3.4.9 Bibliometrics of the publication during the year based on average citation Index in Scopus / Web of Science / Pub Med.

S.No	Title of the publication	Author	Journal	Year	ISBN
1.	Hedonic Shopping Experience in Malls: A Scale Development	Dr.S. Premkumar	Journal of critical Reviews	July 2020	2394-5125
2.	Good Governance in National Olympic committee (NOC) of SAARC countries	Dr.S.Premkumar	Journal of Huazhong University of Science and Technology	2020	1671-4512
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JOURNAL OF CRITICAL REVIEWS

ISSN- 2394-5125 VOL 7, ISSUE 13, 2020

Hedonic Shopping Experience in Malls: A Scale Development Study

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Received: 11 May 2020 Revised and Accepted: 09 July 2020

ABSTRACT: The evolving retail sector, rising customer expectations and competitive landscape have emphasized the need for hedonic ingredients to enrich the shopping experience of consumers. Malls being a prime destination for hedonic shopping in India, this study aims to develop a practical hedonic shopping experience scale encapsulating the various types of hedonic experiences offered in malls. The study employed qualitative research using in-depth interviews to thoroughly investigate the shopping experiences of mall consumers and to generate the initial scale items. A structured questionnaire comprising these items was designed for the quantitative study. The data collected (n = 224) using mall intercept survey were subjected to exploratory and confirmatory factor analyses which yielded a 26-item hedonic shopping experience scale consisting of seven dimensions: window shopping experience, social experience, entertainment experience, gratifying experience, bargain shopping experience, status shopping experience and aesthetic experience. The potential applications of the proposed scale are discussed along with its limitations and directions for future research.

KEYWORDS: Shopping experience, Hedonic consumption, Malls, Scale development

I. INTRODUCTION

Shopping in India has witnessed a transformation with the evolution of the retail industry and specifically, the expansion of the organized retail sector. Shopping malls constitute a significant part of the Indian organised retail format which has developed dramatically in major tier 1 and tier 2 cities over the past decade (Pani, 2015; Dungarwal, 2016). Malls have revolutionized the shopping experience of consumers by influencing their shopping habits, preferences, and behaviour.

In the past, shopping was primarily about making need-based purchases. This can be termed as utilitarian shopping which is directed towards satisfying a functional or economic need and its value weighed on its success or completion (Holbrook and Hirschman 1982; Babin et al., 1994). Utilitarian shoppers are believed to be more task-oriented, efficient and rational who are concerned with 'expectations of consequences' i.e. means-ends type (Batra and Ahtola, 1991; Fiore and Kim, 2007). However, in recent times, consumers do not just shop for purchasing goods and services, but also for experiential and emotional reasons that go well beyond the traditional shopping paradigm. These multisensory, fantasy and emotive aspects of one's experience with products or services represent the hedonic consumption (Holbrook and Hirschman 1982). This hedonic view explores consumption experience not as a purely cognitive or information processing event, but via a phenomenological or experiential perspective.

Malls are the common destination for shoppertainment in urban India, which offer a wholesome shopping experience, specifically in the hedonic sense which includes shopping, entertainment and leisure. Visitors can not only purchase and consume various products and services, but the mall itself offers experiences which are consumable (Bloch et al., 1994). For the discerning modern consumers, malls are proving to be a panacea to all their shopping woes (Mohan and Tandon, 2015). Hence, malls have become increasingly popular among Indian

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consumers with an average weekday footfall of 30,000 - 50,000 that further spikes during weekends in case of the large city malls (Largest malls of India, 2013; Srivastava, 2017).

Despite the boom in mall culture and success stories of some popular malls, industry experts state that 60-90 percent of shopping malls in major cities across India are performing lamentably and face a bleak future owing to their non-adaptation and competition from new shopping malls offering sophisticated shopping experience to their customers (Khare and Rakesh, 2010; Shopping Malls dying in India, 2016; Survival Crisis, 2017). It is easier to get people to the mall once, but to get them to return and spend money depends on the mall's ability to offer hedonic shopping experience. Urban consumers in India and especially youth visit malls primarily for the hedonic shopping experience rather than just utilitarian purpose (Kaur and Singh, 2007). Most visitors are attracted to malls for varied experiential reasons such as aesthetics, luxury, safe environment, good ambience, entertainment, leisure, and best hang-out place for families and friends (Dungarwal, 2016). Malls which failed to offer such experiences have witnessed dipping footfalls and sales with some even forced to shut down (Shah and Bose, 2012; Nair and Maheshwari, 2017).

Since hedonic constituents have become the unique selling proposition of malls, it is essential to gain a comprehensive understanding of the hedonic shopping experience offered by malls to their consumers.

II. LITERATURE REVIEW

Shopping research in the past has generally focussed on the utilitarian aspects of the shopping experience, which are characterized as task-oriented and means-end type (Batra and Ahtola, 1991; Arnold and Reynolds, 2003). However, consumers are not just logical decision-makers who focus on functional benefits; they are also emotional human beings who are concerned with gaining hedonic experiences (Schmitt, 1999; Sadachar, 2014).

This shift from the traditional information processing approach to a more hedonic, experiential view of consumption was initially recognized by Tauber (1972) who found that shoppers have numerous psychological shopping motives other than just purchase of products and services. Holbrook and Hirschman (1982) presented the experiential view of consumption experience which emphasizes the importance of pleasure and happiness for a satisfying shopping experience. In a widely cited study, Pine and Gilmore (1999) proposed the concept of "Experience Economy" which contends that consumers are no longer interested in just purchasing goods and services; they desire engaging and entertaining experiences during shopping. They presented four dimensions of experience: educational, entertainment, escapist and esthetic experiences. Thus, to run a successful business in the retail space, retailers must offer enchanting shopping experiences that stimulate the consumers' senses and touch their hearts and minds (Pine and Gilmore, 1999; Sadachar, 2014).

Hedonic shopping experience in the context of malls

Past studies have highlighted the importance of hedonic attributes such as entertainment and leisure in drawing consumers to a mall. According to Bloch et al. (1994), malls are not just strictly purchase sites, but a centre for many hedonic activities. Wilhelm and Mottner (2005) found that consumers in developed countries prefer malls with experiential features rather than a typical status quo mall. Similarly, in recent times, Indian consumers largely shop from a hedonic perspective which involves getting product ideas, meeting friends, alleviating stress or breaking the monotony of everyday life (Kaur and Singh, 2007; Khare, 2011). Hence, urban Indian consumers desire to visit malls which offer an entertaining shopping experience (Srinivasan and Srivastava, 2010).

Recognizing the importance of hedonic aspect in retailing, most studies focused on incorporating it as one of the dimensions of various constructs such as consumer attitude (Batra and Ahtola, 1991), shopping value (Babin et al., 1994), shopping motivations (Tauber, 1972; Kaur and Singh, 2007; Farrag et al., 2010) and shopping orientations (Sinha, 2003). Very few studies concentrated on analyzing the shopping experience of consumers, specifically from the hedonic perspective. Pandey & Darji (2011) and Srinivasan & Srivastava (2010) qualitatively explored the concept of experience economy; while Sadachar et al. (2014) empirically examined the applicability of the 4Es (Pine and Gilmore, 1999) to understand the shopping experience of consumers in the context of Indian malls. These studies analyzed shopping experience within Pine and Gilmore's Experiential Realms. Singh and Prashar (2013) analyzed the composition of shopping experience in the view of Dubai mall shoppers and they found that mall experience can be conceptualized as a mix of five factors i.e. ambience, physical infrastructure, marketing focus, convenience, and safety and security. In a similar study, Singh and Prashar (2014) explored the anatomy of shopping experience with respect to malls in Mumbai. They identified ambience, convenience, marketing focus, safety and security and physical infrastructure as the important components defining shopping experience.

It is a fact that with the evolving consumer expectations and competitive market, the composition of shopping experience offered by Indian malls has been changing. Also, the existing studies focus on the overall shopping

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experience and not specifically on the hedonic perspective. This necessitates the study of consumer perception of hedonic shopping experience offered in malls.

III. OBJECTIVE OF THE STUDY

Given the growing significance of hedonic experiences during mall shopping, this study aimed at investigating the hedonic shopping experiences of consumers in malls. Specifically, the objective of the study was to develop a scale representing the wide range of hedonic shopping experiences offered in malls.

IV. RESEARCH METHODOLOGY

To achieve the research objective, a qualitative study was conducted followed by a quantitative study involving exploratory factor analysis and confirmatory factor analysis to develop a scale summarizing the comprehensive range of hedonic shopping experiences in malls. In-depth interviews were conducted with regular mall going consumers as well as mall administrators to qualitatively explore the shopping experience of mall consumers. Based on these qualitative inputs and literature review, 42 scale items were generated which were validated by two marketing professors for content adequacy and representativeness. Finally, 37 items were retained after content validity.

A structured questionnaire was used as the data collection instrument for the quantitative study. The 37 items obtained from qualitative research was used to construct the questionnaire. The items were evaluated using the 5 point Likert scale (1 - strongly disagree and 5 - strongly agree). The sampling sites for the study were three prominent shopping malls in Chennai city, India. The data were collected using the mall intercept survey (Bush and Hair, 1985) where respondents were selected through convenience sampling technique. The respondents were asked to think about their shopping experiences in malls, the activities they indulged in while visiting malls and the feelings and level of satisfaction experienced during shopping. A total of 300 questionnaires were administered of which 224 filled questionnaires were found usable for further data analysis. The demographic analysis of the data revealed that the sample was diverse in terms of gender, age and income. It comprised approximately 41 percent men and 59 percent women between 18 to 60 years of age and varied income levels.

V. EXPLORATORY FACTOR ANALYSIS

The 37 items were subjected to exploratory factor analysis (EFA) using principal components method and varimax rotation to determine the number of distinct factors/dimensions and to categorize the generated items under these dimensions. A seven-factor solution was estimated and 6 items with factor loadings less than 0.5 were discarded for further iterations (Hair et al., 2006). The grouping of the items was examined for domain representation and 3 items were removed since they theoretically did not match other items in the factors they were grouped into. The remaining items were subjected to EFA which yielded a seven-factor solution with 26 items. The solution explained 63 percent of the total variance and the KMO measure of sampling adequacy of 0.762 indicated the fitness of data for factor analysis. The factor loadings ranged from 0.633 to 0.853. The Cronbach alpha coefficients, average variance extracted (AVE) and composite reliability (CR) estimates were above the prescribed threshold signifying good reliability and validity of the factor structure (Fornell and Larcker, 1981; Nunnally and Bernstein, 1994).

VI. CONFIRMATORY FACTOR ANALYSIS

The confirmatory factor analysis (CFA) was carried out for thorough examination of the scale's psychometric properties (Anderson and Gerbing, 1988). The 26 items obtained from EFA were subjected to CFA using maximum likelihood (ML) method in SPSS AMOS 22. The results revealed a 26-item seven-factor measurement model which was consistent with the EFA factor solution. The measurement model showed an adequate fit as the fit indices above the acceptable thresholds ($\chi 2_{(303)} = 354.72$, p = .001; GFI = .901; AGFI = .875; CFI = .954; NFI = .823; IFI = 0.955; standardized RMR = .073; RMSEA = .035) indicating a good model fit with the data (Schermelleh-Engel et al., 2003; Vandenberg and Grelle, 2009). The CFA results showed that the standardized factor loadings of all items ranging from 0.558 to 0.859 were significant and above the prescribed limit of 0.5 (Hair et al., 2006). The item SMCs ranged from 0.312 to 0.738 and all modification indices were low and insignificant. Hence, no items were removed. Table 1 presents the 26-item factor structure obtained from the confirmatory factor analysis (Refer Appendix Figure A1 for the measurement model obtained from SPSS AMOS).

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Table 1: Confirmatory Factor Analysis Results

Dimension	Items	Factor Loadings	Squared Multiple Correlations
Window shopping experience	This mall helps me explore the latest products/designs/brands available.	0.728	0.548
	I enjoy browsing and trying different products in this mall.	0.693	0.436
	Shopping in this mall keeps me up with the new fashion and trends.	0.698	0.437
	This mall offers the best window shopping experience.	0.621	0.428
Social experience	This mall is a great place to hang-out with family.	0.698	0.421
	I enjoy visiting this mall with my friends.	0.666	0.401
	This mall is the best place to socialize.	0.759	0.312
Entertainment experience	I enjoy visiting this mall since it has a variety of food and entertainment services.	0.699	0.738
	This mall offers first-class movie experience.	0.594	0.488
	This mall is entertaining with play areas, adventure games, health clubs and salons/spas.	0.611	0.535
	I like this mall as it is a one-stop destination for fashion, fun, food and films.	0.795	0.519
Gratifying experience	I visit this mall to break the monotony of my daily routine.	0.665	0.500
	Shopping in this mall feels like self-gratification for a hard day's work.	0.742	0.462
	When I am in a bad mood or stressed, I visit this mall to make me feel better.	0.680	0.550
	When I am alone and bored, this mall is a good place to go.	0.707	0.442
Bargain shopping experience	I like visiting this mall when there is an end of season sale or festive offers.	0.720	0.632
	I enjoy browsing different stores in this mall for good discounts.	0.731	0.374
	This mall is a convenient place to hunt for bargains.	0.699	0.352
Status shopping experience	Shopping in this mall is a sign of status and prestige.	0.859	0.488
	I prefer to shop in this mall just like my peers do.	0.558	0.576
	I feel more socially accepted when I visit this mall as my friends/colleagues do.	0.634	0.443
	Shopping in this mall helps make a good impression on others.	0.649	0.487
Aesthetic experience	I love shopping in this mall because of the artistic and pleasant interiors.	0.654	0.385
	The mall facilities (escalators, restrooms, parking) make the shopping experience convenient and pleasurable.	0.661	0.487
	I like the ambience (lighting, music, hygiene, aromas, and temperature) of this mall.	0.660	0.480

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	I prefer this mall for shopping since it is peaceful and spacious.	0.740	0.530

Reliability and Validity

The scale reliability was assessed using composite reliability (CR) estimates. As shown in Table 2, CR values of the dimensions ranged from 0.751 to 0.792 which were above the prescribed limit of 0.7 (Fornell and Larcker, 1981; Nunnally and Bernstein, 1994). The convergent validity was examined using factor loadings and average variance extracted (AVE) estimates. The standardized factor loadings of all 24 items were significant and ranged from 0.558 to 0.859. As presented in Table 2, the AVE values of the dimensions ranged from 0.462 to 0.514 which were closer to the acceptable threshold of 0.4. Thus, the scale was considered to have adequate convergent validity (Fornell and Larcker, 1981; Hair et al., 2006). The discriminant validity was tested by comparing the AVE estimates of the dimensions and the correlations between them (Fornell and Larcker, 1981). As shown in Table 2, the AVE estimates of all dimensions ranging from 0.462 to 0.514 were greater than the squared correlation coefficients ranging from 0.00 to 0.269; hence the scale possessed adequate discriminant validity.

By analyzing the content of the items grouped together, the seven dimensions were labelled appropriately symbolizing the different hedonic shopping experiences offered in malls i.e. window shopping experience, social experience, entertainment experience, escapist experience, bargain shopping experience, status shopping experience and aesthetic experience. Table 2 presents the reliability and validity results obtained from confirmatory factor analysis.

Table 2: Confirmatory Factor Analysis - Reliability and Validity Results

Dimensions	Composite Reliability	Discriminant Validity - Comparison of AVE and squared correlations						
		WS	SO	EE	GE	BS	SS	AE
WS	0.780	**0.471**						
SO	0.751	0.078	**0.502**					
EE	0.772	0.003	0.173	**0.462**				
GE	0.792	0.206	0.269	0.120	**0.489**			
BS	0.760	0.015	0.061	0.004	0.027	**0.514**		
SS	0.774	0.000	0.023	0.008	0.004	0.000	**0.468**	
AE	0.774	0.179	0.007	0.031	0.019	0.091	0.004	**0.462**

*Note: Diagonal values in **bold** are AVE estimates and off-diagonal values are squared correlation coefficients*

WS-window shopping experience; SO-social experience; EE-entertainment experience; GE-Gratifying experience; BS-bargain shopping experience; SS-status shopping experience; AE-aesthetic experience

VII. RESULTS AND DISCUSSION

The data analysis yielded a reliable and valid scale for hedonic shopping experience with seven dimensions. Each of these hedonic experiences is discussed taking into account the qualitative study findings, theoretical background and literature.

1. Window shopping experience

The first dimension was labelled as 'window shopping experience' which consisted of items such as exploring latest products, trying different products and being up-to-date with new trends. Thus, window shopping experience refers to the feeling of pleasure obtained from browsing and examining various merchandise in a mall. During window shopping, consumers derive fun from exploring and seeking information, but they may not necessarily make a purchase. They regard the fashion updates they gain and the pleasure they experience from exploring as their main drive, irrespective of them making a purchase or not.

Tauber (1972) identified that learning about new trends is one of the personal shopping motives where people are interested in keeping track of the up-to-date trends in fashion and styling. This concept of window shopping/exploration corresponds with Arnold and Reynold's (2003) hedonic motivation of idea shopping which signifies shopping as a means to be cognizant with current vogue and popular designs and products. It is roughly

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similar to the 'educational experience' dimension of the 4Es concept (Pine and Gilmore, 1999) which comprises consumers' active participation with mind and/or body actively engaged to improve their skills and knowledge (Sadachar, 2014). Indian malls are generally focussed on captivating customers through shopping experience rather than educating them through events or classes. Since shopping is regarded as fun rather than an educational experience, this dimension is termed as window shopping which is one of the common hedonic experiences offered in malls.

2. Social experience

The second dimension was named as 'social experience' which consisted of items such as malls being a hang-out place for family and friends and a place to socialize offering good bonding experience. Thus, social experience refers to the pleasure derived from socializing with others. In urban India, malls have become a one-stop destination for shopping, fun and leisure. Hence, a majority of Indian consumers prefer mall as a happening and safe place to hang-out with family and friends. Malls have now become a desired place for working professionals to conduct unofficial business meetings, corporate events, lunch and dinner get-togethers and colleagues' birthday, promotion or farewell parties.

Malls are an expedient place for socialization which implies going out, meeting and hanging out with friends, family or colleagues. Past research has unearthed different shades of socialization while shopping. Stone (1954) first identified 'personalising' shopper as a distinct shopper type who tends to personalize and have close relationships with shop personnel. Tauber (1974) recognized the social motives of shopping i.e. having social experiences outside the home and communicating with other people. While these researchers solely focused on socializing with outsiders, Arnold and Reynold (2003) recognized social shopping as a hedonic motive which represents the pleasure of shopping with friends and family as well as bonding with outsiders. Social experience is a significant hedonic shopping experience desired by Indians since they are intrinsically embedded in their socio-cultural society characterized by social interdependence, deeper involvement with others and desire for social acceptance and support (Jacobson, 2004). Thus, malls are popular destinations to socialize and interact with others while shopping.

3. *Entertainment experience*

The third dimension was labelled as 'entertainment experience' which consisted of items such as malls offering a variety of food and entertainment services, movie experience and a one-stop place for fashion, food, fun and films. Thus, entertainment experience refers to the feeling of enjoyment and adventure derived from the various entertainment services such as movies, bowling alleys, video game arcades, kids' play areas and food courts offered in malls. Recent surveys found that nearly 50 percent of the mall visitors use entertainment services compared to a mere 20 percent who go shopping which emphasizes consumer preference for entertainment (Khare and Rakesh, 2010). Hence, all new-age malls are designed with a significant share of mall space for entertainment services to improve their customer footfalls and revenue.

Bloch et al. (1994), Anuradha and Manohar (2011) and Sadachar (2014) identified that the entertainment experience offered by mall services such as movies, cafes, food courts, arcades, health clubs, salon/spa, pubs and recreational services help attract consumer traffic to the malls. The hedonic motives of gaining enjoyment, fun and adventure have boosted the consumer demand for entertainment consumption (Sit et al., 2003). Hence, entertainment has now become a common hedonic shopping experience offered by malls.

4. Gratifying experience

The fourth dimension was identified as 'gratifying experience' which consisted of items such as visiting malls to break the monotony, self-gratification and to feel better. It refers to the pleasure obtained from recreation, relaxation and relief from the monotony of daily life. With the changing and demanding lifestyle, not many places offer both leisure and peace to people and malls are one such space which offers these along with shopping. For most people, mall atmosphere helps rejuvenate mood and shopping relieves stress. Thus, shopping in malls to gratify oneself is regarded as truly fun and stress buster.

The concept of gratification during shopping has been emphasized in past research. Hirschman (1983) introduced the escapism as one of the four hedonic behaviours to escape unpleasantness. Tauber (1972) was one of the first to recognize the self-gratifying benefits of shopping which are motivated not by the consumption value, but by the utility of the buying process. Similarly, Arnold and Reynolds (2003) found gratification as a hedonic shopping motive that helps alleviate stress, negative mood and as a way to unwind. Thus, malls offer a feeling of gratification which is a notable hedonic experience desired by customers.

5. Bargain shopping experience

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The fifth dimension was labelled as ' bargain shopping experience' which consisted of items such as visiting mall for sale and offers, enjoy browsing for discounts and mall being a convenient place for bargain hunting. Thus, bargain shopping experience refers to the pleasure derived during the process of bargain hunting i.e. searching for sale, offers and best deals on purchases. Consumers in India rarely make purchases in malls since they are regarded as luxurious and expensive place for purchasing merchandise. However, in case of offers such as end-of-season sale and festive discounts, Indian consumers desire to visit malls, browse various stores and hunt for the best deals irrespective of them making a purchase.

The concept of pleasure from bargaining was formerly recognized by Tauber (1974) who posited that the ability to seek bargains makes one a sensible shopper. Similarly, Arnold and Reynolds (2003) identified value shopping as a hedonic motive which signifies customers' tendency to hunt for best deals at low prices. Though it can be contended that seeking bargains is a utilitarian behaviour, the process itself offers an adventure and emotional satisfaction which is inherently pleasure-driven or hedonic. Thus, malls can be regarded as a convenient spot with numerous shops and brands in one place to easily compare and hunt for bargains.

6. Status shopping experience

The sixth dimension was termed as 'status shopping experience' which consisted of items such as shopping in mall as a sign of status and prestige, to feel more socially accepted and to make a good impression. Thus, status shopping experience refers to the pleasure obtained from mall shopping owing to the status it confers. In this age, especially youngsters and middle class consumers who believe in display of wealth generally prefer shopping in malls since it is a matter of prestige. According to them, mall shopping enhances the way they are perceived by others and helps gain social approval. These conspicuous consumers buy some products and services in malls just as a status symbol to advertise how wealthy and classy they are.

Past studies have highlighted the significance of status-driven shopping and the proclivity of Indian consumers towards prestige over rationality while making purchases (Bullis, 1997; Kaur and Singh, 2007). Thus, malls offer pleasure through status shopping which is an intrinsic hedonic experience.

7. Aesthetic experience

The last dimension was labelled as 'aesthetic experience' which consisted of items such as mall ambience, interior design, architecture, facilities and spaciousness. Aesthetic experience refers to the pleasure obtained from the sensory appeal, comfort and opulence of the mall. In recent times, the rising customer expectations along with competitive market have compelled mall administrators to focus on mall atmospherics and customer service. Customers expect captivating and hygienic environment to make their shopping experience convenient and mesmerizing.

The concept of mall aesthetics has been highlighted in past research. Tauber (1972) recognized that sensory stimulation is one of the consumer shopping motives wherein the shopping environment may be an influencer of the consumer's decision to visit and shop in a store. Wakefield and Baker (1998) established that perceived physical environment of the mall is a vital determinant of consumers' excitement and desire to stay at the mall. According to Haytko and Baker (2004), physical comfort and atmospheric features of malls influenced the purchase patterns and favouritism of adolescent girls. Atmospherics comprising the mall interior design, layout, lighting, and music create an esthetic experience, which is one of the four experiential relams (4Es) identified by Pine and Gilmore (1999). Thus, aesthetic experience is one of the fundamental hedonic experiences that malls need to offer to improve the customer satisfaction and repatronage behaviour.

These seven types of hedonic shopping experiences were conceptualized and defined based on the qualitative study findings, review of literature and experts' opinion.

VIII. CONCLUSION

This study demonstrates the development of a practical hedonic shopping experience scale consisting of 26 items across seven types of hedonic shopping experience offered in malls. The hedonic experience dimensions are: window shopping experience, social experience, entertainment experience, gratifying experience, bargain shopping experience, status shopping experience and aesthetic experience.

For the scale development process, this study employed a qualitative study followed by a quantitative study consisting of data collection and analysis. In-depth interviews with mall consumers and administrators were conducted to qualitatively explore the various hedonic shopping experiences offered in malls. Initial scale items were generated using qualitative study results and literature review. A questionnaire consisting of these items were used for data collection through mall intercept survey. The data were subjected to exploratory and

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confirmatory factor analyses which yielded a 26-item seven-dimensional hedonic shopping experience scale with adequate reliability and validity.

IX. RESEARCH IMPLICATIONS

The hedonic shopping experience scale summarizes a wide range of hedonic experiences offered in malls which has a broad array of applications for researchers, retailers and mall administrators. The scale can function as a tool to measure the degree of hedonism offered by malls as perceived by its customers. This will indicate the extent to which the mall offers various hedonic shopping experiences. It can help the mall administrators in identifying the hedonic features prominently appealing to their customers and those missing in their mall. This information can facilitate in making better strategic and marketing decisions which include designing mall interiors, selection of retailers and entertainment services, allocation of mall resources and facilities.

The scale developed in this study can be used as a base to analyze hedonic experiences offered by other retail formats such as supermarkets, hypermarkets, grocery stores, e-tailers and street bazaars. Researchers and retailers can use this scale to test the level of hedonism provided by other retail settings. Based on the results indicating the customer perception of various hedonic experiences, the retailers can appropriately plan and strategize to improve their business model.

X. LIMITATIONS OF THE STUDY

The study has certain limitations which ought to be mentioned. First, the hedonic shopping experience scale is specific to malls in India. Hence, researchers and retailers must be cautious while applying the scale to other shopping contexts and regions. Secondly, the seven types of hedonic experiences are based on the qualitative research performed in this study which might not be the exhaustive list of hedonic shopping experiences offered in malls. Finally, the study was limited to Chennai city in India due to time and financial constraints. Besides, data was collected through mall intercept survey using convenience sampling which is a non-probability sampling technique. These limitations in terms of the sampling method affect the generalizability of results.

XI. FUTURE RESEARCH DIRECTIONS

This study provides considerable scope for future research. The hedonic shopping experience scale developed in this study can be further validated using a larger, geographically diverse sample for better generalizability of results. Besides, the applicability of the scale can be tested by adapting it for other retail formats such as supermarkets, hypermarkets, chain stores and e-tailers. In future, researchers can conduct an in-depth analysis of each of the hedonic shopping experiences found in this study. Further, the scale can be used to investigate the impact of various hedonic shopping experiences on customer satisfaction, loyalty and repatronage behaviour.

XII. APPENDIX

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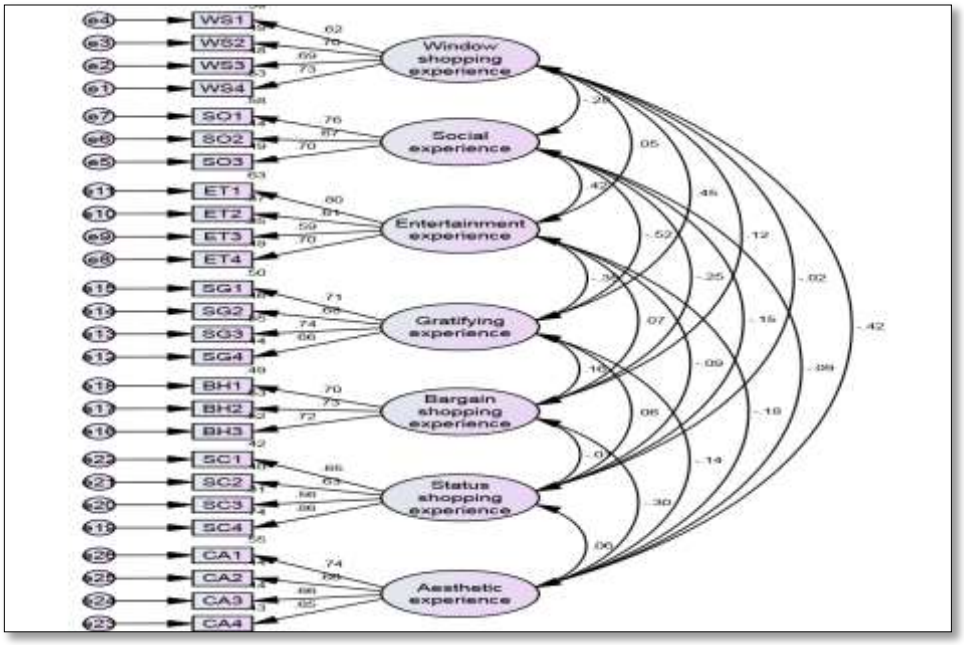

Figure A1 - Measurement Model from Confirmatory Factor Analysis

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Good Governance in National Olympic Committees (NOC) of SAARC Countries

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Abstract

This paper is concerned with the assessment of the governance and in particular, evaluating good governance in National Olympic Committees (NOC). For this study, a case study approached was adopted focusing on seven National Olympic Committees of SAARC (South Asian Association for Regional Cooperation) countries (India, Maldives, Nepal, Pakistan, Bangladesh, Bhutan, and Sri Lanka). The purpose of this study is to identify the gap if any in the governance of National Olympic Committees in SAARC countries and offer the basic set of recommendations on good governance practices. The researchers developed a questionnaire to evaluate the present level of governance of the organization and then to investigate what space among Olympic Committees in SAARC that has to be improved in parallel with the good governance theoretical framework. The review of literature collected for this study reveals that not much research were conducted in South Asian Countries in sports governance. The researchers used document analysis as a research method to examine the level of governance practices. Desktop research was conducted for the collection of the data for this study. The Organization's websites, statutes, internal regulations, and any other relevant available documents were analyzed thoroughly. Scoring took place based on publicly available data. The researcher used the Sports Governance Observer (SGO) as groundwork to measure governance in Olympic Committees in SAARC countries. The SGO survey is a combination of the four most important dimensions of the principles of good governance; transparency, democracy, checks and balances, and solidarity. The analysis has indicated that the results of football federations in SAARC countries on good governance are governed is not satisfactory. The average score and overall SGO index of Olympic Committees of SAARC countries are 2.46 and 36.4% respectively. Out of seven countries, India has the highest SGO index with 52.5 % whereas Nepal has the lowest with 30%. This overall score point indicates that NOCs in SAARC Countries have severe governance problems with transparency, checks and balances, and Solidarity. It has been significantly proved that the NOCs of SAARC countries need to put more efforts to further improve on the different dimensions of Good Governance.

Keywords: Governance, Transparency, Democratic Process, Checks and Balances, Solidarity.

Reference:

Geeraert, A. (2015). *Sports Governance Observer 2015: the legitimacy crisis in international sports governance*. Copenhagen: Play the Game.

1. INTRODUCTION

Corruption is nothing new in sports. The history of written corruption goes back to the Olympics in 338 BC, and the scandals of corruption over the past 20 years have confirmed that these problems are still relevant today (Maennig, 2002). Many notable corruption scandals include the vote-buying scandal over the Salt Lake City Olympic bid (Longman, 2000) and the decision to win gold medals at the same time as the 2002 Olympic Winter Games in a figure-skating in favor of the Russian duo and two Canadian contestants (Clarey, 2002), as well as systematic corruption among FIFA officials currently under investigation at the time of writing. The similarities between immorality and drug use are evident in the recent whistle-blowing scandal that plagued Russia and its drug rehabilitation program during (at least) the 2012 and 2014 Olympic Games (Ruiz, 2016). As a result, Olympic medals from fraudulent athletes from 2012 and 2014 have been canceled, and many Russian athletes were banned from the 2016 Olympics in Rio de Janeiro.

One of the purposes of good governance is to prevent corruption in a transparent manner, not to give a member of the board of government or an organization holding a potential reason or incentive to participate in the corrupt process. From an economic point of view, corruption can be caused if “the expected use of corrupt practices (large enough) on both sides to overcome any social decline” (Maennig, 2005, p. 205).

