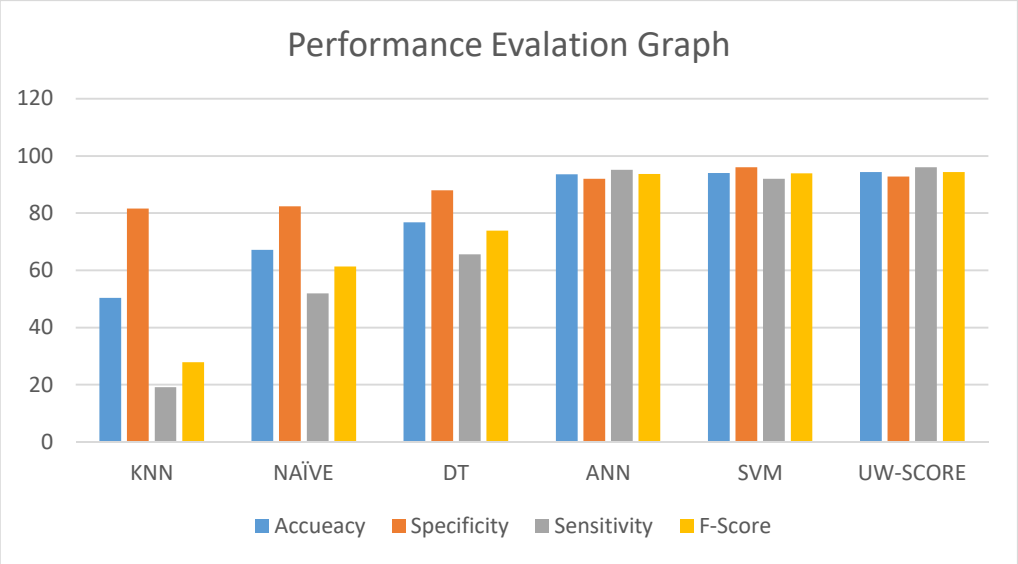

Table 5: The performance of the different classification methods and the proposed uw-score method

ADVANCED ENSEMBLE LEARNING APPROACH FOR DYSLEXIA CLASSIFICATION USING EYE TRACKING

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ABSTRACT

Dyslexia is a neurological disorder which manifests in the form of difficulty to read, spell and write. Almost 15 – 20% of the world's population is detected having dyslexia and if not detected at a early stage it will lead to many cognitive development disorders. Eye tracking movement can be used as one of the ways of detecting this condition as it is observed that dyslexic people have difficulty in reading and it is manifested. Various machine learning models can be used for predicting dyslexia based on the eye tracking movement collected when the subject is reading. In this paper we propose to use ensemble learning approach to improve the accuracy of such machine learning classifiers. There are three major types of ensemble techniques and they are bagging, boosting and stacking. One classifier from each of these techniques is considered and the result observed to understand whether the classifier accuracy has increased.

Keywords: *Eye tracking, Ensemble learning, Bagging, Boosting, Stacking*

Introduction

Dyslexia is a specific learning disability which manifests in the form of difficulty in reading, spelling and writing. Children with dyslexia experience deficits in phoneme awareness, letter-sound knowledge and rapid automatized naming in the preschool years and beyond[1]. According to International Dyslexia Organization, dyslexia is defined as " Dyslexia is a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge"[2]. Predicting Dyslexia is costly and usually requires the intervention of clinical and professional expert[3]. The current methods of diagnosis requires professionals to collect performance measures related to reading and writing and also conducting reading tests , writing tests and ability to comprehend among other things[4]. Machine learning techniques are extensively used in the field of medical diagnosis nowadays[5]. In the case of detecting dyslexia, machine learning techniques can be used in combination with eye-tracking measures[4]. Eye tracking studies done so far have suggested that there is significant differences among readers with and without dyslexia[6]. So eye tracking movement collected after reading, can be combined with machine learning models to understand whether an individiual has a risk of dyslexia or not. The scope of this paper is to present advanced ensemble learning approaches for improving the classification accuracy of machine learning classifiers built using the dataset of eye tracking movements.

Materials and methods

Dataset

The dataset has been collected from the Kronoberg reading development project, a longitudianl resarch project on reading development and reading disability in swedish school chidren running between 1989 and 2010. Eye tracking data was collected from 185 subjects out of which 97 were high risk dyslexics and 88 were low risk[7]. The eye tracking was done using google-based infrared cornea reflection system, Ober-2. All the subjects were made to read one and the same text presented on a single page of white paper with high contrast. The raw eye tracking movements for each of the subjects is available in the form of a csv file with

the following data. The first one is T, standing for the frequency or the time interval. For each of the time interval, lx,ly,rx and ry representing the left eye's x and y positions and right eye's x and y positions were recorded. In order to extract features from this raw eye data, we used a velocity threshold identification algorithm[8].

T	LX	LY	RX	RY
0	0	0	0	0
20	0,65535	-1.00E+08	0,6553599	-0,65536
40	0,65534	-1.00E+08	0,6553599	-0,65536
60	0,65534	-1.00E+08	0,65535	-0,65536
80	0,65534	-1.00E+08	0,65534	0
100	0,65533	-1.00E+08	0,65534	-0,65536
120	131,069	-1.00E+08	0,65534	-0,65536
140	131,069	-0,65537	131,069	-0,65536

Figure 1 : Snapshot of the raw data obtained from eye tracking movement[8]

After obtaining the eye tracking movement, a python program was written to extract important metrics like fixation and saccade using velocity threshold identification algorithm[9]. There are two important elements of eye movement. A saccade is the rapid eye movement between fixations to move the eye-gaze from one point to another. A fixation is the point between two saccades, during which the eyes are relatively stationary and virtually all visual input occurs[10]. Using these two basic eye movements and combination of the raw eye tracking data set, 101 features were extracted from the data set. The target feature is called the "Label" which can have either a 1 or 0 indicating the risk of dyslexia or not. Features 1 – 2 were the SubjectId and Gender of the participant. Features 3 – 4 is the sum DistanceX and DistanceY which is a sum of the pupil movement of the left and right eye throughout the recording. Then Features 5 onwards is the calculation of fixation and saccade and its mean, standard deviation, variance and other measurements of the left and right eye. Various machine learning classifiers were applied on these features and the accuracy of the classification is captured. The following experiments were performed on the data set. First is the application of different machine learning models to understand the classification accuracy of each of them.

Predictive model

The machine learning models applied to understand the accuracy of classification were LogisticRegression, NaiveBayes, RandomForest, ExtremeGradientBoost, k-Nearest Neighbour, decision tree and SupportVector classifier.

	Model	Accuracy
0	Logistic Regression	91.891892
1	Naive Bayes	86.486486
2	Random Forest	97.297297
3	Extreme Gradient Boost	94.594595
4	K-Nearest Neighbour	89.189189
5	Decision Tree	78.378378
6	Support Vector Machine	94.594595

Figure 2 : Classification accuracy of ML models

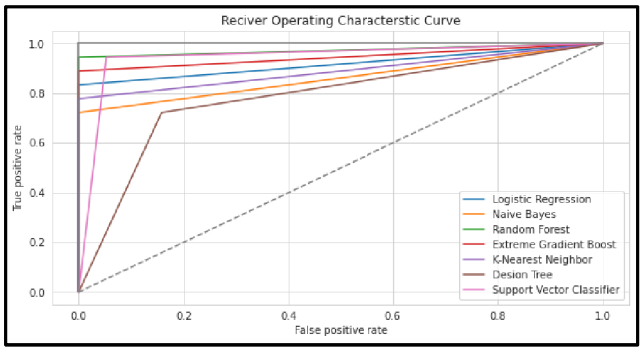

Figure 3 : ROC Curve of ML models

The following barplot represents the accuracy of the various ML models.

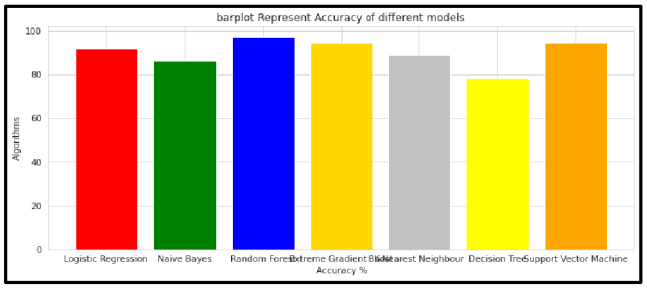

Figure 4 : Barplot representing the accuracy of various ML models

Ensemble learning approach

In real life, when critical decisions have to be taken, it is observed that the opinion of more than one expert is taken into consideration for better results. In the same way, in the field of

machine learning, a model generated can be called an expert[11]. The performance of the expert largely depends on the number and quality of data in hand and also on the fact whether the algorithm is suitable for explaining the problem at hand. So one of the important approaches to make a machine learning model is to combine the learning of an ensemble of models and consider its perfromance. There are three important techniques used in ensemble learning. They are Bagging, boosting and stacking. These techniques can be applied to regression as well as classification models[11]. Ensemble methods use multiple learning algorithms to obtain better predictive performance than what can be obtained from individual learning algorithms.

Bagging

Bagging is also called as bootstrap aggregating. It is a technique that repeatedly samples (with replacement) from a data set according to a uniform probability distribution[12]. Bagging combines the results of multiple models to get a generalized result. A question which arises is if different models are created with the same set of data, will it not generate the uniform result. In order to avoid this problem, bootstrap technique is adopted. In this sampling technique, subsets of observations from the original dataset are created with replacement. The general steps that are adopted in bagging are

i) Multiple different subsets are created from the original dataset, selecting observations with replacement.
ii) A base model is created using these subsets and all of these models are created and run in parallel.
iii) The final prediction is obtained by combining the results of all these models.

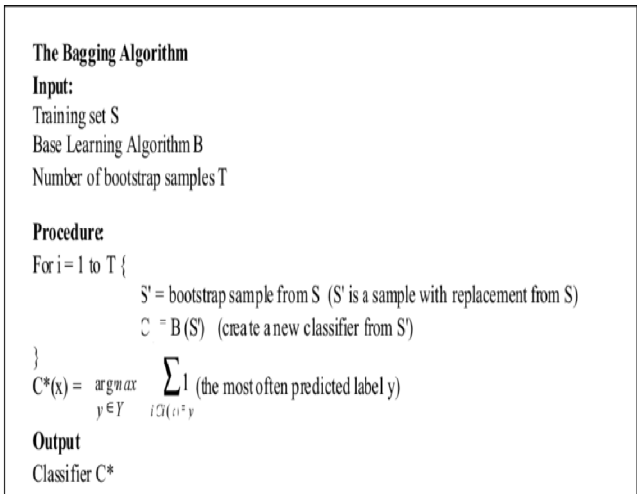

Figure 5 : Bagging algorithm [13]

Boosting

Boosting is an iterative procedure used to adaptively change the distribution of training examples so that the base classifiers will focun on examples that are hard to classify[12]. Boosting is iterative and sequential and each one tries to correct the mistakes of the earlier ones. One more difference between bagging and boosting is that unlike bagging, boosting assigns a weight to each training example and may adaptively change the weight at the end of each boosting round[12].

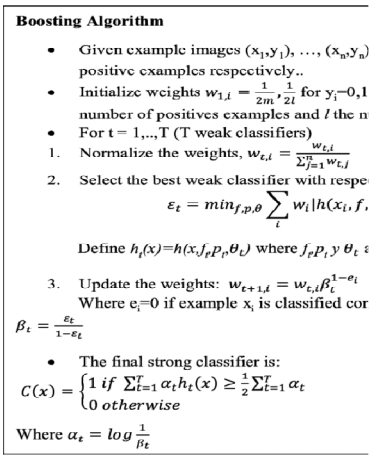

Figure 6 : Boosting algorithm [14]

Results of Ensemble learning approach

The ensemble learning techniques of bagging and boosting were applied on the original dataset of eye tracking movement to understand the performance of the ensemble classifiers.

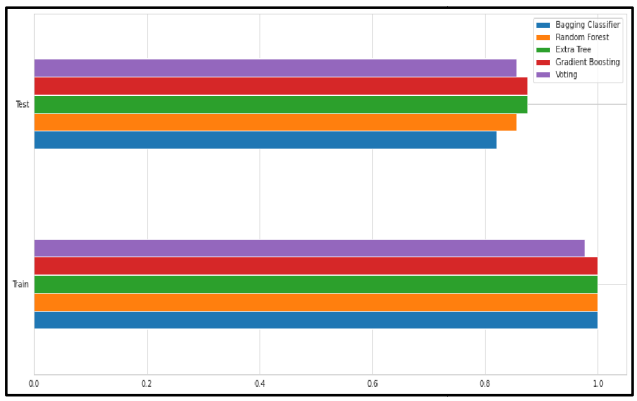

Figure 6. Performance of Ensemble learning approach on the dataset

Discussion

The machine learning models used for predicting the presence of dyslexia from the featured dataset produced an accuracy of less than 90% for Decision tree, K-Nearest neighbours and Naïve Bayes. In fact the decision tree produced the least accuracy value of 78.4%. The performance of the ensemble learning approach for classification produced very good results on the training data set. The accuracy on the test data set can still be improved further.

Conclusion

In this paper, an attempt has been made to apply ensemble learning approach for improving the classification accuracy of machine learning model. It was observed that the accuracy of these ensemble models were better than the classification accuracy of some of the lowest performing machine learning models. But still more work can be done on increasing the accuracy performance of these models.

