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Study the Customer's Perception and Preference towards towards AYU-health (water-based beverage) Pune".

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Abstract :

Shelke Group is a renowned FMCG Company developing new products and entering into the market with new product category. The title "To Study of consumer buying behaviour towards AYU-health (water-based beverage)".which help to understand the perception, opinion and reviews of customers like which brand is a leader in a specific given area. Two hundred customers were selected by using purposive sampling method from two study areas (retailers, residence) in overall Pune City which will help the company to understand customers opinion and it will be utilized for new product development process too.

Keyword: Consumer behavior, purchase behavior , new product development, Packed drinking water etc.

I.   INTRODUCTION

Shelke Beverages is a private limited company that was incorporated in 2008 under "The Shelke Group of Companies". Shelke beverages mainly focus on manufacturing the packed drinking water with the brand name Oxycool. Having introduced the world endorsed and famous treatment processes, Shelke Beverages Pvt. Ltd has steadily become synonymous with pure and quality products. With a plethora of other products already under its name, it is poised to reach new heights and change the landscape of the **beverage industry** in India.

This Research focused on consumer buying behavior towards AYU-health (water-based beverage), as it was a perusal for developing new product. Understanding customer perception, ideas and expectations creates a scope to develop, improve or maintain the product. Routine life of customers or human being faces enormous interconnected health issues. This is the reason majority customer would willing take balance diet. Ayuhealth water is a product which gives the relief to the customer due to that it is essential to study buying behavior of customer towards Ayuhealth water.

II.   Review of Literature

Consumer behavior is the study of when, why, how, and where people do or do not buy a product and it blends elements from psychology, sociology, social anthropology, and economics [1]. Even if the significance of packaged water is not doubtful, there are different constraints that customers should consider when buying packaged water. Customer's complaints about packaged water have been regularly arising mainly due to products storage and han- dling schemes [2]. Majority of customers do not identify points where they can get genuine information on the pros and cons of the packaged drinking water available on the market except media's advertisings. Researcher has been used a combination theory approach, by using descriptive analysis, and

qualitatively. This finding is a strong signal for beverage producers to market the products widely to reach small stores in residential areas. Producers of beverages other than coffee are suggested to emphasize the refreshing or health benefits of the beverage products to gain consumers' preference.[3]

III.   Research Methodology

In this research descriptive research type has been used. The primary data is collected through structured questionnaire and analyzed that made to identify the behavior of customers towards AYU-health (water-based beverage). Universe of the study – Population of Pune City (western Pune) by 2021 is approximately 7,166,374

- Target samplers –Retailers (100) and Residential (100)
- Sample Size – Sample size has been calculated by mean method is 384, however collected responses by all means are 200
- Sampling Method – Purposive Sampling Method.

Data Collection Method – This study based on both primary and secondary data source. Primary data was collected by using semi structured questionnaire for formal survey. In addition, Individual observation on quality of the product, group of customers (age, sex, income) who frequently purchase packaged water, frequently asked questions about the products, customers understanding level of the label, and questions related to motivational factors, preferences, price were given major emphasis. Questionnaire included questions based on demographic data also secondary data sources such as company website, flayers, research paper which described the drinking water access and distribution around Pune city.

- Data Analysis- Graphical Presentation

IV.   Objectives

- To know the awareness of customer towards Packed water.
- To understand the Consumer perception towards Ayuhealth water.
- To know the customer's motivational influence to purchase Ayuhealth water
- To check prime expectations from consumers by Ayuhealth water

V.   Hypothesis of study

H1: There is Significant relationship between sales of Ayuhealth water and motivational factors

H0: : There is no any Significant relationship between sales of Ayuhealth water and motivational factor as an immunity booster

VI.   Data Analysis & Interpretation

- Demographic Information of respondents with statistical details

Descriptive variable Total (N): 200 Retailers of **AYU-health** n=100 and Family Purpose use n=100