The challenge of a general good governance framework, including the code of conduct and rules of each relevant organization, to integrate the various priorities under the umbrella of independent management of sports federations. Besides, the management framework needs to uphold the ethical standards of the sport in general, which is why previous attempts to use existing checklists in

principles of transparency, accountability, and integrity (as well as social responsibility) play an important role in creating a framework within which sport industry organizations can operate (Geeraert, 2016). It is important to clarify that these basic principles cannot be considered in isolation, as they are interrelated (Houlihan, 2013). Additionally, there are several other principles on how good governance can be done, as there are a variety of important topics for each organization.

The policy of transparency includes the opportunity to obtain relevant organizational information, clear external communications, and external audits and monitoring. Transparency is based on the individual ideology of democratic government, preventing corruption and the abuse of power in general (Geeraert, 2016); however, transparency does not happen in some of the leading sports organizations. Transparency requires a certain openness ("disclosure", commercially) of traditional closed corporations of external auditors and government audits. This is difficult to achieve because the same people are often involved in both the decision-making process and the management itself, even after the scandals of recent corruption (Chappelet, 2016).

2. RESEARCH METHODOLOGY

After reviewing various literatures, it was found that the research questions in this study were not fully answered by the current sports governance framework because there is insufficient theory or model showing the problems investigated in this study. The question in this research study is to find out the current level of good governance in the National Olympic Committees of SAARC countries. The researcher used textual analysis as a research method to assess the level of governance practices. The desktop study is for the collection of data for this study. The corporate websites, policies, internal regulations, and other relevant documents available were carefully analyzed. The calculation is based on publicly available data. Therefore, the researcher used an existing research tool for the Sports

governance practices in SAARC National Olympic Committees. This testing tool is used in the South Asia Sport System since the NOCs in SAARC countries have similar structures and rules that make this measurement tool an appropriate tool.

The Sports Governance Observer (SGO) test tool was developed jointly by the Play the Game and Danish Institute for Sports Studies in 2012 and 2013, in partnership with six reputable European universities and the European Journalism Center. It is a self-assessment checklist for good governance in international sports organizations. The tool is also defined using a scoring system. Importantly, the Supervisor of Sports Management is based on the basic indicators of good governance. A thorough examination of good governance practices on ISFs requires in-depth research in some way. The existing and non-SGO checklists lists four factors that are considered to be the most important factors related to good governance in sport, including transparency, democratic process, checks and balances, and Solidarity. (Geeraert, 2015,) SGO research is a combination of the four most important values of good governance principles; each element contains an unequal number of indicators (36 in total), including transparency (12 indicators), democracy (10 indicators), checks and balances (7 indicators), and solidarity (7 indicators) . Each indicator is measured using the scales below:

1.	2.	3.	4.	5.
Not fulfilled at all	Weak	Moderate	Good	State of the art

The below SGO index formula will be used to synthesized and examined the survey scores:

$$SGO\ index_{fed\ x} = \frac{\left(\frac{\sum_{i=1}^{12} Trans_i}{12} + \frac{\sum_{j=1}^{10} Dem_j}{10} + \frac{\sum_{k=1}^{7} Check_k}{7} + \frac{\sum_{l=1}^{7} Sol_l}{7}\right)}{4} - 1 \times 100$$

Table – 1

Sport Governance Observer Index and Sport Governance Observer Scores.

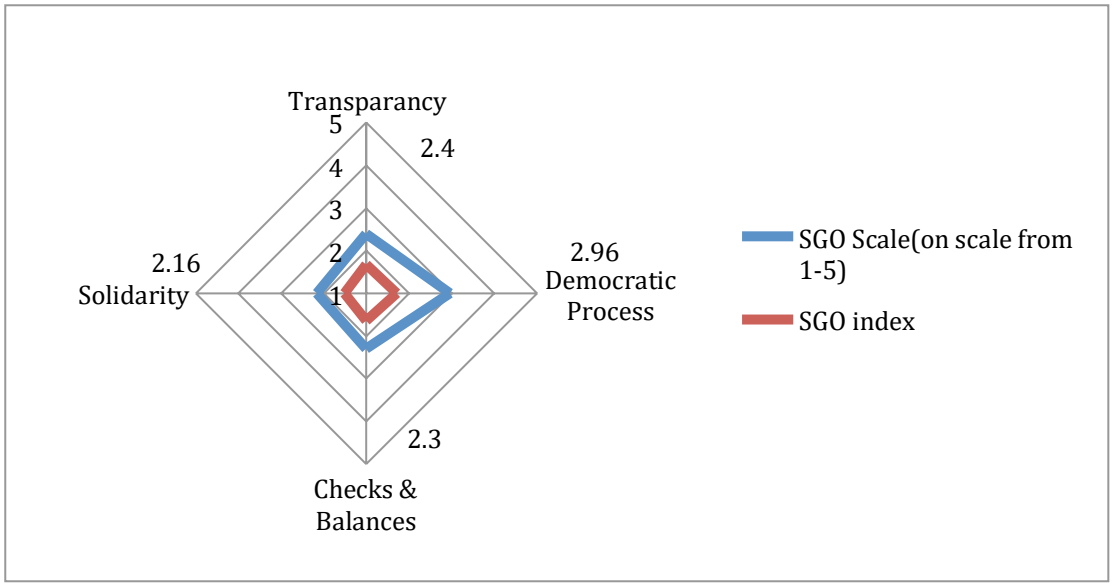
Sl.No	Countries/ Indicators		Transparency	Democratic Process	Checks & Balance	Solidarity	Average SGO scale & Index
1.	**Bangladesh**	**SGO Scale (on scale from 1-5)**	2.3	2.4	2.2	2	**2.23**
		SGO index	32.5%	35%	30%	25%	**30.63%%**
2.	**Bhutan**	**SGO Scale (on scale from 1-5)**	2.2	2.9	2.1	2.1	**2.33**
		SGO index	30%	47.5%	27.5%	27.5%	**33.13%**
3.	**India**	**SGO Scale (on scale from 1-5)**	2.5	3.7	3.3	2.9	**3.1**
		SGO index	37.5%	67.5%	57.5%	47.5%	**52.5%**
4.	**Maldives**	**SGO Scale (on scale from 1-5)**	2.3	3.1	2.2	2.1	**2.43**
		SGO index	32.5%	52.5%	30%	27.5%	**35.63%**
5.	**Nepal**	**SGO Scale (on scale from 1-5)**	2.1	2.9	2	1.8	**2.2**
		SGO index	27.5%	47.5%	25%	20%	**30%**
6.	**Pakistan**	**SGO Scale (on scale from 1-5)**	3	2.5	2	2	**2.37**
		SGO index	50%	37.5%	25%	25%	**34.38%**
7.	**Srilanka**	**SGO Scale (on scale from 1-5)**	2.4	3.2	2.3	2.2	**2.53**
		SGO index	35%	55%	32.5%	30%	**38.13%**
8.	**Mean of SGO Index of SAARC Countries**	**SGO Scale (on scale from 1-5)**	2.4	2.96	2.3	2.16	**2.46**
		SGO index	35%	48.92%	32.5%	29%	**36.4%**

3. RESULTS AND DISCUSSION

It is observed from the above table.1 that, the SGO index of SAARC National Olympic Committees is 36.4% collected from Transparency (35%), Democratic Process (48.92%), checks and balances (32.5%), and Solidarity (29%). This complete figure clearly shows that the National Olympic Committees of SAARC countries have serious administrative problems on all sides. Pakistan has the highest 3 SGO values with a 50% SGO index and Nepal has the lowest SGO rating at 2.1 with an SGO index of 27.5% respectively. India tops the Democratic Process with 3.7 and 67.5% SGO and SGO indicators respectively while Bangladesh has a low score of 2.4 SGO Score with a 35% SGO index. In Checks & Balances and Solidarity, India has the highest SGO on a scale of 3.3 and 2.9 respectively and the SGO index with 57.5% and 47.5%, while Nepal and Pakistan share the lowest scores with 2 SGO scores on the scale and 25% SGO index. Collectively, Nepal has the lowest points on the SGO scale and the SGO index with 1.8 and 20% respectively. Overall, India has the highest SGO rating of 3.1 with an SGO index of 52.5%, and Nepal with the lowest SGO rating of 2.2 with an SGO index of 30%. It is inferred that NOCs of SAARC countries' weak to moderate positions in all dimensions. Transparency (35%), Democratic Process (48.92%), Check and Balance (32.5%) and Solidarity (29%) calling for the organization to take extra effort to develop all areas. The mean value of SGO scale is represented in Figure.1.

Figure-1

Sport Governance Observer Result Chart: Olympic Committees of SAARC Region



4. CONCLUSION

The stakeholders of NOC need to have confidence that they are effectively and fairly governed at every level. To ensure this, the roles and responsibilities of all participants have to be clearly defined in the NOCs and the same to be communicated to each participant of the Olympic movement of the country besides making them know the significance of each dimension of good governance such as Transparency, Democratic Process, Check and Balance and Solidarity. Further, NOCs of SAARC countries need to have systematic good governance practices to take full advantage of organizational resources. The NOCs must have detailed medium and long-term plans for them as to how to go ahead of achieving good governance in the future. The task of achieving good governance is possible when the NOC itself is sound and strong, the NOC has

adequate and good administration, and when the management of the NOC is well-organized and efficient. It is therefore suggested that NOCs of SAARC countries must take efforts to strengthen 1) the organizational structure 2) the administration and management to enable them to achieve good governance in the coming days.

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The Impact of Knowledge Management on Employees Productivity: The Case of Lebanon

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Abstract

Knowledge management nowadays had been considered as a main element for achieving organizational success and survival in today's knowledge age and competitive environments. The performance of the Lebanese Banking Sector nowadays is fluctuating, and the main reason behind that is the absence of knowledge management in the workplace and by that absence of communication among employees and managers in their workplace. The primary motivation which lies behind the research is to identify the importance of knowledge sharing, and how it affects employees' involvement and engagement in the workplace. The research had implemented both quantitative and qualitative methods, and the data were analyzed using both descriptive and inferential statistics to validate the research hypotheses scientifically. The findings of the research proved that there is a significant positive relationship between Knowledge enhancement, E-Learning, Knowledge management and organizational commitment.

Keywords: E-Learning, Knowledge Management, Knowledge Enhancement, and Organizational Commitment.

Manuscript; Original published in: Productivity management, 25(4), GITO Verlag, P. 52-67,
ISSN 1868-8519, 2020

Introduction

Alavi and Leidner [1] claimed that many organizations are equipped with information management, which seeks to preserve, collect and disseminate knowledge throughout the enterprise in a world in which knowledge are increasingly regarded as the most critical resources of an organization. Kiantoet al. [2] has been proposed to inspire and empower skilled individuals to use and share their understandings and develop new knowledge, in large part in knowledge management to build, provide, encourage and support reasonable learning conditions in associations. Knowledge is in the form of intelligence, awareness, contextualization and thought, according to Davenport and Prusak [3]. It is a powerful form of data available for use in choices and events. Organizations will accurately see which knowledge gives them a handle. Wenger et al. [4] said the group would have a creative and concentrated advantage over knowledge or know-how. Knowledge has become a means of accomplishment. It is inherently unnecessary and impossible to be used as a weapon [5]. Despite its value and expertise, many organizations face difficulties in coping with the demands of the economy powered by learning. In many organizations, research institutions and various parts of the economy, the topic of information management is a moving subject today. Education has played a critical role in building and promoting monetary confidence among traditional assets of property, work and money. In the last decade, important work assessing information, like treatment, intellectual resources (human capital), society and the process over knowledge management have been recognized as critical factors, according to Wiig et al. [6]. The evaluation aims to provide a theoretical model of casework to improve the research administration by compellingly reconciling these considerations and making active use of knowledge properties. It will emphasize the integrative effect on information management of processes, academic (human), society and methodology.

An Overview of Knowledge Management

The absence of the information management concept (KM), continues to decline in the business community and that can be observed from the last decade of the twentieth century. The business world has seen the emergence of innovation in the new information-age system. The caring for vital and strategic expertise in the new knowledge ecosystem and its ongoing growth allow companies to generate additional benefits. Knowledge management has now been extended to various segments, universities, administrative, agencies, research, and development etc. (Lee, 2005) Pruzinsky et al. [7] also claimed that knowledge management is about how people trained can use and communicate their experiences to gain new experience and expertise. Pruzinsky et al. [8] explore whether and how knowledge management practices can be used in order to promote employee work satisfaction. Knowledge Management (KM) consists of a set of procedures for the development, dissemination and use of information in an entity [9]. As described in IFLA, KM is' a system in which authoritative knowledge is made (produced, captured) is placed out (protected, organized, coordinated) and used (imparted), used (implanted)

Manuscript; Original published in: Productivity management, 25(4), GITO Verlag, P. 52-67,
ISSN 1868-8519, 2020

and reused (changed) in order to enable an entity to achieve its objectives.' It involves formal information management and tacit knowledge sharing (i.e. skills/mastery / know-how) [10]. Of starters, within the group, minutes of meetings, resolutions, guidelines of notes, documentation, etc. and other records such as files, documents, government data, research papers are gathered inside organizations' associations and other material is retrieved. Tacit knowledge, though, integrated into the working people's brains through extensive knowledge of rules and regulations, job processes, etc. [11]. Tacit and specifically knowledge is considered to be the most important part of an organization's information, and the handling of which should be performed with the utmost care and should be the prime motive for all organizations [12].

According to Javed et al. [13], based on previous research, employees will be proactive, more creative, and innovative when they are satisfied with their work. They will do their job. Not many research studies on the management of information and job satisfaction to the organization were addressed, as mentioned by Pruzinsky et al. [14]. Therefore, while conducting Knowledge Management, the researcher intended to analyze job satisfaction in detail. Tsai [15] reveals that job efficiency can be improved if incremental fragments provide focal structures that enable the exposure of different divisions of an enterprise to new learning [15]. The relationship between KM and efficiency had been recognized with conspicuous inspection of facts, the management of knowledge, and its unique impact on employee performance [16]. Accordingly, Woods [17] mainly offers multinational organizations (MMC) and public offices and agencies for establishing and accepting information management in Malaysia. The insistence on improving information systems in their organizations has shown to be less on small-medium businesses (SMEs). KM activities continue to be discussed in Malaysia, where penetration is small. It involves companies with a large level of knowledge which are known to be highly structured entities [18].

Literature Review

Concept of Knowledge Management

The impact of knowledge management on employee satisfaction is the main aim of this research. Studies will recognize and examine in this respect, whether the application in knowledge management can have an impact on the job satisfaction of workers. Knowledge management is the willingness of an organization to acquire, archive, exchange and use knowledge with a common aim to improve their success and achievement. The successful use of information control unlocks members, according to Moffet and Hinds [19]. Knowledge workers are adaptable and agile in order to manage their jobs according to their knowledge, expertise and activities. Based on its bookkeeping interest and its contribution to expertise, companies make progress in the business field and thrive in rivalries [20]. In Syed [21] most specialists strongly recommend the collection and implementation of KM practices, such as the capturing and distribution of the

best practices that effectively track consumer relations and provide active input. Malaysian companies have always been behind their distant partners from moving markets, given the uncertainty between the sectors. Rahman [22] has reported that 46% (139 organizations) have formalized KM operations, with 303 educational and policy organizations overviewed. Irritably, only a small amount of 46 per cent (32 organizations) started use and evaluation (18 organizations). At the same time, larger groups were still in the underlying stages of study, review, planning, or setting up spending plans. It is not because companies did not know KM that the sluggish execution is based.

Instead, most Malaysian institutions as they did not know what the potential advantages of KM were, adopted a' sit back and watch' attitude to the introduction of KM projects within their organizations [23]. In comparison, an inability by institutions to understand KM is attributed to the crucial shortage of confirmatory studies on the interaction between KM's operation and work satisfaction. Many scholars with empirical support through the process review approach [24] have stressed how the findings could not be generalized by a broader population even though significant correlations between the KM procedures and KM implementation were established. From now on, the study must cover this void with the exact acceptance that most organizations, in particular information-based companies, must be confident of the relationship between these components. This would promote appropriate KM activities to gain an improved strategic advantage.

KM Practices

KM relates to the distinction and use of the aggregated data in an enterprise to support the company [25]. KM is reportedly a mechanism of information, such as the processing, collection, distribution, transition, and compliance, according to Lee [26]. The independent method of information formation, storage and transmission by Nonaka and Takeuchi has been announced. Demarest and Pruzinsky have also suggested KM mechanisms such as information formation, codification, accumulation of knowledge, knowledge sharing, and preservation of knowledge.

Knowledge Acquisition

According to Zahra and George, the collection of details from extra-organized outlets remains a question of authoritative activity. For a wide range of organizations, global networks and collaboration partnerships become essential information outlets. If the organization works, its clients plan a particularly crucial meeting from which information should be obtained. For starters, the highly-developed information gathering processes are characteristic of customer feedback networks, data mining, business intelligence and collaboration with collaborators or research institutes. The acquisition of knowledge is a complex and continuous process. The ability to develop original thoughts, information, and structures and link them within the

company requires knowledge development.

Knowledge Sharing

King has observed that information exchange or diffusion is one of the key components of knowledge management practices. This determines which phase members should send bosses and subordinates their thoughts and productive skills to accomplish their tasks and improve their performance. On the other side, it also speaks about the system used in the different section and entities of the company by workers for the collection or exchanging of data. The approaches used to gather, develop, give, and use information in a viable way for fulfilling different goals are provided by the management of knowledge by Awad. Essentially it is a multidisciplinary technique with defining techniques and processes. The idea that workplace information is communicated with others to maintain successful knowledge management practices is a significant factor to be considered. According to Trivellas, based on previous research, companies are unable to pursue effective information management practices without employee involvement, because employees do not share knowledge. Although several studies have found the role of organizational culture and the system of knowledge sharing, this research was also sponsored by King and needs to find out its effects on employee satisfaction.

Knowledge Creation

Knowledge management refers to the ability of the organization, from technical methods to product and managerial activity, to develop new and useful concepts and strategies about different parts of operational activities. According to Eisenhardt and Martin, he developed the information to motivate the success assisted in chaotic circumstances. Creation of information is created by learning and improving an institution and its knowledge. According to Scharmer, knowledge-building companies cultivate employee capacity and self-experience in order to develop new experiences, grow, and focus on each stage of the company.

Knowledge Retention

Kanto describes the conservation of information as practices related to the management of employee turnover and the resulting lack of experience that is a fundamental advantage of the company. Once employees leave a company for some cause, professional information can be lost. When children's boomers retire, it will become a considerably more pressing task to retain and keep the best employees.

Job Satisfaction

Spector says that job satisfaction is defined as how much people like their jobs (fulfilment) or

hate them (unsatisfaction). Employment satisfaction will lead to job performance. The satisfaction of the profession, as defined in Shaikh, indicates that the workers enjoy their job or the positive and happy condition of the worker after assessment. The value of job satisfaction varies according to Fritzsche and Parrish because of the emotions that the individual has in his / her career. Locke also defined job satisfaction as "a component of the obvious relation between what one wants from one's work and what one sees as an advertisement" and the degree to which a worker feels firmly or contrary to his job. The word job satisfaction is similar to the concept of happiness of the worker. The general nature of workplace engagement and functioning is job happiness, as stated by Grant. Three satisfaction indicators are included in the definition: emotional, physical and social. Satisfaction is a primary indicator of human and organizational efficiency. Mismanagement, truancy, presentism, abolishing leave and selling are the result of low satisfaction. The job satisfaction endorsed by Vroom often coincides with the motivation exchange, in which the root of job gratification can be connected with social issues, confidence and self-actualization.

Knowledge Management in Organization

Like the word ' knowledge,' it is also challenging to describe the phrase ' Information Management' (KM). Ultimately, the scale and form of issues that KM is used to consider determine for each company at last the proper definition. In any case, what is most relevant is that each interpretation concentrates on the KM to improve methods of collaboration and appreciation. While KM has earned a terrible name in some quarters because of the fizzled cases of experts making a fast buck, KM is in reality digging in. Spiegler has shown that the KM is simply another thinking, segregated by and removed from data systems, preference of emotionally supportive networks and the management of the data in the past because of the unique nature of the "wisdom" aspect regarding the question of whether KM is "another thought." The importance of information in culture has been viewed.

According to Becerra-Fernandez, the universal belief that learning to live separately, and primarily among employees, is the wealthiest commodity of the enterprise it represents the value of the processes that facilitate production, sharing and use. Given the increasing value of information and modes of instruction, Fahey and Prusak also recognized that organizations are not mainly well managed either. The desire to concentrate on learning and knowledge sources, and to better monitor them, has led to the development of the concept and routine for (KM). Bimpitsos and Petridou, have said that organizations work in an area defined as instability, failure and transition, can contribute to the emergence of various problems. It involves other factors, including increased globalization, accelerated technological changes, the production of professional workplace qualifications and improved performance. The power group, Savaneviciene and Stakeviciute, has announced itself to seek and adventure the properties at their move with a common aim to achieve a target. The criteria to high job satisfaction for

instance, task design, ability diversity and complexity has been widely studied according to Glisson and Durick. Nonetheless, among the many job satisfaction indicators to be researched, the challenges of KM have not been listed. Generally speaking, it seems that KM literature in the previous study has scarcely dealt with.

Dominguez defined KM as fundamental elements to the fulfillment of a client. The distinctive difficulties faced by organizations must be understood by Othman, who makes critical use of the KM system. This allows it possible for all organizations to work with these properties. The use of a variety of activities to help organizations and monitor their success while they focus on their state of mind and their procedures as Ortega-Parra and Sastre-Castillo say. With the help of Yew, companies are looking to develop the workplace conference and to find the perfect way to maintain the morale of their workers. The organization's operations, as suggested by Tiwari and Saxena can be improved through the operation of the KM available to the organization in areas such as staff service, expertise and adaptability.

More precisely, few KM activities can impact the roles of workers, which can include registration and choosing, planning and development, assessment of results, collaboration and compensation and incentives. Nevertheless, as reported by Fong, staff chooses to leave the organization, the awareness would eventually be lost. That's why companies are trying to improve (KM) protecting, appropriating, recognizing and bureaucratic knowledge processes. The study is based on the interaction between KM and employee satisfaction, organizational accountability on the one side, and the company on the other. The essential parts analyze the logical context, explore method, research concept and hypotheses to achieve this.

Justification for using quantitative data

Quantitative and qualitative methods are two different techniques used for data collection. The quantitative method is based on distributing questionnaires over specified number of respondents, while the qualitative depends on conducting interview questions to study the point of view regarding a specific topic. Both methodologies will be implemented in the research.

Research Design

The research design (Figure 1) is made up of six elements, and they are listed as follows:

- Questions of the Research: The primary motivation behind the research is to address the impact of knowledge management on organizational commitment in the Organizations.
- Methods Used: Is a tool used for collecting data, both methods will be practiced in the research. Data Collected: Data will be gathered through distributing surveys.

- Variables: The dependent and independent variables are two different types and both will be studied in the research.
- Data Analysis: Data will be analyzed using the SPSS statistical tool for hypotheses validation
- Theoretical Framework: addressed through previous studies and researchers and it is mentioned in the review of the literature.

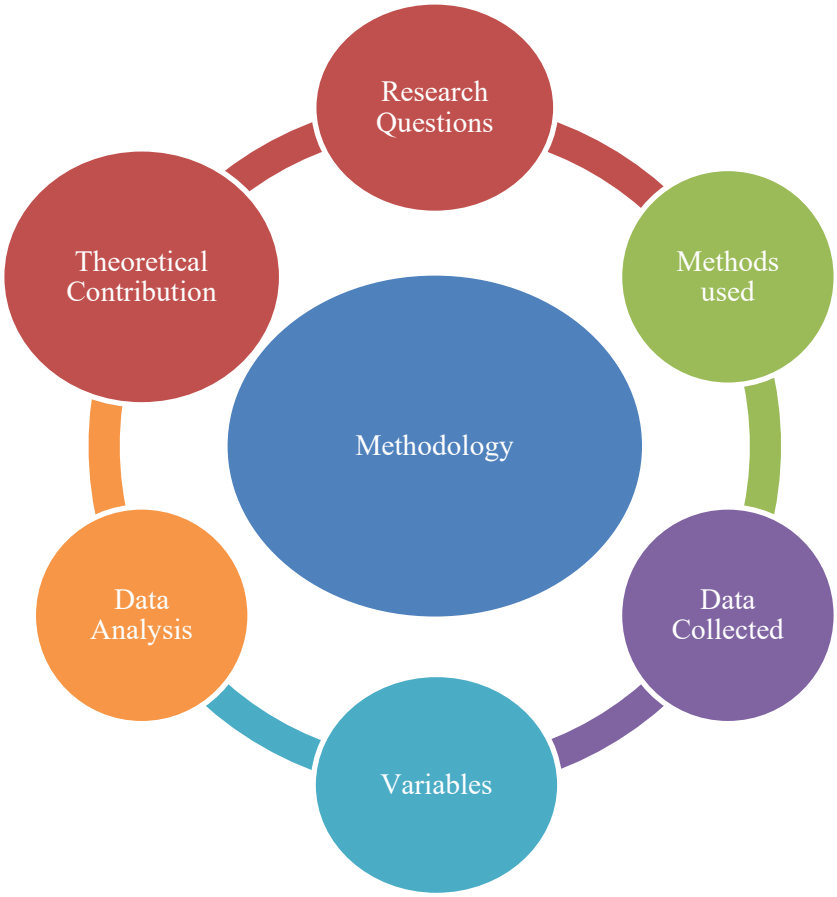

Figure 1. Research Design

Instrumentation

The research will practice both methodologies for data collection. The quantitative methodology will be distributed among 100 respondents in different positions. The collected data will be analyzed using the SPSS statistical tool, and the outcomes will be viewed in the form of statistical Figure 1 and inferential statistics for hypotheses validation.

Regression

Table 1. regression analysis of relationship between Knowledge management and employees commitment

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.546[a]	.299	.287	.882

a. Predictors: (Constant), Knowledge management is enhanced through E-Learning Systems

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.467	.266		5.524	.000
	Knowledge management is enhanced through E-Learning Systems	.570	.114	.546	5.011	.000

a. Dependent Variable: E-Learning tools enhances team cooperation

The above regression analysis showed in Table 1, a standard error of 0.00 which is much lower than 0.05 which means the null hypothesis which states that "There is an insignificant relationship between Knowledge management and employees commitment", and the alternative hypothesis which states that "There is a significant relationship between Knowledge management and employees commitment." is accepted. As for the R-Square, it showed a sign of 29.9%, which is above 25% this means that there is a strong relationship among the research variables.

Table 2. regression analysis of relationship between E-Learning and employee's commitment

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.610[a]	.373	.362	.834

a. Predictors: (Constant), E-Learning helps employees achieve satisfaction in their workplace

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.272	.259		4.904	.000
	E-Learning helps employees achieve satisfaction in their workplace	.601	.102	.610	5.920	.000

a. Dependent Variable: E-Learning tools enhances team cooperation

The above regression analysis showed in table 2, a standard error of 0.00 which is much lower than 0.05 which means the null hypothesis which states that "There is an insignificant relationship between E-Learning and employees' commitment", and the alternative hypothesis which states that "There is a significant relationship between E-Learning and employees commitment" is accepted. As for the R-Square, it showed a sign of 37.3%, which is above 25% this means that there is a strong correlation among the research variables.

Table 3. regression analysis of correlation among knowledge enhancement and employee's commitment

Model Summary

Model	R	R Square	Adjusted R Square	Std. error of the Estimate
1	.488[a]	.238	.225	.919

a. Predictors: (Constant), The knowledge I've gained through the Bank e-learning system enables me to do my job better

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.629	.270		6.036	.000
	The knowledge I've gained through the Bank e-learning system enables me to do my job better	.405	.094	.488	4.297	.000

Dependent Variable: E-Learning tools enhances team cooperation

The above regression analysis showed in table 3, a standard error of 0.00 which is much lower than 0.05 which means the hypothesis which reveals that "There is an insignificant correlation among knowledge enhancement and employees commitment" is not accepted, and the alternative hypothesis which states that "There is a significant correlation among knowledge enhancement and employees commitment" is accepted. As for the R-Square, it showed a sign of 23.8%, which is near 25% this means that there is a strong correlation among the research variables.

Pearson Correlations

Table 4. Implemented to test of Pearson correlations

Correlations

		E-Learning tools enhance team cooperation	Motivation is enhanced through E-learning tools	E-Learning systems enhance work engagement	E-Learning helps employees achieve satisfaction in their workplace	Employees use E-Learning tools to develop their skills
E-Learning tools enhances team corporation	Pearson Correlation	1	.361**	.500**	.610**	.589**
	Sig. (2-tailed)		.004	.000	.000	.000
	N	61	61	61	61	61
Motivation is enhanced through E-learning tools	Pearson Correlation	.361**	1	.588**	.590**	.374**
	Sig. (2-tailed)	.004		.000	.000	.003
	N	61	61	61	61	61
E-Learning systems enhances work engagement	Pearson Correlation	.500**	.588**	1	.670**	.482**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	61	61	61	61	61
E-Learning helps employees achieve satisfaction in their workplace	Pearson Correlation	.610**	.590**	.670**	1	.586**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	61	61	61	61	61
Employees use E-Learning tools to develop their skills	Pearson Correlation	.589**	.374**	.482**	.586**	1
	Sig. (2-tailed)	.000	.003	.000	.000	
	N	61	61	61	61	61

Pearson Test had been implemented to test whether there is a positive or negative relationship between the research variables as shown in table 4, and the results are as follows:

- Positive correlation among team corporation and motivation (0.361)
- Positive correlation among team corporation and work engagement (0.50)
- Positive correlation among team corporation and job satisfaction (0.610)
- Positive correlation among team corporation and skills development (0.589)
- Positive correlation among motivation and work engagement (0.588)
- Positive correlation among motivation and job satisfaction (0.590)
- Positive correlation among motivation and skills development (0.374)
- Positive correlation among engagement and job satisfaction (0.670)
- Positive correlation among engagement and skills development (0.482)
- Positive correlation among satisfaction and skills development (0.586)

Validity and Reliability`

Table 5: The reliability Statistics of data collected

Reliability Statistics

Cronbach's Alpha	N of Items
.894	13

The validity of the data collected had been tested using the validity and reliability analysis as shown in table 5. The Cronbach Alpha should indicate a sign between 0.7 and 1 to ensure that the collected data are valid and ready for statistical analysis. Referring to the Cronbach Alpha mentioned in the above table, it showed a sign of 0.894 which is between 0.7 and 1, this means that the data collected is valid and ready for statistical analysis.

Theoretical Framework and Hypothesis

The paper describes the conceptual framework used by the evolving systems and by incorporating previous studies and literature. Wise information, knowledge sharing, development of knowledge and knowledge preservation are activities adapted as an independent variable (IV). Thus, employee satisfaction as a predictor is the dependent variable (DV). In this portion, alongside the variable overview and the association with another analysis, you will find the definition of each variable. This research would investigate and suggest hypotheses for the interaction between the independent variables and the dependent variable.