References

1. Hulme C, Snowling MJ. Reading disorders and dyslexia. Curr Opin Pediatr. 2016 Dec;28(6):731-735. doi: 10.1097/MOP.0000000000000411. Erratum in: Curr Opin Pediatr. 2018 Aug;30(4):597. PMID: 27496059; PMCID: PMC5293161.
2. https://dyslexiaida.org/definition-of-dyslexia/
3. Prabha A, J., R, B., & Ragala, R. (2018). Prediction of dyslexia using support vector machine in distributed environment. *International Journal of Engineering & Technology, 7*(4), 2795-2799. doi:http://dx.doi.org/10.14419/ijet.v7i4.17222
4. Rello, L., Baeza-Yates, R., Ali, A., Bigham, J. P., & Serra, M. (2020). Predicting risk of dyslexia with an online gamified test. *PloS one*, *15*(12), e0241687. https://doi.org/10.1371/journal.pone.0241687
5. Shalev-Shwartz, S., & Ben-David, S. (2014). *Understanding machine learning: From theory to algorithms*. Cambridge university press.
6. Luz Rello and Miguel Ballesteros. 2015. Detecting readers with dyslexia using machine learning with eye tracking measures. In Proceedings of the 12th International Web for All Conference (W4A '15). Association for Computing Machinery, New York, NY, USA, Article 16, 1–8. DOI:https://doi.org/10.1145/2745555.2746644
7. Nilsson Benfatto M, Öqvist Seimyr G, Ygge J, Pansell T, Rydberg A, Jacobson C (2016) Screening for Dyslexia Using Eye Tracking during Reading. PLoS ONE 11(12): e0165508. https://doi.org/10.1371/journal.pone.0165508
8. Chakraborty, V. (2020). A Study on different Classification Models for predicting Dyslexia. *Kristu Jayanti Journal of Computational Sciences (KJCS)*, *1*(1), 29-35. Retrieved from http://www.kristujayantijournal.com/index.php/ijcs/article/view/1264
9. Salvucci, D.D., & Goldberg, J. (2000). Identifying fixations and saccades in eye-tracking protocols. *ETRA*.
10. https://www.igi-global.com/dictionary/fixation-and-saccade/11204

11. Ian H. Witten & Eibe Frank, Data Mining Practical Machine Learning Tools and Techniques, Morgan Kauffman publishers
12. Dr. B.L.Shivakumar, Prof.M.Shakthivel, Data Warehousing & Data Mining, Thakur Publishers, Chennai.
13. Ledezma, A., Aler, R., & Borrajo, D. (2002). Heuristic Search-Based Stacking of Classifiers. In H. Abbass, C. Newton, & R. Sarker (Ed.), *Heuristic and Optimization for Knowledge Discovery* (pp. 54-67). IGI Global. http://doi:10.4018/978-1-930708-26-6.ch004
14. Viola P., Jones M.: Robust Real-Time Face Detection. International Journal of Computer Vision, 57(2): 137–154, May 2004.

A STUDY ON FORMERS PERCEPTION ON THE IMPACT OF MILLET PRODUCTION AMONG THE YOUNGER GENERATION IN SALEM DISTRICT

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ABSTRACT

In India, Millet product are taken into consideration a healthy and important food, however in other countries it's far a critical food protection and cash crop. But its manufacturing is controlled by using many elements. However, information on farmer restrictions and one of a kind alternative is scarce. A study changed into carried out; Identify extraordinary options in Millet product types, and evaluate farmers' barriers to methods of production and handling Millet. Participation within the look at includes a rural evaluation and a survey. More than 95% of the farmers used broadcasting as a technique of planting, which changed into identified via the farmers as excessive hard work necessities particularly for weeding. All other barriers are floods, rains, storms and low-yielding plants within the districts. It is likewise pronounced that the farmers have evolved a few coping mechanisms to face the boundaries. Depending on the choice for brand spanking new crop, growers may also pick excessive grain yield, brown seed shade, small head shape, flood, rain, storm, ailment tolerance, excessive sewing potential, moderate plant peak (1 ± 0.2 m), early maturity, dispersal tolerance and ease. Radiation without compromising homes. The observe further discovered that a sizable part of the farmers had confined or no expertise approximately the disorder affecting millet crops, its reasons and techniques of coping. Millet products specifically are high in nutrients, making it healthier for human beings to shop for, for this reason growing the fee of millet products. This study is an empirical evaluation designed to degree the effect of farmer notion in houses with a sample of one hundred eighty younger technology humans.

Keywords: *Farmer perception, Impact of millet younger generation, Millet production.*

Origin And The History Of Millets

India is the second largest food producing country in the world, and it has the ability to become the largest food producer in the world. Food industry in India includes many varieties of food products like milk and milk products, fruits, vegetables, beverages; and amidst these products, millets are produced and consumed on the largest scale. The harvest period of millets is considerably short when compared to other cereals. The maximum time frame from sowing of seeds to harvesting the yield takes up to three to four months' time. The most commonly grown millets in India are Sorghum, Pearl, and Finger millet. Millets as such have played significant role and is an integral part of the growth of agriculture. It has helped in retaining the sustenance of agriculture and it could enhance the growth of agriculture as well. Millets are considered to be the drought tolerant grains, people have stated on large numbers, due to scarce water supply and availability they have shifted their focus on the growth of such grains. In addition, for enhancing the production and utilization of food, the funds have been allotted for the scientific research. At global levels of the production, millet is one of the most significant drought resistant vegetation's and holds 6th position on the list of cereals.

Benefits of Millets

Millets have a high fiber content which makes one feel full of energy despite consuming in lesser quantities, it even restricts the overall intake of carbohydrate. Millets are widely used to make variety of dishes in various parts across India. It is highly used for the incredible nutrient rich composition. India is the second largest diabetes capital of the world, and this pushes the public towards millets which in parallel connects to the increased produce of the same. problems pertaining to health are controlled with continual use of millets, and on a larger extent prevent the spread of epidemics. Millets are a rich source of fiber, and minerals like magnesium, phosphorous, iron, calcium, zinc and potassium. Millets are good supplements to offer cure from coronary diseases, millet products like Pearl millet, finger millet, sorghum millet, proso millet and foxtail millet are powerhouses of nutrition.

These millet products help in improving the functioning of the heart, retains it in good state, and also reduces coronary blockages. Millets are highly enriched with the goodness of magnesium thus, effectively lessens risk of blood pressure and menace of stroke and heart attacks.

Demand For Millet-Based Products On The Farmers Perception

The market is now teeming with food products made from millets such as ragi biscuits or pasta and noodles made of barnyard millet, ladoo made of thinai and many more," farmers says , that makes products using millets. According to, research manager at Tamil Nadu Agricultural University's Technology Business Incubator, about five startups, including a farmer society, are involved in millet-based product-making currently. They make millet flakes, noodles, cookies, ready-to-cook powders. With amassed perception among consumers the demand for these products are up. Even the neighborhood stores now sell millet-based food items Some of these companies also run training programs for farmers to increase millet cultivation. As the demand for millet-based food increases, so does the production of millet. Perception among farmers and knowledge about millet cultivation should be improved, he said These are normally three to four month crops. There are two major seasons to sow millets in India June-July and September-October. Low water requirements of millets make them farmer-friendly crops, especially in drought prone areas, City-based endocrinologist P. Velayutham says millets have several health benefits. With higher volume of fibre, iron, vitamin B and calcium these help with better absorption of nutrients and minerals.

Food- The Basic Necessity

Food refers to the ones objects obtained either from plant life or animals which have the requirements to offer the required factors to sustain the existence. Food is combination of protein, carbohydrate, and fats help in retaining health, increase and repair of the body. Food provides the supplements required via the frame which consist of; minerals, vitamins, iron, carbohydrates, calcium, potassium etcetera. Food gives the vitamins crucial for the regular prosperous. Since time immemorial, it's been tuned that ways of acquiring dispersed food could require expenditure of power. Previously it was via hunting and agriculture all human beings received food, now the instances have changed, food industries deliver the necessities to the arena population. Agencies like International Association for Food Protection, World Resources Institute, World Food Programme, Food and Agriculture Organization, and International Food Information Council have been tracking the food supply.

Millet Industry Trends

Millets Market size become over USD nine Billion fashionable 2018 and could witness more than 4.5% CAGR at some point of the forecast timespan. Growing inclination of city populace toward healthy food in Asia The city lifestyle choices and related food conduct have given upward push to quantity of diseases which include diabetes, weight problems and cardiovascular troubles as per coronary heart attack, coronary artery disorder, arrhythmias and many others. Millets have excessive content of proteins and minerals including calcium, iron and so on. That can assist in fending off such diseases. Therefore, growing awareness among population concerning health blessings associated with millets consumption will improve industry growth by means of 2025.

Farmers' Perceptions Of Constraints For Scaling-Up

The elements that count farmers, 59 scaling factors do not forget 39 to be applicable to farmers. At age 39, farmers identified a loss of fee introduced beyond implementation measures, a loss of predictable and sustainable advertising facilities, and a loss of technical physical inputs essential barriers to measuring decided on dealers within the examine location. The assessment of the 3 dealers using Scala shows that the use of fertilizers and advanced seeds meets the scaling resource requirements well, while the small scale irrigation scales

meet the resource requirements handiest in part. Based on the common (ratings) of the findings from the three focus organization discussions, each agent suggests the scaling factors and the farmer's assessment of the rankings. When taken into consideration personally, the farmers find that in addition to ordinary constraints each Agent is similarly restrained with the aid of other scaling-up factors. They find that the usage of fertilizers is further confined with the aid of the financial risks confronted by using the farmers, the know-how needed, the effect of Agent at the land and water assets, and the constrained contribution of an Agent to the farmer's autonomy. Improved seeds are perceived to be similarly restricted with the aid of lack of mechanisms for international standardization, loss of contribution of Agents closer to farmer autonomy, loss of processing centers, and shortage of initial natural inputs. The farmers understand small-scale irrigation to have the maximum range of constraints of the three Agents. They indicated the shortage of mechanisms for worldwide standardization, lack of understanding regarding Agents, the associated financial hazard, the bad effect of Agent on land and water assets, the adorability, suitability, and adaptability of the Agents as other major constraints for scaling-up.

Objectives Of This Study

1. To study the demographic profile of the respondent.
2. Toanalyse the farmer perception and themillet products among younger generation.
3. To study the research gap between perception and impact of millet products.
4. To finalize the further suggestion to extent of perception about millet products.

Limitations Of The Study

1. The study is limited to only 180 respondents due to time constraints.
2. Farmers are spread over Salem district, thus gathering and analysing information is time consuming and difficult
3. Subsequently farmer response was highly higher in suburban and suburban areas, the researcher needed to journey to remote places, so the far flung rural regions ought to be explored with much less journey canters.
4. Respondents from city areas were true contributors, while respondents of rural areas did now not show a whole lot concerned participation, as they had other chores.
5. The examine is constrained best to Salem District.

Research Methodology

This article offers an outline of research techniques that had been followed in this study. It provides information on the of millet former perception products among younger generation. This becomes important criterion in the study, who the participants were and the way they were sampled forms the next crucial part of this study.

The researcher describes the research design chosen for the purpose of this research and the reasons for having chosen the particular design is elaborated additionally. The tools used for data collection are given and defined too, and the methodologies adapted throughout the researchprocess are included. The researcher additionally discusses the strategies implemented for analysis of the data. Finally, the problems that were observed within the techniques are also discussed.

Research Design

A cross sectional study design was farmer in this article. Under this design, data from farmer perception respondents were collected from the representative population at a single point of time without repetition. The design has been functional as it could provide the necessary descriptions**,** and determination of relationships between variables has been made possible with it as well. This design is ideal when resources are limiting to permit longitudinal studies.

Sampling Frame

In this study, the sampling frame indirectly includes farmers, consumers, processors and traders both wholesalers and retailers and directly includes domestic families of Salem district. Altogether the study covers about 180 respondents. The respondents were selected on

the basis of their potential farmer perception of millet products and its impact of younger generation.

- **Universe:** Salem District is covered in this article.
- **Population:** Younger Generation in Salem District are considered to the respondent groups in the Article.
- **Sample Size:** The sample size is 180 respondents, the residents of Salem District.
- **Sampling Method:** Multi stage Sampling Method has been farmers for this study.

Sampling Technique and Sample Size

This study applies Multi stage sampling namely Simple Random sampling and Snowball sampling.

Simple Random sampling: Randomly the samples are selected from heterogeneous population to carry out the study.

Snowball sampling: In the second stage, Snowball sampling is used to shortlist the Younger Generation of millet products.

Stratified Sampling:

These techniques have been recommended in social science research by C.R. Kothari, 2014 as they focus directly to the area intended to be studied. Selection of wards and Salem District was done during the Study. The sample size consisted of 180 respondents from Salem district. The choice of this sample size was based on the fact that a sample size of greater than 180 respondents is good for statistical inferences, as suggested in his work.

Farmer Selection and Data Collection

Data for this study were gathered from both primary and secondary sources.

Primary Data- Primary data were collected through direct interviews to get an in-depth understanding of issues related to millet products consumption in the study area. Then the Survey was conducted, which involved personal interview using pre-tested questionnaires.

Secondary Data- Secondary data on millet products and food industries were obtained from various sources including the articles, journals, books, and websites.

Tools For Analysis

1. Chi Square Test
2. Fried man Test

Statistical Tools Applied

To consider the socio-economic upliftment of Formers Perception On the Impact of Millet Production Among the Younger Generation in Salem District data through SPSS version 21.

Introduction

Analysis according to Polit and Hungler is a process of arranging and synthesizing data which would help in answering research questions and further pave way for testing hypothesis. It also refers to calculating the available resources and looking for patterns of relationships existing between the computed data groups. According to Kothari C. R, analysis of data generally includes many relevant operations, which are performed and further summarized and organized in a way to answer the research questions. In this chapter, the analysis is done with the data collected which are further processed systemically, tabulated and appropriated for interpretations. The results obtained are classified for answering the research question

Scope of the Study

This study examines the views of farmers and the impact of millet on the younger generation and the acceptance of food items, which is still in its infancy in India. The findings will be useful for researchers, business planners, policymakers, charities, business management activists and more. Further findings will provide information with feedback from farmers. Consumer acceptance of these products helps to provide potential recommendations for implementing positive changes for effective market penetration that are acceptable to the consumer. The outcomes of the study can be used effectively in other areas where similar socio-economic conditions exist with necessary changes. This will bring about a huge economic change among the farmers.

Thoughts Related To Millet Products

Describes the opinions on factor coming to mind on hearing the term Millets. Some of the statements dealt are "*Healthy and Nutritious, Easy Availability, taste, affordability, energizing, controls diseases*". Majority of the respondents strongly Agreed with these factors.

Factor comes in mind when hearing the term Millet products

Factor	SDA		DA		N		A		SA		Total
	N	%	N	%	N	%	N	%	N	%	
Healthy and Nutritious	8	1	17	2	9	1	61	5	101	**91**	180
Easy Availability	7	1	64	6	23	2	75	7	143	**85**	180
Millets taste better	7	1	24	2	15	1	82	7	174	**88**	180
Millets are affordable	5	0	210	19	15	1	94	17	178	**62**	180
Millets save energy	3	0	26	2	4	0	113	19	166	**78**	180
Controls disease	3	0	35	3	7	1	163	24	104	**72**	180

For analyzing the factors mentioned above, Friedman's test was used and the results are given in Table.