	Retailers	Family/Individual uses	
Age (mean ± SD)	34.86 ± 10.8	34.73 ± 11.33	34.8 ± 11.04
Gender			
Male	53	41	94 (47)
Female	47	59	106 (53)
Educational Qualification			
Uneducated	5	2	7 (3.5)
SSC	21	15	36 (18)
HSC	47	48	95 (47.5)
Above college or diploma	27	35	62 (31)
Type of occupation			
Non- Government	72	83	155 (77.5%)
Government	28	17	45 (22.5%)
Family Members (mean ± SD)	4.06 ± 2.24	4.78 ± 1.85	4.42 ± 2.05
Ownership of housing			
personal	34	71	105 (52.5%)
Rental	66	29	95 (47.5%)

Monthly income/ETB			
Below 15,000	30	25	55 (27.5%)
15,000–25,000	45	26	71 (35.5%)
25,000–35,000	12	37	49 (24.5%)
Above 35,000	3	12	15 (7.5%)
Medical history (yes)	31	42	73 (36.5%)
Type of health dilemma persistent disease or symptoms	24	10	34 (46.6)
Child conceived and serving newborn	7	32	39 (53.4)

Interpretation :

From above Table it shows that the respondents from the selected sample areas. Majority age of respondents who purchasing packaged drinking water lies between 34 and 35 years. Both male 94 (47%) and female 106. (53%) had been participated. Female who uses packed drinking water for family purpose are slight higher (59%) than female group as compared to retailers (47%). Most of the respondents had an education qualification of above HSC (78%)), and higher education level proportion (35%) was observed in Individual use -place respondents.

- Promotional Activities of AYU-health water-based beverage.

    Total (N): 200 Retailers n=100 and Family Purpose use l n=100

	N (index)	Rank	N (index)	Rank	N (index)	Rank
Print Media : Flyer	215 (0.22)	3	235 (0.24)	3	450	3

Newspapers, magazines etc						(0.23)	
Broadcasting Media: Radio and Television	364 (0.36)	1	312 (0.32)	1	675 (0.34)		1
Online Display Media : Website/window, social media display etc.	120 (0.12)	4	151 (0.16)	4	271 (0.14)		4
Mouth –Mouth publicity	301 (0.30)	2	271 (0.28)	2	572 (0.29)		2

Interpretation :

Above Table reveals that Table 2 de- scribes Promotional Activities of AYU-health water-based beverage. Television and radio 675 (0.34) were the major media used for creating awareness followed by mouth to mouth publicity from colleagues, 572 (0.29), and print media 450 (0.23). Though customer online access is significantly increased still the promotion through online display is very minor 271 (0.14).

- Customer Preferences and motives behind the buying packaged drinking water.
  Total (N): 200 Retailers n=100 and Family Purpose use l n=100

Reason for purchasing and preference	*N* (index)	Rank	*N* (index)	Rank	*N* (index)	Rank
Traveling (Individually)	359 (0.20)	2	266 (0.19)	4	625 (0.21)	2
Journey and household use	263 (0.14)	5	272 (0.19)	3	535 (0.18)	5
shortage of water	285 (0.16)	4	292	2	577 (0.19)	4

			(0.21)			
pollution in tap/existing water	315 (0.17)	3	302 (0.21)	1	617 (0.20)	3
Hotel and Restaurant service	603 (0.33)	1	264 (0.19)	5	667 (0.22)	1
Packaging material*	192 (0.20)	3	247 (0.25)	3	439 (0.22)	3
Quality of water product*	183 (0.18)	4	282 (0.28)	1	465 (0.23)	2
Price of water Product *	378 (0.38)	1	264 (0.26)	2	642 (0.32)	1
Test of water *	234 (0.24)	2	204 (0.20)	4	438 (0.22)	4

Interpretation:

Above Table depicts that, Customer Preferences and motives behind the buying packaged drinking water. Customers purchased packaged water because of rationales; among these, the basic ones were Traveling (Individually), shortage of water, pollution in tap/existing water and restaurants and hotels service. The prime reason for purchasing packaged water for retailers place respondents was restaurants and hotels service, 603 (0.33), followed by long Journey and household use pollution in tap/existing water, and Shortage of water and individually travel, correspondingly. However, Polluted tap water was the major reason for increase emphasis on buying packaged drinking water for household place respondents. Shortage of water, uses of packed water during individual travel, long journey travel, and food service were ranked second, third, and fourth, respectively. Price of product, 378 (0.38), for retailers packaged water was the main factor to understand customer's preference which is followed by test of water and packaging materials used to pack water. On other hand , quality of the water product (0.28), was the basic fact for household uses and also they are focusing on price and packaging material.