Knowledge Acquisition and Job Satisfaction

The acquisition of knowledge (creation) requires an opportunity to formulate, and integrate into the organization, original thoughts, knowledge and arrangements. The KM scale developed by Darroch has been used to assess KM activities in the organizations surveyed based on Jayasingam, researching them. The metric requires the development of information. According to Jayasingam this research concentrates on the success of KM projects viewed by individuals with the consequences of KM projects instead of taking objective measures as the KM outcome were difficult to measure. Bose notes that KM projects are constant, and continuing programs and success assessments of KM projects should be seen as factors that contribute to or strengthen an organization rather than as an end alone. The degree of change is therefore used instead of the level of achievement as success calculation. The analyst then suggests that the correlations are

between the acquisition of knowledge and employee satisfaction.
Hypothesis 1: The relationship between knowledge acquisition and job satisfaction

Knowledge Sharing and Job Satisfaction

The exchange of information between individuals, communities, organizations and institutions is a function of knowledge sharing. The association between job satisfaction and the sharing of knowledge is highly correlated to the value of 0.934 based on Saeed results. Saeed proposed that information exchange would be more relevant than worker efficiency based on the results. Improved incentives for workers to share knowledge and other personnel to develop new concepts, to discuss facts, and to make an essential commitment to achieving the goals of the organization. This is also evident from the findings of this study, which the workers seek to share knowledge with others to enhance their job performance. In line with Trivellas, this finding also explored the positive connection between sharing knowledge and interaction with the workplace. The study concludes that the correlation between the exchange of information and employee satisfaction is fulfilled.
Hypothesis 2: There is a relationship between knowledge sharing and job satisfaction

Knowledge Creation and Job Satisfaction

Knowledge development applies in turn to the capability of the company, from publications and technologies to management practices, to developing a new and useful concept and approach in different areas of the corporate operations. According to the research by Prunzinsky, the development of information does not affect happiness at work. This could be attributed to the research background. It is likely that neither acquisition of information (particularly from sources or collaborators outside the organization) nor creation of new knowledge may be essential for the nature of the work carried out in that municipal institution. Such practices are not supported by the organization's sponsorship or recompense. We, therefore, have no effect on productivity at work. The researcher then concludes that the connection between generating information and pleasing the workforce. Based on the above study, the researcher therefore proposed for the following hypothesis
Hypothesis 3: There is a significant relationship between Knowledge Creation and Job Satisfaction

The Relationship between Knowledge Retention and Job Satisfaction

Information preservation relates to a critical strategic tool, the activities related to staff change reduction and associated professional information depletion. The critical KM method of this organization was information conservation, which implies that the consistency and maintenance of knowledge were crucial for the functioning of the company. This is to be anticipated as, when

developing path-dependent approaches, an entity wants a comprehensive and meaningful view of its past. The Team, therefore, needs to understand the external forces and the organization's structural and regulatory climate. The remaining knowledge retention and job satisfaction are based on a study by Kianto. The findings specifically show that information exchange is the primary KM mechanism in the company and encourages job satisfaction for most classes of workers. The writer then suggests that the exploration of generating information and rewarding workers. Based on the above study, the researcher therefore proposed for the following hypothesis

Hypothesis 4: There is significant relationship between Knowledge Retention and Job Satisfaction

Conclusions

Finally, this design paper provides a broad understanding of knowledge management and happiness in work. In consideration of research papers and ideas published by academics and experts in this area, the literature from past studies is reviewed. This research also explores the end goal of clarifying and interpreting the effect of information management on the productivity of workers through numerous performance reports in the past. A systematic analysis examination is also carried out to research the elements to be included in the study addressing the aspects of information management and job satisfaction. The happiness of an employee can be shown with the calculation of a person's job satisfaction that KM practices. A philosophical structure is proposed as the basis for conducting the study, using the principle of embracing and adapting. More research should be done to improve the understanding of concepts and the impact of KM on the happiness of workers.

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International Journal of Advanced Science and Technology
Vol. 29, No. 7, (2020), pp. 10141-10159

Design and Analysis of Biceps and Triceps Muscle Strengthening Structure

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Abstract

The field of sports engineering is a relatively new discipline of engineering. It connects two very different domains: engineering and sports. Engineers concerned with sports design build customized equipment related to a sportsperson's needs and also measure the sportsperson's performance, the equipment's effectiveness, and analyze how the two interact. Engineering, along with technology today, is playing a key role in not merely enhancing the sportsperson's performance, but in making fitness more safe and attractive. In this study, an exercise regimen is proposed for improving the strength of biceps and triceps of a sportsperson, followed by a proposed structure (equipment) for executing this regimen. The design of this structure is validated using theoretical calculations and simulations on ANSYS software.

1. Introduction

In the last few decades, sports engineering, a relatively new engineering discipline, has made much progress in research. In technical and scientific terms, it is a field which applies engineering concepts to solve the problems associated with sports equipment design, structure and development which are used by the sports professionals to enhance their performance (Taha et al., 2013). In this field, the sports engineers use raw material and technology to develop sports equipment as per the demands of an athlete.

Sports equipments are selected based on their design, unique features, and context of use. The sports equipment is designed with an idea to create new equipment or upgrade the existing equipment. The present-day improved material technology and processing have made a significant impact on the materials, equipments, and designs (Jenkins, 2003).

The quality or state of being fit defines fitness. Physical exercise involves planned, structured, and repetitive actions with an objective to improve the physical fitness (Mandolesi et al., 2018). The advent of technology into the sports field has enabled sports engineers to improve the performance of athletes by applying new technologies. In this regard, strength training is essential for athletes, army professionals, body builders, and for many other individuals who are either recouping from any type of injury or wish to attain a certain level of fitness. Specific work routines are decided to strengthen an isolated muscle group

ISSN: 2005-4238 IJAST

or a set of muscle groups. Exercise equipment should be made in a way that it encourages people, including those who use the equipment casually. It must require less manipulation, and must be designed so as to avoid injuries.

Any kind of physical exercise is essential for the body and mind. In this study, a novel training routine is presented for improving fitness, followed by the design of the equipment for carrying out this routine. In this study, the psychological and biological aspects of physical exercise are not covered. The study proposes a design for a simple muscle strengthening structure for the proposed exercise routine using simple materials. A blend of sports science and engineering is used to design the structure.

2. Literature review

Wilson et al. (2017), in their research methodology, proposed the development and validation of sports equipment design through four steps. According to the authors, sports design process model is a cyclic process with two major activities: the user involvement and design review. The initial step is the research, followed by conceptual design, design development, and final design refinement. Throughout this process, the user is involved in exploration, evaluation and feedback, and testing of the product. This was the first proposed sport design process model detailing the process, and it highlights the importance of user-focused design processing of equipment. According to Alwasif (2019), in parallel bars strength training, the nine-week program involving 20 min on parallel bar once a week improved the performance in terms of increased rates of the execution quality in gymnasts. This routine, though not specific to any muscle, suggests that the use of operating muscle groups improves the physical characteristics and technical performance of the gymnasts.

Using surface electromyography (EMG), Dickie et al. (2017) showed that among the different grip pull exercises, namely, supinated grip, pronated grip, neutral grip, and rope pull up exercises, the pronated grip pull exercise had a significantly greater peak muscle activation and average rectified variable muscle activation of the middle trapezius when compared to the neutral grip pull-up. Likewise, muscle activation of brachioradialis, biceps brachii, and pectoralis major was higher in the pull up exercise in concentric phases. Bagchi (2015) showed that performing a repetition of four different freehand exercises, i.e. vertical dips, wider grip vertical dips, back dips, and diamond push-ups, the muscle activation of triceps brachii was higher in all except diamond push-ups; and vertical dips was more effective in activating the primary mover (triceps brachii). Likewise, activation of pectoralis major was more effective in wider grip vertical dips.

ISSN: 2005-4238 IJAST

Calatayud et al. (2014) showed that push-ups, using different suspension devices, activates different upper extreme and core muscles of the body. Maximum activation of muscles such as triceps brachii, upper trapezius, anterior deltoid, clavicular pectoralis, rectus abdominis, rectus femoris, and lumbar erector spinae was found when the pulley system was used. The suspended push-up with a pulley system showed greatest activation of triceps brachii, upper trapezius, rectus femoris, and erector lumbar spinae muscles. Likewise, pectoralis major and anterior deltoid muscles were activated when standard push-up or a parallel band system were used. The study suggested that instead of standard push-ups on the floor, suspended pushups must be performed to increase core muscle activation. The pushups performed with the 50% palmar width resulted in greater activation of pectoralis minor, triceps brachii, and infraspinatus muscle activities (Kim et al., 2016). Saeterbakken et al. (2017) worked on selective activations of muscles as a result of bench press variations involving 6 RM. Based on EMG activity, a significant activation of lower triceps brachii activation in flat, inclined, and declined bench position, and activation of greater biceps brachii activation in the inclined bench was observed. The study suggested that a wide grip and a flat bench position gives greater muscle activation when 6-RM loads are used.

Some issues merit consideration while designing the geometry of its structure: (i) Topological aspects, which pertain to the quantity and connectivity of its components, (ii) Shaping aspects, which relate to the positions of its structural joints, and (iii) Size aspects, which concern the cross-sectional geometries of its members (Kicinger et al. 2005). Specifications for all structural aspects generally relate to three key phases of the flow of engineering design: concept stage, development stage, and the detailing stage (Pahl and Beitz, 2013). The topological structure is usually established at the concept design stage and relates to the functional needs and structural aesthetics. On the other hand, the shape of the structure including the sizes of the members is evaluated in the stages of development and detailing, respectively.

Selection of materials and process-related data is required at all designing phases. The identification of materials at the initial designing phase require data approximations for every process and material, whereas selecting materials at the last detailing phase requires the consideration of exact and detailed information of a few selected processes and materials (Ashby, 2010). Among the vast plethora of materials and production processes, the right choice requires to be made for shaping, joining and finishing the equipment. Engineers will either make an assumption regarding a material before the optimization of the geometry, or opt for the most suitable material for a structure’s geometry that is available already. However, both these methods do not guarantee the best combination of material and geometry. Several optimizing techniques have been presented in the literature for the integration of geometric design and selection of materials (Edwards, 2005).

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The fitness apparatus available today consists of commercial and home equipment. Organizations catering to these sectors generally split their products in three specific yet different product categories: (i) cardio-based systems, which are utilized for endurance exercises, such as treadmills, (ii) resistance-based systems, which are utilized for power and strength exercises, such as benches and weights, and (iii) related accessories such as parallel bars, dumbbells, and the like (Caine and Yang, 2007).

In India, the fitness products and equipment market is predicted to increase at 15% in the period 2017–2023. The number of gymnasiums and health centers are increasing, and so are governmental attempts for encouraging fitness, which are spurring the already growing Indian fitness product market. The Indian government in 2017 had promulgated that all its offices needed to provide gymnasium facilities. Additionally, the HRD and Training departments are encouraging gymnasium facilities in its offices through monetarily compensating the offices. Also, increasing preferences of people for being physically fit in the face of increasing lifestyle illnesses is spurring the market's growth further. In 2016, it was seen that stationery bicycles and treadmills were the highest selling cardio-training products (Business Wire, 2017).

3. Methodology

Any type of physical training results in changes in the ultra-structure of the muscles, muscles strength and the performance. Changes in different muscle areas and protein in the muscles results in a change in the muscle structure. First, the proposed training routine is presented.

3.1. Biceps and Triceps

The biceps, also biceps brachii (Latin for 'two-headed muscle of the arm'), is a large muscle that lies on the front of the upper arm between the shoulder and the elbow. Both heads of the muscle arise on the scapula and join to form a single muscle belly, which is attached to the upper forearm. While the biceps crosses both the shoulder and elbow joints, its main function is at the elbow where it flexes the forearm and supinates the forearm.

Triceps, also known as triceps brachii, is often referred to as a 'three-headed muscle'. The three muscle bundles, namely, the lateral head, the long head, and the medial head, make up the triceps and are the only muscles that lie along the posterior humerus (upper arm). Triceps function as extensors and help increase the angle between the forearm and the upper arm. Triceps are the muscles exerted for the pushing action (Landin et al., 2018). To develop the triceps, one needs to focus on exercises that push weights away from the body, and dips are a popular exercise to strengthen triceps along with deltoids and pectoralis muscles (Goodson, 2017) .

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3.2. Biceps Program

With a focus to improve the body form and build stabilized strength, the biceps program involves 5 workouts per week, with at least 2 rest days between workouts for a duration of 3 to 4 months. To build the strength and muscle, both, a repetition of 10–12 repetitions per set is suggested, depending on the subject's exercise stamina, and whether the subject is at a beginner, intermediate or advanced level. The bicep exercise is shown in Figure 1. The push up is done in a position where feet are positioned on the central rod, and the hands are positioned on the small inverted rods, ensuring that hands and shoulders are apart, and the trunk is in a rigid straight position. In the first stage of the push up, the elbows are fully extended, and when the subject descends down towards the ground, the elbows are flexed until the upper arm is in line with the trunk. This is repeated as given in Table 1.

Figure 1 Biceps exercise

Table 1 Biceps exercise program

Exercise	**Sets**	**Repetitions**	**Rest**
Push Ups (Beginner)	3	12-15	2 min
Push Ups (Intermediate)	4	18-20	3 min
Push Ups (Advanced)	5	20-22	4 min

3.3. Triceps Program

Similarly, a triceps program involves dips with a frequency of 5 workouts per week, with at least 2 rest days between workouts for a duration of 3 to 4 months. For each category of participants, a minimum of 10-12 repetitions is proposed for building their muscle strength. For this particular exercise regimen, the

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participant has to keep the feet supported by the heel on the second rod, with hands backward on the small inverted rods (as if sitting on a ground in a dipping position) (Table 2). In the initial stage, the elbows are extended, and when going down towards the ground, the elbows are flexed such that the folded elbow and shoulder are at the same height (Figure 2). A dip exercise trains the upper body as well as the core.

Figure 2 Triceps exercise

Table 2 Triceps exercise program

Exercise	**Sets**	**Repetitions**	**Rest**
Dips (Beginner)	3	12-15	2 min
Dips (Intermediate)	4	18-20	3 min
Dips (Advanced)	5	20-22	4 min

It is to be noted that beginners have muscles that are ready and willing to grow as long as they are challenged. Each set is stopped when the exercise form starts to slip, or when it is felt that one might fail on the next repetition. As many repetitions as possible are done for each set.

3.4. Proposed design structure

Based on the exercise regimens, a structure is proposed (Figure 3). An inverted U shaped structure, 40' long and 5' high is grouted on a cement concrete prepared bed. This structure is supported by seven vertical supports made of the same material, again grouted on the concrete surface. Another 40' long GI pipe is welded to this structure 2' above the concrete surface. All joints are welded firmly on all sides. Located 2.5' away from this axis are 24 inverted U shaped hand supports, placed at repetitive intervals

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of 1.5' -1.0' -1.5' from each other. These hand supports are 1.5' long and 2' high. They are made of steel and are 2' ' thick.

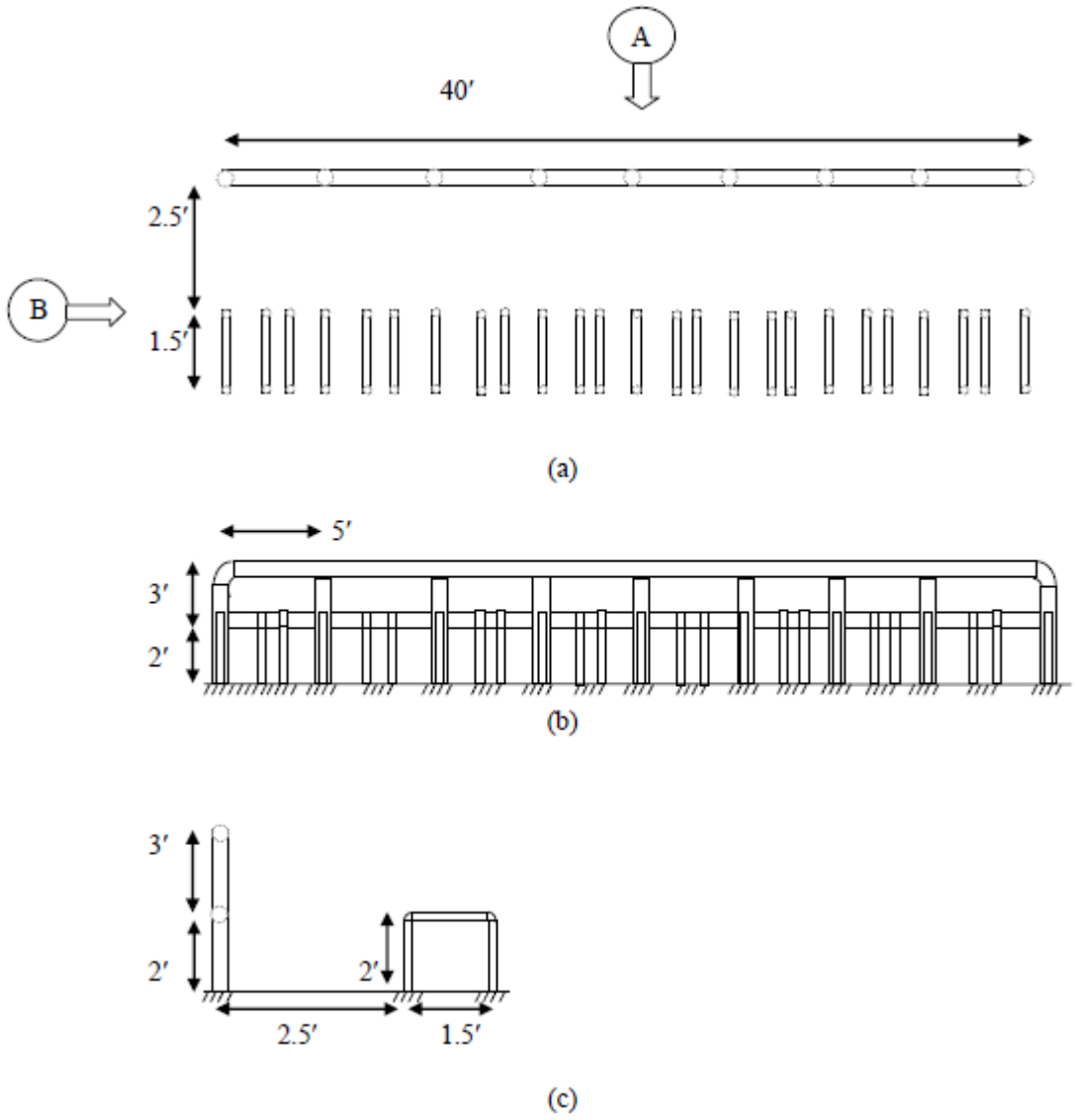

Figure 3 Proposed structure for the exercise regimen. (a) Plan of the structure (b) Elevation (view from A) (c) Elevation (view from B)

3.5. Calculations for beam deformation

For calculating deformation, the beam is considered as being supported at 8 points. Each section between two points is depicted in Figure 4. It is assumed that the user exerts a point load of F=900 N on the beam as shown. This point load is first exerted on the left, center and right of the beam section.

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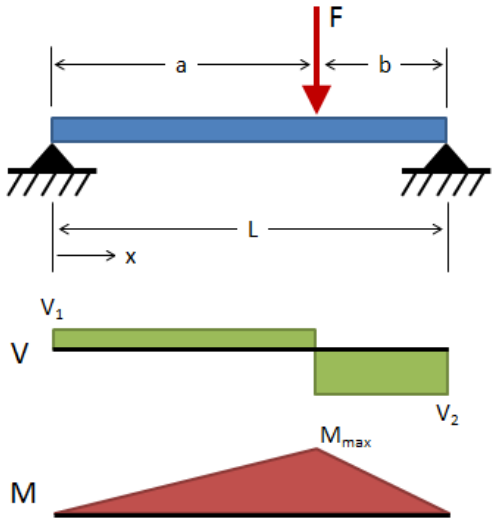

Figure 2 Beam loading diagram

The formulae for beam deformation and location of maximum deformation are as follows (Timoshenko and Young 1968):

$$\delta_{\max} = \frac{Fb(L^2-b^2)^{3/2}}{9\sqrt{3}LEI} \text{ at } x = \sqrt{\frac{L^2-b^2}{3}} \qquad (1)$$

where E is the Young's Modulus, I the Moment of Inertia, and L and b are as shown in Figure 2.

Moment of Inertia $I_y = \pi\,(d_o^4 - d_i^4) / 64$ (2)

4. Results

The results section is divided in two subsections. First, the calculations for deformation are presented based on equations 1 and 2. Next, the results based on ANSYS simulation are presented.

4.1. Calculated deformations

Three cases are presented as follows:

Case 1: **Load located at the center**

Here, L = 1524 mm, F = 900 N, b = 762 mm, d_o = 26.75 mm, and d_i = 23.25 mm.

$E = 3\times10^{11}$N/mm^2

By substituting these values in equations 1 and 2, one gets

$\delta_{max} = 1.762\times10^{-8}$ mm at x = 762 mm.

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Case 2: Load at right corner

Here, L = 1524 mm, F = 900 N, b = 381 mm, d_o = 26.75 mm, and d_i = 23.25 mm.

$E = 3\times10^{11}\text{N/mm}^2$

By substituting these values in equations 1 and 2, one gets

$\delta_{max} = 2.203\times10^{-8}$ mm at x = 852 mm.

Case 3: Load located at left corner

Here, L = 1524 mm, F = 900 N, b = 381 mm, d_o = 26.75 mm, and d_i = 23.25 mm.

$E = 3\times10^{11}\text{N/mm}^2$

By substituting these values in equations 1 and 2, one gets

$\delta_{max} = 2.203\times10^{-8}$ mm at x = 582 mm.

4.2. Simulation results

Ansys Mechanical APDL was used for simulation. The code structural problem to be solved is first selected. The element type describes the shape of the problem for analysis and characteristic describes the material arrangement.

The following beam properties were selected:

Type - Hollow Spherical Beam

Element Type - BEAM 188

Characteristic - Isentropic (Constant Material Characteristic)

Solution - Linear (Elastic Behaviour of the beam)

Inner Radius = 23.25 mm

Outer Radius = 26.75 mm

The 2-node linear/quadratic beam element in 3-D was selected with six or seven degrees of freedom at each node and which is suitable for both, linear and non-linear applications.

Also, the following material parameters were chosen (Table 3).

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Table 3 Material properties

Material Property	**Value**
Point load (Newton)	900
Young's Modulus (N/mm)	3×10^{11}
Poisson Ratio	0.3

Case 1: Load located at Centre

The loading pattern is shown in Table 4. Figure 5 shows the simulated loading diagram.

Table 4 Loading pattern for case 1

Distance from the Center (mm)	**Load (N)**
0	
762	900
1524	
2286	900
3048	
3810	900
4572	
5334	900
6096	
6858	900
7620	
8382	900
9144	

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9906	900
10668	
11430	900
12192	

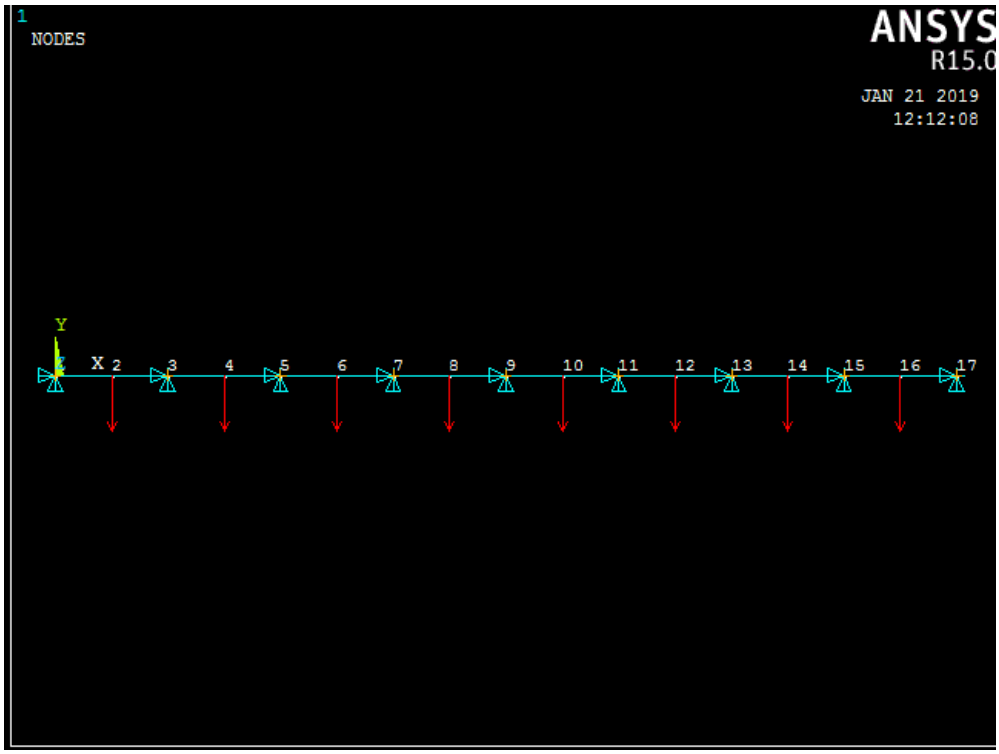

Figure 5 Simulated load at centre

The resulting beam deflection is shown in Figure 6.

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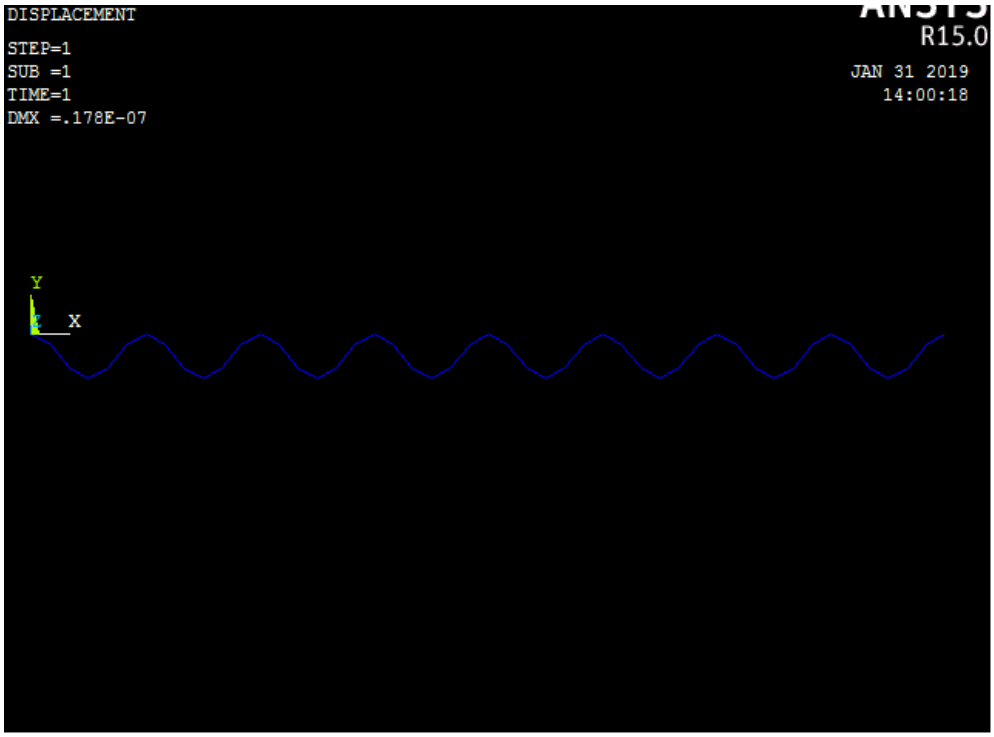

Figure 6 Case 1: beam deflection

Case 2: Load located at right corner

The loading pattern is shown in Table 5. Figure 7 shows the simulated loading diagram.

Table 5 Loading pattern for case 2

Distance from the Centre (mm)	**Load (N)**
0	
381	900
1524	
1905	900
3048	
3429	900
4572	
4953	900
6096	
6477	900

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7620	
8001	900
9144	
9525	900
10668	
11049	900
12192	

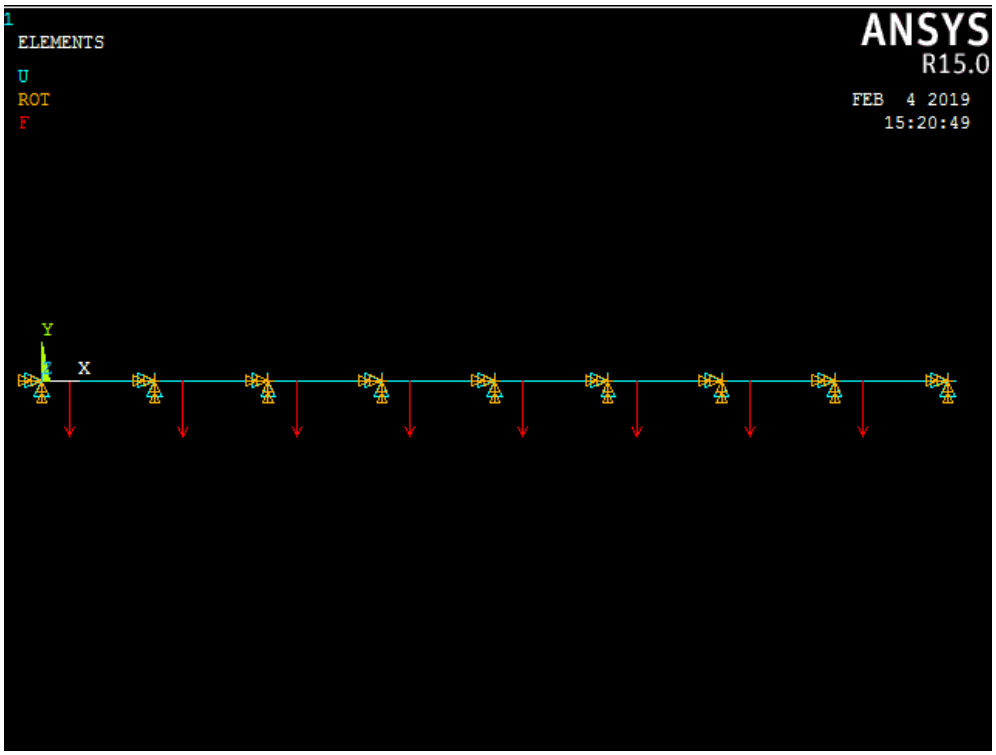

Figure 7 Simulated load at right corner

The resulting beam deflection is shown in Figure 8.

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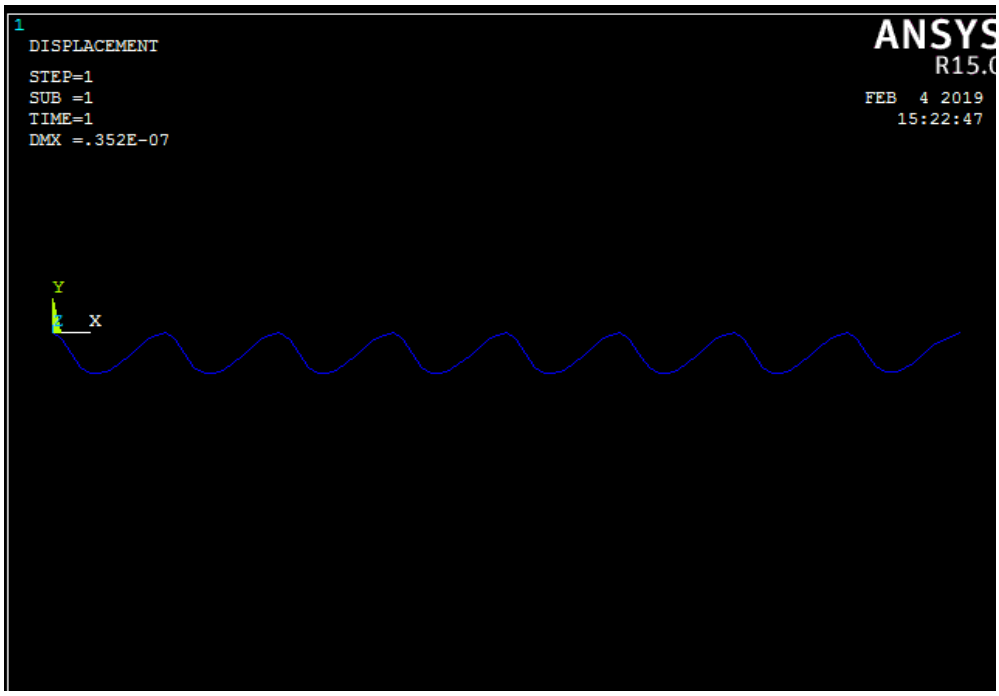

Figure 8 Case 2: beam deflection

Case 3: Load located at left corner

The loading pattern is shown in Table 6. Figure 9 shows the simulated loading diagram.