Friedman Test- Factor comes in mind when hearing the term Millet products

	Mean	SD	Mean Rank	Reliability
Healthy and Nutritious	4.85	0.56	**3.87**	0.566
Easy Availability	4.69	0.82	**3.64**	
Millets taste better	4.81	0.62	**3.77**	
Millets are affordable	4.21	1.18	2.96	
Millets save energy	4.72	0.62	3.46	

Prices of millet products as compared to normal food products

		Prices of millet products as compared to normal food products										Total
		Higher		Lower		Same/Average		Reasonable		Don't Know		
		N	%	N	%	N	%	N	%	N	%	
Age	20 – 30	56	5	35	3	30	3	47	18	151	23	169
	30 - 40	21	2	15	1	9	1	91	8	94	8	130
	40 - 50	17	2	12	1	11	1	51	5	68	6	159
	Above - 60	27	2	11	1	10	1	56	5	50	4	154
Gender	Male	85	8	52	5	37	3	175	25	327	29	176
	Female	36	3	21	2	23	2	120	11	136	12	136
Level of education	School level	57	5	34	3	42	4	125	20	268	24	126
	Graduate or diploma	12	1	11	1	3	0	58	5	53	5	137
	PG level	9	1	8	1	2	0	35	3	41	4	95
	Illiterate	43	4	20	2	13	1	77	7	101	9	145
Occupation	Government Employee	36	3	21	2	26	2	171	15	235	21	129
	Private Employee	26	2	26	2	9	1	121	11	98	9	160
	Farmer	38	3	16	1	19	2	75	7	78	7	126
	Business man	21	2	10	1	6	1	28	3	52	5	117
Marital	Single	52	5	27	2	21	2	159	14	132	21	141

Status	Married	69	6	46	4	39	4	136	21	121	21	121
Type of family	Joint family	71	6	34	3	28	3	156	18	128	24	179
	Nuclear family	50	4	39	4	32	3	69	18	175	18	115
Place of residence	Rural	94	8	53	5	46	4	139	25	131	32	123
	Urban	17	2	10	1	12	1	36	3	41	4	116
	Semi-urban	10	1	10	1	2	0	80	7	71	6	163
Monthly income	Below 10,000	90	8	49	4	52	5	174	25	144	30	179
	Rs.10000 - 20000	20	2	12	1	6	1	35	3	50	4	123
	Rs.20000 - 30000	2	0	5	0	1	0	62	6	51	5	121
	Above Rs.30000	9	1	7	1	1	0	24	2	28	3	69
Size of family	1 - 2	42	4	17	2	20	2	144	13	126	20	149
	3 - 4	35	3	31	3	22	2	89	8	113	10	170
	5 & above	44	4	25	2	18	2	162	15	124	11	173
Total		121	11	73	7	60	5	125	36	163	42	180

Regarding price of millet products as compared to normal food products, Table shows that 11% of the respondents selected Higher, 7% of the respondents opted Lower, 5% of the respondents went with Average, 36% of the respondents stated reasonable and 42% of the respondents opted Don't Know. Hence, it is found from the analysis that majority of the respondents didn't know about the prices of millet products.

Null Hypothesis: There is no significant association between the profile of the respondents and the Prices of millet products as compared to normal food products.

Further in order to find the association between the demographic variables and their Opinion about Prices of millet products as compared to normal food products the chi- square test was used and result of the test shown in table.

Findings

- The majority of the farmer perception's consumers in rural areas are consuming traditional food.
- The younger generation is mostly employees
- For more than ten years the purchasing process of millet products has been increasing and many younger generation consumers are consuming different types of millets.
- These are the millets that are mostly bought by the younger generation finger millet, pearl millet, foxtail millet, maize millet, Little millet and Kodu millet.
- Farmers' opinion on millet products but the productivity of cereals is very high.

Suggestion

- Farmers' perception of millet production is high in both rural and urban areas.
- Millet products are consumed more in rural areas because it is not consumed much in urban areas
- Millet products are healthy for everyone, and it is essential to consume this type of millet products.
- Millet products can be converted into value-added products for young people to consume
- This has a huge impact on millet products among the youth, which can increase the productivity of millet products

Conclusion

This article reveals that the role of millet in farmers' perception has a major impact on the younger generation. most of the younger generation in rural areas consume more millet products. Many educated youths today are interested in agriculture and farming as fast food is not as available in the present generation. If so, the malnutrition of the people will be greatly reduced. As the habit of consuming millet products increases, tradition and traditional foods will be preserved. This is because it does not require any pesticides like other foods. Natural methods alone are sufficient.

References

1. Abubacar, N., Botorou, O., & John, H. S. (2015, September). Demand for Millet Processed Products in Mali and Burkina Faso. 1-20.
2. Amir, G., Gulzar, A. N., Kamalesh, P., & Pradyuman, K. (2015, September). Retracted Article: Nutritional, Technological, and Medical Approach of Finger Millet (Eleusin Coracana). Gull et al Cogent Food and Agriculture, 1, 1-9.
3. Amos, O. O. (2016). Finger Millet: food Security Crop in the Arid and Semi-Arid Lands (ASALS) OF kenya. World Environment, 6(2), 62-70.
4. Analysis of value chain-Kodo and Kutki (Minor Millets). (n.d.). Centre for Advanced Research and Development (CARD).
5. Bhumika, T., & Kalpana, P. (2009). Finger Millet (Eleucine Coracana) Flour as a Vehicle for Fortification With Zinc. Journal of Trace Elements in Medicine and Biology , 24, 46-51.
6. Brunda, S. M., Jayashree, P. H., & Darshan, G. B. (2016). Malted Foxtail Millet (Setaria italica) & Wheat flours in Formulation of Complementary food. International Journal of Science Environment, 5(2), 708-176.
7. C, M. M. (n.d.). Pearl Millet Production Systems in the Communal Areas of Northern Namibia:Priority Research Foci Arising From a Diagnostic Study.
8. Centre of Excellence on Small Millets (NFSM). (2016, March). 1-2. Bangaluru: University of Agricultural Science, Bangaluru.
9. Clifton , M., Marshall, M., & Nelson , M. (2017). Smallholder farmers Perceptions an Climate Change & the use of Sustainable Agricultural Practices in the Chinyanja Triange, Southern Africa. Social Sciences, 6(30), 3-14.
10. D Jerusha, I. C., & J, S. (2017, Feb). A Study on Consumer Awareness and Consumption of Minor Millets as a Diabetic Food Product- with Reference to Madurai City. International Journal of Advanced Scientific Research &Development, 4(1), 38-44.
11. D, S. D., B, R. P., P, P. Y., & V, U. L. (2010, Feb and May). Consumers Preference for Pearl Millet Products. Hind Agricultural research and Training Institute, 5(1 & 2), 122-124.
12. D, V., K, G., Jayarame, G., S, B. R., S, P., & Bhag, M. (2010). Empowerment of Women Farmers through Value Addition on Minor Millets Genetic Resources : A Case Study in karnataka. Indian Journal of Plant Genet Resour, 23(1), 132-135.
13. Durga , D. P. (2015). Factors Associated With Farm Level Variation & farmers' Perception & Climate Change Adaptation in Smallholder Mixed farming Livestock Production System in Nepal. International Journal of Environment & Susta: Nabal development , 14(3), 231-257.
14. Elshazali, A. M., Isam, A., Mohamed, A., & Elfadil, E. B. (2011). Preservation of Millet Flour by Refrigeration: Changes in Total Protein And Amino Acids Composition During Storage. International Scholarly & Scientific Research &Innovation, 5(4), 346-349.
15. Emmanuel, M., Felix, N., & Benson, A. M. (2015). Households Perception of Ethnic Material Culture in Socio –Economic Enterprises in Kanoni and Engari –Say Sub- Counties of Kiruhura District, S. W. Uganda. Sociology and Anthropology , 3(8), 371-378.
16. Fasasi, Olufunmilayo, & Sade. (2009). Proximate, Antinutritional Factors and Functional Properties of Processed pearl Millet (Pennisetum glaucum). Journal of Food Technology, 7(3), 92-97.
17. Florence, S. P., Asna, U., Asha, M. R., & Jyotsna, R. (2014). Sensory Physical and Nutritional Qualities of Cookies Prepared from Pearl Millet (Pennisetum typhoideum). Food Processing and Technology , 5(10), 3-6.
18. G, H. L., S, A., D, M., P, V., & G, R. (n.d.). Development of Little Millet (Panicum Sumatrense) Substituted Biscuits & Characterization of Packaging Requirements. Tropical Agricultural Research, 18.

19. G, L., P, T., J, D., & J, S. (2016, June). Production Determinants of the Pearl Millet Cropping System in Uganda and Implication to productivity. Journal of Agriculture Science, 8(7), 97-111.
20. Harold , M. (2015, October). Cereal Crops: Maize, Millet, Sorghum, Wheat. Abdou Diouf International Conference Center, 1-31.
21. Irene, K., Irini, Zimitra, K., Yiorgos, Z., & Konstantinos, M. (n.d.). Households Purchasing and Consumption Behaviour towards Processed Peach Products.
22. Issoufou, A., Mahamadou, E., & Gounga, G. W. (2013). Millets: Nutritional Composition same Health fits and Processing- A Review. Emir J. food Agric, 25(7), 501-508.
23. J, R. N., S, C. B., & L, W. R. (2010, Febuary). Pearl Millet – New Develpments in Ancient Food Grain. AACC International, Inc, 55(1), 16-19.
24. Jupiter, N., & Carl, H. N. (n.d.). Prospects for a Pearl Millet & Sorghum food Processing Industry in west Africa Semi-Arid Tropics.
25. K, S., & M, G. C. (2015). Total Factor Productivity and Returns to Investment in Ragi(finger millet) Crop Research in Karnataka State, india. Indian Journal of Economics &Development, 3(3), 199-205.
26. Kajal, S., & A, K. S. (2012, February). Nutraceutical Importance of Finger Millet (Eleusine Coracana) for Improved Human Health. The European Journal of Plant Science & Biotechnology, 6(2), 91-95.
27. Weizhang, Edward, K., Felix, B., Prapti, B., Gerrit, G., & Wopke, V. W. (2018). Farmes Perception of Crop Pest Severity in Nigeria aer Associated with Lanscape, Agronimic &Socio-Economic Factors. Agricultural, Ecosystems and Environment, 159-167.

A STUDY ON FAMILY CLIMATE AND ACADEMIC ACHIEVEMENT OF HIGH SCHOOL STUDENTS

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ABSTRACT

Effective and favorable parenting and family climate are very much essential for overall development of children and family and they are significant contributors for personal, academic and professional and social development of their children and it is also influencing academic performance of their school students. The findings show that significant difference exits in family climate with respect to gender, type of school, locality of school, medium of instruction and type of family of high school students. Family climate is highly, significantly and positively related with academic achievement of high school students. Hence, parents should provide all facilities and favourable family climate to their high school students in order to enhance their academic achievement. Parents must support and motivate their high school students to improve their academic activities. Furthermore, parents should interact and discuss frequently with their high school students and solve their problems efficiently.

Keywords: *Academic Achievement, Family Climate, High School Students.*

Introduction

Family climate is the emotional and physical atmosphere and status of the family as it is bad or good or enthusiastically functional cultural unit. Family climate is persistently and very deeply influencing life of individuals through which they get warm experience and happiness (Govindarajan, 2018). Family is in fact a social system that creates association among members of family and it is influencing dynamic of the family. In the present day complex social and personal life system, it is necessary to understand exclusive relation among parents and their children (Singh and Devi, 2018). Effective and favourable parenting and family climate are very much essential for overall development of children and family and they are significant contributors for personal, academic and professional and social development of their children (Varsha and Ritu, 2015). Children are highly adjustable, achievers and largely successful if they are growing in the better family climate and having good relation among their family members. Thus, family climate is playing an important role in creating good attitude for people, community and society and intellectual development of children and is helping them to attain their personal desires and objectives and it is also influencing their academic achievement (Kumar and Lal, 2014).

Academic achievement is the attainment of capabilities to perform well in school activities it may be specific or general in a particular subject and it is the self assessment of objective of individual student in school system and it usually exhibits outcomes from learning of students (Kuldip, 2014). Academic achievement is the skill, knowledge and attitude developed among school students in the subjects which is assessed by marks scored by them in those subjects through examinations (Manika and Khatoon, 2011). Academic achievement is the degree to which a student have achieved their educational objectives in short or long run. Generally academic achievement of students is assessed by means of examinations at school level. As students are coming from different cultural, social and family back grounds and they are undergoing different learning situations(Tella and Tella, 2003), it is very essential to find learning interest and styles of students in order to encourage and help them to achieve greater heights in their academics. Further, family climate is mainly and significantly influencing academic performance of school students. With this back drop, the present research is made to study family climate and academic achievement of high school students.

Review Of Related Literature

Das (2020) found that there existed significant difference among gender of ninth grade students and their family climate and family climate was positively relating with academic achievement of ninth grade students. Family

climate was higher to female ninth grade students in comparison with female.

Mishra (2019) concluded that male adolescent students were having favourable family climate in comparing with female adolescent students and significant difference was witnessed among them with respect to their family climate.

Shanoji and Wani (2018) revealed that significant difference existed amongst family climate and private and government school students. Family climate was positively and significantly related with academic achievement of secondary students.

Dandagal and Yarriswami (2017) indicated that there existed no significant difference among gender and medium of instruction of secondary students and locality of schools and their family climate and there exited significant differences amongst type of school of secondary students and their family climate. Family climate has positive and significant relation with academic achievement of secondary students.

Xia et al (2016) showed that significant difference exited among gender of sixth grade students and their family climate. Family climate was having reciprocal relation with school attachment of sixth grade students and it was not significantly relating with their academic achievement.

Shafeeq and Tazeen (2015) found that significant difference exited among male and female secondary school students and their family climate and significant difference exited amongst type of school of secondary students and their family climate. Academic achievement of secondary students was not significantly related with their family climate.

Yunus et al (2014) concluded that there exited significant difference amongst family climate and gender of primary school students and family climate had no impact on academic performance and adjustment of primary school students.

Objectives of The Study

1. To find difference in family climate with respect to gender, type of school and locality of school of high school students.
2. To find difference in family climate with respect to medium of instruction and type of family of high school students.
3. To assess relation amongst family climate of high school students and their academic achievement.

Hypotheses of The Study

1. There is no significant difference in family climate with respect to gender, type of school and locality of school of high school students.
2. There is no significant difference in family climate with respect to medium of instruction and type of family of high school students.
3. There is no significant relation amongst family climate of high school students and their academic achievement.

Methodology

Method of Study

This study is carried out in Tiruvannamalai District. Survey method is used for this study.

Tools Used in the Study

Family Climate Scale developed and standardized by the Research Scholar through pilot study is used for this study. Academic achievement of high school students is determined based on their marks scored in Secondary Board Examination, thus, it is used to assess academic performance of high school students.

Sampling Method

Random sampling method is used for selection of high school students and data are collected from 300 high school students by using questionnaire.

Statistical Techniques Employed

Percentage analysis is done to understand profile of high school students. Mean, standard deviation, t-test and ANOVA test are employed to inspect difference in family climate with respect to gender, type of school, locality of school, medium of instruction and type of family of high school students. Relation among family climate and academic achievement of high school students is assessed by using correlation analysis.

Results

Profile of High School Students

The profile of high school students is disclosed in Table-1. The results show that 53.67 per

cent of high school students are in male category, whilst, 46.33 per cent of them are in female category and 44.00 per cent of them are studying in private schools, whilst, 23.33 per cent of them are studying in Government aided schools. The results also indicate that 37.67 per cent of them are studying in schools located in urban area, whilst, 27.00 per cent of them are studying in schools located in rural area, 59.00 per cent of them are studying in English medium, whilst, 41.00 per cent of them are studying in Tamil medium and 68.67 per cent of them are having nuclear family and 31.33 per cent of them are having joint family.