- Customer Satisfaction towards the AYU-health packed drinking water and quantity purchased by Consumers

Total (N): 200   Retailers n=100   Family Purpose use l n=100

Packaged water quantity consumed Liter/wk. ETB/wk.	4.1 ± 3.04 401	11.29 ± 15.05 1129	7.7* ± 11.41 765*
Level of customer satisfaction - Poor	33	12	45 (22.5)
Satisfactory	13	09	21 (10.5)
Good	19	34	53 (26.5)
Very good	14	34	48 (24)
Excellent	21	11	32 (16)

Interpretation:

Above statistical table shows that, Average of both sample size respondents was purchased 7.7 litres. It specifies that, great quantity of Ayu -health packed drinking water was purchased by family members (11.29 ± 15.05) as compared to retailers (4.1 ± 3.04). 26.5%) it is indirectly denoted that there is high level of satisfaction among family members. Average satisfaction of retailers is 67% and family members those who are using Ayu packed drinking water is 88%.

- Customer's issues against Ayu-health packaged drinking water

Total (N): 200   Retailers n=100   Family Purpose uses l n=100

	Retailers	Family Purpose uses	
Do you have any issues complaint against Ayu-health packaged drinking water (yes)	63	50	113 (61.5)
Area of complaint Packing water bottle	1 (1.6)	10 (20)	11 (10.8)
Quality of water	14 (22.2)	20 (40)	34 (31.1)
Price of product	39 (61.9)	12 (24)	51 (42.9)
Taste	9 (14.3)	8 (16)	17 (15.15)
Who is responsible persona for arising issues? Manufacturer	46 (73)	41 (82)	87 (79)
Distributors	8 (12.7)	5 (10)	13 (10.5)
Both	9 (14.3)	4 (8)	13 (10.5)
Are you loyal towards the AYU-health (yes)	23	76	99 (49.8)

Are you Prefer to Shifting brand(yes)	77	24	101 (50.5)
Major reasons for shifting brands Accessibility	5 (6.5)	10 (41.67)	15 (14.85)
Water Taste	8 (10. 39)	2 (8.33)	10 (10.1)
Bottle size	6 (7.8)	6 (25)	12 (11.88)
Competitors brand	41 (53. 25)	4 (16.67)	45 (44.55)
Healthy Ingredient in water	17 (22. 08)	2 (8.33)	19 (18.81)

Interpretation:

Above table states that Customer's issues against Ayu-health packaged drinking water. Out of total sample size 113 (61.5%) customers revealed they had issues against Ayu-health packaged drinking water. Among them, the majority (62%) of retailer's complaints were about price. On the other hand, packaged drinking water quality (40%) was the major criticism for dwellers. Generally, price (43%) was the primary area of complaint followed by quality and test. The majority of customers (79%) thought that producers are responsible for the forwarded complaints.

On an average half of the respondents are shifted their packaged drinking water product for various reasons. (77%) respondents were retailers who change the brand of water product but loyal customer respondents are (23%). and 76% of household respondents were The major reasons for shifting brands in the retailers cases were improved competitors brand

(53.25%) and healthy Ingredient in water (22.08%).Also test of water is objectionable to respondents (retailers) .

Findings :

- Majority age of customers who purchasing packaged drinking water lies between 34 and 35 years
- Television and radio were the major media used for creating awareness followed by mouth to mouth publicity from colleagues, and print media
- The prime reason for purchasing packaged water for retailers place respondents was restaurants and hotels service and Polluted tap water was the major reason for increase emphasis on buying packaged drinking water for household place respondents.
- Price of product for retailers packaged water was the main factor to understand customer's preference which is followed by test of water and packaging materials used to pack water.
- Satisfaction among family members those who are using Ayu packed drinking water more as compared to satisfaction of retailers
- Customer loyalty is more among the customers who are using the packed drinking water for family compared to retailers. And retailers are shifting one brand to another brand of water product because of modified competitors water product
- Retailer customer's issues have price related complaint against Ayu-health packaged drinking water, and family purpose people mainly having concerns related to water quality.