Table 6 Loading pattern for case 3

Distance from the Centre (mm)	**Load (N)**
0	
1143	900
1524	
2667	900
3048	
4192	900
4572	
5715	900
6096	
7239	900

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7620	
8763	900
9144	
10287	900
10668	
11811	900
12192	

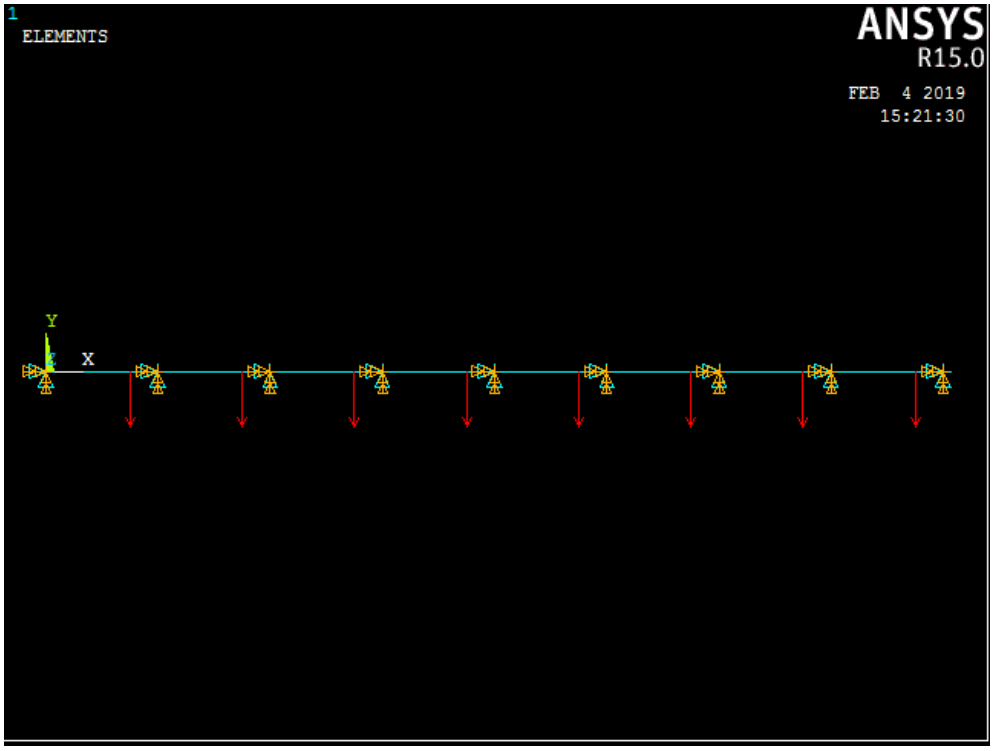

Figure 9 Simulated load at left corner

The resulting beam deflection is shown in Figure 10.

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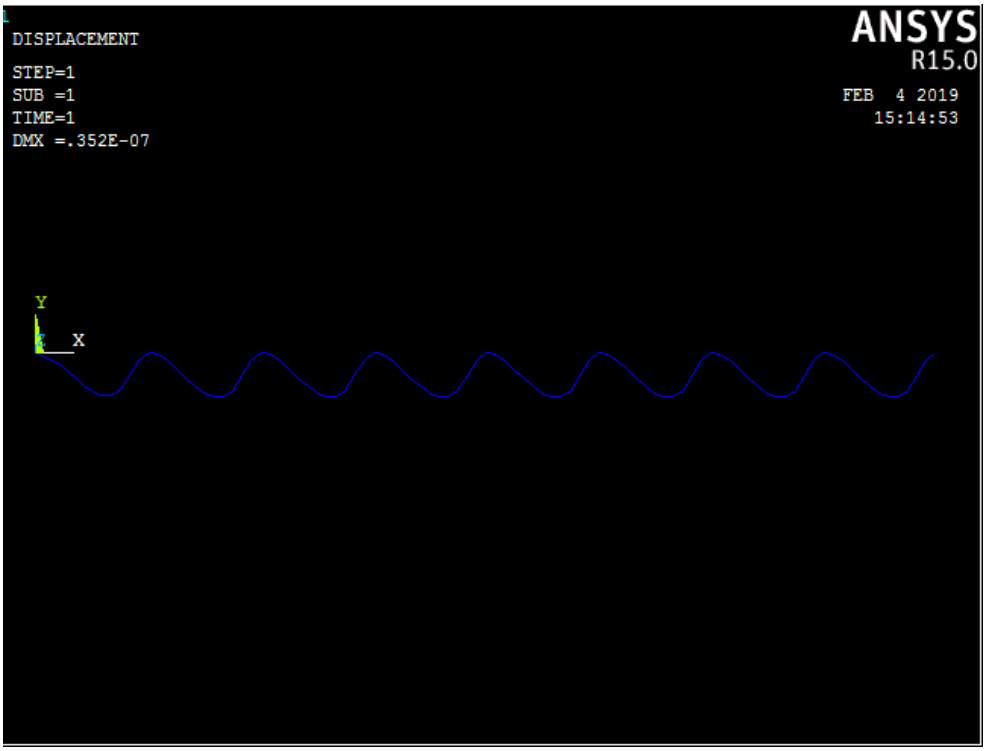

Figure 10 Case 3: beam deflection

4.3. Analysis

The summarized results of the theoretical calculations and simulations are presented in Table 7.

Table 7 Summary of results

Loading location	**Maximum deflection: Theoritical (mm)**	**Maximum delection: Simulated (mm)**
Load located at the center	1.762×10^{-8}	1.78×10^{-8}
Load at right corner	2.203×10^{-8}	3.52×10^{-8}
Load located at left corner	2.203×10^{-8}	3.52×10^{-8}

It is seen from the above table that the results of the theoretical calculations and simulations agree with each other, i.e. there is a very little difference of value.

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As per codes of practice, the deflections must not exceed $\frac{1}{250}^{\text{th}}$ times the length of the beam (1524 mm) between the supports, and the results clearly indicate that the deflections are well within this limit.

Thus, the structure meets the requirement the proposed exercise regimen.

5. Discussion and conclusion

There is a constant challenge while designing fitness products and systems, i.e. the need for lesser weights, reduced costs, and good performance. The main aim of an engineer's design is the definition of the component dimensions, including the material selection for its construction in order that the product can carry out its functions in an acceptable and economical manner (Edwards, 2005). An optimized product design includes the selecting of product geometry and production processes for meeting requirements for design and maximizing its performance while keeping it economical (Ashby, 2010).

In keeping with the above principles, in this study, the sports structure has been designed using GI pipes. The GI pipe is an easily available material, with lesser cost and required flexibility. This makes the structure economical to produce. The design is simple comprising of only welded joints, hence is easy to manufacture. Also, eight people at a time can use the apparatus for exercise. This makes it ideal for use in establishments which train large groups of people.

The maximum deflection was seen to be 3.52×10^{-8} mm. This is very much within the limit for failure. Thus, it is seen that this fitness equipment meets the requirements of the proposed fitness regimen. The engineering design is, thus, validated for safety against failure.

Therefore, the proposed structure meets the design requirements, is simple to manufacture, and is economical, making it ideal for implementation in the Indian context.

6. Limitations of this study and future research

The analysis of muscle morphology, muscle activation, and performance is not evaluated in this study. The measurement of these variables will help to expand the understanding of the muscle strengthening program and the designed structure.

Changes in the muscles depending on the specificity of the training were established. In a pilot study, the authors suggested programs to strengthen the biceps and triceps, and it was found to be effective in increasing the muscle strength and the performance. The future research will include the estimation of muscle area and activation in the control and experimental group performing these programs at pre-intervention and post-intervention. This model and the program could be used as a reference to strengthen

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the bicep and tricep muscles. This would also enable the testing of the involvement and activation of other muscles, too.

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ISSN: 2005-4238 IJAST

Design of Optimal Parameter for Solid-State Welding of EN 10028-P355 GH Steel Using gray Incidence Reinforced Response Surface Methodology

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Arabian Journal for Science and Engineering

ISSN 2193-567X

Arab J Sci Eng
DOI 10.1007/s13369-020-05169-z

Springer

Arabian Journal for Science and Engineering
https://doi.org/10.1007/s13369-020-05169-z

RESEARCH ARTICLE-MECHANICAL ENGINEERING

Design of Optimal Parameter for Solid-State Welding of EN 10028-P355 GH Steel Using gray Incidence Reinforced Response Surface Methodology

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Received: 25 April 2020 / Accepted: 18 November 2020

Abstract
EN 10028-P355 GH steel is normalized steel used in high-temperature applications including pipes carrying hot fluids. Fusion welding of such class of steels produces a larger heat affected zone, unwanted metallurgical changes and increased hardness in the weld area. The study explores the possibility of using a solid-state welding process (continuous drive friction welding) on EN 10028-P355 GH steel. The experimentation involves an L_{27} orthogonal array with the welding parameters like frictional pressure, forging pressure, friction time, forging time and rotational speed varied in three levels. The quality characteristics observed include the yield strength, tensile strength, axial shortening and impact toughness. The merits of gray theory are combined the statistical analysing capabilities of response surface methodology in an integrated approach of gray incidence reinforced response surface methodology to select the optimal friction welding inputs (frictional pressure-93.94 MPa, friction time-5.22 s, upset pressure-138.14 MPa, forging time-3.58 s and rotational speed-1282.67 rpm). The optimal friction welding inputs were validated with proper experiments, and microscopic images concerned with optimal bond is also analyzed. The study will offer the guiding database to weld EN 10028-P355 GH steel in solid-state using continuous drive friction welding.

Keywords EN 10028 GH steel · Continuous drive friction welding · Response surface methodology · gray theory · L_{27} orthogonal array

1 Introduction

The EN 10028-P355 GH steel finds its widespread applications in pressure vessels and boilers. The high tensile strength and impact toughness of EN 10028-P355 GH steel makes it a primary choice for tubes and pipes transporting hot fluids in heat exchangers. There are concerns in joining EN 10028-P355 GH steel using the conventional liquid state joining processes. The fusion welding techniques are characterized by the presence of a larger heat affected zone (HAZ) and consequent changes in the metallurgy of parent, producing corrosion at grain boundaries on a microscopic scale. This could affect the mechanical properties of joint, which is significant in applications at elevated temperature and stress. Hence, joining EN 10028-P355 GH steel in a solid-state could open up the possibilities of minimizing such unwanted mechanical and metallurgical changes. The temperature involved in solid-state processing is considerably lesser than the melting point of parent material hence producing a meager or zero HAZ. The continuous drive friction welding is a joining process employed to join tubes and pipes of both ferrous and non-ferrous materials. The process involves the generation of heat by mechanical rubbing (rotation) of one part with the other half of the joint. The desired rotational speed ensures a constant and continuous stirring at the weld interface and the applied upset pressure produces a bond with a certain amount of flash. Further the volume of material close to the weld interface alone is subjected to plastic deformation, restricting the axial shortening of joint. In the preliminary stages of the formation of a bond,

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Published online: 03 January 2021

the end of the rotating part was made tapered and inserted into a bore ring made of a material with good thermal resistance [1]. During the process, the plastic flow of material was observed at the joint interface. The mechanism regulating the plastic flow of material at the weld interface was important for controlling the amount of flash produced. A sound joint with a reasonably lesser flash was always desired to reduce axial shortening [2]. The observations patented by United Launch Alliance, Inc., had described the essential improvements in hardware employed to produce joints in solid-state [3]. A self-reacting pin tool was also proposed to eliminate the difficulties experienced in using a rigid and static tool in friction stir welding.

Friction welding was used to produce dissimilar steel joints with reasonably good strength and ductility compared to that of the parent material. The investigation revealed that the susceptibility of the weld area to failure under uniaxial loading as the weld interface was the weaker zone due to increased microhardness. The friction welding inputs including frictional pressure, upset pressure, burn off length and rotational speed were found to significantly influence the mechanical properties of joints [4, 5]. The design parameters in friction welding were varied to study their roles in the strength related aspects. The mechanical tests on joints had revealed a higher hardness in the plastic weld zone, while the microhardness variation was found to be lesser in the parent material [6, 7]. In the joints formed between AISI 4140 and AISI 1050 steels, the temperature rise was observed to play a vital role in affecting the quality characteristics of the bonds. The initial rise in temperature was found to be larger, followed by a steady rise with the continuous rotation, and the joints were formed with zero blank spaces [8]. Austenitic stainless steels known for weldability and corrosion resistance were produced with desirable mechanical properties friction welded at high temperatures [9]. Non-ferrous alloys could also be joined by friction welding and proper selection of process parameters could yield a joint efficiency of 89% in as-welded condition [10]. However, the dissimilar joints formed between aluminum and copper showed poor strength as a result of the accumulation of alloying elements and intermetallic compounds at the weld interface [11].

Generally, the friction welded interface included three different regions: unaffected zone, partially deformed zone and fully deformed recrystallized zone. Most of the microstructural changes were observed in the fully deformed and partially deformed zones [12]. A near-perfect bonding strength, close to that of parent material was possible by selecting proper values of friction time and rotational speed. The temperature distribution in the friction interface was mainly dependent on the welding parameters [13]. High strength nickel alloys joined using friction welding displayed a harder and stronger weld zone due to the formation of precipitates [14]. Dissimilar bonds involving maraging steel and low alloy steel were also formed using continuous drive friction welding. An interlayer of nickel was used as a diffusion barrier to improve the joint strength. The bonds were observed to respond to solutionizing and aging positively during post-weld heat treatment [15]. The tensile strength of steel joints increases with frictional pressure and friction time up to a certain level, but tend to decrease at higher values of these welding inputs. A similar trend was observed with the fatigue strength of joints [16]. Rotational speed and frictional pressure were found to influence the distribution of temperature and plastic flow of material at the weld interface. Optimal values of these welding inputs were observed to produce defect-free joints [17]. Hence, it is observed from the literature that superior quality characteristics of a joint depends primarily on the optimal selection of friction welding parameters like frictional pressure, friction time, upset pressure, forging time, burn off length and rotational speed.

Identifying the proper levels of various friction welding inputs could result in a joint with better quality characteristics. Hence, finding the optimal levels of design variables, their relationships with the responses and understanding the interaction among them is essential to form good joints. Design of experiment and evolutionary algorithms could be used to develop a mathematical relationship between the welding parameters and quality characteristics of the joint. The available literature had revealed a considerable interest in the application of response surface methodology (RSM) and artificial neural network to predict the responses. Optimization could be performed by using simulated annealing, genetic algorithm and particle swarm techniques. Among the three methods, genetic algorithm was observed to outperform the other methods [18]. Genetic algorithm was a good tool for experimental welding optimization even without a model for the process, however, difficulty was experienced in setting its parameters such as population size and number of generations for sufficient sweeping of search space. The technique of RSM technique was found to arrive at a better compromise between the evaluated responses though it struggles in the irregular experimental region [19]. The RSM technique was applied to find the optimal condition of friction welding parameters for joining dissimilar metals D3 tool steel and 304 austenitic stainless steel. The experimentation was based on Box–Behnken design to obtain the highest tensile strength [20]. The process parameters of friction welding were optimized using RSM for joining duplex stainless steel (DSS) UNS S32205. The central composite design (CCD) was used for experimentation. The upset pressure, friction pressure and speed of rotation were identified as most influencing parameters in maximizing the hardness and tensile strength [21, 22].

The application of hybrid techniques was employed for the optimization of process parameters and modeling the response values of various process. These integrated

approaches have opened up the possibilities of combining the merits of the algorithms. The gray relational analysis was coupled with RSM technique for optimization and modeling of responses [22, 23]. The gray Taguchi-RSM was used for optimizing the friction welding parameters to join Al6061/SiC/Al_2O_3 metal matrix Composite [24]. It is a statistical tool used for optimization, and the technique is used to generate response surfaces to study the interaction effects of various design variables. Generally, Box–Behnken design and central composite design are used as the major response surface designs [23, 25, 26]. In a traditional RSM generating a quadratic response surface model for each of the responses, central composite design (CCD) or Box–Behnken design (BBD) is used for experimentation. This limits the study to the effects of design variables on single responses hence restricting the observations concerned with simultaneous optimization [27].

A considerable amount of literature is available in friction welding of similar and dissimilar materials of equivalent grade materials. An equivalent grade material, nuclear grade austenitic stainless steel 321 was joined by using a conventional TIG welding process, and their parameters were optimized using gray relational analysis to improve the mechanical properties of weld joints [28]. The effect of the heat input on the bead width and depth of penetration with various arc lengths was analyzed. The tensile strength measured at weld line (624 MPa) was observed higher than that of base metal (621 MPa). The flux activated—TIG welding process was employed for joining a square-groove butt weld joint of modified 9Cr–1Mo steel and the influence of MnO_2 flux activation on mechanical and metallurgical properties was analyzed. The activated TIG welding improved the depth of penetration and depth-to-width ratio (D/W) compared to the TIG welding process [29]. The Fe–2.25Cr–1Mo steel tube was joined with carbon steel tube using TIG welding process with the application of chromium containing filler material. The formation of Cr_2O_3 due to chromium content improved the corrosion resistance behavior of the weld [30]. The literature related to solid-state joining of EN 10028-P355 GH steel are not enough even the material has major applications in heat exchanger tubes. Further, little attention is observed in welding parameter design involving EN 10028-P355 GH steel within the scientific literature. Hence, the work explores the possibility of forming good quality welded joints using continuous drive friction welding with the objective of offering the guidelines and welding database for joining EN 10028-P355 GH steel using friction welding process. Though applications of RSM with central composite design are available in manufacturing processes, orthogonal arrays-based RSM is limited in the literature. Hence, the scope for simultaneous optimization of multiple responses is widened in the proposed work by application of an integrated approach of gray incidence reinforced response surface methodology for optimal parameter design.

2 Material and Experimental Procedure

2.1 Machine and Material

The EN 10028-P355 GH steel used as heat exchanger tubes is procured in the form of a normalized steel rod of diameter 16 mm. The chemical composition of parent material is as follows: Mn-1.10%, C-0.18%, Si-0.50%, Cr-0.30%, Mo-0.08%, Ni-0.5%, V-0.10, Cu-0.30%, S-0.01% and Fe-remaining. The rods machined to lengths of 130 mm each are subjected to friction welding in a continuous drive friction welding machine (Model: FW-6T) manufactured by RV machine tools, Coimbatore, India. The machine houses a hydraulic chuck with a spindle driven at a maximum speed of 3000 rpm and rated at 12 kW. The servomotor gearbox is used for slide drive, and the friction welding parameters are precisely set by 'Indra Control VCP-02' at the operator terminal. The machine has an inbuilt unit of the 'Rexroth controller' manufactured by the automation assembly unit of Bosch Rexroth, Germany (Fig. 1a, b).

(a) (b)

Figure 1 **a** Friction welding machine, **b** operator terminal

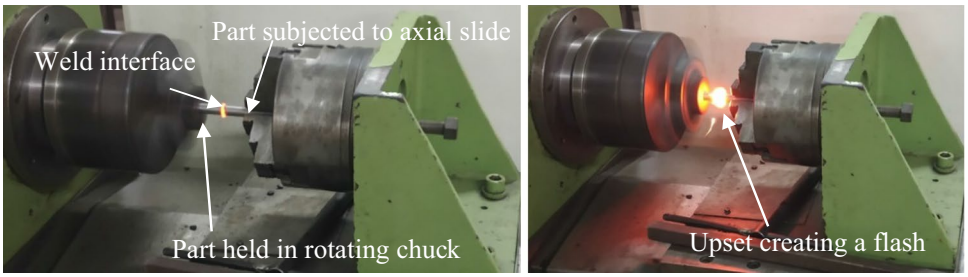


Figure 2 **a** Application of frictional pressure in the initial phase, **b** upset and formation of flash.

Table 1 Levels of various friction welding inputs

Friction welding inputs	Symbol	Unit	Levels of parameters		
			Level 1	Level 2	Level 3
Frictional pressure	A	MPa	70	90	110
Upset pressure	B	MPa	100	120	140
Frictional time	C	s	3	5	7
Forging time	D	s	3	5	7
Rotational speed	E	rpm	1000	1200	1400

2.2 Experimentation

During friction welding, one half of the joint was attached to spindle drive, precisely controlled by Rexroth while the other half is held stationary and impending to slide. The two parts are allowed to get in contact after ensuring equal overhang on both the parts to be joined. With the required setting of parameters, a smooth transition is ensured across different phases of the formation of joint. Figure 2a, b shows the initial phase, upset and formation of flash at weld interface during the process of friction welding. The predominant welding parameters used in experimentation include the frictional pressure, friction time, upset pressure, forging time and rotational speed [20, 21]. These parameters affect the temperature, and hence, the plastic flow at weld interfaces determining the joint characteristics [4, 6, 8, 16, 22]. The levels of various parameters were found out using the preliminary experimental trials resulting in bonds without any defects/failure on visual inspection. Trials for determining the range of various parameters were conducted based on pre guidance from scientific literature. Table 1 displays the levels of various welding parameters used in experimentation.

Taguchi's orthogonal array (L_{27}) was used to conduct the experiments, which opens the possibility of studying the necessary interaction effects among various design variables [27]. The quality characteristics include the yield strength (YS), ultimate tensile strength (UTS), axial shortening (AS) and impact toughness (IT). To reduce the effects of uncontrollable factors, the trials were conducted

Fig. 3 Sample joints formed during friction welding

at random [20] with necessary replications, and the formed joints were observed for the quality characteristics. The sample joints formed during experimentation are shown in Fig. 3.

The tension test was performed in Instron-Computerized tension tester after preparing the specimen as per the ASTM E8 standard. The layout of specimen for tensile testing is shown in Fig. 4. A few samples of tensile specimen before and after testing are shown in Fig. 5. Failure was observed near the weld interface in most of the samples subjected to tension tests.

Axial shortening was measured as the decrease in length of the final joint obtained at the end of the friction welding process. Impact toughness was primarily studied to observe the effect of larger deformation speeds on the material. The amount of energy absorbed by the specimen during fracture, as observed from the impact test gives a toughness measure of samples. This offers the scope for further studies related to the ductile–brittle transition. Charpy V-notch testing (pendulum type) is performed to find the energy absorbed by samples on dynamic loading as per ASTM E23 standard. The layout of specimen for impact testing is shown in Fig. 6. The sample specimen for the Charpy V-notch test after failure is shown in Fig. 7. The quality characteristics observed in various friction

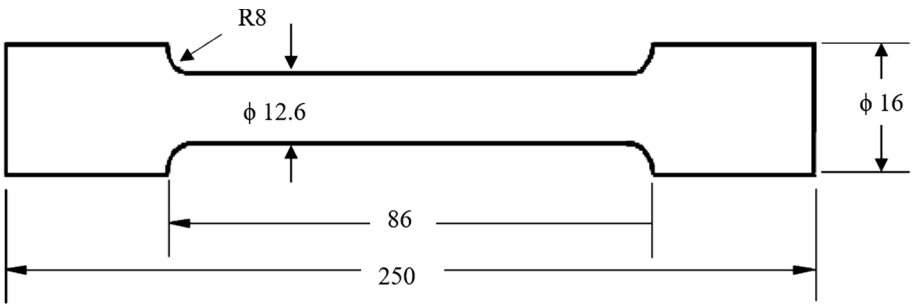


Fig. 4 Layout of specimen for tensile testing

All the dimensions are in mm

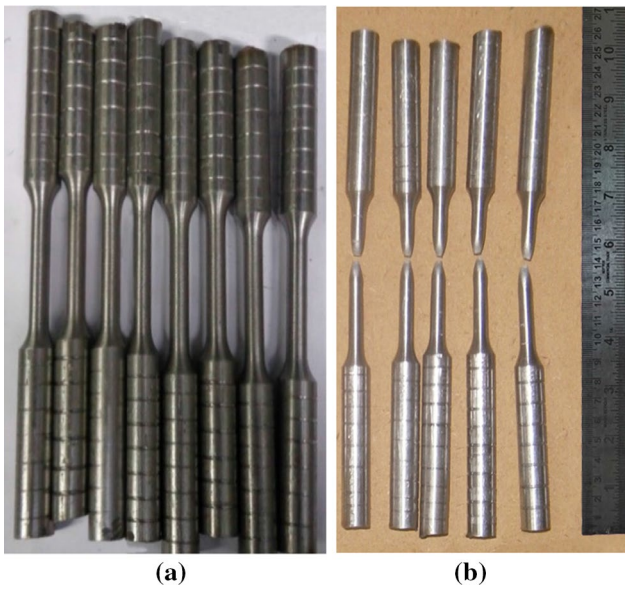
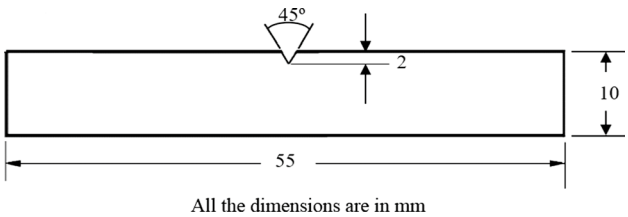


Fig. 5 Samples **a** before tension test, **b** after tension test



All the dimensions are in mm

Fig. 6 Layout of specimen for Charpy V-notch test

Fig. 7 Specimen subjected to Charpy V-notch test

welded joints formed using different combinations of welding inputs (L_{27} orthogonal array) is shown in Table 2.

3 gray Incidence Reinforced Response Surface Methodology

RSM is a statistical approach with a module for modeling the design variables and desirability analysis for optimizing the responses. The effects of parameters on responses are illustrated by 3D surface graphs. The integrated strategy of gray incidence reinforced response surface methodology combines the uncertainty handling ability of gray incidence analysis with the modeling abilities of RSM. The multiple responses observed via experimentations are transformed into a single measure of quality as gray relational grade (GRG). It is used for further modeling using RSM and simultaneous optimization of the welding inputs (design variables). The various steps in gray incidence reinforced response surface methodology are presented in two stages.

3.1 Part I: gray Incidence Analysis

During the first stage of gray incidence, the experimental data are processed by calculating the reciprocal of coefficient of variation termed as the 'signal-to-noise' (S/N) ratio. The normalized S/N ratio converts experimental data in the range of zero to one. The processed data are further analyzed by forming gray relational grade and projecting it as the single representative of various outputs obtained from experimentations. The various steps are discussed below.

Step 1 Estimate the S/N ratio (η_{ij}) for each output using the appropriate equation based on its quality characteristics. The three formats in which an output are analyzed include the following: *nominal-the-best, smaller-the-better or larger-the-better*. A *nominal-the-best* characteristic has a user-defined target value. The target of *smaller-the-better* characteristic is attaining a minimum value of response (zero), while a *larger-the-better* characteristic has a target of infinity i.e. attaining a

Table 2 Levels of various friction welding inputs and observed responses

Trial order	Friction welding inputs						Responses							
Actual	Random	*A*	*B*	*C*	*D*	*E*	YS (MPa)		UTS (MPa)		AS (mm)		IT (J)	
1	7	70	100	3	3	1000	281.95	282.55	483.02	485.10	10.50	10.67	14	15
2	23	70	100	5	5	1200	304.35	304.75	501.60	503.60	16.80	16.63	18	18
3	3	70	100	7	7	1400	314.46	314.06	551.55	553.55	21.10	22.93	21	20
4	4	70	120	3	5	1400	286.54	287.14	525.70	525.70	15.80	15.97	17	17
5	17	70	120	5	7	1000	276.13	275.73	548.55	548.55	22.70	22.70	18	16
6	22	70	120	7	3	1200	290.82	291.54	563.35	562.35	16.20	16.37	19	19
7	2	70	140	3	7	1200	305.39	305.79	592.80	593.80	22.20	22.37	19	18
8	8	70	140	5	3	1400	300.24	300.24	542.80	540.80	20.90	21.07	21	22
9	12	70	140	7	5	1000	310.48	310.88	578.05	576.05	24.80	24.80	20	20
10	14	90	100	3	3	1000	308.25	307.85	584.25	585.25	12.60	12.27	17	18
11	27	90	100	5	5	1200	316.24	316.24	587.10	588.10	17.80	17.80	19	20
12	9	90	100	7	7	1400	320.15	319.55	599.45	600.45	23.60	23.77	22	21
13	25	90	120	3	5	1400	319.51	319.11	581.68	582.95	20.90	20.90	20	20
14	26	90	120	5	7	1000	320.27	320.67	575.70	576.70	21.40	21.07	19	18
15	13	90	120	7	3	1200	313.54	313.74	586.15	589.15	22.40	22.23	20	20
16	16	90	140	3	7	1200	317.87	317.47	584.25	586.25	23.20	23.20	21	22
17	20	90	140	5	3	1400	319.26	319.26	570.10	570.10	20.40	20.40	22	22
18	15	90	140	7	5	1000	319.77	319.97	548.55	547.55	22.10	22.77	20	21
19	5	110	100	3	3	1000	304.14	303.94	549.10	551.10	15.70	15.37	17	17
20	10	110	100	5	5	1200	319.27	319.87	581.40	582.40	21.90	21.23	18	20
21	18	110	100	7	7	1400	330.65	330.85	602.15	601.23	24.60	25.37	21	18
22	6	110	120	3	5	1400	321.54	321.14	600.40	598.40	22.80	22.37	19	18
23	1	110	120	5	7	1000	308.47	309.07	557.55	559.55	21.60	21.27	17	17
24	11	110	120	7	3	1200	319.67	319.67	606.10	605.10	22.70	22.03	18	18
25	24	110	140	3	7	1200	309.82	309.82	593.95	596.95	20.90	21.07	20	18
26	21	110	140	5	3	1400	312.52	311.92	605.15	606.15	25.70	25.87	22	20
27	19	110	140	7	5	1000	310.84	310.44	578.40	579.40	24.20	24.37	20	22

maximum value of output. The S/N ratio (η_{ij}) for such characteristics is calculated by using Eqs. (1) and (2).

$$\text{Smaller-the-better characteristic:} \quad \text{S/N Ratio}(\eta) = -10\log_{10}\left(\frac{1}{r}\cdot\sum_{i=1}^{r} y_{ij}^2\right) \tag{1}$$

$$\text{Larger-the-bettercharacteristic}: \quad \text{S/N Ratio}(\eta) = -10\log_{10}\left(\frac{1}{r}\right)\sum_{i=1}^{r}\frac{1}{y_{ij}^2} \tag{2}$$

where y_{ij} = observed response values, $i = 1, 2, 3 \ldots r$, and $j = 1, 2, \ldots m$, r = number of replications, m = number of observations.

Step 2 Estimate the normalized S/N ratio (Z_{ij}) using Eq. (3) to reduce the variability among the calculated values of S/N ratio for various responses. 'n' represents the number of trials.

$$Z_{ij} = \frac{y_{ij} - \min(y_{ij}, i = 1, 2, \ldots, n)}{\max(y_{ij}, i = 1, 2, \ldots, n) - \min(y_{ij}, i = 1, 2, \ldots, n)} \tag{3}$$

Step 3 calculate the gray incidence coefficient (γ) from the normalized S/N ratio values using Eq. (4)

$$\gamma_i^j = \frac{\Delta\min + \xi\Delta\max}{\Delta_{oj}(i) + \xi\Delta\max} \tag{4}$$

where $i = 1, 2 \ldots n$ and $j = 1,2 \ldots m$, n is the number of responses and m is the number of trials.

$\Delta_{oj} = \left\| z_o(i) - z_j(i) \right\|$, $z_o(i)$ is the reference sequence ($z_o(i) = 1$; $i = 1,2,\ldots,n$) and $z_j(i)$ is the specific comparison sequence.

$\Delta \min = \min_{\forall j \in i} \min_{\forall i} \left\| z_o(i) - z_j(i) \right\|$ is the smallest value of $z_j(i)$, $\Delta \max = \max_{\forall j \in i} \max_{\forall i} \left\| z_o(i) - z_j(i) \right\|$ is the largest value of $z_j(i)$, and 'ξ' is the distinguishing coefficient whose value is taken as 0.25.

Step 4 Find the GRG values (γ_i) for every trial using Eq. (5)

$$\mathrm{GRG}_i = \frac{1}{n} \sum_{i=1}^{n} (\gamma_i). \tag{5}$$

3.2 Part II: GRG Reinforced RSM

The GRG value for various trials is seen as a single quality measure representing various responses. The GRG value for various experimental conditions is used in the RSM technique as a single response and a polynomial model for GRG value is generated. The response surfaces plots are also generated to observe the influence of welding inputs.