Table-1. Profile of High School Students

Profile	Number(n=300)	Percentage
Gender		
Male	161	53.67
Female	139	46.33
Type of School		
Government	98	32.67
Government Aided	70	23.33
Private	132	44.00
Locality of School		
Urban	113	37.67
Semi – Urban	106	35.33
Rural	81	27.00
Medium of Instruction		
Tamil	`123	41.00
English	177	59.00
Type of Family		
Joint	94	31.33
Nuclear	206	68.67

Family Climate and Profile Of High School Students

The difference amongst family climate and profile of high school students is disclosed as below.

Gender and Family Climate

The difference amongst gender of high school students and their family climate is disclosed in Table-2.

Table-2. Gender and Family Climate

Gender	No.	Mean	Standard Deviation	t-value	Sig.
Male	161	326.55	12.36	3.635**	.000
Female	139	320.52	13.07		

** Significant in 1% level

Mean value of family climate is 326.55 for male and it is 320.52 for female high school students and it indicates that family support is higher for male as compared to female high school students.

The t-value is 3.635 revealing that there exits significant difference amongst gender and family climate of high school students. In consequence, null hypothesis is not accepted.

Type of School and Family Climate

The difference amongst type of school of high school students and their family climate is disclosed in Table-3.

Table-3. Type of School and Family Climate

Type of School	No	Mean	Standard Deviation	F-value	Sig.
Government	98	320.76	11.90	7.530**	.000
Government Aided	70	323.79	12.56		
Private	132	325.53	10.67		

** Significant in 1% level

Mean value of family climate is varying from 325.53 for high school students studying in private schools to 320.76 for high school students studying in Government schools and it indicates that family support is higher for high school students studying in private schools as compared to others.

The F-value is 7.530 revealing that there exits significant difference amongst type of school and family climate of high school students. In consequence, null hypothesis is not accepted.

Locality of School and Family Climate

The difference amongst locality of school of high school students and their family climate is disclosed in Table-4.

Table-4. Locality of School and Family Climate

Locality of School	No.	Mean	Standard Deviation	F-value	Sig.
Urban	113	326.35	13.89	6.929**	.000
Semi – Urban	106	323.91	14.06		
Rural	81	318.77	10.76		

** Significant in 1% level

Mean value of family climate is varying from 326.35 for high school students studying in schools located in urban area to 318.77 for high school students studying in schools located in

rural area and it indicates that family support is higher for high school students studying in schools located in urban as compared to others.
The F-value is 6.929 revealing that there exits significant difference amongst locality of school and family climate of high school students. In consequence, null hypothesis is not accepted.

Medium of Instruction and Family Climate

The difference amongst medium of instruction of high school students and their family climate is disclosed in Table-5.

Table-5. Medium of Instruction and Family Climate

Medium of Instruction	Number	Mean	Standard Deviation	t-value	Sig.
Tamil	`123	321.68	13.53	3.208**	.000
English	177	325.70	12.16		

** Significant in 1% level

Mean value of family climate is 325.70 for high school students studying in English medium and it is 321.68 for high school students studying in Tamil medium and it indicates that family support is higher for high school students studying in English medium as compared to Tamil medium.
The t-value is 3.208 revealing that there exits significant difference amongst medium of instruction and family climate of high school students. In consequence, null hypothesis is not accepted.

Type of Family and Family Climate

The difference amongst type of family of high school students and their family climate is disclosed in Table-6.

Table-6. Type of Family and Family Climate

Type of Family	Number	Mean	Standard Deviation	t-value	Sig.
Joint	94	325.59	11,42	3.086**	.000
Nuclear	206	321.73	14.18		

** Significant in 1% level

Mean value of family climate is 325.59 for high school students having joint family to 321.73 for high school students having nuclear family and it indicates that family support is higher for high school students having joint family as compared to nuclear family.
The t-value is 3.086 revealing that there exits significant difference amongst type of family and family climate of high school students. In consequence, null hypothesis is not accepted.

Relation Amongst Family Climate And Academic Achievement Of High School Students

The correlation analysis is done to assess relation amongst family climate and academic achievement of high school students and the result is disclosed in Table-7.

Table-7. Family Climate and Academic Achievement of High School Students

Particulars	Correlation Coefficient(r)
Family Climate and Academic Achievement of High School Students	0.63**

** Significant in 1% level

The correlation coefficient amongst family climate and their academic achievement of high school students is 0.63 and it explains that they are highly, significantly and positively related. In consequence, null hypothesis is not accepted.

Conclusion

The findings reveal that significant difference exits in family climate with respect to gender, type of school, locality of school, medium of instruction and type of family of high school students. Family climate is highly, significantly and positively related with academic achievement of high school students. Hence, parents should provide all facilities and favourable family climate to their high school students in order to enhance their academic achievement. Parents must support and motivate their high school students to improve their academic activities. Furthermore, parents should interact and discuss frequently with their high school students and solve their problems efficiently.

References

1. Amisha Singh, & Sharmila Devi.(2018). Mental health of secondary school students in relation to family climate. International Journal of Research in Social Sciences, 8(4), 853-861.
2. Arjun Chandra Das.(2020). Impact of family climate on the academic achievement of ninth grade students in Nadia district, West Bengal. AEGAEUM Journal,8(9), 817-828.
3. Dandagal, S.N., & Yarriswami, M.C.(2017). A study of family climate in relation to academic achievement of secondary school students. International Journal of Advanced Research in Education & Technology, 4(3), 7-10.
4. Govindarajan, K.(2018). Family climate, emotional maturity and academic achievement of secondary school students. International Journal of Science and Research, 8(6), 2397-2400.
5. Kuldip, K. G. (2014). A study of academic achievement of adolescents in relation to family climate, An International for Humanity Science and English Language, 1(4), 437-446.
6. Mengya Xia, Gregory M. Fosco, & Mark E. Feinberg.(2016). Examining reciprocal influences among family climate, school attachment, and academic self-regulation: implications for school success. Journal of Family Psychology, 30(4), 442-452.
7. Nikhat Yasmin Shafeeq, & Aliya Tazeen.(2015). Comparative study of the effects of family climate on the academic achievements of government and private secondary school students. International Journal of Research-GRANTHAALAYAH, 3(6), 118-127.
8. Rajesh Kumar, & Roshan Lal.(2014). Study of academic achievement in relation to family environment among adolescents. The International Journal of Indian Psychology, 2(1), 146-155.
9. Santwana G. Mishra.(2019). Gender-wise study of family climate for adolescents in urban India. Indian Journal of Women and Social Change, 4(2), 174-180.
10. Shafa .A. Yunus, Samuel Laraba Baba, & Paul S. Wai.(2014). Effect of family environment on student academic performance and adjustment problems in school. Journal of Education and Practice, 5(19), 1-7.
11. Shanoji, &. Gulshan Wani.(2019). Study of academic achievement of private and government secondary school students in relation to their family climate. International Journal of Advance Research in Science and Engineering, 7(7), 183-190.
12. Sharma Manika, & Tahira Khatoon. (2011). Family variables as predictors of students achievement in science. Journal of Community Guidance and Research, 28(1), 28-36.
13. Tella, A., & Tella, A. (2003). Parental involvement, home background and school environment as determinant of academic achievement of secondary school students in Osun State, Nigeria. African Journal of Cross Cultural Psychology and Sport Facilitation, 5(2), 42-48.
14. Varsha, G., & Ritu, G. (2015). A study of the effect of family climate on social competence in adolescents, International Journal of Home Science Extension and Communication Management, 2(1) 49-57.

WIND LOAD CALCULATION FOR PITCH ROOF BUILDING AS PER IS875(PART 3):2015AND IS875(PART3):1987 AND COMPARISION WITH AMERICAN CODE

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ABSTRACT

The paper is related to calculation of wind load on structural members of industrial shed structures. The paper presents comparative results of study to urge optimum design of steel roof truss or industrial shed structure. This study gives a thought to hold out the planning of an industrial warehouse. This topic of labor is set on know the various sorts of force/load effects to be considered while designing industrial warehouse with the assistance of literature review. This structure is proposed to design according to IS 800:2007 and the dead, live, the wind load analysis is done according to IS 875:1987 (Part-I, Part-II, Part-III). The area for proposed warehouse design was decided and proper plan was prepared consistent with the wants. Finally the conclusion is formed that warehouse are often designed easily adopting simple design procedure and IS specifications.

Keywords: *Terrain category, typified design, topography, Dead Load, Live Load, Wind Load.*

Introduction

In our daily life we can see many structures of steel which has higher strength as well as durable. Hence it is used for large column free spaces. An industrial shed is basically a framed structure formed by connecting various components joint at their ends to form a system of triangles, arranged in pre-decided pattern depending upon the span, so steel trusses are commonly used. An industrial shed is any building structure used by the industry to store raw materials, goods or for manufacturing products of the industry. These building require large clear spans without any obstruction by the columns. The large floor area provides the sufficient flexibility and durability of the production layout without major building alterations. In this paper comparative analysis of result from the IS:875-Part3 (2015) code and IS:875-Part3 (1987) are discussed so that we can understand the application of wind forces using both code. In this paper, the procedure recommended by the current IS code and the proposed revisions have been reviewed in comparison to other international codes of practice such as ASCE.

Objective

The main objective of this paper is to get minimum and optimize the quantity of steel consumption in PEB structures.

1. To study the provisions for wind load given by IS875:1987 (PART3), IS875:2015 (PART 3) MBMA 1996AISC
2. To compare the results of wind forces by using wind coefficients given in IS code and MBMA code.
3. To study the researches being carried out with wind loading on industrial sheds.
4. To give the optimum requirement of steel for the economic construction.

Modelling & Analysis Of Building

Design considerations as per IS 875:1987 and IS 875 :2015 PART I, II, III have been used in calculating loads.

Wind Load:

IS: 875 - PART3 - (1987)

a) wind speed (Vz)

Design wind speed is given by the following equation

$Vz = Vb\ K1\ K2\ K3$

Where,

Vb = Basic wind speed in m/s

K1 represents Risk Coefficient factor (As per Table 1 of IS 875:1987- part3)

K2 =Terrain, height and structure size factor (Table 2 of IS 875- part3).

K3 = Topography factor (According to Clause given 5.3.3.1 of IS 875 - part3)

b) Design Wind Pressure (Pz)

The design wind pressure at any height above ground level can be expressed by the following equation of wind pressure and wind velocity:

$Pz = 0.6\ Vz2$

Where,

Vz denotes design wind speed at any height z in m/s,

Pz denotes design wind pressure in N/m2 at specified height z.

c) Wind Pressures and Forces on Buildings/Structures (F)

For pitch roof structures, it is necessary to know the internal pressure and the external pressure. Then the wind load, F, acting in a direction normal to the individual structural element is:

F = (Cpe – Cpi).A.Pz

Where,

Cpe = external pressure coefficient,

Cpi = internal pressure coefficient,

A = surface area of structural element,

Pz = design wind pressure.

IS: 875 - PART3 - (2015)

a) wind speed (Vz)

Design wind speed is given by the equation

Vz = Vb k1 k2 k3 k4

Where,

Vz = design wind speed at height z, in m/s;

k1 = probability factor (risk coefficient) (see 6.3.1) of IS Code;

k2 = terrain roughness and height factor (see 6.3.2.2) of IS Code;

k3 = topography factor (see 6.3.3.1) of IS Code;

k4 = importance factor for the cyclonic region (see 6.3.4) of IS Code

Details of Structure

Preliminary Data:

Design of steel building for (industrial building) (open structure)

Location : Nagpur (Vb=44m/s)

Length of structure =90m

Width of structure = 16m

Clear height of structure =6m

Bay spacing =7.5m

Purlins (Z) spaced at =1.5m c/c

Dead Load (DL) =0.1KN/m2

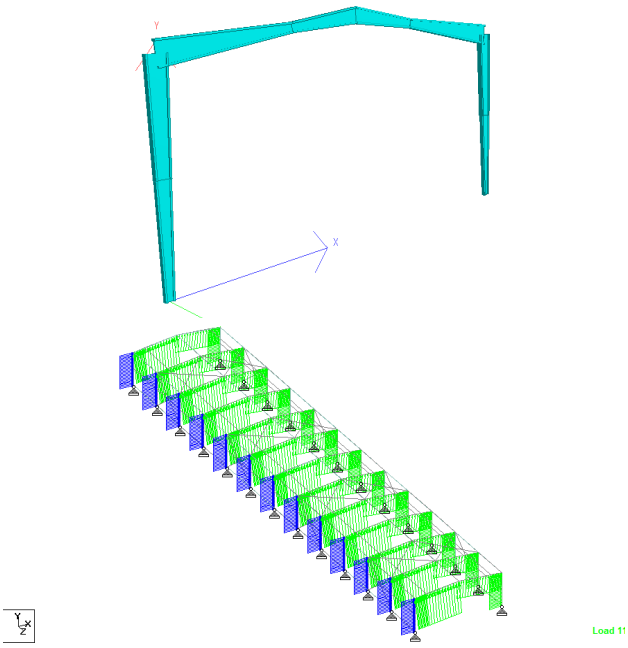
Live Load(LL) =0.75KN/m2

Colateral Load (CL) =0.15KN/m2

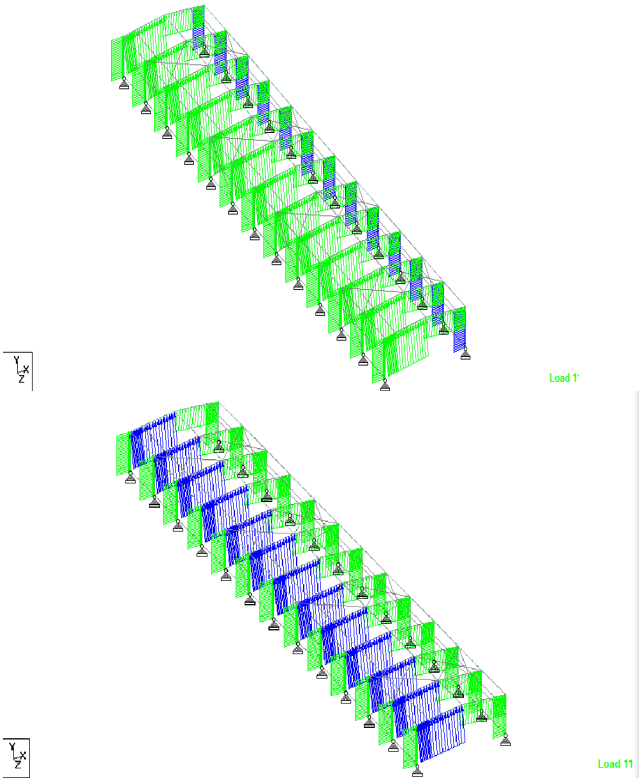
Slope of structure =1:10

Internal Pressure (Cpi) = (-/+0.2)

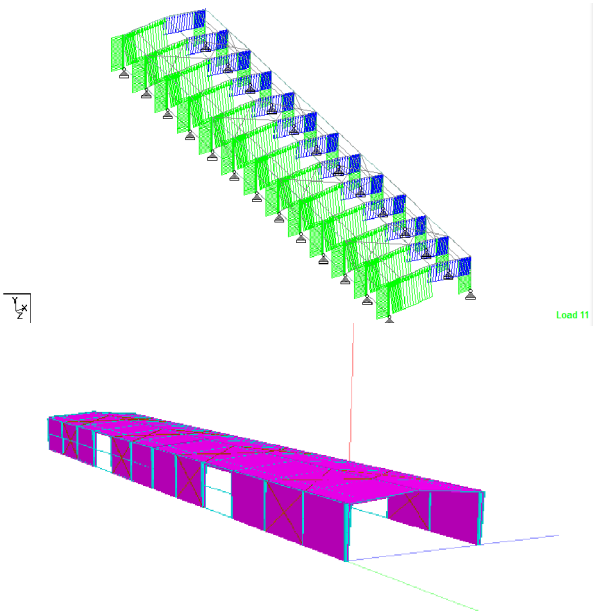
In this paper we calculated wind load calculations for 3 different cities as Nagpur, Mumbai and Guntur having same basic wind speed with reference to IS 875 (PART 3):1987 and IS 875 (PART3):2015.