Conclusion:

Water is the fundamental need of human being and also it is a medium of transformation of diseases. In the developing country like India there is major co-relation between customer's level of income, education and trends of purchasing water, preferences and motives and purchasing packed drinking water. Some customers more emphasis on health, quality of water.

It has been confirmed that there is Significant relationship between sales of Ayuhealth water and motivational factors by accepting alternative hypothesis.

Recommendation :

1. Regular Quality check of products, have to increase the plastic quality of bottle because in last few days many complaints are coming regarding the plastic quality of the bottle.

2. The company is able to the problems of the retailers as soon as possible because product price and availability of water product were the major complaint. It would be helpful to reduce dissatisfaction towards packed drinking water or other products of the company.

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IMPACT OF DIGITAL TRANSFORMATION ON TEACHING ATTITUDE OF PRIVATE PROFESSIONAL INSTITUTES' TEACHERS DURING COVID-19 PANDEMIC

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ABSTRACT

Global pandemic Covid-19 changed the entire world and so the Teaching World. When the entire world was leveled ground, a complete transformation occurred in the field of education. The entire mode of education from offline had to be online as learners and instructors could not be together face to face and thus to adapt to the new way of teaching-learning the teachers had to change their attitude. As per the research, nearly 1.5 billion students including 90% of learners are unable to go to Institute physically and the Teachers were left with no option but to rely on this mode yet it is investigated how did teachers adapt and respond to the situation. It was observed that a variety of virtual tools were explored to make teaching happen and this study would explore the various tools explored in professional private higher educational institutes for teaching In this study overall impact on academics is not assessed however the attitude of teachers is apparently transformative and thus the teaching attitude of teachers during this situation in the professional institute will be investigated. This study proposes the qualitative and quantitative interpretation of the impact of Digital Transformation on teaching attitude through in-depth interviews and observations of respondents. It is indicated that research would be carried out with regression analysis to measure the impact of digital transformation on teaching attitude.

Index Terms—Digital transformation, Teaching Attitude, Covid-19 Pandemic

INTRODUCTION

During pandemicit was very imperative for the education sector to understand and provide panacea to this unpredictable situation. Educators had to come out with the roadmap and be the torch bearer. This disruption time was considered as the time of transformation and resilience was demonstrated by the learners and the knowledge disseminators.

The beginning of resilience and transformation in education sector started on the day the country had announcement of lockdown i.e. 24th April 2020 and it was observed and contemplated that digital transformation was the solution however imparting knowledge to make students world ready, was still dangling rather sounded a distant dream at that point in time. The thought of bringing absolute change in entire functioning and system of education was not easy butmissionDigital India acted as boon.

The only panacea for the students now remotely located could have been accessed through this means only.

Educators witnessed very difficult time. There were many limitation such as poor digital infrastructure, absence of techno-savvy trainers or mentors and learning facilitations or strategies which can improvise on student's engagements, however the educators were scrupulously trying to find out the way to this . Albeit solution to all these to large extent was found and soon from offline to online education the redefining, redesigning and restructuring of education happened during this pandemic. The brightest side of this period was the resilience among the teachers and the impact on their attitude transformation in the education sector. In this regard, to determine how this sector has responded to the pandemic as a mitigation that

ensures that learning continues, we have The adaptive attitude among teachers was observed.

1.1. Digital Transformation

The first Global pandemic Covid-19 case was found in India on 30th Jan 2020 and the entire world got affected which in turn resulted into temporary closure of 160 countries (Agrawal et.al 2020). It was estimated by World Bank that almost 1.6 billion of students were not attending schools and colleges across world because the offline functioning of educational Institutes were put on standstillstate. The closure of educational institutes lead to exploration of various tools such as Microsoft teams, Zoom, Webex, Google meet and other virtual tools to make the teaching functional. Also, various tools such a Telegram, What's app, skype were few other virtual tools to make teaching possible. There were few more platforms which facilitated

higher education.