Step 5 Execute the analysis of variance (ANOVA) using GRG values to find the significant contribution of welding inputs.

Step 6 Develop a quadratic model to relate the GRG with various inputs and their interactions. Test the model fitness with the experimental data.

Step 7 Plot the response surfaces (3D) graphs to study the effects of various welding inputs on GRG and use desirability analysis to find the optimal welding condition. Validate the same via experimentations.

4 Results and Discussion

4.1 gray Incidence Analysis and GRG Values

gray incidence analysis was performed using the gray theory which uses S/N ratio as the preliminary index and gives solutions that are more appropriate to real-world problems [20]. The three quality characteristics studied via experimentations (YS, UTS and IT) were treated as 'larger-the-better' characteristics with an intended magnitude of one, while the fourth response (AS) was analyzed as the 'smaller-the-better' characteristic with a desired value of zero. The calculated S/N values of various responses were subjected to linear normalization to align those towards normal distribution and make the values of design variables more comparable. The normalized values of S/N ratios are presented in Table 3. The GRG values were obtained using the GRC values calculated using Eq. (6). The GRG functions as a representative for the various measured responses, deserving a higher value regardless of their nature. The variations in GRG values for the 27 experimental trials are described graphically in Fig. 8. The maximum observed value of GRG was 0.6370 (21st trial), indicating a closer proximity of the experimental conditions to a near-optimal one.

4.2 Second-Order Polynomial for GRG (Fitness and Adequacy)

The methodology of RSM uses a mathematical technique for model building. The design variables used in friction welding were mapped with the quality characteristics observed in solid-state joints in terms of GRG. A quadratic model [Eqs. (6), (7)] which was a polynomial of order two was formed to relate the various welding inputs with GRG using Design-Expert software. The formulated model includes both individual and interaction effects of various welding inputs on GRG thus offering the scope to observe the mathematical behavior within the system. Equations (6, 7) represent the representative of responses (GRG) in terms of coded and actual factors respectively. The insignificant terms were excluded (model reduction) to make it less expensive computationally, but preserving the closeness and stability of actual model [20]. A considerable reduction in the number of experimental trials was realized with the L_{27} orthogonal array compared to the conventional experimental designs (CCD/BBD) used with RSM [27].

$$\begin{aligned}\mathrm{GRG} = {} & +0.50 + 0.054 \times A + 0.057 \times B + 0.064 \\ & \times C - 0.043 \times D + 0.052 \times E + 0.020 \\ & \times A \times C + 0.045 \times A \times E - 0.082 \times B \times C \\ & + 0.080 \times B \times D + 0.091 \times C \times D - 0.076 \times A^2\end{aligned}$$

$$\begin{aligned}\mathrm{GRG} = {} & +0.014862 + 0.020672 \times A + 3.03400 \times 10^{-3} \\ & \times B + 0.11713 \times C - 0.37594 \times D - 7.58611 \times 10^{-4} \\ & \times E + 5.01554 \times 10^{-4} \times A \times C + 1.13312 \times 10^{-5} \\ & \times A \times E - 2.04031 \times 10^{-3} \times B \times C + 2.00232 \times 10^{-3} \\ & \times B \times D + 0.022870 \times C \times D - 1.89203 \times 10^{-4} \times A^2\end{aligned}$$

Analysis of variance (Table 4) was carried out to study the model adequacy and fitness in relating the welding inputs with GRG [23, 24]. This could help in understanding the importance of model coefficients identified using Design−Expert software in forming a technical link with responses represented by GRG. The polynomial model was found to be significant with an F value of 14.97 and a p value of less than 0.0001, declaring the minimal effects of noise factors. The p value probability less than 0.05 indicates the substantial importance of all the terms in the model including frictional pressure (A), upset pressure (B), friction time

Table 3 Calculations leading to the performance index

Trial	S/N ratio				Normalized S/N ratio				gray relational co-efficient (GRC)				GRG
	YS	UTS	AS	IT	YS	UTS	AS	IT	YS	UTS	AS	IT	
1	49.013	53.697	− 20.493	23.212	0.125	0.000	1.000	0.000	0.222	0.200	1.000	0.200	0.4055
2	49.673	54.024	− 24.463	25.105	0.545	0.168	0.487	0.521	0.354	0.231	0.327	0.343	0.3139
3	49.946	54.847	− 26.863	26.227	0.718	0.591	0.176	0.829	0.470	0.379	0.233	0.594	0.4189
4	49.153	54.415	− 24.019	24.609	0.214	0.369	0.544	0.384	0.241	0.284	0.354	0.289	0.2919
5	48.816	54.784	− 27.121	24.564	0.000	0.558	0.143	0.372	0.200	0.361	0.226	0.285	0.2679
6	49.283	55.008	− 24.235	25.575	0.297	0.673	0.516	0.650	0.262	0.433	0.341	0.417	0.3632
7	49.703	55.465	− 26.960	25.334	0.563	0.908	0.164	0.584	0.364	0.731	0.230	0.375	0.4251
8	49.549	54.677	− 26.438	26.642	0.466	0.503	0.231	0.943	0.319	0.335	0.245	0.815	0.4284
9	49.846	55.224	− 27.889	26.021	0.655	0.784	0.044	0.772	0.420	0.537	0.207	0.523	0.4218
10	49.772	55.339	− 21.893	24.850	0.608	0.843	0.819	0.450	0.389	0.615	0.580	0.313	0.4741
11	50.000	55.382	− 25.008	25.792	0.752	0.865	0.416	0.710	0.502	0.649	0.300	0.463	0.4785
12	50.099	55.562	− 27.489	26.642	0.815	0.958	0.095	0.943	0.575	0.856	0.217	0.815	0.6154
13	50.084	55.303	− 26.403	26.021	0.806	0.825	0.236	0.772	0.563	0.588	0.247	0.523	0.4801
14	50.116	55.211	− 26.541	25.334	0.826	0.778	0.218	0.584	0.589	0.529	0.242	0.375	0.4339
15	49.929	55.382	− 26.973	26.021	0.707	0.865	0.162	0.772	0.460	0.650	0.230	0.523	0.4658
16	50.040	55.347	− 27.310	26.642	0.777	0.847	0.119	0.943	0.529	0.621	0.221	0.815	0.5463
17	50.083	55.119	− 26.193	26.848	0.805	0.730	0.263	1.000	0.562	0.481	0.253	1.000	0.5739
18	50.099	54.776	− 27.019	26.227	0.815	0.554	0.156	0.829	0.575	0.359	0.229	0.594	0.4393
19	49.659	54.809	− 23.826	24.609	0.535	0.571	0.569	0.384	0.350	0.368	0.367	0.289	0.3434
20	50.091	55.297	− 26.677	25.539	0.810	0.822	0.200	0.640	0.568	0.584	0.238	0.410	0.4501
21	50.390	55.587	− 27.954	25.724	1.000	0.971	0.035	0.691	1.000	0.895	0.206	0.447	0.6370
22	50.139	55.554	− 27.076	25.334	0.841	0.954	0.149	0.584	0.611	0.844	0.227	0.375	0.5141
23	49.793	54.941	− 26.622	24.609	0.621	0.639	0.207	0.384	0.397	0.409	0.240	0.289	0.3337
24	50.094	55.644	− 26.993	25.105	0.812	1.000	0.160	0.521	0.571	0.999	0.229	0.343	0.5353
25	49.822	55.497	− 26.438	25.539	0.639	0.924	0.231	0.640	0.409	0.767	0.245	0.410	0.4579
26	49.889	55.644	− 28.227	26.415	0.682	1.000	0.000	0.881	0.440	1.000	0.200	0.677	0.5792
27	49.845	55.252	− 27.706	26.415	0.654	0.799	0.067	0.881	0.419	0.554	0.211	0.677	0.4653

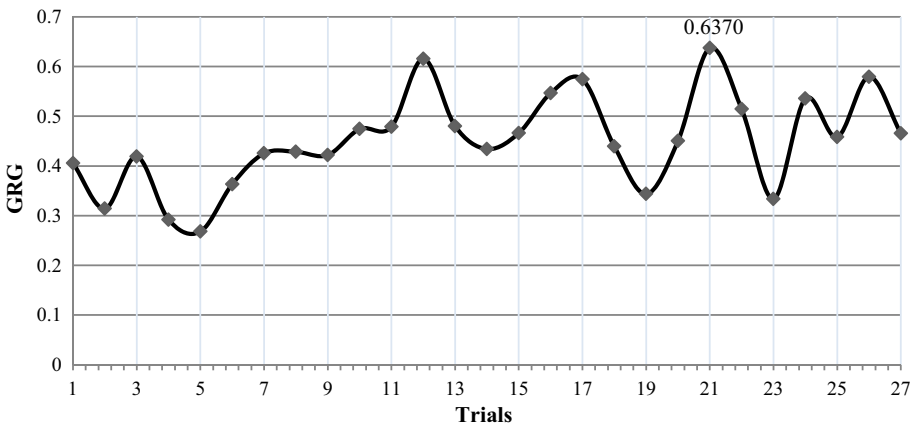


Fig. 8 Plot of GRG values for different experimental trials

(C), forging time (D), rotational speed (E) and their interactions (AE, BC, BD and CD). Second-order of term A (frictional pressure) was also found to be significant in influencing the GRG and hence the responses. The quadratic model was capable of simulating the solid-state friction welding conditions in EN 10028-P355 steel.

The *R*-squared value (coefficient of determination) and adequate precision value is shown in Table 5. The *R*-squared value is a statistical measure to understand the closeness

Table 4 ANOVA for response surface quadratic model

Source	Sum of squares	Degrees of freedom	Mean sum of square	*F* value	*p* value	Remarks
Model	0.212782	11	0.019344	14.97374	< 0.0001	Significant
A—Frictional pressure	0.053276	1	0.053276	41.23997	< 0.0001	
B—Upset pressure	0.025479	1	0.025479	19.723	0.0005	
C—Friction time	0.020368	1	0.020368	15.76649	0.0012	
D—Forging time	0.009158	1	0.009158	7.089374	0.0177	
E—Rotational speed	0.007017	1	0.007017	5.431853	0.0341	
AC	0.00483	1	0.00483	3.73874	0.0723	
AE	0.024652	1	0.024652	19.08267	0.0006	
BC	0.011656	1	0.011656	9.0228	0.0089	
BD	0.011226	1	0.011226	8.689914	0.0100	
CD	0.029291	1	0.029291	22.67372	0.0003	
A^2	0.034366	1	0.034366	26.60214	0.0001	
Residual	0.019378	15	0.001292			
Cor total	0.232159	26				

Table 5 Coefficient of determination and model discrimination

SD	0.036	*R*-squared	0.9378
Mean	0.45	Adj *R*-squared	0.8553
C.V. %	7.98	Pred *R*-squared	0.7114
PRESS	0.067	Adeq precision	14.205

of data to the regression line. A higher value of the coefficient of determination (greater than 0.7) is desired to ensure better fitness of the generated model to experimental data. The *R*-squared value of 0.9378, nearer to unity ensures a good fit between the generated polynomial equation and data measured within the welding domain. Though the predicted *R*-squared value (0.7114) was observed to be lesser than the adjusted *R*-squared value (0.8553), it proves the capability of the model to predict the response for a new set of observations in welding inputs. The predicted *R*-squared value (0.7114) observed from Table 5 was reasonable in preventing an overfit model, which would explain noise otherwise. Adequate precision could compare the range of predictions from the polynomial model to the associated errors. Adequate Precision was observed to be 14.205 (a value greater than 4 is desired), which proves the sufficiency in model discrimination in terms of signal adequacy. Hence the generated polynomial equation can be deemed fit and adequate in describing the relationship between the welding inputs and response represented in terms of GRG.

The closeness of actual and predicted values of response (GRG) for the 27 trials is shown in Fig. 9 (Plot of the predicted versus actual GRG values). The points are closer to the diagonal regression line without a foggy pattern proving the model fitness [24]. The plot of internally studentized

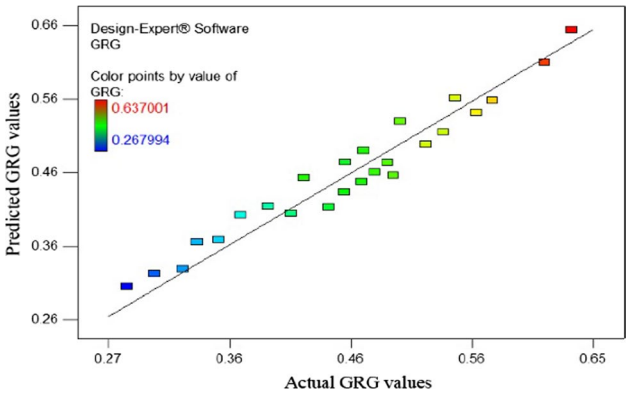


Fig. 9 Scatter plot of predicted versus actual GRG values

residuals is shown in Fig. 10. It considers the difference in predicted and observed values of GRG along with the standard deviation. The majority of the residuals are observed to be positive or along the diagonal line with an almost symmetric distribution without any clear patterns. The randomness in the residual plot further ascertains the fitness of the generated model for the response.

4.3 Analysis of Response Surface Plots

The various welding parameters including the frictional pressure, friction time, upset pressure, forging time and rotational speed, along with their interactions were observed to influence the yield strength, tensile strength, impact toughness and axial shortening significantly. Frictional pressure along with a defined rotational speed helps in creating the required temperature at the weld interface. The heat generation at the

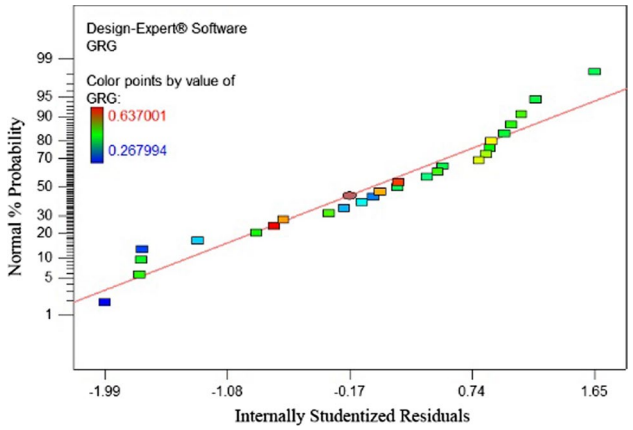


Fig. 10 Plot of studentized residuals to ascertain fitness

localized region is due to the rubbing action of irregularities in the mating surface. The constant frictional pressure ensures flattening of irregularities at the weld interface eliminating surface preparation in friction welding. A moderate value of frictional pressure (93 MPa) was observed to produce a better response as observed from the response surface plots (Fig. 11a, b). However, a moderate level of friction time (5.22 s) was desired to generate the heat and necessary temperature at the interface (Fig. 11b–d). A higher value of upset pressure (138 MPa) was found to produce a larger GRG (Fig. 11c, e) and hence, an improved response. The effect of upset along with the frictional energy input softens the materials assuring a plastic flow at the interface in the form of flash creating a good bond. When the forging pressure was maintained for more time, a considerable axial shortening was observed, and GRG was observed to decrease. Increased forging time allows for more heat dissipation in lesser time by increasing the surface area of flash. This could cause an increased hardness at the weld interface area. Hence, a small forging time was desired as observed from the plots (Fig. 11d, e). Also heat transfer by forced convective mode was realized at higher rotational speeds resulting in temperature drop at an increased rate. Hence, a moderate value of rotational speed (1282 rpm) was observed to be effective in producing better response (Fig. 11a).

4.4 Desirability Analysis on GRG Values and Ramp Graph

The technique of desirability analysis uses a desirability function to identify the scale-free value of desirability for the various responses [27]. The desirability function used in analysis of the calculated GRG values is of 'larger-the-better' type which forms the individual values of desirability ranging from zero to one. The combination of friction welding inputs producing the maximum value of desirability was identified and marked as the near-optimal condition (frictional pressure-93.94 MPa, friction time-5.22 s, upset pressure-138.14 MPa, forging time-3.58 s and rotational speed-1282.67 rpm). The outcome of desirability analysis is presented in Table 6. The ramp graph with optimal levels of welding inputs is shown in Fig. 12. The ramp graphs of individual welding inputs are combined and presented for the greatest overall desirability. The red dot on each ramp shows the most desired level of each welding input within the range chosen for experimental trials, hence representing the highest value of GRG (0.6508).

4.5 Welding Trial Using Predicted Optimal Values of Inputs

A proper experimental endorsement of near-optimal setting of friction welding inputs (frictional pressure-93.94 MPa, friction time-5.22 s, upset pressure-138.14 MPa, forging time-3.58 s and rotational speed-1282.67 rpm) becomes important to validate the approach of gray incidence reinforced response surface methodology and confirm the improvement in the observed quality characteristics. The outputs of experimental trial (No. 21) with the largest calculated value of GRG (0.6370) were compared with outputs obtained with the optimal setting of welding inputs predicted by gray incidence reinforced response surface methodology. Improvements were observed in the quality characteristics of the joint formed with optimal welding inputs substantiating the approach adopted for multi-response optimization. The properties of joint obtained with optimal parameters are YS = 339.42 MPa, UTS = 612.21 MPa and IT = 27 J, and properties of base metal are YS = 292 MPa, UTS = 528 MPa, IT = 23.90 J. It was observed that the YS and UTS are appeared higher than the values observed at base metal. The improvement in impact toughness appears minimal, but still the value (23.90 J) appears closer to the impact toughness value of parent material (27 J), during Charpy V-notch testing. The axial shortening obtained with the optimal setting of welding inputs was not significantly remarkable (20.75 mm). However, tensile strength and impact toughness were observed to be good at moderate/higher values of axial shortening. Hence, a good bond which promises good mechanical properties can be obtained with only reasonable values of shortening (Table 7).

4.6 Macroscopic and Microscopic Examination of Optimal Joint

The joint formed with an optimal welding input setting is shown in Fig. 13a, b. The heat flux generated due to frictional pressure and rotational speed creates the necessary thermal input for the softening of material closer to the weld interface. The application of optimal upset pressure creates

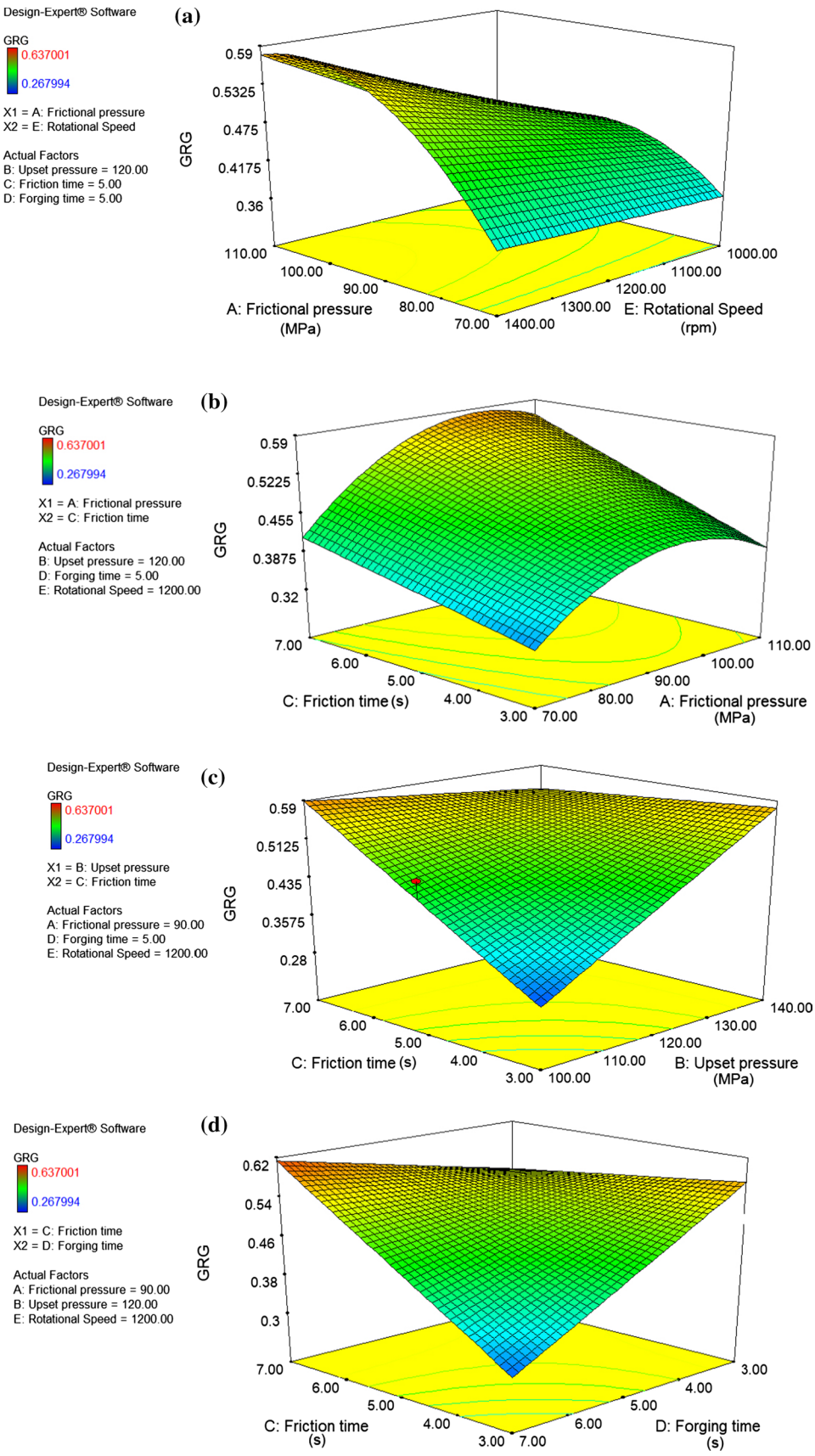


Fig. 11 Response surface plots displaying the parameter effects on GRG, **a** frictional pressure and rotational speed, **b** friction time and frictional pressure, **c** friction time and upset pressure, **d** forging time and friction time, **e** upset pressure and forging time

Fig. 11 (continued)

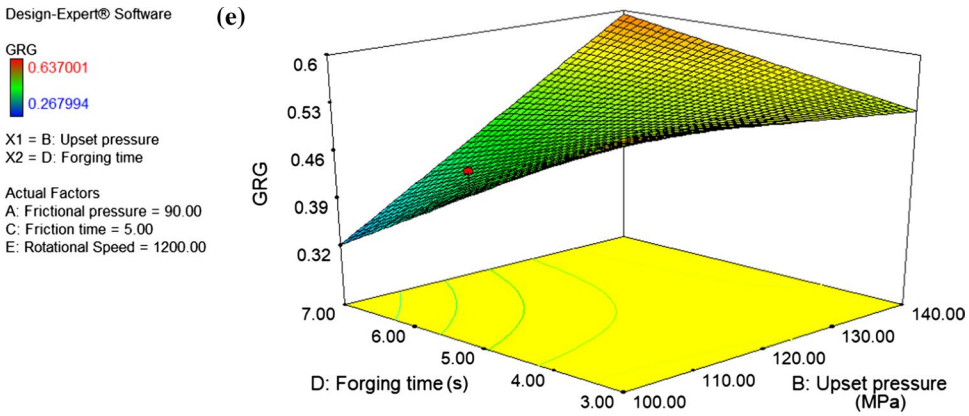


Table 6 Optimal levels of friction welding inputs

Symbol	Welding inputs	Optimal level	Low level	High level
A	Frictional pressure	93.944	70	110
B	Upset pressure	138.147	100	140
C	Frictional time	5.22	3	7
D	Forging time	3.58	3	7
E	Rotational speed	1282.67	1000	1400
Response	Prediction	SE mean	95% CI low	95% CI high
GRG	0.65088	0.06041	0.520419	0.780006

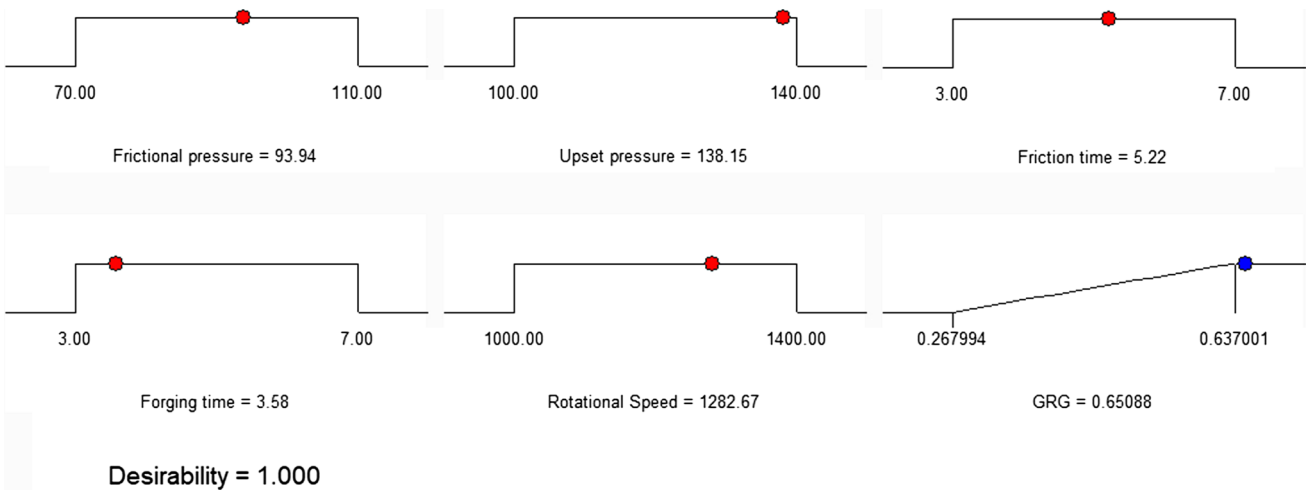


Fig. 12 Ramp graph with optimal level of friction welding inputs

Table 7 Responses obtained with optimal friction welding inputs

Responses	Initial setting	Optimal setting	Enhancement
GRG	0.637	0.65088	0.01388
Yield strength (MPa)	330.62	339.42	8.80
Ultimate tensile strength (MPa)	600.54	612.21	11.67
Axial shortening (mm)	24.15	20.75	3.40
Impact toughness (J)	21.70	23.90	2.20

plastic movement of material closer to interface radially outwards in the form of flash. The curl of parent material in the form of flash was evident, and the weld penetration was thoroughly complete as the weld line was not visible in Fig. 13b. Macroscopic examination further reveals the uniform width of flash, portraying the goodness of bond. The stereo microscope (model SZX16) equipped with DP series digital camera, and an inbuilt imaging software was used to analyse the microstructural characteristics near the weld area (Figs. 14, 15). The weld zone including the interface is seen along with the advancing and receding parts of the joint.

The microstructure of the tensile and impact specimen formed from the bonds with optimal parameter setting is shown in Fig. 14a, b. In both the microstructures, a small amount of pearlitic phase and predominantly ferritic phases are seen. However, pearlite itself is made of ferritic and cementite bonds [6, 8]. The grains appear to be pulled along the direction of uniaxial loading in tensile specimen (Fig. 14a), however, a relatively equi-axed grain is seen in impact specimen (Fig. 14b).

The region circled in Fig. 15a is enlarged to make a clear picture of the different zones near the weld area. Three different regions observed near the weld area

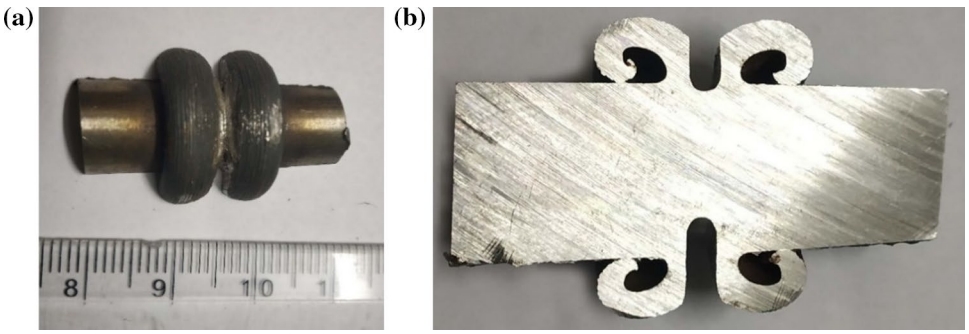


Fig. 13 **a** Weld interface of optimal joint, **b** longitudinal cut section revealing flash.

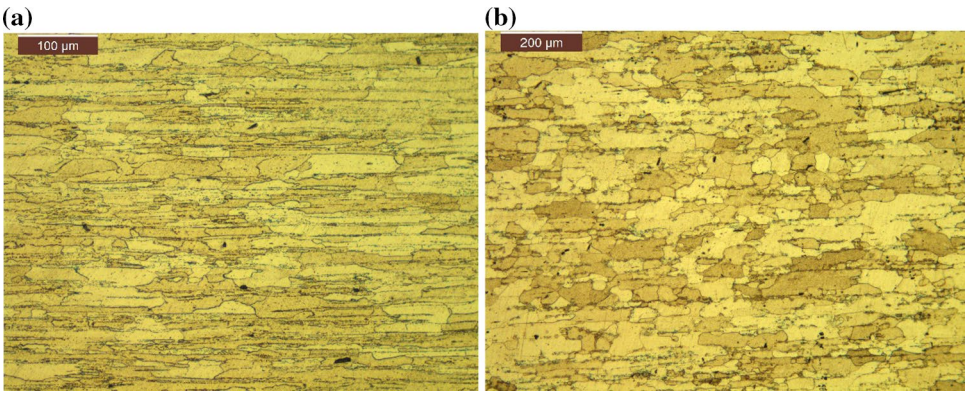


Fig. 14 Microstructure of **a** tensile specimen, **b** impact specimen

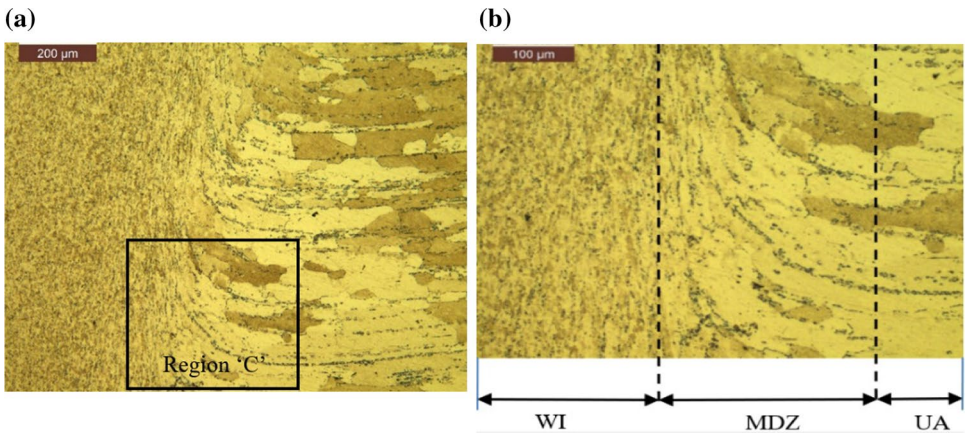


Figure 15 **a** Weld interface of optimal joint, **b** different areas near weld line

include the weld interface (WI), moderately deformed area (MDA) and the unaffected area (UA) (Fig. 15 b). The microstructures on the weld interface are characterized by the dynamic recrystallization due to higher rotational speed. The weld interface appears relatively darker compared to the other areas, as it was subjected to high temperature, stress and deformation. The grains appear dragged in the moderately deformed zone because of torque experienced by rotation at higher temperatures. More drag was found in the advancing part of the joint compared to the retreating half. The unaffected area signals the end of plastic flow and the onset of parent material away from the joint interface on both sides. Hence, the softening of material due to thermal input was more evident in the weld interface and moderately deformed zone. The remaining part of `parent material was unaffected by temperature and stress hence reducing the chances of undesirable microstructural changes and degradation of properties a possibility in fusion welded joints. The fractured surface of bond subjected to tensile loading is shown in the scanning electron microscope (SEM) images in Fig. 16a–c. Fracture was observed near the weld area as it happened in most of the experimental trials.