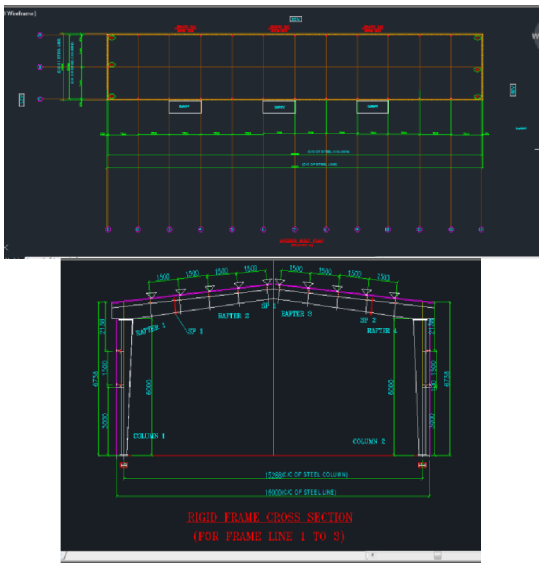
2D Model of structure on StaadPro Wind load acting on Wall A



Wind load acting on Wall B
Wind load acting on Roof C



3D Model of structure on StaadPro
Wind load acting on Roof D



Plan of Modeled Structure

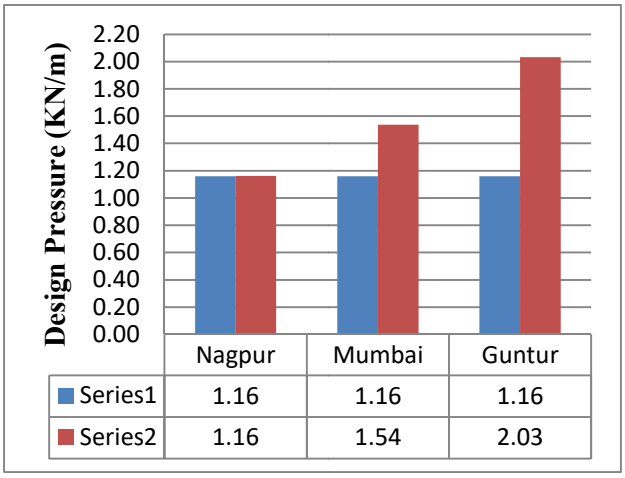
Results

Comparison of Wind Forces from Different Codes

Wind loads are calculated by taking single terrain category and basic wind speed of 44m/s. Comparison of equations of all the codes to calculate forces are given.

1.Design Pressure v/s cities

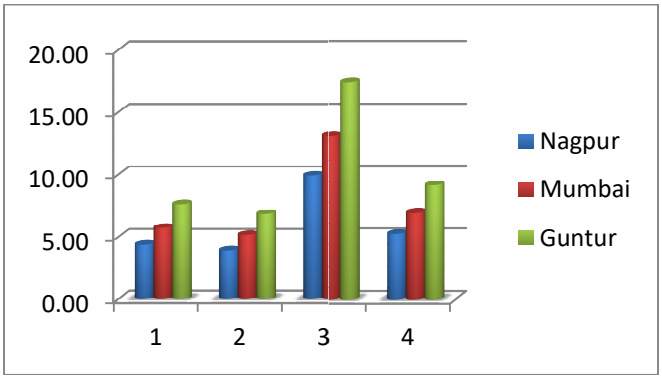
Code	IS 875 (PART3)		
	1987	2015	2015
City	Nagpur	Mumbai	Guntur
Vb(m/s)	44	44	44
Vz(m/s)	44	50.6	58.19
Pz(KN/m2)	1.16	1.54	2.03
%Increase	-	24%	43%



Design pressures v/s cities (Vb=44m/s)

2.Loads v/s Cities for Windward side

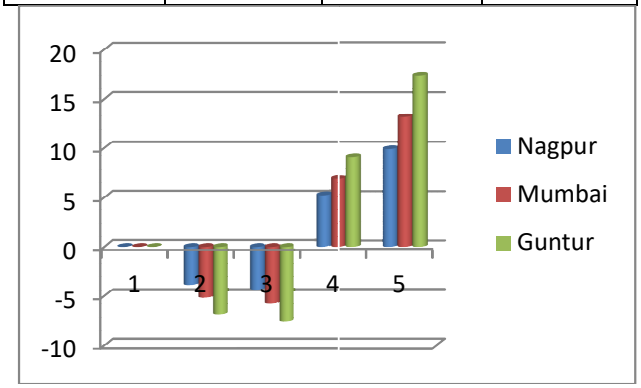
Windward	Nagpur	Mumbai	Guntur
WL A	4.36	5.76	7.62
WL B	3.92	5.18	6.86
WL C	9.93	13.13	17.37
WL D	5.23	6.91	9.14



Loads v/s cities (Vb=44m/s) [Windward]

3.Loads v/s Cities for Leeward side

Leeward	Nagpur	Mumbai	Guntur
WL A	-3.92	-5.18	-6.86
WL B	-4.36	-5.76	-7.62
WL C	5.23	6.91	9.14
WL D	9.93	13.13	17.37



Loads v/s cities (Vb=44m/s) [Leeward]

4.Nodal Displacement On Single Frame

City	Nagpur		Mumbai		Guntur	
node	x	y	x	y	x	y
2	3.482	0.025	2.406	0.024	1.274	0.022
4	-3.482	0.025	-2.412	0.024	-1.274	0.022
5	0.00	4.642	-0.003	3.257	1.136	1.503

5. Bending Moment and Load On Single Frame

City	Nagpur		Mumbai		Guntur	
No	BM	Load	BM	Load	BM	Load
1	47.696	0.851	52.124	0.935	70.274	1.262

6. MinimumSection Sizes Designed For Nagpur City

Member No	section	depth of web (dw)mm	web thick (tw) mm	flange width (fw)mm	flange thick(tf) mm	Actual ratio
101,201	Taperd	300-450	5	150	5	0.974
102,202	Taperd	450-600	5	150	5	0.935
301		600-300	5	150	5	0.905
302		300-300	5	150	5	0.972
401	Taperd	300-300	5	150	5	0.972
402		300-600	5	150	5	0.905

7. Minimum Section Sizes Designed For Mumbai City

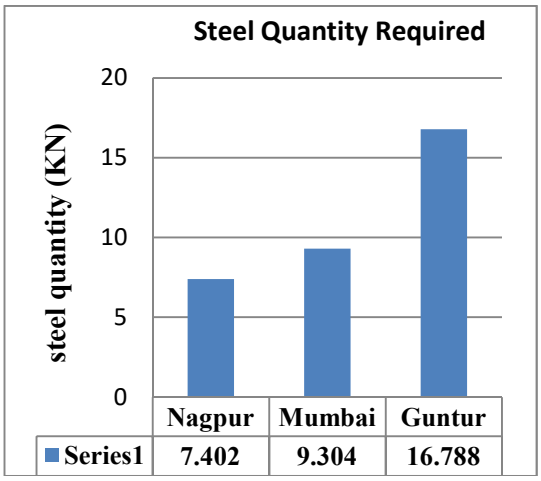
Member No	section	depth of web (dw)mm	web thick (tw) mm	flange width (fw)mm	flange thick(tf) mm	Actual ratio
101,201	Taperd	300-600	6	150	6	0.933
102,202	Taperd	600-700	6	150	6	0.939
301		750-400	5	150	5	0.977
302		400-400	5	150	5	0.943
401	Taperd	400-400	5	150	5	0.948
402		400-750	5	150	5	0.977

8. Minimum Section Sizes Designed For Guntur City

Member No	section	depth of web (dw)mm	web thick (tw) mm	flange width (fw)mm	flange thick(tf) mm	Actual ratio
101,201	Taperd	300-500	12	180	12	0.952
102,202	Taperd	500-750	12	180	12	0.912
301		900-600	10	180	10	0.923
302		600-600	8	180	8	0.9
401	Taperd	600-600	8	180	8	0.9
402		600-900	10	180	10	0.923

9. Quantity Of Steel Required

Member No	**length**	**Nagpur**	**Mumbai**	**Guntur**
	m	weight (KN)		
101	**3**	0.779	1.037	1.532
102	**3**	0.951	1.314	1.843
201	**3**	0.779	1.037	1.532
202	**3**	0.951	1.314	1.843
301	**2.04**	0.588	0.686	1.494
302	**6**	1.383	1.615	3.525
401	**6**	1.383	1.615	3.525
402	**2.04**	0.588	0.686	1.494
	Total =	7.402	9.304	16.788



Graph Showing Quantity Of Steel Required For Each City

Conclusion

Based on the analysis results obtained the following conclusions are made:-

1. One of the main reason to increase in weight in IS 800-1984 compared to MBMA is "Serviceability Criteria". According to IS code Deflection limits are higher than deflection limits by MBMA.
2. Reason for higher wt. in IS 800-2007 compared to AISC/MBMA is limiting ratios of the sections (Table 2 of IS 800-2007).
3. Comparing impose loads by different codes as per IS CODE Live load is 0.75 KN/m2 whereas as per AISC it is 0.57KN/m2 . Thus, it can be concluded that loading combinations as per Indian codes is greater than MBMA code.
4. The basic difference between the Indian Code (IS800-2007) to the other equivalent international codes such as American Codes are in the classification of the cross-section of the steel member. According to Indian code, the classes of section are to be considered for design are Plastic, Compact and Semi- compact, slender cross-section. It is observed that many PEB manufacturers use sections with very thin webs in order to reduce the weight of the section and be economical in their commercial offers, and these thin webs do not satisfy the codal provisions of IS800: 2007.
5. In recent studied it was concluded that in industries most of the structures are done with AISC/MBMA. May be that is the reason people are using AISC code & the main reason to use the AISC code for PEB structures is due the fact that it gives an economical structural solution as compared to the Indian Code.

Future Scope

Purchase of raw material is an integral part of any business. Warehouses are constructed to save the goods and raw material used for production. So economically efficient warehouses are to be needed for future civilization. The design will serve the purpose of storage of goods for large industries.

Applications:

1.Various industries requires warehouse to store their goods such as packing warehouses, Railway warehouses, Canal warehouses, Cool warehouses and cold storage.

2.The calculations and design is executed considering economy and safety factors.

3.Efficient designing and analysis for any similar industrial shed which is to be constructed.

4.Getting to know factors affecting the construction.

References

1. Bureau Of Indian Standards. Is 875(Part 1):1987; Code of Practice for Design Loads (Other than Earthquake), Part 1: Dead Loads.
2. Bureau Of Indian Standards. Is 875(Part 2):1987; Code of Practice for Design Loads (Other than Earthquake), Part 2: Live Loads.
3. Bureau Of Indian Standards. Is 875(Part 3):1987; Code of Practice for Design Loads (Other than Earthquake), Part 3: Wind Loads.
4. Agarwal, N., Mittal, A.K., and Gupta, V.K. (2012). "Along wind interference effects on tall buildings."VI National Conference of Wind Engineering, December 14-15.
5. Rajmani, A., & Guha, P. P. (2015). Analysis of wind & earthquake load for

different shapes of high rise building. International Journal of Civil Engineering and Technology, 38-45.

6. American Standard ASCE 05-7, "Minimum Design Loads for Buildings and Other Structures"
7. Riya Dey Sagnik Sen Sarma,Abhirup Bhattacharjee, "Wind and Earthquake Effect on Steel Structure". International Journal of Civil Engineering and Technology (IJCIET) Volume 6, Issue 8, Aug 2015.
8. Blackmore, P.A. & Tsokri, E. (2006). Wind loads on curved roofs. Journal of Wind Engineering & Industrial Aerodynamics, 94, 833-844
9. Krishna, P., Kumar, K. and Bhandari, N. M., "IS: 875:Part3: Wind Loads on Buildings and Structures -Proposed Draft & Commentary"

ANALYSIS OF TUNING METHODS OF PID CONTROLLER FOR LINEARIZED COUPLED TANK LIQUID LEVEL SYSTEM

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ABSTRACT

Liquid level control is playing an increasingly important role in the industrial process. Coupled tank system has two inputs and two outputs therefore its control strategy is complex. With the help of the PID controller tuning, we can adjust the parameters of the PID controller to achieve the desired set point and minimize disturbance as well as error. So, for this study the mathematical model of coupled tank level control system is developed. The dynamic model of a multivariable coupled tank system being nonlinear requires linearization so that a conventional PID controller can be designed. Linearization is carried out using Taylor series expansion. Simulation is carried out in MATLAB to compare a closed-loop performance of various PID tuning methods such as Trial and error(T&E), Ziegler-Nichols (ZN), Cohen-coon (CC) and Auto-tuning. From this comparative analysis of various controller tuning techniques, it is observed that the Ziegler Nichols method gives the satisfactory performance than other tuning techniques.

Keywords: *Coupled tank system (CTS), Linearization, MIMO liquid level control, PID controller tuning methods.*

Introduction

One of the vital components of a vehicle is its cooling system [1]. Its main objective is to maintain vehicle system from overheating at constant temperature for improving vehicle efficiency. Controlling the coolant level on a regular basis is important to maintain good condition of the cooling system. A coolant is a substance, typically liquid that is used to reduce or regulate the temperature of a system. It is very important to maintain coolant level in the coolant reservoir, which will avoid the coolant level in the tank being low. The study carried out in this paper will be helpful for coolant level monitoring in applications such as coolant level control of the flexible management system machine.