SWAYAM covers over 1900 courses which is national online education platform from school to higher education. This platform has included almost all subjects and the unique feature of this platform is that by doing some certification under this course, credit transfers up to 20% are possible(Agrawal et.al 2020). Another platform is SWYAM PRABHA which has 32 DTH TV channelswhich telecast educational contents throughout the day (Agrawal et.al. 2020).

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Several tertiary sector of education in the country have started to provide online classes to help students continue their education from the comfort of their homes. We are of the view that this pandemic has acted as a driving force towards digital extracted some of the tools used by the sector during the lockdown which talks about digital transformation.

Virtual Learning Tools during Lockdown

Toolsused	Description	Connectivity	Platform	TargetGroup	Conditions of Use
Microsoft Teams	Used mainly by staff and learners in tertiary institutions to hold discussions	Online	Desktop, Laptop, Mobile	Tertiary	All RightsReserved
Microsoft Teams	Teachers in schools offer classes througha livestream	Online	Desktop, Laptop, Mobile	PrimarySecondary	All Rights Reserved
Skype	Used mainly by staff and learners in tertiary institutions to hold discussions	Online	Desktop, Laptop, Mobile	Tertiary	All Rights Reserved
WhatsApp Groups	Used mainly by staff and learners in tertiary institutions to hold discussions	Online	Desktop, Laptop, Mobile	Tertiary	All Rights Reserved
Zoom	Group Discussions	Online	Desktop, Laptop, Mobile	Tertiary	All Rights Reserved
Google Classroom	Teachers deliver lessons and bring assignments and home work	Online	Desktop, Laptop, Mobile	Tertiary, Secondary, Primary	All Rights Reserved
Google Meet	Used mainly by staff and learners in tertiary institutions to holddiscussions	Online	Desktop, Laptop, Mobile	Tertiary	All Rights Reserved

(*Source:* Agrwal, Sharma (2020), The Digital Transformation Of Education In India During The Period of Lockdowndue To Covid-19,7(5)

1.2 TEACHING ATTITUDE

During pandemic Teachers have shown change in the attitude. The entire education system from offline to online had to redefine, redesign and restructure itself. Teachers with the skills they possessed had to opt for skill, unskill and upskill or learn, unlearn and relearn. And by doing this proved to be resilient. The observation of researcher about the teaching attitude of teachers during this pandemic was remarkable. Researcher observed that teachers' attitude towards learning was significantly different. This change in attitude needs investigation as to what extent there was impact of digital transformation.

As we know attitude of Individual can defined with its three components:

1.2.1 COMPONENTS OF ATTITUDE

Components of attitude can be shown with chart shown below in Fig 1.2:

This can be further elaborated as: An individual responds towards an attitudinal object on affective, cognitive and behavioural basis. Affect is considered as emotional component of attitude. It is referred as individual's feeling towards something or someone. Statement such as "I like this" or "I prefer that" reflects the affective component of attitude. Affect is measured by physiological indicators, verbal statement about feelings. (Retrieved from: Docstoc; Article on Attitude).

The second component of attitude is the intention to behave in a certain way towards an object. Behavioral intention is measured by the observed behavior, verbal statement about intention like if we say "I would be willing to do certain work, assigned to me". The component which talks about the 'belief' iscalledcognitive component of attitude. It reflects a person's belief or perception. Cognitive component are measured by attitude scales or by verbal statements about beliefs and thoughts.