A gross permanent deformation (necked down) was observed near the center of the workpiece in Fig. 16a, and a closer examination reveals the microfractures and smaller voids, which appear after the specimen was stressed beyond tensile strength (Fig. 16b). The plastic deformation from the necked down area is also visible in Fig. 16c. These are primarily the features or patterns observed in ductile failure in uniaxial tension. The Vicker's hardness values were measured from the weld line towards unaffected parent material on both sides of the weld zone as per the ASTM E-18 standard with the total test force of 100 g for 10 s time. The hardness values measured at the WI, MDA and UA for the optimal joint were 204, 181 and 168 respectively. The joint obtained using initial input parameter setting (Trial No: 21) was found to possess a hardness value of WI, MDA and UA are 198, 178 and 166 respectively. Hence, it was observed that the hardness in the weld zone is relatively higher than that in the unaffected zone of parent material.

5 Conclusion

An effective attempt has been made to joint EN 10028-P355 GH steel in solid-state and possibility of forming good quality welded joints using continuous drive friction welding was also explored. The scope for simultaneous optimization of multiple responses is widened by authorizing an integrated approach of gray incidence reinforced response surface methodology for optimal parameter selection. A notorious reduction in the number of experiments was observed, as L_{27} orthogonal array was used in experimental trials unlike the

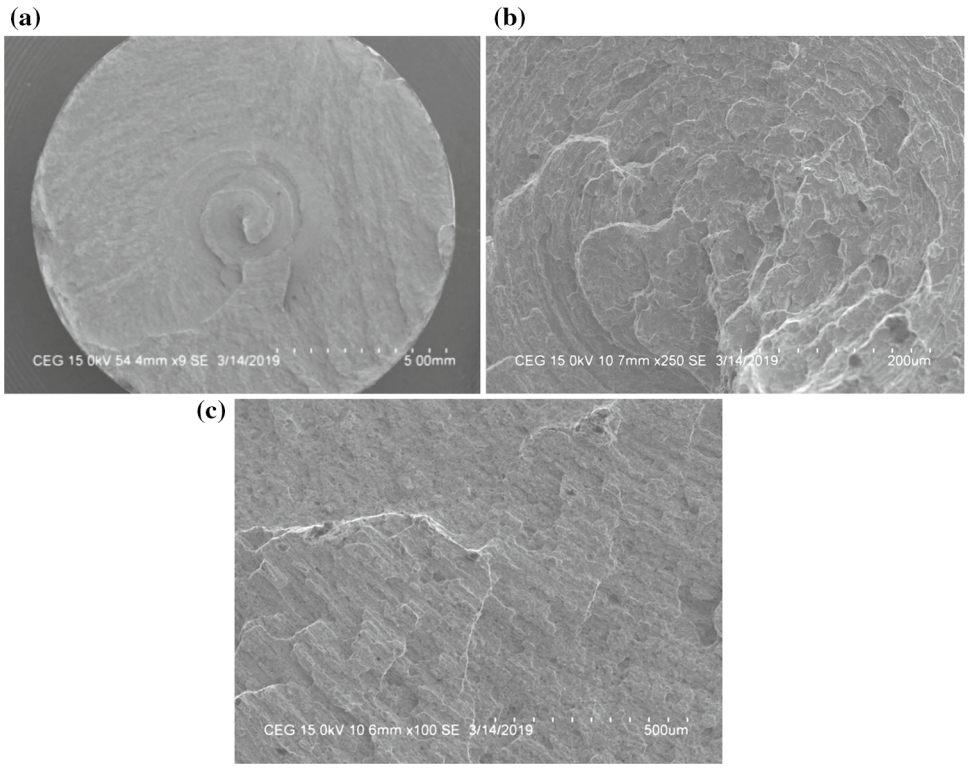


Figure 16 **a** Fractured surface, **b** voids and coalescence, **c** closer look at 'necked down' surface

conventional strategies using CCD or BBD with traditional RSM to arrive at the optimal friction welding inputs. The conclusions drawn include the following.

1. The gray incidence reinforced response surface methodology was effective in predicting the near-optimal welding condition (frictional pressure-93.94 MPa, friction time-5.22 s, upset pressure-138.14 MPa, forging time-3.58 s and rotational speed-1282.67 rpm) for joining EN 10028-P355 GH steel in a solid-state.
2. The developed quadratic model was adequate and effective in relating the various welding inputs and predicting the responses in terms of gray relational grade. The predicted and experimentally observed values were found to be reasonably closer demonstrating the model adequacy.
3. In addition to the individual welding parameters, their interactions were also observed to influence the quality characteristics of the joints. A ductile pattern was found in the fractured surface of joint.
4. The optimal welding inputs predicted by the integrated approach of gray incidence reinforced response surface methodology were found to improve the tensile strength and impact toughness. However, a less significant reduction in axial shortening could be better understood from the point of formation of a good bond with reasonably improved strength.

The findings of study could offer the sought-after guidelines for joining EN 10028-P355 GH steel in solid-state using continuous drive friction welding. The generated polynomial equations along with the experimentations will provide the necessary databank for improving the joining characteristics of material employed in boilers and pressure vessels, where the quality of joints is of utmost importance. The results could contribute in enhancing the engineering applications of the material and usage of gray incidence reinforced response surface methodology in different manufacturing strategies. The scope can be extended further to modeling the temperature at the weld interface, correlating the same with joint properties and studying the effects on ductile–brittle transition.

Acknowledgements The authors would wish to extend their sincere gratitude to the facilities and guidance offered by CEMAJOR LAB, Department of Manufacturing Engineering, Annamalai University. Chidambaram, Tamilnadu, India to carry out the investigation.

Compliance with Ethical Standards

Conflict of interest The authors declare no possible conflict of interest regarding the research, authorship and publication of this article.

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International Journal of Current Research and Review
DOI: http://dx.doi.org/10.31782/IJCRR.2021.131116

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IJCRR
Section: Healthcare
ISI Impact Factor (2019-20): 1.628
IC Value (2019): 90.81
SJIF (2020) = 7.893

Efficacy of Push-Ups on a Fitness Structure Compared to that on the Ground on Upper Body Muscular Activation in Healthy Indian Males – A Comparative Study

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ABSTRACT

Introduction: Conventional push-ups on the ground are recognized for fairly improving shoulder strength. A fitness structure has been developed for push up for improved muscle activation.

Objective: The present study aimed to compare the activity of the shoulder and trunk muscles in two push-up positions: push-ups on the fitness structure vs standard push-ups on the ground.

Methods: The study was a comparative study conducted among physically fit adult males in which 18 volunteers were recruited from physical training organization. Participants received instructions on proper push-up position and technique. Participants did 10 push-ups each and Electromyography (EMG) measures were recorded on biceps, triceps, deltoid anterior and pectoralis major muscle. These participants were asked to initially complete push-ups on the fitness structure followed by push up on the ground. The recordings of push-ups under the two conditions were analysed and compared using an unpaired t-test.

Results: The mean age of the study participants was 26.94 ± 1.259. The activity of shoulder and trunk muscles was better in the case of push-ups on the structure than on the ground. The difference in mean EMG readings of biceps muscle (11.133 ± 0.871 vs 7.346 ± 1.121) ($p<0.001$), triceps muscle (4.992 ± 0.881 vs 3.228 ± 0.438) ($p<0.001$), deltoid muscle (5.328 ± 1.373 vs 3.257 ± 1.103) ($p<0.001$) and pectoralis muscle (5.631 ± 1.290 vs 3.2906 ± 0.94875) ($p<0.001$) was statistically significant.

Conclusion: These results indicate that the designed structure could be a promising tool to those who perform rigorous physical activity. Future studies must include randomized trials to further validate our study results.

Key Words: Electromyography, Push-up exercise, Muscle activation, Upper body workout, Upper body activation, Fitness structure

INTRODUCTION

Physical fitness is a state of well-being with a low risk of premature health problems and the energy to participate in a variety of physical activities.[1] The conventional push-up is a fairly popular technique for improving muscle performance and assessing an individual's muscular endurance.[2] Push-ups are admired for being simple to learn with the involvement of very little or no equipment.[3] It is known to strengthen the upper body muscles, shoulder, arm and trunk to be precise.[2] The other advantages being rehabilitating the shoulder, stabilization training of dynamic joints, and improving proprioceptive feedback mechanisms.[4] Using Electromyographic (EMG) procedures, investigators have documented push-up as an effective method for activating muscles of the upper body.[5] However, ground push-ups are also known to place much resistance on the trunk muscles, which can place a huge load on the lumbar vertebrae causing lower back pain.[6] Changing the push-up position can affect the abdominal and vertebral muscles and lumbar angle and load.[7] Also, it's been suggested that instead of the standard push-up, using different devices for push-ups can better improve upper extremity and core muscles of the body.[8,9] It is valuable for athletes where strength training is essential, especially army professionals, bodybuilders and for many other individuals who are either recouping from any type of injury or wish to attain a certain level of fitness.[10]

A fitness structure was designed to activate different upper body muscles.[10] The fitness structure was designed to make it economical, simple to use and manufacture, and ideal for high strength training. However, the muscle activation and

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ISSN: 2231-2196 (Print) **ISSN:** 0975-5241 (Online)

Received: 04.09.2020 **Revised:** 26.11.2020 **Accepted:** 06.02.2021 **Published:** 04.06.2021

performance were not evaluated using the apparatus. Hence, the study was conducted to compare the activity of the upper body muscles in two push-up positions: push-ups on the fitness structure (experimental) vs standard push-ups on the ground (control).

MATERIALS AND METHODS

This was a comparative study conducted for a period of 2 months from June 2020- July 2020. Eighteen (18) Healthy males in the age range of 25 - 30 years who were physically fit with no upper extremity pathology within the past year were included in the study. Additionally, participants were required to engage in upper extremity resistance training including conventional push-ups at least twice a week for the past 3 months. The participants were excluded if they had upper back or upper extremity pain or if they had any recent surgeries. The study protocol was approved by the institutional ethical and review board before the commencement of the study.

Volunteers were recruited through convenience sampling technique from physical training organization till the sample of 18 was reached. Written informed consent was taken from all the participants before the commencement of the study. The participants attended two programmes separated by a minimum of 48 hours. An orientation was held to educate the participants about the purpose of the investigation. The study participants signed informed consent before the start of the study. They received instructions on proper push-up position and technique. Once assured that the subjects could correctly perform the muscle tests and exercises, the sites for electrode placement were prepared by abrading the skin with fine sandpaper and cleansing the area with 70% isopropyl alcohol. Shaving of hair was performed if necessary. Initially, the participants performed push up on the fitness structure followed by standard push-ups on the ground.

Data recording

A surface electrode was used to determine the activation of muscles. The electrodes were applied unilaterally with no preference for left or right sides. Electromyography (EMG) data were collected using a NeuroScan EMG/NCV/EP (Innotech Medical (P) Ltd., Punjab, India). All EMG signals were amplified, band-pass filtered (20–450 Hz), and sampled at 1,000 Hz. The position of placement of electrode is mentioned in Table 1 and Figure 1.

Fitness structure

The structure used in the study was an inverted U-shaped structure, 40′ long and 5′ high is grouted on a cement concrete prepared bed. This structure is supported by seven vertical supports made of the same material, again grouted on the concrete surface. Another 40′ long galvanized iron pipe is welded to this structure 2′ above the concrete surface. All joints are welded firmly on all sides. Located 2.5′ away from this axis are 24 inverted U-shaped hand supports, placed at repetitive intervals of 1.5′ -1.0′ -1.5′ from each other. These hand supports are 1.5′ long and 2′ high. They are made of steel and are 2′ ′ thick.[10] (Figures 2 and 3)

Procedure

To standardize hand and leg placement between exercises, a point was marked, where participants placed their hands and legs both on the ground and the fitness structure. While exercising the participants were asked to keep the spine straight, and shoulders flexed 90° relative to the trunk's longitudinal axis and elbows flexed 90°. The investigator placed the Electrode first on the biceps muscle (one muscle at one time). The exercise began in the "up" position with the arms extended, forearms and wrists in the neutral position. After 1st round of 10 push-ups, EMG reading on biceps muscle was recorded. Next, the patient was asked to stand up and the electrode was attached to the triceps muscle. 10 push-ups were repeated on the structure and EMG values were noted down. The same procedure was again repeated for deltoid muscle and pectoralis muscles (Figures 2 and 3).

Statistical analysis

Descriptive and inferential statistical analyses were carried out in the present study. Results on continuous measurements were presented on Mean ± SD and results on categorical measurement were presented in number (%). The level of significance was fixed at p=0.05 and any value less than or equal to 0.05 was considered to be statistically significant. Student t-tests (two-tailed, unpaired) was used to find the significance of study parameters on a continuous scale between two groups. The Statistical software IBM SPSS statistics 20.0 (IBM Corporation, Armonk, NY, USA) was used for the analyses of the data and Microsoft Word and Excel were used to generate graphs, tables etc**.** The ethical clearance was obtained from the institutional review board (no: TNPESU/R4/Ph.D./Feb-2017/08)

RESULTS

The Mean age of the study participants was 26.94 ± 1.259 years. The Mean height of the study participants was 173.11 ± 4.764 and the mean weight was 70.06 ± 7.696 (Table 2). The activity of shoulder and trunk muscles was better in the case of push-ups on the structure than on the ground. The difference in mean Electromyography readings of biceps muscle (11.133 ± 0.8714 vs 7.346 ± 1.1210) (P<0.001), triceps muscle (4.992 ± 0.8819 vs 3.228 ± 0.4383) (P<0.001), deltoid muscle (5.328 ± 1.3736 vs 3.257 ± 1.1039) (P<0.001) and pectoralis muscle (5.631 ± 1.2909 vs 3.290 ± 0.9487) (P<0.001) was statistically significant (Table 3).

DISCUSSION

The push-up exercises are very popular in upper body strengthening programs. They are closed kinetic chain exercises, for which pectoralis major and triceps brachii are the principles acting muscles.[11] Different variants of the exercise have been suggested in the past, either using different postures[12], altering the position of hands and feet[13], or compared to the movable-load bench press exercise[14], stable or unstable surfaces[15] or sling-and ground-based push-up exercise.[16] Therefore, we compared the activity of the shoulder and trunk muscles between push-ups on the fitness structure and standard push-ups on the ground.

A total of 18 volunteers participated in the study. The study findings suggested that the push-ups on fitness structure showed better activation compared to push-ups on the ground. Calatayud et al.[8] used a suspended push-up with a pulley system showed greater activation compared to standard push-ups on the floor. They suggested that suspended push helped increase core muscle activation. These findings were also comparable to the study conducted by Snarr et al.[17] which also supported this evidence. The Perfect Pushup™, a rotating handgrip device was found to be superior for activating the pectoralis major and posterior deltoid compared to conventional push-ups in the study by Allen et al.[9] and Youdas et al.[2] Sandhu et al.[18] suggested that the addition of a simple Swiss ball to your push up is capable of improving shoulder muscle activity. Kim et al.[19] suggested that the push-ups performed with the 50% palmar width resulted in greater activation of pectoralis minor, triceps brachii, and infraspinatus muscle activities. Borreani et al.[20] suggested that any unstable surface such as wobble board, stability disc, fitness dome, and Suspension Trainer improves muscle activation. All these studies showed that modification of conventional push-up technique may yield positive results in terms of better muscle activation.

The study results showed that fitness structure is a decent alternative for ground push-ups providing better muscular activation. The structure used is cost-effective. However, we did not conduct an in-depth analysis of the push-ups on the patients. The other limitations were that the convenience sampling technique was employed for the study which does not truly represent the general population. This study was a simple comparative study with a limited sample size; thus, the observed association cannot be interpreted as causal inferences. However, this was the first study that contributed significantly to the literature by introducing a new apparatus in fitness training. In future, it's recommended to conduct a multicentric large scale randomized trial on a wider population (including females, different ethnicity, people from different geographical location etc.) to further validate the study results.

CONCLUSION

The study results showed that fitness structure is a cost-effective and good alternative for ground push-ups providing better muscular activation. This study was one of the very first studies that developed and studied the modified push-ups on an apparatus. This apparatus could be deemed useful in already fit individuals like army personal, bodybuilders and many other fitness enthusiasts.

Conflict of interest and source of funding: NIL

Authors contributions:

1. Vikas Malik: concept, design, literature search, data acquisition, the definition of intellectual content, manuscript editing and manuscript review.
2. Dr. R. Ramakrishnan: concept, data analysis, statistical analysis, the definition of intellectual content, manuscript editing and manuscript review.

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Table 1: Position of electrode placement

S no	Muscle name	Position of EMG electrode	Muscle activation
1	Biceps brachii	Placed in the middle of the forearm just anterior to the radius.	Flexing the distal phalanx of the thumb activates the muscle
2	Triceps	Placed posterior to deltoid tubercle, for long head 6-8 cm (4 fingerbreadths) distal to the posterior axillary fold	Activated during push up on fitness structure
3	Deltoid Anterior	Placed 4-5 cm below the anterior margin of the acromion	Activated by forwarding elevation of the arm
4	Pectoralis Major	Placed on the anterior axillary fold	Measured during exercise

Table 2: Descriptive statistics (N=18)

Variable	Mean	Standard Deviation
Age	26.94	1.259
Height	173.11	4.764
Weight	70.06	7.696

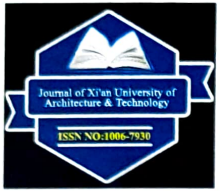
Table 3: Comparison of the Electromyography readings of push-ups on structure and on ground using unpaired t-test (N=18)

Muscles	Structure	Ground	t value	P-value
Biceps	11.133 ± 0.8714	7.346 ± 1.1210	11.316	<0.001**
Triceps	4.992 ± 0.8819	3.228 ± 0.4383	7.601	<0.001**
Deltoid	5.328 ± 1.3736	3.257 ± 1.1039	4.986	<0.001**
Pectoralis	5.631 ± 1.2909	3.290 ± 0.9487	6.198	<0.001**

Figure 1: Position of electrode placement.

Figure 2: Push-up on structure.

Figure 3: Push-up on the ground.



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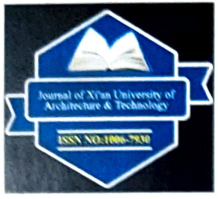

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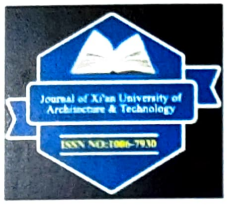

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Impact Factor : 3.7, Issn : 1006-7930

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Certificate ID : JXAT/4598

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Hardware Implementation of PV fed boost converter with quasi resonant voltage doubler and snubber circuit

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Abstract— In this article, hardware implementation of PV fed boost converter with quasi resonant voltage double and snubber circuit is presented. This method clarifies the improvement of a boost half-bridge (BHB) DC-DC converter with high power transformation efficiency and a wide voltage range for photovoltaic smaller scale inverter. The improvement is accomplished by presenting an isolation Transformer, interfacing the BHB DC-DC converter on the essential side of the transformer and including a voltage doubler with a snubber capacitor on the auxiliary side. Quasi Resonance (QR) strategies are utilized to accomplish zero-voltage exchanging (ZVS) turn-on for the switches, just as ZVS turn-on for the diodes. Furthermore, the new improved converter has no DC-charging current for the transformer because of the DC blocking capacitor, and it duplicates the voltage increase through the voltage doubler and snubber capacitor to diminish spikes Further, an extensive hardware validation show the effectiveness of the system.

Keywords— Photo voltaic Systems, Micro Inverter, DC-DC Converter, Quasi Resonance, Power Conversion.

I. INTRODUCTION

Lately numerous nations satisfy the power need, so the age of renewable power source is expanded, for example, photovoltaic, wind, fuel and so on. The sun gives all that anyone could need vitality to meet the entire world's vitality needs, and not at all like petroleum products, it won't run out at any point in the near future [1-2]. As a sustainable power source, the main impediment of sun oriented force is our capacity to transform it into power in a proficient and savvy way. No ozone depleting substance emanations are discharged into the environment when you utilize sun powered boards to make power. Also, on the grounds that the sun gives more vitality than we'll ever require, power from sun based force is a significant vitality source in the transition to clean vitality creation. After sun based boards have been introduced, operational expenses are very low contrasted with different types of intensity age. Fuel isn't required, and this implies sun based force can make huge sums of power without the vulnerability and cost of verifying a fuel supply. The progression up DC-DC converter for a smaller scale inverter must have a high voltage gain G (V_O/V_{IN}) of a few tens or more [3-4]. In this manner, if a traditional DC-DC help converter is utilized for a small scale inverter, the switch must have an incredibly high duty ratio. Be that as it may, this outcomes in huge current flows, losses due to conduction, and losses due to switching losses of the electric influence segments in the converter. Non-isolated DC-DC converters have been concentrated to defeat these issues in Step-up DC-DC Converters above [5-7].

To accomplish high voltage gain without an amazingly high duty ratio of the principle switch, non-isolated converters utilize detached and dynamic parts rather than a transformer. In any case, non-isolated DC-DC Converters have complex structure, electro-attractive obstruction, grid current contortion, and extra misfortunes because of the spillage current produced by the galvanic association between the PV module and grid [8-9]. The traditional flyback converter has the littlest circuit parts and circuit size. In any case, it has burdens of the low voltage increase, high voltage worry of the rectifier diode, and high voltage spike issue of switch[10-11]. To take care of these issues, the dynamic clamp flyback converter with a voltage doubler was presented.

The proposed converter utilizes the quasi-resonance among C_1 and L_{lk}. Contrasted with the past converter it can decrease the turn off current of S_1 and obligation loss of the circuit in view of the quasi-resonance among C_1 and L_{lk}. Along these lines, this converter of has the littler turn off misfortunes and more extensive voltage at the input side run than that of past converter

PROPOSED SYSTEM

In proposed system shown in Fig 1 the PV panel input voltge is fed to the DC load with the help of half bridge boost converter which converts the DC voltage with AC voltage with some boost ratio and then it converted AC voltage is stepped up using turns ratio of transformer and then voltage doubler circuit converts the doubles the AC voltage to DC voltage which drives the load.

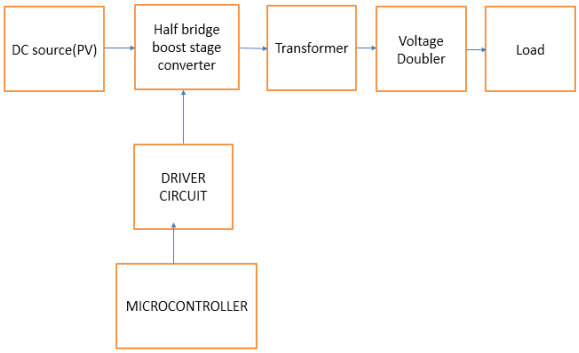

Fig 1. Block Diagram of Proposed System

The siwtching pulses to the switch is given by microcontroller which is amplified by the driver circuit.

II. MODELS

A. PROPOSED CONVERTER

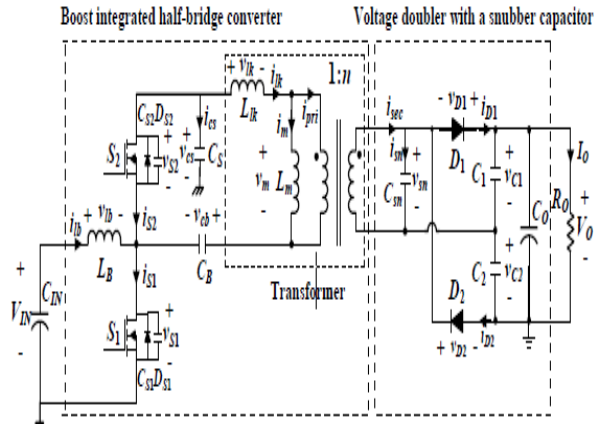

Fig 2. Circuit Diagram of Quasi Z source inverter

The proposed converter has a combined structure of a boost integrated half-bridge converter on the primary side of the transformer and a voltage doubler with a snubber capacitor on the secondary side. The boost integrated half-bridge converter consists of a boost inductor (L_b), two switches (S_1, S2), a storage capacitor (C_s), a blocking capacitor (C_b), and a transformer with a leakage inductance (L_{lk}), turn ratio of 1:n, and a magnetizing inductance (L_m). It performs the operation of the boost converter of stepping up the input voltage (V_{in}) to the higher voltage (V_{Cs}) of C_s. It then performs the operation of the half-bridge converter of transferring the electric energy from Cs to the load (R_0). An Isolation Transformer is used to step up the Voltage of BHB Converter. The voltage doubler with a snubber capacitor consists of two diodes (D_1, D_2), a snubber capacitors (C_{sn}), two capacitors(C1, C_2), and an output capacitor (C_O). It generates a DC output voltage (V_O) of twice the secondary voltage of the transformer and reduces the voltage stresses of D_1 and D_2 to V_O. The simple PWM circuit has been used to give the switching pulses to the switches. The swithces S_1 and S_2 works complemetary for giving the AC like signals. The circuit diagram of proposed converter is shown in Fig 2.

The operation includes when switch S_1 is in ON condition the positive cycle is generated, switch S_2 is responsible for the negative cycle generation. The input boost inductor L_b charges and discharges linearly with respect of switching condition of switches S_1 and S_2.

B. DRIVER CIRCUIT

A driver is an electrical circuit or other electronic component used to control another circuit or component, such as a high-power transistor, liquid crystal display (LCD), and numerous others. They are usually used to regulate current flowing through a circuit or to control other factors such as other components, some devices in the circuit. The term is often used, for example, for a specialized integrated circuit that controls high-power switches in switched-mode power converters. Typically the driver stage(s) of a circuit requires different characteristics to other circuit stages. For example in a transistor power amplifier circuit, typically the driver circuit requires current gain often the ability to discharge the following transistor bases rapidly, and low output impedance to avoid or minimize distortion.

C. MICROCONTROLLER(PIC16F877A)

The term PIC, or Peripheral Interface Controller, is the name given by Microchip Technologies to its single – chip microcontrollers. PIC micros have grown to become the most widely used microcontrollers in the 8- bit microcontroller segment. The PIC16F877A CMOS FLASH-based 8-bit microcontroller is upward compatible with the PIC16C5x, PIC12Cxxx and PIC16C7x devices. It features 200 ns instruction execution, 256 bytes of EEPROM data memory, self-programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, a synchronous serial port that can be configured as either 3-wire SPI or 2-wire I2C bus, a USART, and a Parallel Slave Port.

III. RESULTS

Fig 3 shows the overall hardware setup of proposed converter for the measurement and acquisition of Input & Output Waveforms.

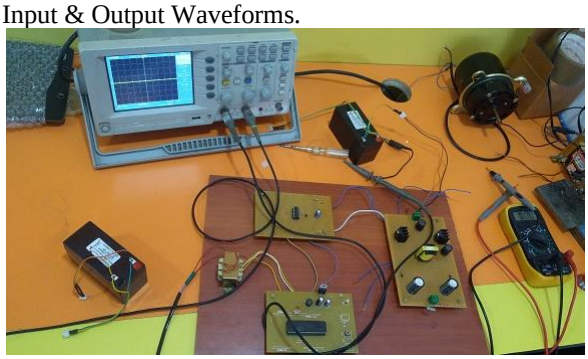

Fig 3. Overall hardware setup

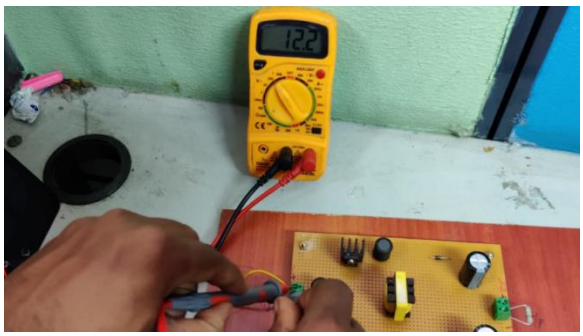

Fig 4. Input voltage of 12V

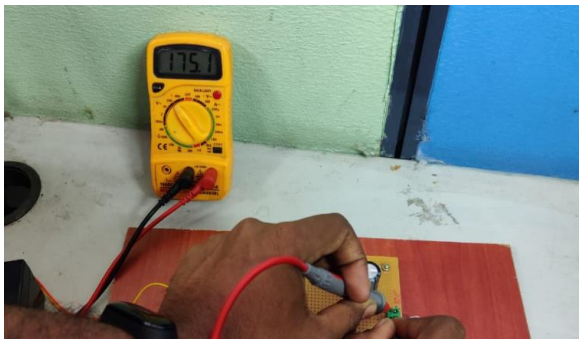

Fig 5. Output voltage of 175V

Fig 4 & 5 show the input and output voltage of proposed converter

IV. OUTPUT WAVEFORMS

The Input and Output Waveforms were captured in Digital Storage Oscilloscope (DSO). Fig 6 shows the the Input DC voltage fed from a Solar Panel or any DC source (12.5 Volts).

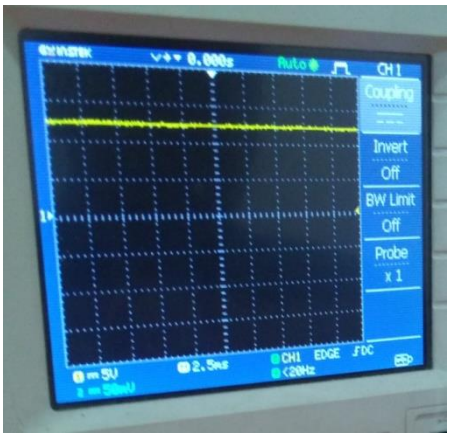

Fig 6. DC Input to BHB Converter

Fig 7 shows the Switching Pulse to MOSFET so that the DC input given to the BHB Converter Switches ON and OF the S1 & S2 pair of MOSFETS.

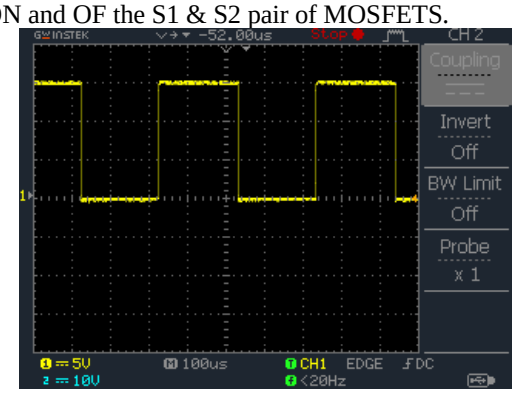

Fig 7. Switching Pulse to MOSFETs S1 & S2

The Output of BHB Converter and input to primary of the Transformer is shown in Fig 8.

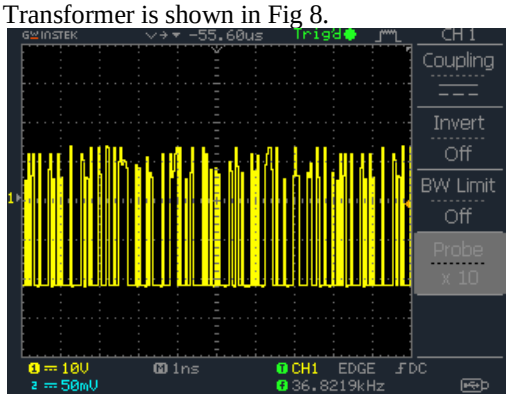

Fig 8. Input to Primary of Transformer

Fig 9 shows the waveform available in the secondary of the Transformer. The voltage is stepped up here and is fed to the Voltage Doubler.

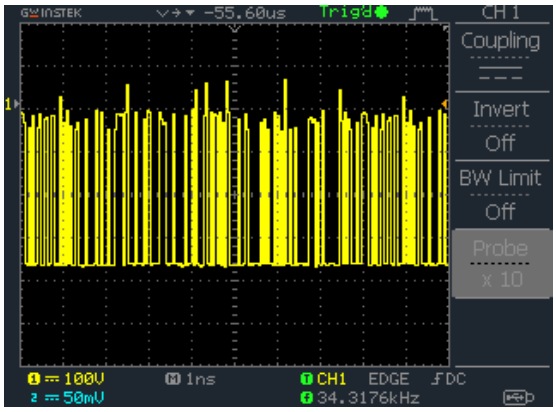

Fig 9. Voltage avaialbe at Transformer Secondary

The Voltage Doubler doubles the Voltage and then to eliminate the spikes Snubber Capacitors are introduced. Fig 10 shows the Output wave form of the Voltage Doubler and Fig 11 shows the final DC output after Snubber Circuit.