PID controllers are commonly used in process control industries hence it becomes necessary to study various techniques of PID controller tuning to achieve desired performance from the system. The tuning method to be selected for determining the proportional, integral & derivative gain of the controller depends upon dynamic response of the plant. The dynamic response is dependent on the type of liquid present in the tank. With change in liquid type, it becomes necessary to modify the PID parameters and its tuning methodology.

For the present experimentation, we have selected Ethylene glycol as a liquid coolant. It has density greater than that of water. The purpose for choosing this liquid coolant is its easy availability and operationally safe while handling during experimentation. The density of coolant is 1114 kg/m^3 while its viscosity is $1.61*10^{-2}$ Pascal-second. It has high thermal capacity, thermal conductivity, low cost, non-toxic, chemically inert and neither causes nor promotes corrosion of the cooling system.

This paper is organized as follows: literature survey, description about the coupled tank system and its laboratory setup, the mathematical modelling of coupled tank level system, the experimentation and MATLAB simulations along with the discussion on simulation results of the interacting system followed by the conclusion and future direction of the research.

Literature survey

The linearized mathematical model of coupled tank liquid level system is discussed in [2]. For the past 60 years, the PID controller is the most commonly used controller. Most of the PID controller parameters are adjusted on-site with various types of tuning techniques have been discussed in the literature. The invention of the PID controller was in 1910 while the Ziegler-Nichols (Z-N) tuning rules were

proposed in 1942. The PID tuning methods are broadly classified into two categories namely classical methods and intelligent methods. Classical methods for PID controller tuning include Trial and Error method, Ziegler–Nichols step response method, Cohen-coon method [3,4,5,6]. Intelligent methods for PID controller tuning [3] are mainly include auto-tuning, genetic algorithm approach and system theoretic approach etc. Minimizing integral of time-weighted absolute error (ITAE) is commonly referred to as a good performance index in fine tuning of PID controller [7,8]. The mathematical modelling of coupled tank system has been discussed in [9-15].

Coupled Tank System (CTS) Laboratory Setup

General arrangement of the CTS trainer teaching system (Model no.: XPO PCT/3T) provides facilities to be operated as MIMO (Multiple Input Multiple Output) system model configurations [2,16]. The MIMO configuration with PI controllers has considered for experimentation. This trainer is equipped with three tanks which are mounted vertically, as can be seen in the Figure 1. These have identical volumes of 6 liters each. Each of the tanks has a metric scale fitted to its front. Out of the three tanks, two tanks, LT1 and LT2, are coupled to each other at the bottom by two ½ inch ball valve and each of the tanks consists of one drain valve emptying into a small reservoir placed on the floor. This reservoir stores the liquid coolant for recycling throughout the system. Two pumps are mounted over this reservoir.

Figure 1: The Coupled Tank Trainer Model-XPO PCT/3T

Liquid coolant is supplied to the tanks LT1 and LT2 using two centrifugal type pumps. Flow meters are connected in the inflow pipes of the tanks LT1 and LT2 for measuring the flow rates. Level sensors (i.e., bubbler method) are attached with both the tanks which transmit voltage signal in the range (0 – 2.5 V). The tanks are connected through a cylindrical pipe which results in interaction between them. The connecting pipes are equipped with manually adjustable valves.

Mathematical Modelling of Multi Input Multi Output (MIMO) Interacting System

Mathematical Modelling of the Coupled Tank System

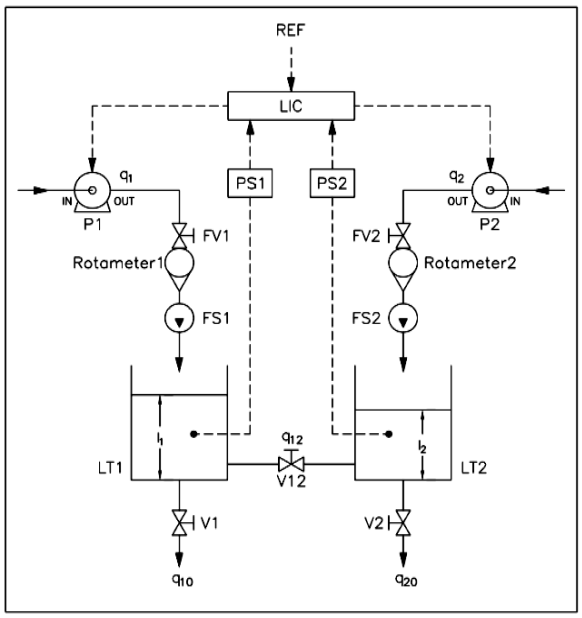


Figure 2: Schematic of Coupled Tank System (CTS) laboratory setup in MIMO configuration

The system described in earlier section can be made to operate with different combinations of inputs and outputs. In MIMO configuration as shown in Figure 2, the objective is to control the liquid levels, l_1 of tank LT1 and l_2 of LT2 by adjusting the input flow rate q_1 and q_2 (max flow rate 200 LPH) flowing into tanks LT1 and LT2 respectively [2,16].

The mathematical model can be derived by using the following simplifying assumptions:

1. Liquid level of tank 1 is greater than liquid level of tank 2.

2. The Set point (SP) of two coupled tank can't differ by more than 25% maximum tank height otherwise the control becomes unstable.

Let, q_1 and q_2 be supply fluid's flow rates in m^3/sec, q_{10}, q_{12}, q_{20} be the exit flow rates in m^3/sec, a_T be the area of the tank's base in m^2, a_0 be the cross-sectional area of the outlet pipes in m^2,l_1, l_2 be the fluid's levels of tanks LT1 and LT2 in m, P1, P2 are pump motors,PS1, PS2 are Bubbler method-based pressure sensors, LT1, LT2 are the liquid tanks, FV1, FV2 are the flow valves, which are kept half open, Valves V1 and V2 are two drain valves while V12 is an interacting valve, LIC is level indicator and the controller.

Using the mass balance equation, the relation between input and output flow for the tanks 1 and 2 can be expressed as,

$$a_T \frac{dl_1}{dt} = q_1 - q_{10} - q_{12} \quad (1.1)$$

$$a_T \frac{dl_2}{dt} = q_2 - q_{20} + q_{12} \quad (1.2)$$

According to Torricelli's law, the flow rates q_{10}, q_{20} and q_{12} are defined by,

$$q_{10} = s_1 a_0 \sqrt{2gl_1} \quad (1.3)$$

$$q_{20} = s_2 a_0 \sqrt{2gl_2} \quad (1.4)$$

$$q_{12} = s_0 a_0 \sqrt{2g(l_1 - l_2)} \quad (1.5)$$

Where, s_0 is the discharge coefficient of valve V12, s_1 is discharge coefficient of valve V1, s_2 is discharge coefficient of valve V2. These discharge coefficients are obtained experimentally. Replacing the values of q_{10}, q_{20} and q_{12} from equations (1.3), (1.4) and (1.5) respectively, in equations (1.1) and (1.2), we get the non-linear system equations,

$$\frac{dl_1}{dt} = \frac{1}{a_T}(q_1 - s_1 a_0 \sqrt{2gl_1} - s_0 a_0 \sqrt{2g(l_1 - l_2)}) \quad (1.6)$$

$$\frac{dl_2}{dt} = \frac{1}{a_T}(q_2 - s_2 a_0 \sqrt{2gl_2} + s_0 a_0 \sqrt{2g(l_1 - l_2)}) \quad (1.7)$$

The two equations (1.6) and (1.7) are nonlinear due to the presence of square root term. In multiple-input multiple-output coupled tank system, there are 2 inputs q_1, q_2 and 2 outputs l_1, l_2. State variables are $\dot{l}_1$ and $\dot{l}_2$ then the system can be described by,

$$\dot{l}_1 = f_1(l_1, l_2; q_1, q_2; t) \quad (1.8)$$

$$\dot{l}_2 = f_2(l_1, l_2; q_1, q_2; t) \quad (1.9)$$

$$\dot{l} = \begin{bmatrix} \dot{l}_1 \\ \dot{l}_2 \end{bmatrix}, \; l = y = \begin{bmatrix} l_1 \\ l_2 \end{bmatrix}, q = \begin{bmatrix} q_1 \\ q_2 \end{bmatrix}$$

$$y = g(l, q, t) \quad (1.10)$$

Linearization of Nonlinear Mathematical Model

Linearization of the system equations (1.8) and (1.9) is required for designing the controller [2]. These equations can be linearized about the set points or operating points l_{10} and l_{20} using Taylor series expansion. The Jacobian matrix which is the first order partial derivatives of the Taylor Series w.r.t l_1 and l_2 is formed as shown below. The Jacobian is calculated as $\begin{bmatrix} \frac{\partial f_1}{\partial l_1} & \frac{\partial f_1}{\partial l_2} \\ \frac{\partial f_2}{\partial l_1} & \frac{\partial f_2}{\partial l_2} \end{bmatrix}$ which becomes the linearized system matrix as shown in equation (1.11).

Linearized system matrix A,

$$A = \begin{bmatrix} -\frac{s_1 a_0\sqrt{2g}}{2a_T\sqrt{l_{10}}} - \frac{s_0 a_0\sqrt{2g}}{2a_T\sqrt{l_{10}-l_{20}}} & \frac{s_0 a_0\sqrt{2g}}{2a_T\sqrt{l_{10}-l_{20}}} \\ \frac{s_0 a_0\sqrt{2g}}{2a_T\sqrt{l_{10}-l_{20}}} & -\frac{s_2 a_0\sqrt{2g}}{2a_T\sqrt{l_{20}}} - \frac{s_0 a_0\sqrt{2g}}{2a_T\sqrt{l_{10}-l_{20}}} \end{bmatrix} \quad (1.11)$$

, $B=\begin{bmatrix} 1/a_T & 0 \\ 0 & 1/a_T \end{bmatrix}$, $C=\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, $D=\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$

Further state space model after linearization become:

$$\begin{bmatrix} \dot{l_1} \\ \dot{l_2} \end{bmatrix} = A * \begin{bmatrix} l_1 \\ l_2 \end{bmatrix} + B * \begin{bmatrix} q_1 \\ q_2 \end{bmatrix} \quad (1.12)$$

$$y = \begin{bmatrix} l_1 \\ l_2 \end{bmatrix} = C * \begin{bmatrix} l_1 \\ l_2 \end{bmatrix} + D * \begin{bmatrix} q_1 \\ q_2 \end{bmatrix} \quad (1.13)$$

Hence, this is the generalized state space model of CTS in MIMO configuration. The values of coupled tank system parameters are tabulated together in Table 1.

Symbol	Quantity	Value
a_T	Cross sectional area of Tanks LT1 and LT2	0.0169 m^2
a_o	Cross-sectional area of the outlet pipes	0.000127 m^2
l_{10}	Operating point (level) of Tank LT1	0.15 m
l_{20}	Operating point (level) of Tank LT2	0.125 m
g	Acceleration due to gravity	9.81 m/s^2
q_1, q_2 (max)	Maximum input flow rate of Tank LT1 and LT2 respectively	0.000056 m^3/s
l_1, l_2 (max)	Maximum height of Tank LT1 and LT2	0.30 m

Table 1: Coupled tank system parameters

Project Execution Flow Chart

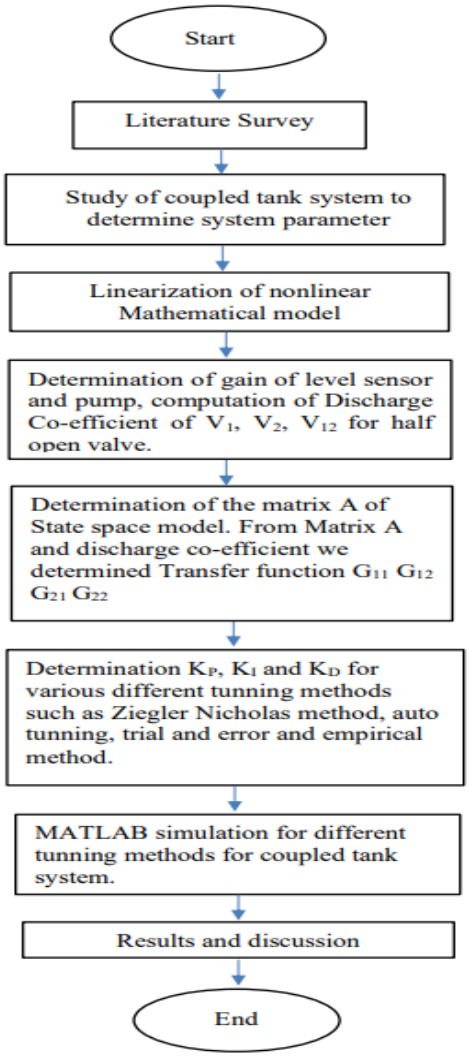


Figure 3: Flow Chart for Project Execution

Figure 3 shows the steps to perform experimentation on the system and simulating output response with the help of MATLAB Simulink.

Experimentation and MATLAB simulation results

Determination of Pump Gain

For determination of the pump gain, we need to calculate how flow rate (m^3/sec) changes with respect to change in voltage applied to pump motor. Experimentally we plot the graph as shown in Figure 4 for variation in flow rate against voltage applied to the pump motor. The slope of this graph represents the gain of pump (Pg), which can be computed as shown below.

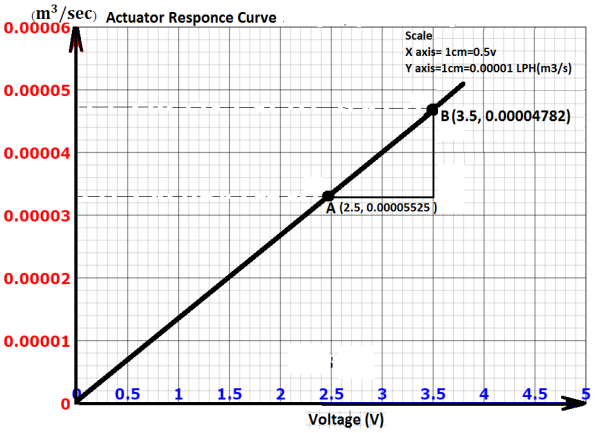


Figure 4: The pump characteristics: Flow rate (m^3/sec) versus Voltage (V) applied to pump motor.

Pg = $\frac{5.55*10^{-5}-3.32*10^{-5}}{2.5-1.5}$ = 2.23*10^-5 m^3/sec-V

Determination of Level sensor gain

The level in the tank is sensed by using bubbler sensor method. For determining the gain of the level sensor, it is required to calculate how coolant level (0-250 mm) in tank changes with respect to change in voltage (0-2.5 V) applied to the comparator. Figure 5 shows variation of level with change in voltage.