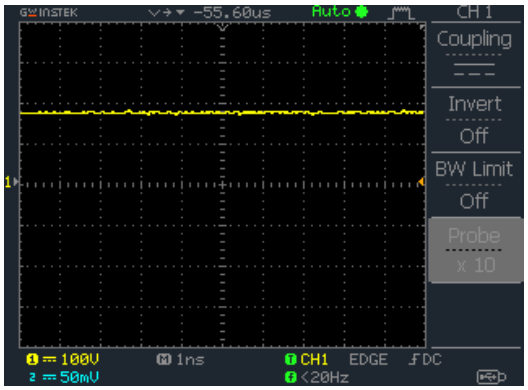

Fig 10. Output after Voltage Doubler.

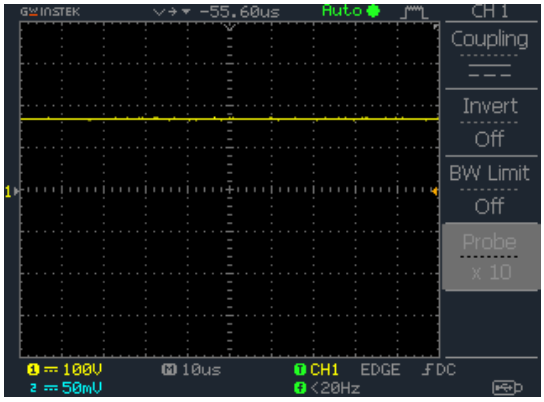

Fig 11. Final DC Output after Snubber Circuit

V. CONCLUSION

This paper presented a hardware implementation quasi-resonant boost half-bridge (BHB) DC-DC converter with high power conversion efficiency (η%) and a wide input voltage range. Moreover, the proposed converter had no DC-magnetizing current of the transformer, and the voltage gain was increased by using the voltage doubler with a snubber capacitor to reduce spikes.

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Hardware Implementation of Improvement in Power Quality by using Advanced Reactive Power Compensation

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Abstract

In this paper it is decided to improve the power quality of power supply. When the power quality is poor at load side which can cause other equipment malfunction even damages the associated devices. Therefore, a reactive power compensation method is suggested to improve the power quality in a distribution power system. To improve the power quality by using the facts device is one of the conventional methods; in our paper we inject the reactive power by using same real power supplying system.

1. Introduction

The power quality (PQ) problems and solutions to theseproblems have gained much importance in recent years.The main causes for poor power quality are: extensive use ofnonlinear loads in distribution system for efficient andcontrolled use of energy, integration of distributed generatorsbased on the renewable power (such as, solar and wind) andthe occurrence of frequent faults on the electrical network.Under the generic name of custom power devices [2] a newgroup of compensators like dynamic voltage restorer (DVR),the distribution static synchronous compensator(DST A TCOM) and unified power quality conditioner (UPQC)have been developed and used for improving power quality inthe distribution system. Some of the critical loads like dairyfood industry, chip manufacturing industry, large computer networks etc. are very sensitive to supply related powerquality problems. Voltage sags, swells, transients, unbalanceand harmonic distortion are major power quality problems in the supply voltage. These power quality problems can beeffectively compensated using a DVR.The DVR is a voltage source converter (VSC) based powerelectronics device connected in series between the supply andsensitive loads through a series transformer. It can protectsensitive loads from supply side voltage quality problems byinjecting the compensating voltage into the distribution line.When the injected voltages by DVR are in quadrature with thefeeder currents, it does not require any active power forcompensation. A small amount of active power to overcomethe DVR system losses however should be supported toachieve a self-supporting DC bus.

The disadvantage ofquadrature voltage injection is that in case of a voltagesag/swell event the restored voltage may not be in-phase withpre-sag/swell voltage and, the compensation range is highly dependent on load power factor [15].The different topologies of DVR and its protection arediscussed in [9-10]. The analysis, design and voltage injectionschemes of a self-supported DVR are explained in the [2, 11].In [11-24], different control strategies have been developed forthe control of the DVR. Some of the popular techniques are:the instantaneous reactive power theory (IRPT) [4],synchronous reference frame theory (SRFT) [12, 24], adalinebased fundamental extraction [13], instantaneous symmetrical component theory (ISCT) [14, 15], and space vectormodulation [19].The frequent unsymmetrical faults in the power systemgenerally cause the unbalanced voltage sags. To compensatefor such unbalanced voltage sags, DVR needs to injectcompensating voltages with both positive and negativesequence components. These can be achieved using twoseparate proportional-integral (PI) controllers, each for positive and negative-sequence voltages, in d-q synchronousframe [24]. The approach proposed in [24] is computationallyintensive due to the transformation from stationary frame tosynchronous frame and vice-versa.In this paper, a new control algorithm is developed based onestimation of instantaneous load reactive power for generationof reference load voltages in the stationary reference frame.The load voltages are controlled to its reference values usingPR controller in the stationary reference frame. A PR controller achieves good positive and negative-sequencefundamental voltage regulation simultaneously as it has highgains around both positive and negative-sequence fundamentalfrequencies [23]. Then implementation of DVR using VSCwith PWM control is discussed in this paper. The extensivesimulations are performed using MATLAB with its Simulink and Sim Power System (SPS) tool boxes for verifying theproposed control algorithm for DVR.

2. Materials and Methodology

In the system consists of ac source and PV panel, DC-DC converter, voltage source converter, and filter used for supplying real and reactive power without using external facts device.AC source provide the real power to the system, when there is consumption real power increase in load side to compensate the power by feed the reactive power by the voltage source inverter with use of capacitor bank.Voltage source converter, convert the dc into ac to the distribution line

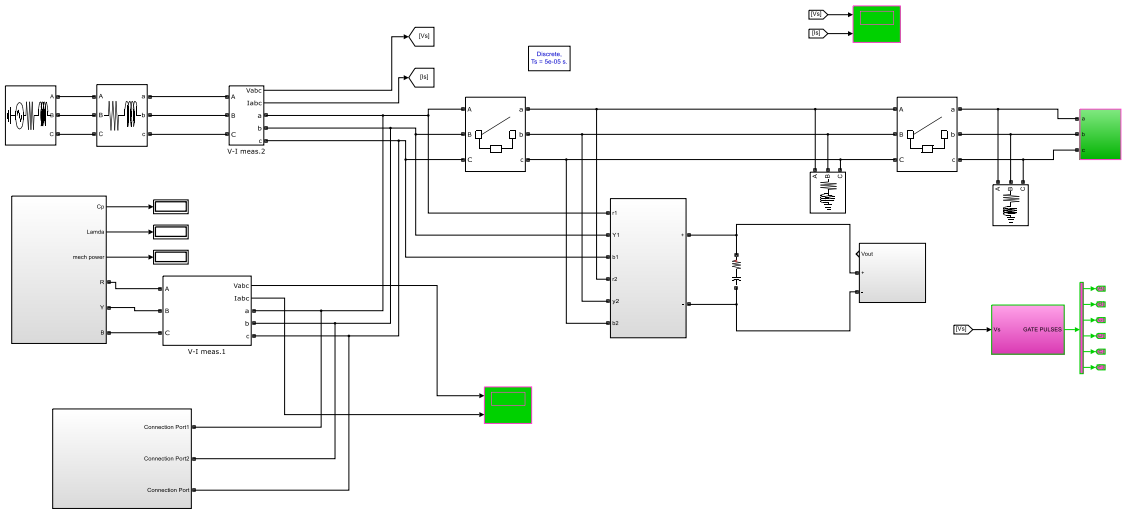

Fig.1.Simulation Diagram of the proposed system

3. Results and Discussion

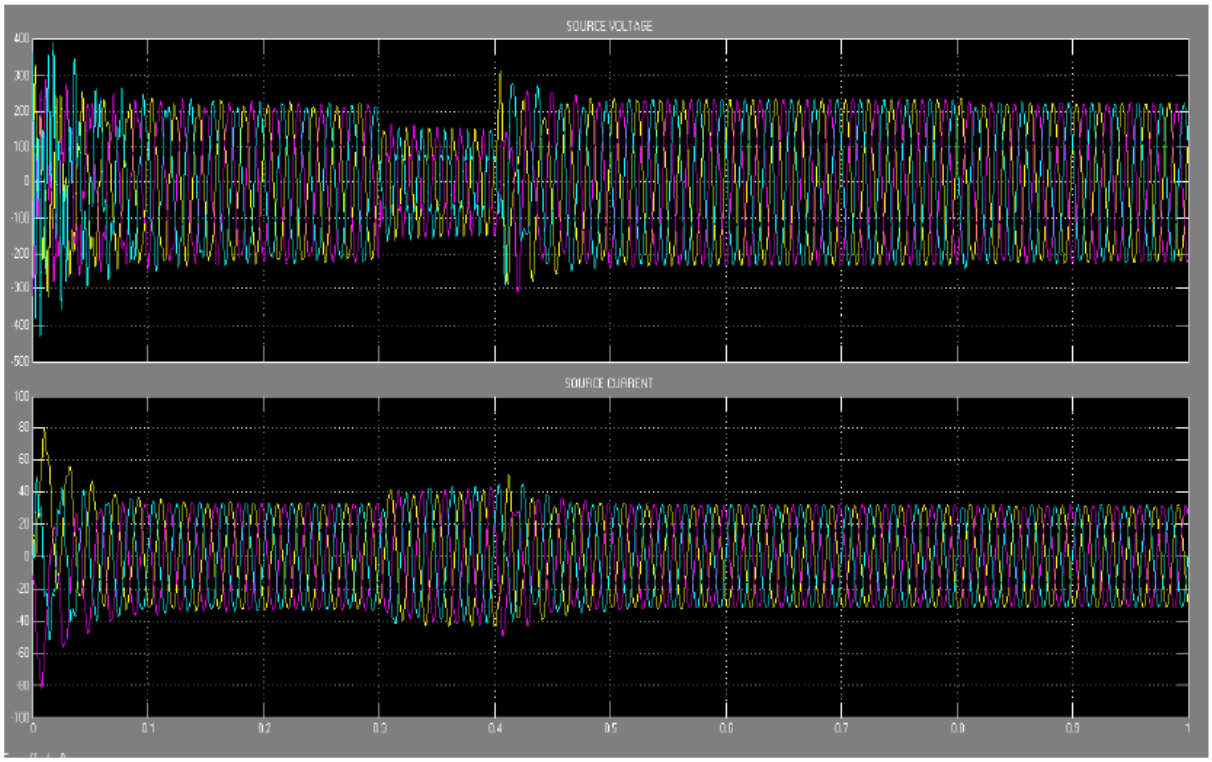

Fig.2.Source voltage before and after reactive power compensation

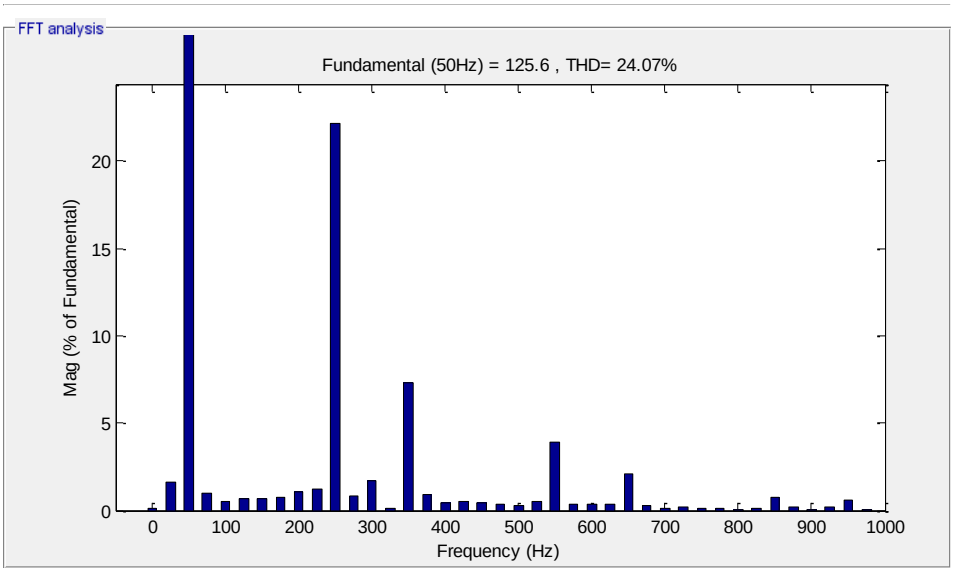

Fig.3. THD before reactive power compensation

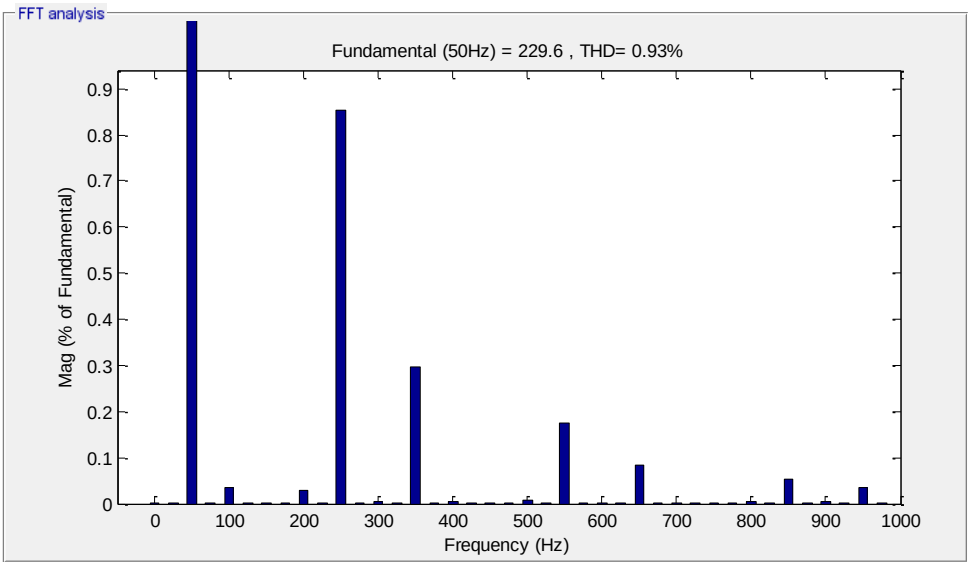

Fig.4. THD after reactive power compensation

4. Hardware Implementation

To repay the reactive power misfortunes in the transmission line and any place in the electrical influence framework, we have completed the writing survey of the different papers and embraced the distinctive procedures to defeat this issue. We have utilized the shunt and series arrangement strategies, in which the compensator like capacitor will be given in parallel and in series to the

inductive load. Since there is dependably a voltage and current transient upon the changing the capacitor steps. Henceforth we adopted the FACTS (Flexible AC Transmission Systems) gadgets to beat the responsive force remuneration issue. The studies for the different FACTS gadgets were completed and we discovered the STATCOMs (Static Synchronous Compensators) is the present day and the most productive approach to conquer the responsive force pay. The different strategies were done for the STATCOMS.

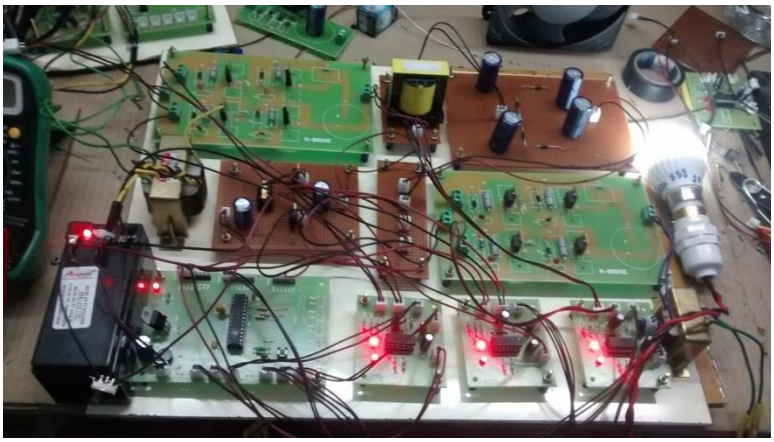

Fig.6.Hardware circuit

To compensate the reactive power in three phase AC system by using STATCOM Static Synchronous Compensator is one of the static component device and comes under the family of FACTS devices. It can absorb or supply reactive power in the single or three phase AC systems. A transmission network reactive power can be compensated using Static Synchronous Compensator. It also helps in preventing fluctuations in the transmission system like sudden voltage increase (voltage sag), sudden voltage decrease (voltage sag), transients etc. A STATCOM comprises of a three phase inverter utilizing SCRs, MOSFETs or IGBTs, a DC capacitor (which when charging will absorb reactive power and while discharging will supply 17 reactive power), a connection reactor whose purpose is to link the inverter output to the AC supply side, channel parts to channel out the high recurrence segments because of the PWM inverter. From the DC side capacitor, a three stage voltage is produced by the inverter. This is synchronized with the AC supply. The connection inductor interfaces this voltage to the AC supply side. This is the essential standard of operation of STATCOM.

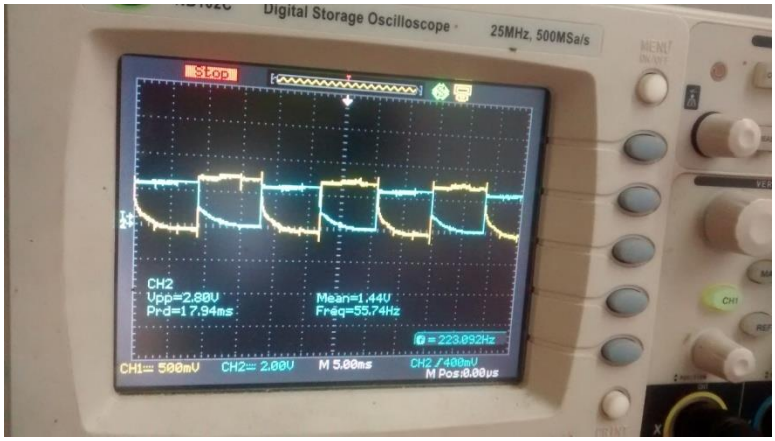

Fig.6.Before Reactive Power Compensation

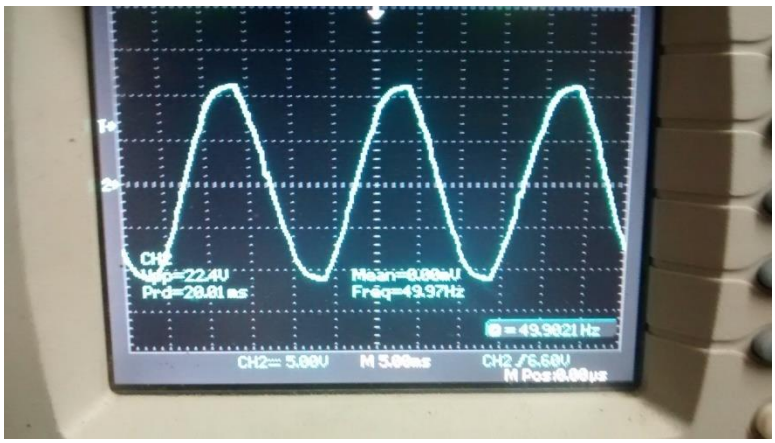

Fig.7.After Reactive Power Compensation

5. Conclusion

The reactive power compensation has been done using Renewable energy based dynamic voltage restorer and static compensator. The results of total harmonic distortion(THD) have been utilized to verify the simulation results. In this article PV based FACTS device has been successfully applied for reactive power compensation, the THD level before compensation is 24.07%, and after reactive power compensation it has been improved to 0.93%.

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Intelligent Door Knocking Security System Using IOT

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Article History: Received: 11 January 2021; Accepted: 27 February 2021; Published online: 5 April 2021

Abstract: In current day security is very important. Nowadays, in all places many robberies are going on. In this security issue, lock is the major parameter. The trustworthy on the lock should me made improve. The lock may be for main door lock, baggage lock, shutter lock, grill door lock, interconnecting door lock etc. This project is based on arduino board and IOT. And also this can be used for main door and for locker door. This lock works based on the knocking pattern. The owners knocking pattern is stored in the register. When the knocking pattern is detected by the sensor, it passes it to the arduino board microcontroller. Based on the trustworthiness of the pattern the lock works. This framework is easy for installation. It can be implemented for commercial use also.

Keywords: IOT, Arduino Uno board, Power supply, Bylynk App, DC motor, Motor driver circuit, Knock pattern, GSM module.

1. Introduction

The World has progressed significantly throughout the years and it has changed the manner in which we live, the manner in which we impart, the manner in which we learn and the manner in which we change. One of those extraordinary headways is progression in Technology. From creation of things like blades out of rocks to things like 3D printer to a super PC, Technology has made some amazing progress. This headway in Technology has been outstanding in the 21st Century.

Be that as it may, with the points of interest and advantages, additionally came the disservices and difficulties. One of the instances of this headway can be taken as the creation of the IPhone. IPhone was a noteworthy redesign from the customary sort of utilizing a telephone since it was ready to call and content as well as had the capacity to play music, recordings, and download applications. Despite the fact that these were the favourable circumstances, there were numerous detriments like battery channel and the decline of vis-à-vis correspondence because of dependence on the cell phone. With such headways in innovation, there's dependably a requirement for security and protection.

One of the methods for verifying security is a mix of ‘lock and key'. Present day locks and the locking framework are unquestionably increasingly intricate and regularly utilize a dabbed system on the key which give a more prominent security. In any case, the drawback is that it's the equivalent 'lock and key' system, which means, the key can generally be imitated with some exertion. One of the arrangements is to totally dispose of the 'lock and key' instrument itself. This venture plans to do likewise by setting up solid security basing on a 'Mystery thumping example', therefore the name, "Thump Based Security System". This framework is involved gadgets like Arduino, GSM Module , Servo Motor and so forth and utilizations a 'Mystery Knocking Pattern' which is known just to the proprietor of that specific safe, bag or some other Property or item that the gadget is introduced on. The expansion in security in executing this framework comes into the image in a few different ways.

2. Existing Systems

RFID technology can be used in the intelligent door knocking system. When anybody tries to open or knocks the door then this action will be sensed and sends information to the user via GSM. But anyone with the false RFID can open door. In finger print method, door will be opened when unique graphical security must be matched. If the culprit has the finger print then they can easily open the door.

In another method, the wireless LAN module fixed on the board receives the transmitted signal and transmits to the microcontroller. The microcontroller passes the data to the servo motor in order to complete the operations on the Door [1].

In thump impression technique, when we thump it, the arduino begins observing the primary thump to secondary thump and keeps the time gap period. In this work 6 thump impressions are taken. Therefore 5 timespans will come. These time lapses were converted interms of variables. Example, if the time period is less than 500ms, then 0. If it is more than 500ms then 1. Like this the total 5 time lapses, converted into 5 digit password. These passwords are used to open the door lock. If it does not match, then lock will not be open.

3. Proposed System

If the entry way thump is entered correctly then the gate will be open. If the thump entry is wrong for consecutive three times then code will be locked and alert will transmitted to approved authenticated client.

Working Principle

In this project work, as an input device capacitive sensor is used. This sensor can detect the electrical capacitance of the human hand. This sensor is built by using aluminium foil, medium to high esteem resistor, wire and a capacitor. When touch sensor contacts with the finger the body capacitance is in parallel to the sensor's capacitance. This makes wavering recurrence decline. The microcontroller recognizes this property.

Here, 3 bits of aluminium foils are introduced on the external side of entry way. The clients can open the entry way by contacting these foils. Because of the usage of three foils, the detection of multifaceted of the finger is possible.

Here, the time period is characterized by RC. Where, R is the resistor, C is the capacitance of the foil. In this system we have to consider the capacitance experienced by the human finger. Suitable rearrangement can balance out sensor readings, making the entire framework solid.

Other than, microcontroller, voltage converter or comparator can be used. This framework can be further improved by using a touch cushion rather than aluminium foils. For example, if the independent momentary capacitive touch sensor used then it can send computerized flag specifically to microcontroller.

BLOCK DIAGRAM & DESCRIPTION

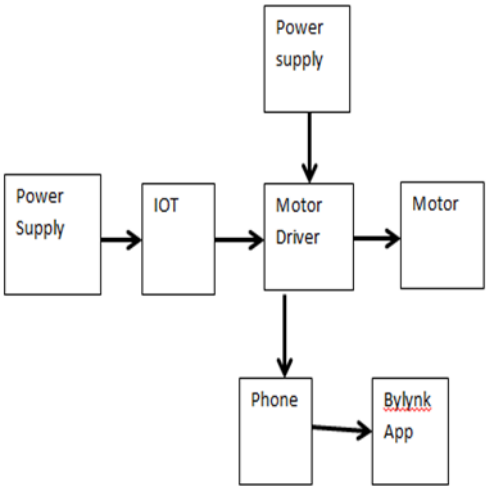

Fig. 1 Block Diagram of Intelligent Door Knocking System

In this work, the door lock is controlled by IOT and Bylynk app. The door is controlled by the motor driver. About the status of the door is delivered to the client mobile phone using bylynk app.

The description of the components are given below

IOT (Internet of Things)

It connects and exchanges the data with other devices and systems using internet. But the drawback is privacy and security. IOT can be used in consumer application field, commercial, industrial and infrastructure spaces. Recent technologies are developed in home automation systems, wearable technologies, in medical applications and remote monitoring systems.

MOTOR DRIVE MODULE:

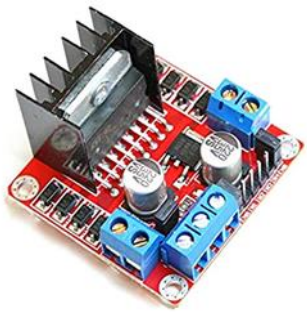

Fig 2 – L298N Motor Driver Module (Source: 2)

The L298N Motor Driver module consists of an L298 Motor Driver IC, 78M05 Voltage Regulator, resistors, capacitor, Power LED, 5V jumper in an integrated circuit.

When jumper is placed at that time only 78M05 voltage regulator is enabled. If the power supply is less than 12V, then the microprocessor is powered by voltage regulator. The speed control pin for Motor A is ENA and for

Motor B is ENB. The direction control pins for Motor A are IN1 & IN2 and for Motor B are IN3 & IN4. This module cab used in robotics, in stepping motors and in drive DC motors. The motor driver used in the project is shown in the Fig.2.

DC MOTOR

DC motor is operated by direct current. It converts DC electrical energy into mechanical energy. This motor works on the principle of when a magnetic field and electric field interact then the mechanical force called as motoring action is produced. Fleming's left hand rule gives the direction of rotation.

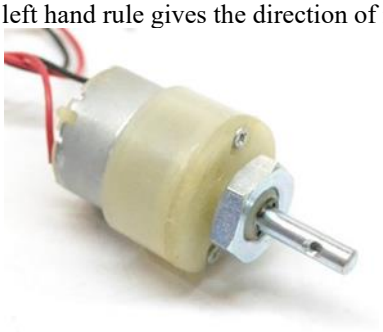

Fig. 3 – DC motor 60 RPM 12V

The Fig.3 represents the DC motor used in the project. The metal gear which is used in it has better wear and tear properties. It requires no maintenance because; the gear box is sealed and lubricated with lithium grease. It runs smoothly from 4V to 12V. It gives 60RPM at 12V.

Tests and Results

This home security system is having two stages. In first stage the client can fix where they want to mark the thump impression and successively they have to do the thump impression. In second stage, from the time gap between the thump impression code word is generated. If the code is correct then door will be unlocked.

The proposed door locks security system shown in the Figure 4. This system is attached on the door with the lock.

When the client wants to open the door, the thumping data were collected. To detect the thumping, piezo electric based vibration sensors were used. These sensor collected data transferred to the arduino. If the data was an authenticated data, then flag will be set to open the door.

All activities are connected with the client's mobile. So the status of the door was continuously monitored by the client.

If suppose any unauthenticated person trying to open the door immediately alert will be given to the client mobile. This system is shown in the Fig. 5

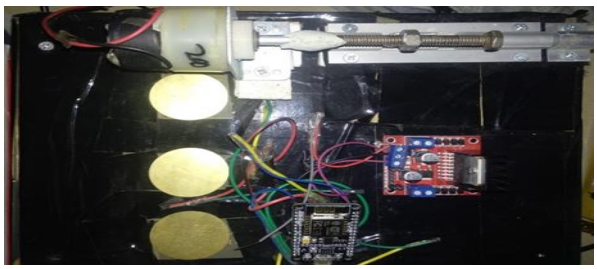

Fig. 4 Door lock security system

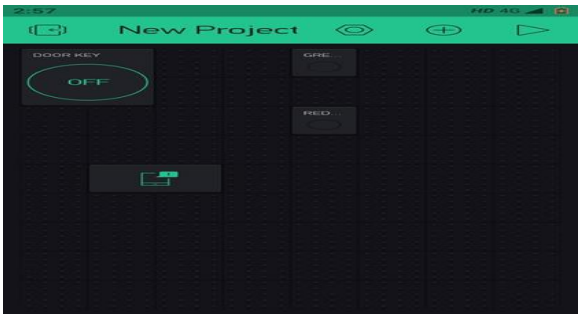

Fig 5: Mobile Alert using blynk app

Pros and Cons

The main drawback is if the door broken then no signal will be transmitted to the client. And the client not aware of this incident. And the advantage is, if any intruder trying to enter with wrong thumping, then alert will be sent to the client through their mobile phone.

In future, the following feature can be added with this project.

If the person is authenticated person and the client having trust then the client can open the door remotely.

4. Conclusion

Thus the proposed framework is very simple and cheaper. The accuracy of the system is very high. So the client can control the entryway remotely. The bylynk app is also a free app. Based on the thumping on the door this security systems works. In future many advanced features like, remote monitoring and contolling of the door can be achieved.

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TEST Engineering & Management

January - February 2020
ISSN: 0193-4120 Page No. 3244 - 3247

Educational Wind Tunnel for the Sports Aerodynamics

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Article Info
Volume 82
Page Number: 3244 - 3247
Publication Issue:
January-February 2020

Article History
Article Received*: 18 May 2019*
Revised*: 14 July 2019*
Accepted*: 22 December 2019*
Publication*: 20 January 2020*

Abstract:
Tamil Nadu Physical Education and Sports University [TNPESU] is India's first university exclusively for physical education and sports in India includes research and courses in Sports technology and science. The Sports Aerodynamics is basic and needed research in the development of Sports products and athlete performance. TNPESU had a Wind Tunnel Laboratory for the Sports science and technology students for education and research purposes. Wind tunnel designed with the objective of analyzing different sports ball, to find the three forces and moments, Pressure distribution and the velocity streamlines in static and rotation of the ball

Keywords: *Sports University, Wind Tunnel. Athletic Performance, Sports Aerodynamics, Sports Ball*

I. INTRODUCTION

The wind tunnel is a facility used for the aerodynamics study to know the motion of air and to calculate the force and moment acting on the body. For the sports aerodynamics research and coursework, the wind tunnel is the essential facility [1].

A wind tunnel is designed based on the application, the velocity of the air in the test section and pattern or quality of the flow in the test section [1]. In the Sports Aerodynamics research the most common models are balls, disc, frisbee, cars, bikes, apparels, cyclists, athletes and stadium mostly all are tested in low Speed subsonic and Atmospheric Boundary Layer [ABL] is generated for the Stadium[1,2].

The Sports Aerodynamics wind tunnel designed and developed based on the maximum speed in the test section, test section size based on the model size with blockage ratio, not more than 5% and the space for fixing the required instruments for the wind tunnel analysis [2,3].

II. SPORTS AERODYNAMICS WIND TUNNEL

A wind tunnel is usually used for the research in Aeronautical, Space and Automobile models like airplanes, wings, rockets, missiles, cars, and trucks [2]. In recent developments in wind engineering, building aerodynamics and sports aerodynamics leads a lot of innovation in the development of the wind tunnel facility [2,3].

In sports aerodynamics wind tunnel the great challenge is to be large enough to study athletes, the length must be large to study the flow stream after the ball and to study the wind characteristics and ventilation inside the stadium[2].

The Education wind tunnel facility aim is to give knowledge and academic activities for students. We will facilitate the wind tunnel for studying sports products like different balls, shuttlecocks, frisbee, disc and apparel analysis with a feasible budget.

III. WIND TUNNEL DESIGN AND DEVELOPMENT

All low-speed Subsonic open circuit and suction type wind tunnel consist of the four main parts honeycomb with settling chamber, convergent

January - February 2020
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section, test section, and divergent section. honeycomb with settling chamber will make the flow steady, linear and laminar flow into the wind tunnel[2,3]. The convergent section will reduce in cross-section area when the flow move to the test section will increase the velocity of the flow. The test section will be large enough to fit the model and measuring devices. The test section leads to the divergent section of the reduction of cross-section area with an increase in length to reduce the velocity of the flow, to avoid vibration and stress on the air suction fan blades [3].

Fig. 1. Low-speed Subsonic open circuit and suction type wind tunnel in TNPESU

Fig. 2. Honeycomb and settling chamber

The wind tunnel has a suction type, ten blade fans have coupled with an AC motor (3Ph, 440V, AC supply) with 7.5 Horse Power at maximum 1480 rotation per minute (RPM) will lead maximum flow velocity of 20 m/s in the test section.

Fig. 3. Wind tunnel fan with 10 blades

The wind tunnel different ball models have developed for education and research purpose. Each ball model was facilitated with pressure and force model. The pressure models will have a valve to connect with a multi-bank manometer or the computerized pressure transducer[4]. The force model to be fixed in Strain Gauge Balance for the measurement of the three axial forces and three moments of the model[5].

Fig. 4. Force model on the left and pressure model

IV. Wind Tunnel Measuring Instruments and Devices

To measure the flow characteristic like pressure, flow velocity, force acts on the model and the flow streamline pattern are in need of measuring instruments and devices. The inclined multi-bank manometer filled with alcohol or water with 13 tubes will help to measure the even a small pressure difference at the model. The pitot-static tube with a

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separate manometer will measure the flow velocity in the test section through static and stagnation pressure readings[4,5]. The pitot-Static tube will move vertically up and down to verify the effect of the boundary layer due to the wall of the wind tunnel. The D3D Camera is set to observe and record the flow patterns (smoke flow) and rotation of the ball [6]. The Smoke generator will generate the linear smoke flow to visualize the flow separation, circulation and the path of the flow streamline

Fig. 5. Wind tunnel control panel and Muti-Bank

Fig. 6. D3D Wind Tunnel Camera

Fig. 7. Smoke Generator

V. Computerization of Wind Tunnel Analysis

The latest development in the electronic instrument made the wind tunnel experiments easier, faster and accurate measurement. Pressure transducer and the Strain gauge balance play a huge role in wind tunnel experiments.

The pitot-static and the pressure models connected the pressure transducer which will display the flow velocity and pressure on the display and in the computer, where the inbuilt software will have the algorithm for the calculation

Fig. 8. Pitot-Static tube and Hotwire anemometer

The hot wire anemometer used to measure the flow velocity which works on the temperature difference due to the flow velocity in the test section. Used for the accurate measurement of the flow velocity in the test section[4].

The Strain gauge balance is used to calculate the 3 axial forces and 3 moments act on the body [3]. The Strain gauge balance mounting system not only supports the model but also rotate clockwise and anti-clockwise direction to study the different sports ball rotational effect.

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Fig. 9. Strain Gauge Balance

The computer had the software with an algorithm to calculate the Pressure distribution, forces acts on the body and the CL & CD measurements and to generate the graphs. All readings can be exported in Excel format[5,6,7].

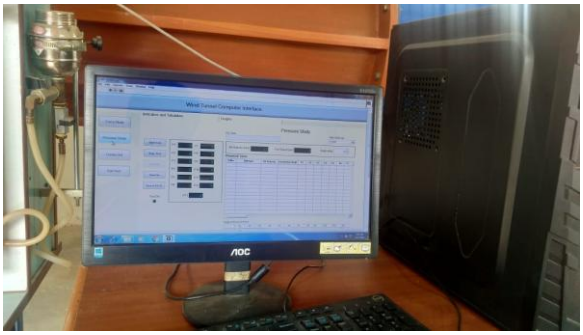

Fig.10. Wind tunnel Computer Software application

VI. CONCLUSION

The wind tunnel is an essential facility for education and research purposes in the Sports Aerodynamics program. The role of the engineer has increased in the development of sports products, infrastructure and athlete performance. Sports technology and aerodynamics skills will lead to a lot of research, career growth and the entrepreneur.

The sports aerodynamics wind tunnel test section is long enough to visualize the flow begin the ball models, the rotating force strain gauge balance is fixed and the multi-bank manometer is customized for the ball pressure models.

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Smart Intelligent Computing and Communication Technology
V.D. Ambeth Kumar et al. (Eds.)

doi:10.3233/APC210023

Study on Intelligent Data Algorithms Implemented in Wearable for Sports Applications

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Abstract: Technological transformation is unlocking new opportunities in wearable devices used in sports application. Nowadays training the sports involves the use of integrating smart sensors, cameras, internet of things and intelligent data algorithms into a device which is wearable making the players to achieve their maximum performance. These smart devices replace the coach and manage all aspects of technical training except for the physical training given by the real coach. This paper provides a comprehensive study on the intelligent data analysis made on the data acquired from sensors to give a meaningful sense to it. The smart training methods employed currently in various sports are identified and presented. The future directions in this area of research are also presented.

Keywords: Wearable devices, intelligent data algorithms, sensors, technical training, sports

1. Introduction

The technological boom has influenced in all areas of human life. Smart devices have changed the way of looking the world. Sports field is not an exception. Wearables take new dimension in monitoring sports activities of the player. These devices incorporated with smart algorithms help the player to understand his performance and help him to compete to next level. Due to developments in internet and cloud services the collected data from sensors can be worked in a detailed manner. Here clever algorithms can be applied which extracts the features, train the data set and can be tested to verify its accuracy. With these resources the devices now become smart Artificial Intelligent (AI) devices which will help the player to train himself and achieve better results. Section 2 discusses the role of wearables in smart training. Section 3 briefs the sensors that are commonly used in devices. Section 4 summarizes the intelligent approach used in the sports wearables and the results obtained. Section 5 lists the challenges faced and section 6 concludes with the limitations and identifies the scope of futureresearch.

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2.Wearables in SportsTraining

The role of coach for a player is very important. Unfortunately all aspirant players do not get their dream coach. Sometimes financial support also poses some problem. So, wearable technology could reduce this burden by providing solution to the above problem. Intelligent algorithms incorporated in these devices gives clues to the player so that he can understand his game profile and take necessary steps to correct and achieve histarget.

Two important sections in wearable device are,

1. Hardware

a. Sensor selection
b. Noise removal
c. Communication to the decision making subsystem

2.Software which takes decision based on acquired signals.

The tasks performed during training require physical effort and it is a continuous process where the ultimate goal is to improve the perfection in the game played. The various stages involved in sports training are,

- Data acquisition
- Intelligent dataanalysis
- Assessment
- Targetrealization

The flow diagram for the sports training is shown in figure 1,

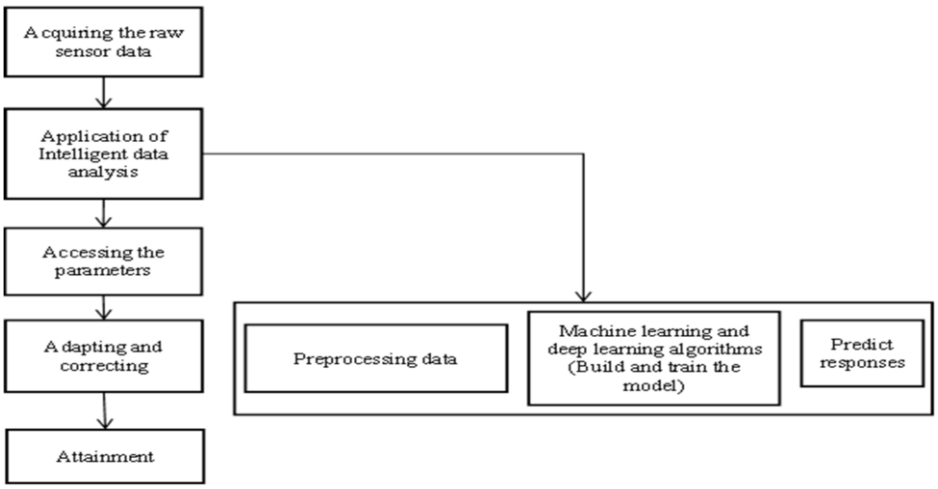

Figure 1. Flow diagram for sports training

3. Sensors

The important consideration for developing a wearable device is the selection of sensors. The sensors should be reliable, small in size, light in weight and durable. The data's from sensors can be used in activity recognition i.e. understand the body kinematics and movement parameters. The machine learning algorithms can be applied on the collected data's to bring out predictions. To get best results the user has to select the suitable algorithm to get the desired insight. The algorithm can be supervised or unsupervised. But all data processing algorithms cannot run on the device itself due to lack of its computational capacity, memory constraints and power back up. So with Bluetooth or wireless module the data's can be transported to a mobile or cloud services where intelligent algorithms can be performed to aid the player in decision making. This virtual coach assists the player in his training replacing the actual trainer. The various sensors deployed in sports wearables are inertial measurement unit which involves accelerometer, gyroscope and magnetometer, pressure sensor array, force sensor, motion sensor etc.

4. Intelligent data algorithms in sports

Intelligent data algorithms and data set can provide a method to analyze the performance parameter of an athlete and can improve his training plan to achieve the best results. Table 1 summarizes the information such as the name of the sport, the sensors used, the features detected, the goal, the classification algorithm and the accuracyobtained.

Table 1. Studies identified in sports wearable sensors with intelligent approach

Ref	Sport	Sensor	Features	Aim	Approach	Result
[1]	Basket ball	Motion sensor	Body acceleration , Gesture	Automatic recognition of basketball training type	Support Vector Machine (SVM)	99.5% accuracy with SVM algorithm or activity recognition
[2]	Basket ball	Accelerometer and Gyroscope	Arithmetic mean and Standard deviation	Classify the action of players	k-Nearest Neighbours (k-NN),Random Forests	Random Forests was more accurate than k-NN
[3]	Fitness	Multiple acceleration sensor on several parts of body/distributed across body	Mean, Maximum, Minimum, Range, Standard deviation, Root mean square	Examine the participant performance on collected data set from a smart wrist wearable device	k-NN, Linear SVM, Naïve Bayes with Gaussian kernel & Bernoulli(NB),SVM polynomial, Decision Tree (DT), Long Short-term Memory (LSTM)	LSTM is best with an accuracy of 92.5%

[4]	Fitness	Accelerometer and Gyroscope, Pulse rate sensor	Mean, Standard Deviation	Classify the indoor exercise activity such as biceps curl, Row, Pushup, Sit up, Squat and Triceps curl	k-NN,SVM, DT	95.3% accuracy for activity recognition and 99.4% for repetition count
[5]	Running	Wireless sensor network deployed in the area of training. MTS 400 sensor board, Crossbow MOTE2 IPR 2400	Mean, Standard Deviation	Develop a prototype to support athlete with ambient intelligent algorithms	k-NN, SVM, Spline Interpolation	Classification system achieves and accuracy of 80% in spline interpolation
[6]	Soccer	Data form video recordings	Mean, Maximum, Minimum, Standard deviation	Classify athlete position and predict the number of goals scored in the game	SVM, RF, Linear Regression (LR)	82% accuracy is achieved in RF and LR
[7]	Football	Data from data set at Tottenham Hotspur Football club	Maximum, Minimum	To predict the recovery time after injury without official diagnosis	SVM Radial basis function (RBF) kernel and polynomial kernel, Gaussian process with RBF and Laplace kernel, Artificial Neural Network (ANN)	Accuracy for SVM-98.43%, Gaussian process-97.4%,ANN –98%
[8]	Table Tennis	IMU sensor	Mean, SD, Skewness, Kurtosis	To detect and classify the stroke in table tennis	SVM linear, SVM RBF, RF, k-NN	SVM linear-95.6%, SVM RBF-96.7%, RF-95.7%, kNN-94.7%
[9]	Tennis	Video recordings	3 layer LSTM network	Classifies the activities in tennis shots	LSTM	81.23% to 88.16%
[10]	Volley ball	IMU, EMG sensors and video cameras	Mean, SD	Identifying and classifying the not allowed moves and providing feedback in training sessions	LSTM	F1 score of 0.74 for labels with 2 classes

[11]	Weight lifting	IMU	Mean, Variance, SD	Classifying the weight lifting exercises	SVM, Linear Discriminant Analysis (LDA)	94.36% accuracy in SVM
[12]	Cricket	Recorded videos	-	Develop AI training system to be used as a coach for trainees to become expert in batting, bowling and fielding	Fuzzy, ANN	Good classification accuracy
[13]	Cricket	Data form IPL matches	Mean, SD	To identify the best set of attributes in the player in the match played	SVM	81%
[14]	Golf	Strain gauge sensor, 3-axis accelerometer and 3-axis gyroscope	-	Investigate Golf swing data classification method	Convolutional Neural Network (CNN), SVM	95% of accuracy is achieved in deep CNN than SVM which is 86.8%

5. Challenges

Plenty of research is open in the field of sports training. Some of the challenges to be addressed are:

1. The authors have shown results conducted with certain method and approach and tabulated their findings. But they are not aware whether these methods will be adopted by all athletes over long term. So the researchers can share their views and results with the real world. Can interact with professional athlete and conduct more experiments and provide a wider scope to researchers.
2. Every player is unique, so integrating intelligent algorithms might not provide expected results for all as the body and thinking are different foreveryone.
3. All most all the design of wearables with intelligent algorithms is still in development phase, it means they are available in prototypes only. So with only proper validation these prototypes can be brought out as a commercialproduct.

6. Conclusion

This paper studies the various intelligent data algorithms proposed and implemented in the field of sports training. With technology the minute details of the game can be perceived. The accuracy and complexity of the models involved in this research vary due to the different classification problems that each model is tasked with. The study observes only few sports are concentrated and research should focus on the design and

implementation of wearable in other sports also. Moreover the security issues in data handling also have to be considered.

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Smart Intelligent Computing and Communication Technology
V.D. Ambeth Kumar et al. (Eds.)

doi:10.3233/APC210082

Smart Industry Monitoring and Controlling System Using IoT

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Abstract. Air pollution in an ecosystem has proliferated industrial automation. This dissertation concentrates more on industrial automation and has design an embedded device with sensors to monitor and control the toxic gases in industries. This entire prototype is an excellent result for observing the toxic gases in industry and generates information by using data acquisition and transmission of data."Internet of Things (IoT)" is a important technology behind this and it provide platform to bring together all the devices in the world to the internet. In this dissertation, the parameters monitored are temperature, humidity and gas leakages in industries. The sensor senses the parameters and uploads these data to the cloud with the help of NodeMCU. If observed gas level is above the threshold which is the safety limit of operation, the first alert is intimated from the Google cloud and the controlling action carried out (ie) automatically close gas leakage valves and then industry will take immediate step to control pollution. Or else, the second alert message is sent through Electronic mail (e-mail) to restore the safe limit, as government play role to power outage in the industries. Cloud is used to store the sensed data, which is then transmitted and processed.

Keywords. Air pollution, Toxic gases, ECO-system, ESP8266 and IoT.

1. Introduction

In the recent years wireless technology and IoT grasped the most industrial area especially automation and control has increasing for need of upholding various sectors. Healthcare has prime importance in our day to day life. This paper reviewed about new industrialization with ESP8266 and arduino UNO. Indoor Air Quality (IAQ) is highly worsens industrial environments, which then spreads from indoor to outdoor, creating a large scale effect around the industrial areas. Long term and short term effects caused by Air pollution causes the people to concern about the air they breathe. The effect of air pollution from industry is monitored scarcely. Our aim is to monitor the air pollution from the heavy industry which leads to undesirable effects on the health of human beings and also affects the environment. Pollution level in comparison to the ambient air quality standards can be done by using monitoring. To protect the people against extreme air pollution. Robust monitoring systems are necessary to alert people and initiate actions.

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2. Review of Related Literature

Kavitha.B.C et al. (2019), insists on using intelligent sensors for pollution monitoring. Collected data from the sensors are sent to the Google cloud makes it possible to monitor the air pollution from anywhere in the world. In case of threating levels of air pollution, alerting is used. This is used in industry and the pollution by vehicular emissions. Rajalakshmi.R et al. (2019), Observes the toxic gases present in the air to ensure the safety of the people in that environment and make it available at any place in the world for monitoring. The composition of chemicals in air like carbon monoxide, LPG, methane and flammable gases is monitored using sensors and this data is sent to the cloud server, which is then represented pictorially for better understanding of the statistics. Rupali et al. (2018), cares for home and industrial safety using fire and gas detection systems. This system detects the leakage of gas and fire using sensing circuit, which is then controlled by microcontroller which in turns triggers the alarm system to alert the leakage of gas and fire. Using GSM modems, SMS are being sent to notify the user. In addition, it is designed with mechanism to sprinkle the water using water sprinkler when there is a fire or gas leakage. MQ-6 and MQ-9 used as gas sensors to detect the gas leakage. IR flame sensor is used for fire detection, which detects the fire and notifies the user using SMS. Manish Verma et al. (2018), uses microcontroller based system to investigate about the toxic gas detection and alerting system. LCD display is used where the levels of hazardous gases like LPG and propane was displayed each second. Authorized person is notified with email and also using alarm generation mechanism. This automated detection and alerting mechanism helps to resolve the problem as soon as possible. Angelica Nieto Lee et al. (2018), this paper focuses on integrating all the contextual data, to provide accurate and relevant information as per the need. System information that already exists but has not been integrated into the monitoring system like 3D models and manuals. It is context aware industrial monitoring systems, which provide information based on system state, environmental conditions and functionalities of the devices in that environment. Ishwarya et al. (2018), insisted on automation of many small tasks around us using Internet of Things (IoT) in order to improve the quality of living. IoT is used for enhancing existing safety standards, using automation process. Gas leakages in open or closed areas can prove to be dangerous and fatal. Traditional gas leakage systems can able to detect the leakage but cannot able to alert the user. Alerting System can be established to alert the authorized person and to perform the data analytics from the obtained readings.

3. Proposed System

The figure 1 below shows the block diagram and prototype of the proposed system. The components used to design the hardware are Arduino UNO, Semiconductor sensor (MQ6 & MQ7), ESP8266, Relay , Power supply. MCP3008 is an analog to digital convertor. Analog values from the sensors are given to MCP3008, which is an 8 channel ADC, that converts the analog data to digital data which is then sent to NodeMCU. The parameters are monitored using DHT11, MQ-6, and MQ-7 sensors. The sensor senses their parameters regarding the temperature, humidity and gas level and uploads these data to the cloud with the help of WiFi device (NodeMCU). If the level of the gas reaches above the normal level, the first alert is intimated from the

Google cloud as it is automatically closes gas leakage valve and then industry will take immediate step to control pollution. Or else, the second alert message is sent through Short Message Service (SMS) to restore the safe limit intended so and as government play role power outage in the industries.

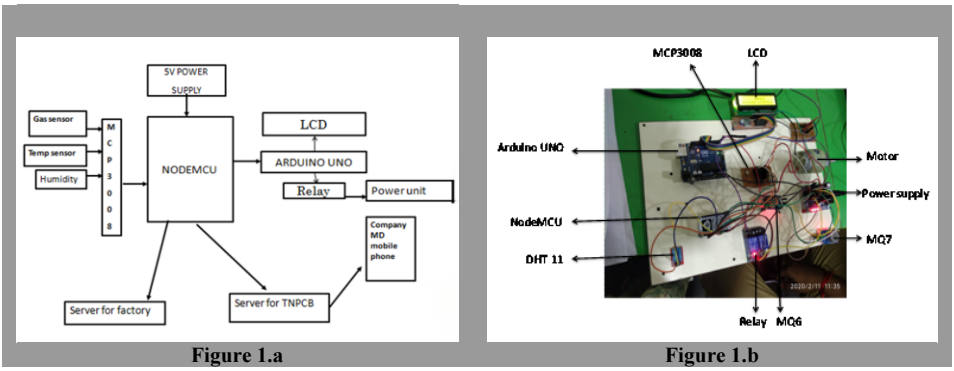

Figure 1.a **Figure 1.b**

Figure 1. Block diagram and prototype of the proposed system

4. Result and Discussion

We are going to test our prototype for different cases are discussed below. For our analysis Gas-1 represents carbon monoxide (CO), Gas-2 represents Isobutane, Propane, Liquefied Natural Gas (LNG) and Methane. Temp represents temperature. Humi represents humidity. Status represents either normal or emergency based on the industrial gas leakage level.

Analysis for Gas-1

In the figure 2.a,the permissible level of Gas-1 is below 300. In this case, Gas-1 does not reaches permissible level, so it is not harmful to the environment. Hence the status is normal.In the figure 2.b, the permissible level of Gas-1 is above 300. In this case, Gas-1 reaches above permissible level so it is harmful to the environment. Hence the status is emergency.

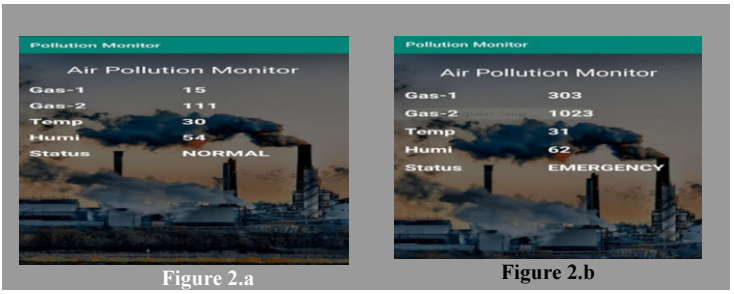

Figure 2.a **Figure 2.b**

Figure 2. Output of Gas-1

Analysis for Gas-2

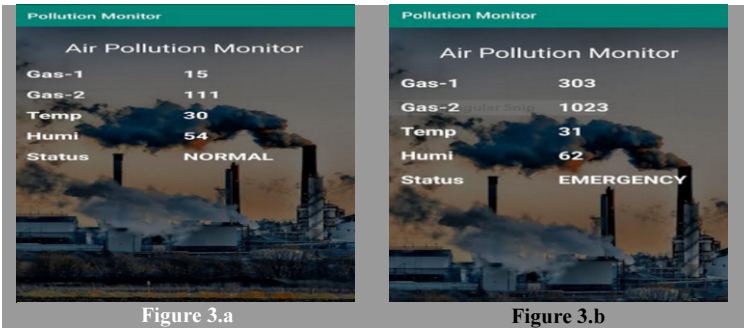

Figure 3.a Figure 3.b

Figure 3. Output Gas-2

In the figure 3.a, the permissible level of Gas-2 is below 300. In this case, Gas-2 does not reaches above permissible level so it is not harmful to the environment. Hence the status is normal. In the figure 3.b, the permissible level of Gas-2 is above 300. In this case, Gas-2 reaches above permissible level so it is harmful to the environment. Hence the status is emergency.

5. Conclusion

In this paper smart Industry Monitoring system based on IoT is proposed which can effectively monitor and controls with alert. A prototype based on Arduino UNO was developed which could sense the concentration of gases. The real time data information obtained from the different sensors has been uploaded to Google Cloud which displayed in the LCD. In addition to this other parameters like temperature, humidity was measured. Provision was also made to vigilant the workers in case of any emergency. The system provides consistently and accurate analysis to prevent any case of accidents. This system makes use of Arduino UNO providing cheap solutions for safety. Slight modification of the model enables the user to adapt it to any environment. Predictive maintenance is an upcoming industrial need, for which the proposed model can be improvised. In case of gas leakage the concentration of gas varies from point to point which has to be analyzed. Moreover, the gases diffusing out during leakage may also combine among themselves producing other by products which have to be dealt in detail.

6. Future Scope

This prototype helps the industrial site from gas leakage deduction and faster resolution of problems afforded by a higher level of expertise focused on control system. This methodology could be applied to monitor distribution network of natural gas as well as industrial, commercial, residential gas pipelines in order to provide a safe operation and to avoid severe human health injuries caused by gas leakages. Proposed solution can act as a automatic vehicle health feed for manufacturer to improve their quality by providing regular vehicle services.

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Smart Intelligent Computing and Communication Technology
V.D. Ambeth Kumar et al. (Eds.)

doi:10.3233/APC210019

A Survey on Sports Video Annotation Frameworks

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Abstract. Video annotation technique delivers many additional video processing capabilities for several applications. Sports broadcast video content is unique in regard to wealth of information as compared to any other video. Sports video annotation is becoming popular among researchers in recent times because of wide range of applications and challenges it pose. The demand for optimized design of framework for sports video annotation is at peak. This paper surveys state-of-the-art in annotation framework design, particularly for sports applications and provides insight into future aspects. This survey may help researchers to further conceive and develop advanced universal frameworks applied to all sports.

Keywords. Sports video annotation, annotation framework design, annotation architecture, broadcasting video, Machine Learning,Neural Networks

1. Introduction

Several technological developments in recent past of video broadcasting and presentation have improved sports video broadcasting quality with significant increase in the number of subscribers. Apart from the conventional TV broadcasting, the boom in OTT platform, web-based (internet) telecasting, reduction in data cost and higher data rate led to a tremendous growth of sports entertainment industry in the recent times. Sports video annotation is regarded as an assisting mechanism in many sports video applications like analysis, retrieval, indexing, summarization[2], browsing/surfing, content mining, video skimming [11], providing supplementary information [10], generate metadata/metainfo for advanced techniques such as artificial intelligence and machine learning [11], video management and many more boundless areas [3,13].

The people in front of various devices watching the broadcast/telecast sports video outnumber the people watching it live on the stadium. So broadcasters have the responsibility to convince the needs of these viewers/consumers to commercially succeed and continuously entertain and retain them as long term subscribers. Annotation in sports video is crucial for broadcasters or even end-users to satisfy their commercial or personal needs respectively [1]. The upcoming sections are categorized as follows: Section 2 outlines the uses of video annotation in various sports video as a specific case.

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Section 3 analyzes various sports video annotation attributes found in literature. Section 4 deals with existing challenges and future aspects on this area. In section 5, we summarize this work and its importance in current research context.

2. Sports Video Annotation

Sports video annotation is still considered as hot research area among researchers due to its knowledge generating capabilities [14] and commercial value [11]. It conveys additional useful information for all kinds of videos [12]. However, the richness of content in sports video is completely different from other general videos. Furthermore, each sport video is diverse in nature, thus demanding different ways of approach in video annotation. For example, ball-only type of sport video annotation is inappropriate for racquet based sport [16].

Framework design of sports video semantic annotation is challenging, complex and very demanding [1,3]. Design of conventional or small scale framework for large scale dataset is becoming impractical [6]. The motive of video annotation and its framework is to relate the video features (low-level) and semantic labels (high-level) [3,13,14]. Moreover the framework should define semantic meaning of objects, events and context [8]. It implies scene interpretation at higher level and data acquisition. It is considered as the toughest task even for computer vision techniques [11,16].

2.1. Framework design/structure

The framework design falls into any one of two major categories. They are specific or generic. Specific frameworks are suitable for many sports videos and they concentrate more on sports/games related annotation tasks and generic frameworks are applied for several genres of videos with sports video as a subset. The Survey related to AVA (Automatic Video Annotation) is proposed by [13] and applicable to all general videos. The literature survey related to Sport video as specialization is carried out in this work.

2.1.1. Specific Framework

Many frameworks proposed in literature are available as sports specific and some of them can be extended to general video applications. This section lists all sport- specific video annotation frameworks and briefly discusses them. Changsheng Xu et al [1] Contributed framework for video summarization and retrieval of sports video. Here, two-level annotation scheme is used. First level gives the overall summary taken from webcasting text. And second level annotates every event of video employing semantics of text as well as video boundaries grabbed from alignment of text or video.

Mentzelopoulos et al [4] has provided a system for extracting shot boundaries using low-level feature video processing algorithms. Campos et al [5] proposed an automatic sports video annotation framework based on Bayesian reasoning framework aiming to annotate court sport videos at all cognitive levels with adaptability and event classification at any time with user request.

Assfalg et al [9] contributed semantic annotation system that utilizes visual cum graphical features on the video frames. Additionally, color histogram is used for object tagging. Xue et al [10] designed an AVA system for archival sports video. This work delivers rich metainfo of the videos archived.

Kolekar et al [11] labeled video clips by automatic segmentation of broadcast videos and framework provides answers of difficult queries related to video clips. Deng et al [16] proposed data analysis annotation framework. It is dedicated to racquet sports videos and has provision for tools to carry out interactive annotation. In addition, they used supporting computer vision algorithms.

2.1.2. Generic Framework

The generic frameworks in literature have potential to satisfy the requirements of sports video annotation. These frameworks are considered in this survey of sports applications, because of having provision to modify them for sport needs. Zhang et al [2] proposed a semi-supervised learning framework with six types of sports events for analysis. It uses labeled, unlabeled, small scale and large scale videos to train the model. Aote and Potnurwar [3] had undergone a novel approach to define a two- level keyframe extraction method for AVA.

Hwang et.al [6] attempted to provide deep insight from enormous video datasets available in internet to train. Getahun and Birara [8] used audio element of scenes to assist identification of object and event using high level architecture. Islam et al [14] highlighted the importance of distributed framework for AVA. The concept is spatio and spatio-temporal oriented that provides application based solution for users. Human action in sports is taken for their analysis. Huskey and Hill [15] facilitated dedicated video pane in video annotation interface with many functionalities.

3. Literature Survey

Various attributes of sports video annotation framework are listed in Table 1 with both specific and generic framework taken into consideration.

Table 1. Attributes of Sports Video Annotation Framework

Reference	Framework Type	Approach	Applications	Sports Use Cases	User/Personal Preference
[1]	Specific	Web Casting Text	Semantic annotation Indexing & Retrieval	Soccer, Basket ball and other sports/ games	Summary Creation
[2]	Generic	Semi-supervised Learning	Training for event detection and annotation	Basket ball	Search and browse Videos

[3]	Generic	Machine Learning	Shot detection, keyframe and feature extraction	Generally sports	None
[4]	Specific	Active region detection & extraction	Automatic Video segmentation for annotation	Football, Squash & Basketball	None
[5]	Specific	Anomaly Detection & Transfer Learning	Annotate court sports video	Tennis	Event Classification
[6]	Generic	Mapreduce training	annotation for large datasets	Basket ball (As framework input)	None
[7]	Generic	Convolutional Neural Network	Analysis and Management	General	None
[8]	Generic	Video Scenes & associated audio	Event and Object Identification	Basket ball (Shot & Scene Identification)	Video addition, threshold setting, result visualizing and XML or SRT file generation for annotation
[9]	Specific	Visual & graphical features using neural networks	annotate videos at different layers of semantic significance	Several sport videos & Studio/Interview shots	Retrieval of specific shots on demand
[10]	Specific	Computer Vision	archival sports video	Baseball	None
[11]	Specific	Event & Concept level	Semantic labeling	Soccer	Answers difficult queries
[14]	Generic	Spatial & Spatio-temporal	1.End-user distributed VA services 2.Developer algorithm services	Baseball (Pitch), Skate boarding & running	create new VA algorithms through VA & APIs
[16]	Specific	Data Analysis with CV Techniques	Multiple level video data annotations	Racquet sports	User event acquiring from videos & offers interactive tools

4. Future aspects

With the advent of advanced learning methods such as machine learning, computer vision and neural networks [3,7,16], the annotation task becomes easier. But, the existing data acquisition abilities suffer from limitations [16] and faces challenges [3]. The need for universal annotation framework for all sports is essential. Preference must be given to scalability, adaptability and applicability features of a framework.

5. Conclusion

This paper summarizes domain-specific and generic frameworks with application to sports video. The characteristics/attributes of frameworks related to sports video annotation are presented. Investigators, particularly in field of sports video annotation may find this work useful for their optimized framework design.

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