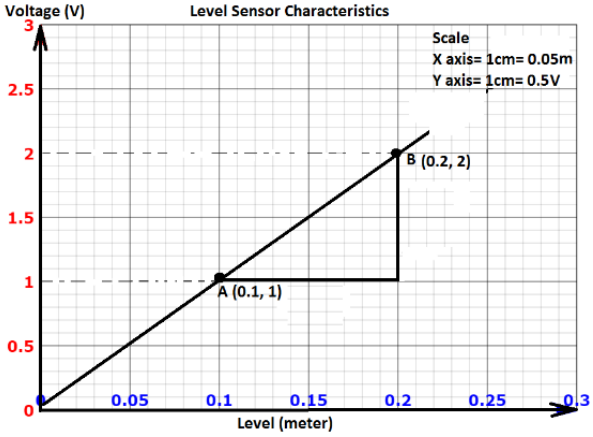


Figure 5: Level sensor characteristics for determining gain of level sensor (Lg)

Lg = $\frac{2-1}{0.2-0.1}$ = 10 V/m

Determination of Discharge Coefficient (s_0, s_1, s_2) for Valve V1, V2, V12 (Half Open valve)

To determine Discharge coefficient of valve V1, V2, V12 for half open, Figure 6 shows hardware connection to perform practical test and observation readings are taken as mentioned in Table 2, 3, 4.

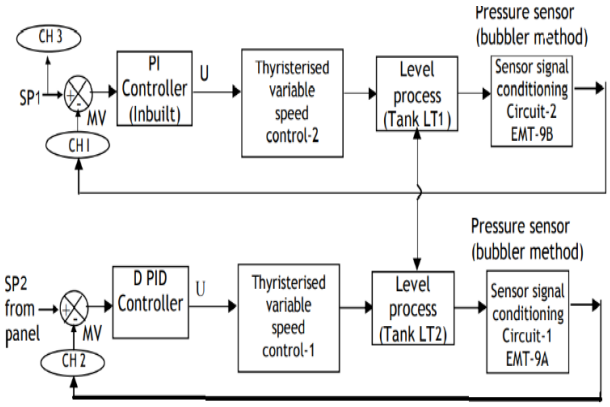


Figure 6: Hardware Connection for Coupled Tank System

Initial Level (0) l_1 (m)	Final Level (t) l_1 (m)	Change in Height (m)	Time t (sec)
0.25	0.20	0.05	22.69
0.20	0.15	0.05	24.37
0.15	0.10	0.05	24.01
0.10	0.5	0.05	23.27

Table 2: Calculation of S_1 for Valve V1 (Half Open)

Initial Level (0) l_2 (m)	Final Level (t) l_2 (m)	Change in Height (m)	Time t (sec)
0.25	0.20	0.05	16.20
0.20	0.15	0.05	14.62
0.15	0.10	0.05	19.90
0.10	0.5	0.05	18.20

Table 3: Calculation of S_2 for Valve V2 (Half Open)

Initial Level (0) l_1 (m)	Initial Level (0) l_2 (m)	Difference in initial level [$l_1(0)$ - $l_2(0)$]	Difference in liquid level at time t [$l_1(t)$ -$l_2(t)$]	Time t (sec)
0.10	0.15	0.05	0	80
0.11	0.14	0.03	0	98
0.12	0.13	0.01	0	76

0.13	0.12	0.01	0	71

Table 4: Calculation of S_0 for Valve V12 (Half Open)

Substituting the values of s_0, s_1, s_2 in the matrix A we get,

$$A=\begin{bmatrix}-0.1568 & 0.0534\\ 0.0534 & -0.1932\end{bmatrix}, B=\begin{bmatrix}58.71 & 0\\ 0 & 58.71\end{bmatrix}$$

$$C=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}, D=\begin{bmatrix}0 & 0\\ 0 & 0\end{bmatrix}$$

Symbol	Quantity	Value
Pg	Pump gain	10 V/m
Lg	Level sensor gain	2.9*10^-5 m^3/sec-V
s0	Discharge coefficient of Valve V12 (half open)	0.3237
s1	Discharge coefficient of Valve V1(half open)	2.0298
s2	Discharge coefficient of Valve V2 (half open)	2.6108

Table 5: Determination of Pump gain (Pg), Level sensor gain (Lg) and Discharge Coefficient (s_0, s_1, s_2)

Converting the state equation in to transfer function TF, from MATLAB we get following equations as

From input 1 to output

$$g_{11}=\frac{58.72s+9.158}{s^2+0.274s+0.01750}$$

$$g_{12}=\frac{1.95}{s^2+0.274s+0.01750}$$

From input 2 to output

$$g_{21}=\frac{1.95}{s^2+0.274s+0.01750}$$

$$g_{22}=\frac{58.72s+7.05}{s^2+0.274s+0.01750}$$

TUNING METHODS FOR PID CONTROLLER

Trial and error is the simplest method of a PID controller tuning. Once we get a clear understanding of PID parameters, the trial-and-error method becomes relatively easy. The trial-and-error method wherein K_I and K_D are set to zero and K_P is increased until the loop starts to oscillate. Once oscillation starts, the critical gain K_c and the period of oscillations P_c are noted. The K_P, K_I and K_D are then adjusted. Ziegler–Nichols conducted numerous experiments and proposed rules for determining the values of K_P, K_I and K_D based on the transient step response of a plant. The unit step response resembles an S-shaped curve with no overshoot. This S-shaped curve is called the reaction curve. Figure 7 shows, step input response curve of the transfer function g_{12}.

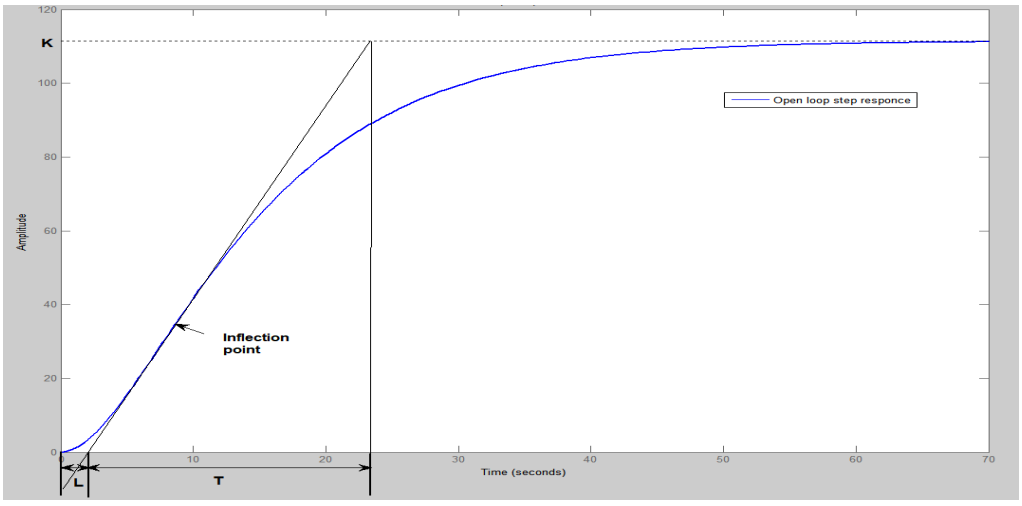


Figure 7: S-shaped Step Input Response Curve for determining value of L, T.

The S-shaped reaction curve can be characterized by two constants, delay time (L), time constant (T) were obtained, which are determined by drawing a tangent line at the inflection point of the S-shaped curve as shown in Figure 7 and finding the intersections of the tangent line with the time axis and the steady-state level line. The value of L and T is determined as, L= 1.9 sec, T= 21.3 sec and process gain K=111. It helps to get the values of K_P, K_I, K_D from Ziegler-Nichols tuning rule as mentioned in Table 6. The Cohen-Coon (CC) is a tuning method based on the Ziegler–Nichols type tuning

algorithm. Referring to Cohen-Coon tuning rule as mentioned in Table 6. get the values of K_P, K_I, K_D for the Cohen-Coon method [5].

Methods	Type of controllers	Parameters		
		Proportional gain (K_c)	Integral time (T_i)	Derivative time (T_d)
Ziegler-Nichols	P	$\frac{T}{L}$	∞	0
	PI	$0.9\frac{T}{L}$	$\frac{L}{0.3}$	0
	PID	$1.2\frac{T}{L}$	2L	0.5L
Cohen-Coon	P	$\frac{T}{K_pL}\left[1+\frac{L}{3T}\right]$	∞	0
	PI	$\frac{T}{K_pL}\left[\frac{9}{10}+\frac{L}{12T}\right]$	$\frac{L\left(30+\frac{3L}{T}\right)}{9+\frac{20L}{T}}$	0
	PID	$\frac{T}{K_pL}\left[\frac{4}{3}+\frac{L}{4T}\right]$	$\frac{L\left(32+\frac{6L}{T}\right)}{13+\frac{8L}{T}}$	$\frac{4L}{11+\frac{2L}{T}}$

Table 6: Ziegler-Nichols and Cohen -coon Tuning Rule

Some of the PID controllers have on-line automatic tuning capabilities. The PID autotuner block from MATLAB Simulink tool works by performing a frequency-response estimation experiment. The blocks inject test
signals into the plant and tune PID parameters based on an estimated frequency response. Controller parameters for different tuning methods are tabulated in Table no.7

PID Tuning Methods	**K_P**	**K_I**	**K_D**
Trial and error (T&E)	15	0.5	0.05
Ziegler–Nichols (ZN)Tuning	13.45	0.2631	0.95
Cohen-Coon (CC)	9.544	0.2218	0.679
PID Auto Tuning (MATLAB Simulink tool)	12.0422	2.4386	-20.87

Table.7: PID parameters used for the different tuning methods

From table 7, we get value of K_P = 13.45, K_I =0.2631, K_D = 0.95 by ZN tuning method. By using the values of K_P, K_I, K_D as obtained from above Table 7, it is possible to improve the output response in better manner after delicate and fine tuning. Moreover, due to delicate and fine tuning it is possible to reduce ITAE, IAE, ISE. By using these error criteria, it may further be possible to reduce the rise time, peak overshoot and settling time. The linearized coupled tank liquid level system model as derived above is simulated on MATLAB Simulink for a set input, l_1=70 % and l_2=45 % as shown in Figure 8. As both the tanks are interconnected, with change in either q_1 or q_2, the coolant levels (l_1, l_2) in both the tanks are seen to be affected.

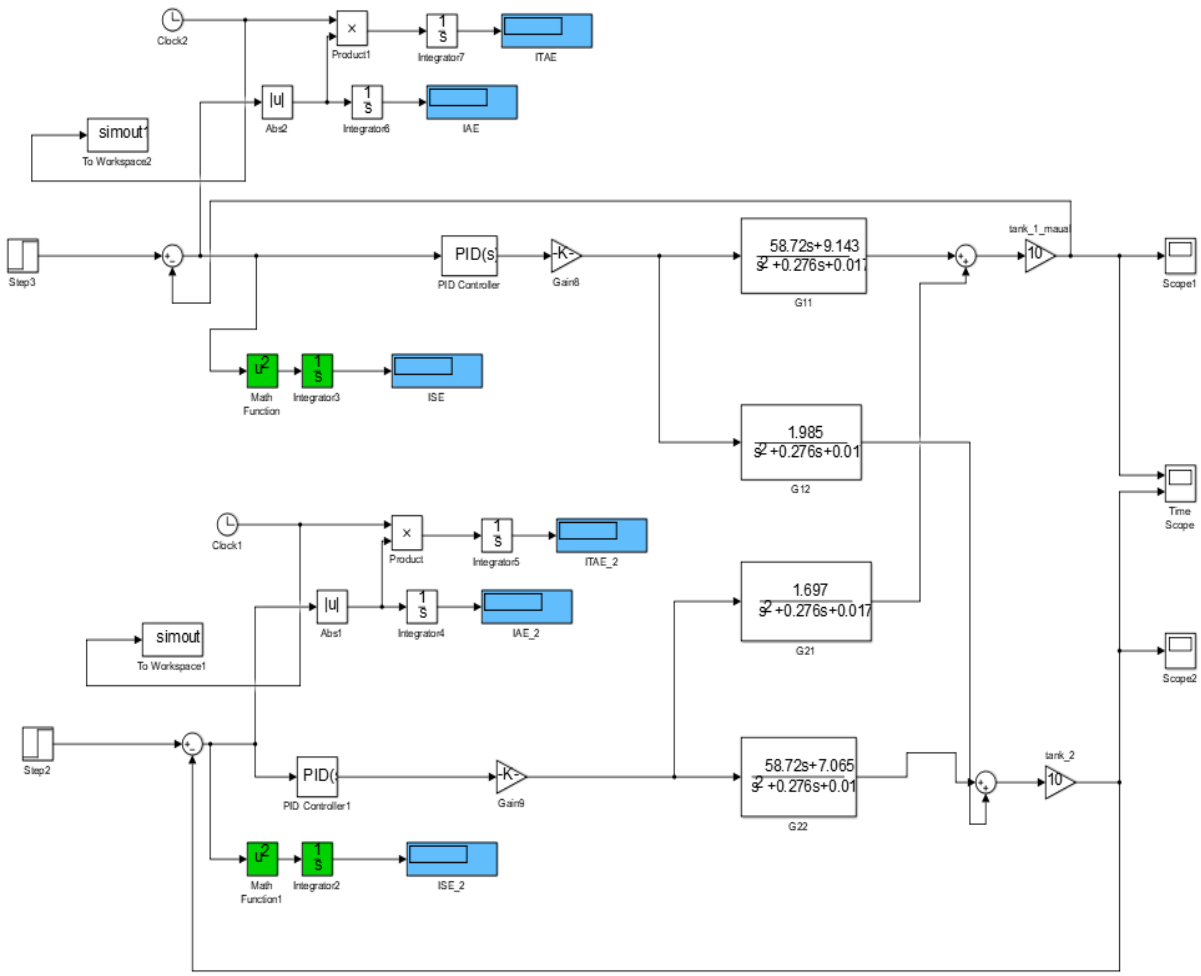
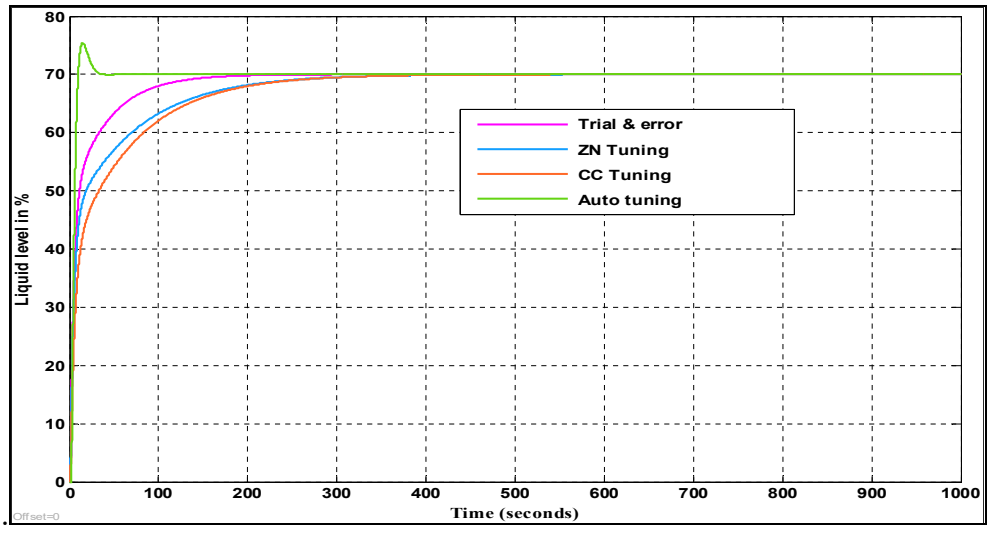
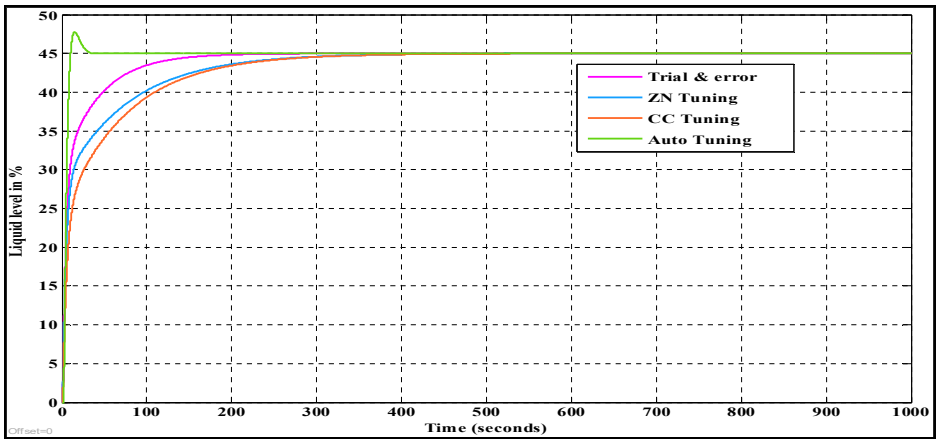


Figure 8: MATLAB simulation of Coupled tank MIMO system for set input, l_1=70% and l_2=45 %.

With the change in set point for any of the tanks, the actual level in both the tanks is observed to be changed due to interconnection



(A)



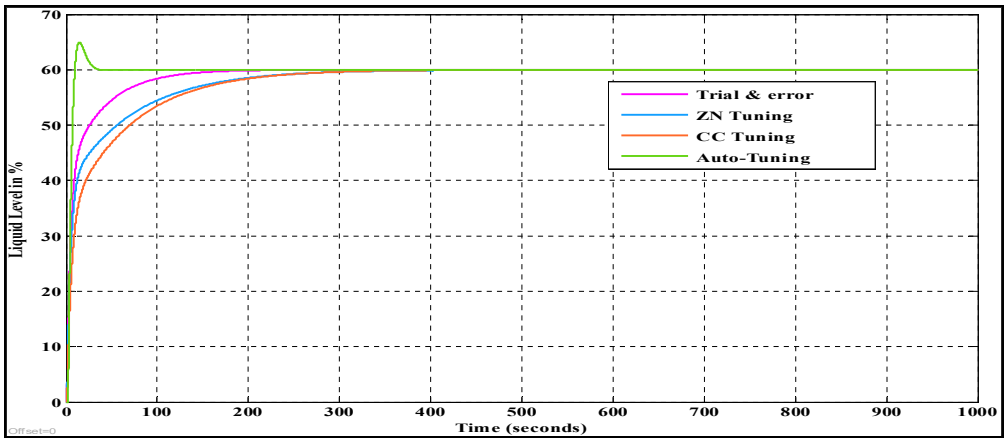
(B)

Figure 9: MATLAB simulation Output response for (A) tank 1, set point l_1=70% (B) tank 2, set point l_2=45% for different tuning methods.

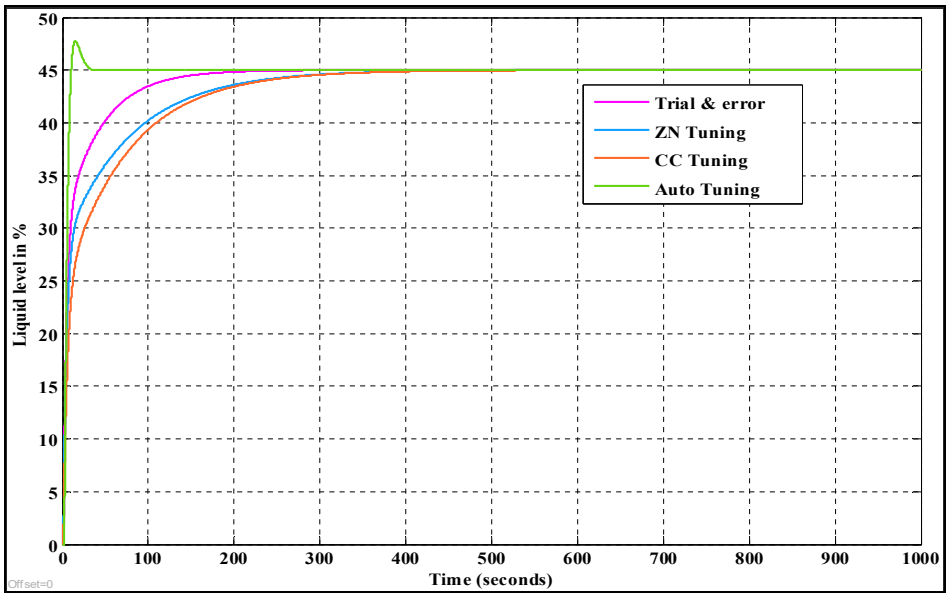
Tank 1 coolant level output response for set level of 70%				
Performance specifications (Time domain specifications and error criteria)	**Tuning Methods**			
	Trial and error	**Ziegler–Nichols (ZN)**	**Cohen-Coon (CC)**	**PID Auto Tuning**
Rise Time (sec)	73.7	113	126	6.33
Settling Time (sec)	158	250	261	22.2
Overshoot (%)	0	0	0	7.04
ITAE	3.94e+4	1.47e+5	1.67e+05	2134
IAE	1082	2057	2440	350.2
ISE	2.1e+4	3.50e+4	4.9e+04	1.6e+4

Tank 2 coolant level output response for set level of 45%				
Performance specifications (Time domain specifications and error criteria)	**Tuning Methods**			
	Trial and error	**Ziegler–Nichols (ZN)**	**Cohen-Coon (CC)**	**PID Auto Tuning**
Rise Time (sec)	73.7	143	159	4.92
Settling Time (sec)	158	296	314	18
Overshoot (%)	0	0	0	7.21
ITAE	2.60e+04	9.68e+04	1.10e+05	1351
IAE	705.3	1340	1590	224.2
ISE	8848	1.47e+4	2.05e+05	6652

Table 8: Comparative performance of various tuning techniques based on time domain specifications and error criteria for setting Tank 1=70% and Tank 2=45%



(A)



(B)

Figure 10: MATLAB simulation Output response for (A) tank 1, set point l_1=60% (B) tank 2, set point l_2=45% for different tuning methods.

Tank 1 coolant level output response for set level of 60%				
Performance specifications (Time domain specifications and error criteria)	**Tuning Methods**			
	Trial and error	**Ziegler–Nichols (ZN)**	**Cohen-Coon (CC)**	**PID Auto Tuning**
Rise Time (sec)	56.4	113	126	5.85
Settling Time (sec)	132	248	258	22.6
Overshoot (%)	0	0	0	6.77%
ITAE	3.17e+04	1.18e+05	1.35e+05	1892
IAE	899.5	1709	2028	303.1
ISE	1.5e+4	2.5e+04	3.5e+04	1.18e+04
Tank 2 coolant level output response for set level of 45%				
Performance specifications (Time domain specifications and error criteria)	**Tuning Methods**			
	Trial and error	**Ziegler–Nichols (ZN)**	**Cohen-Coon (CC)**	**PID Auto Tuning**
Rise Time (sec)	73.7	143	159	4.92
Settling Time (sec)	158	295	311	18
Overshoot (%)	0	0	0	7.21
ITAE	2.97e+4	1.09e+5	1.26e+5	1244
IAE	756.6	1438	1706	219.4
ISE	9380	1.58e+4	2.20e+5	6654

Table 9: Comparative performance of various tuning techniques based on time domain specifications and error criteria for setting Tank 1=60% and Tank 2=45%

From Figure 9,10 and Table 8,9, for the ZN tuning method, the rise time was lower compared to that of the CC tuning method, but has a poor settling time as compared to Trial and error and PID auto tuning and about a percentage overshoot , the PID Auto Tuning method has larger percentage overshoot as compared to other tuning methods. Table 8 and 9 respectively show the values of time domain specifications along with the error criteria for different tunning methods for the both tanks LT1 and LT2.

Conclusion and Future Direction of Research

The four tuning methods namely Trial and error (T&E), Ziegler-Nichols (ZN), Cohen-Coon (CC) and Auto tuning (AT) are considered in this paper for the tuning of PID controllers of both the tanks. The performance of the system after using each of these tuning methods is compared in this paper based on time domain specifications and error criteria. It is evident from the simulation and results that PID controller tuned with auto tuning and trial-error method gives better performance and robustness as compared to other tuning methods.

From the comparative analysis, ZN based tuned PID controller for system control performs relatively better than the CC based tuned PID controller. So, the Ziegler-Nichols PID (ZN-PID) tuning techniques is used in the industrial sector. The selection of tuning method should be based on the characteristics of the process and performance requirements. Our challenging task were to calculate discharge co-efficients, observe the output response with coolant density and viscosity and how it behaves by changing PID parameters. The controlled coolant level output responses obtained from interacting system, indicate that by using proper PID controller tunning method it is very possible to control the coolant liquid level perfectly for the coupled tank system.

Also, as a part of future scope, we are working on Fractional order PID controller and Fuzzy logic PID controller. Fractional order mathematical system will help to get more accurate output response as compared to classical integer method. In a Fractional Order PID controller [14][15][17,19,20], there are two more parameters to tune than the conventional PID controller making it more flexible, controllable and better performance will be obtained. Intelligent controller like fuzzy logic controller (FLC) when combined with PID can give better output responses [18]

References

1. Pallavi N K, Deepa H S. (2018). Coolant Management and Environment Monitoring System in FMS Machine using Microcontroller. International Journal of Engineering Research & Technology (IJERT), NCESC - 2018 Conference Proceedings, ISSN: 2278-0181.
2. Mrs. Deepa. S. Bhandare, Dr. Prof. N. R. Kulkarni, Dr. M.V. Bakshi. (April 2021). Linearization of a coupled tank MIMO system and its validation using MATLAB. IEEE 6th International Conference for Convergence in Technology (I2CT). India.
3. Borase, R. P., Maghade, D. K., Sondkar, S. Y., & Pawar, S. N. (2020). A review of PID control, tuning methods and applications. International Journal of Dynamics and Control.
4. Engr. Joseph, E. A, Olaiya O. O. (2018). Cohen-Coon PID Tuning Method: A Better Option to Ziegler Nichols-Pid Tuning Method. Computer Engineering and Intelligent Systems, ISSN 2222-1719 (Paper) ISSN 2222-2863 (Online) Vol.9, No.5.
5. Thanita Suksawat, Pornsiri Kaewpradit. (2021). Comparison of Ziegler-Nichols and Cohen-Coon Tuning Methods: Implementation to Water Level Control Based MATLAB and Arduino. Eng.J.CMU (Engineering Journal Chiang Mai University) 28, 153-168.
6. Wu, H., Su, W., & Liu, Z. (2014). PID controllers: Design and tuning methods. IEEE 9th Conference on Industrial Electronics and Applications.
7. Dr Roberto Friassin. (2005). Tunning PID Controllers using the ITAE Criterion.

Chemical Engineering Department, LEPAE, Faculty of Engineering, University of Porto,4200- Porto, Portugal.
8. Anagha Philip Antony, Elizabeth Varghese. (2016). Comparison of Performance Indices of PID Controller with Different Tuning Methods. IEEE International Conference on Circuit, Power and Computing Technologies [ICCPCT].
9. Yesudas Muttu. (March 2015). Design and Implementation of SISO and MIMO Processes using PID Controller for Coupled Tank Process. International Journal for Innovative Research in Science & Technology, Volume 1, Issue 10, ISSN (online): 2349-6010.
10. Mohd fuaad rahmat & Sahazati md rozali. Jurnal Teknologi. (June 2008). Modeling and controller design for a coupled tank liquid level system analysis & comparison". Universiti Teknologi Malaysia.
11. Abuja, Nigeria. (2015). Performance Analysis for Coupled - Tank System Liquid Level Control Using MPC, PI and PI-plus-Feedforward Control Scheme. Department of Electrical and Computer Engineering, Baze University.
12. Rama Koteswara Rao Alla a, Lekyasri N b, Rajani K c. (2019). PID Control Design for Second Order Systems", I.J. Engineering and Manufacturing, 4, 45-56 Published Online in MECS.
13. Mircea Dulăua, Tudor-Mircea Dulău. (8-9 October 2015). Multivariable System with Level Control. 9th International Conference Interdisciplinarity in Engineering, INTER-ENG 2015, Tirgu-Mures, Romania.
14. Mostafa A. Fellani, Aboubaker M. Gabaj. (2016). PID Controller Design for Two Tanks Liquid Level Control System using Matlab. Faculty of Electronic Technology, Control Engineering Department.
15. Mr. Parvat. B.J., Mr. Deo.S.A. and Mr.Kadu C.B. (January 2015).Mathematical Modeling of Interacting and Non Interacting Tank System. International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 4, Issue 1, ISSN 2319 – 4847.
16. User guide. XPO-PCT/3T. ANSHUMAN TECH Pvt.Ltd., Pune.
17. C. Monje, B. Vinagre, V. Feliu, and Y. Chen. (2008). Tuning and autotuning of fractional order controllers for industry applications. Control Engineering Practice, vol. 16, no. 7, pp. 798–812.
18. Mrs. Deepa. S. Bhandare, Dr. Prof. N. R. Kulkarni. (October 2015) Performance's evaluation and comparison of PID controller and fuzzy logic controller for process liquid level control. IEEE 15th International Conference on Control, Automation and Systems (ICCAS), South Korea.
19. I. Podlubny, L. Dorcák, and I. Kostial. (1997). On fractional derivatives, fractional-order dynamic systems and PIλDμ-controllers. in Proc. 36th IEEE Conf. Decision and Control, vol. 5, pp. 4985–4990.
20. I. Podlubny. (1999). Fractional-order systems and PIλDμ-controllers. IEEE Trans. Autom. Control, vol. 44, no. 1, pp. 208–214.