When the attitude of teachers towards teaching is observed it can be manifested through emotional component of teachers' toward teaching and thus teachers' feelings towards teaching affected by change in teaching ecosystem. It can be also manifested through another component of teachers' attitude i.e. the belief and thoughts of teachers. The third
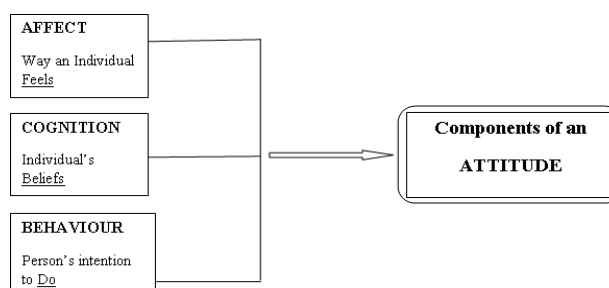
component of individual's attitude is behavioural which can be manifested through observed behaviour or the positive or negative reflection towards the teaching ecosystem. The researcher wants to investigate thatthree components i.e. affective, cognitive and behavioural aspects are impacted due to digital transformation during pandemic and thus the approach of teachers towards teaching changed.

Albeit even before pandemic virtual education system was introduced however complete reliance on virtual education was not there because our education system has three objectives i.e. person and character building, social welfare, and progressive development of knowledge. Apprehension lies about the fulfillment of these goals as having physical

education simultaneously inculcates character building. We learn about coexistence and cooperation while having face to face education. Online education acts as barricade to other goals of education and provides platform for knowledge gain. Unless people learn societal skills education is incomplete. Besides knowledge development also will not have complete circle as there will only theoretical knowledge but people will be deprived of practical knowledge.

Thus, dreaming of complete developed society will remain a dream and will never turn into reality if we just rely on virtual education. This was also a big concern for the educators as they consider themselves the one who cultivates and shapes the society. This also impacted the attitude of teachers towards teaching. The disposition towards teaching brings changes in the value system which is shaped by the three objectives of education i.e. character building, social welfare, and progressive development of knowledge.
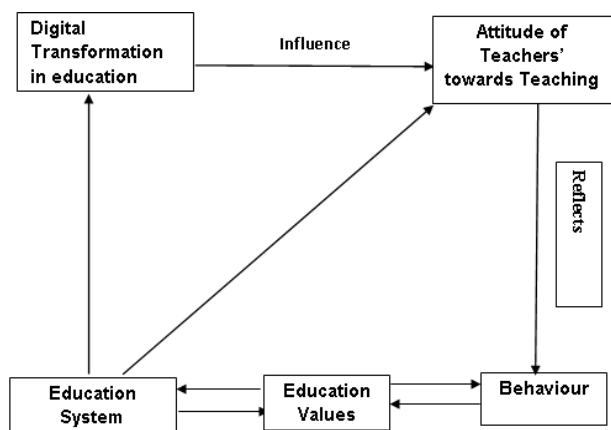
Figure 1.2: Components of attitude

The entire study revolves around Digital Transformation and its impact on teachers' attitude. Change in teachers' attitude which will be reflected through the behavior of teachers will impact the educational values. Educational values are shaped by the objectives of teaching i.e. character building, social welfare and knowledge. Educational values shapes education system which surely further would impact the attitude of teachers. Researcher wants to measure the impact of digital transformation on teachers' attitude during pandemic when they had to completely rely on online teaching. This study would measure whether teachers had positive disposition towards teaching online. Did they prove to be resilient? Did they adapt and made the teaching and understanding as same as it was while having face to face education? Are they satisfied achieving the objectives of teaching and maintain the values of education as it is expected to be?

I.OBJECTIVES OF STUDY

1. To study the Digital Transformation during pandemic in education

2. To study the attitude of teachers towards offline teaching.

3. To study change in education value system during pandemic

4. To study the impact of Digital Transformation during pandemic on teachers' attitude

1. CONCEPTUAL FRAMEWORK OF THE STUDY

Fig.2.1

The entire study revolves around Digital Transformation and its impact on teachers'

attitude. Change in teachers' attitude which will be reflected through the behavior of teachers will impact the educational values. Educational values are shaped by the objectives of teaching i.e. character building, social welfare and knowledge. Educational values shapes education system which surely further would impact the attitude of teachers. Researcher wants to measure the impact of digital transformation on teachers' attitude during pandemic when they had to completely rely on online teaching. This study would measure whether teachers had positive disposition towards teaching online. Did they prove to be resilient? Did they adapt and made the teaching and understanding as same as it was while having face to face education? Are they satisfied achieving the objectives of teaching and maintain the values of education as it is expected to be?

II.RESEARCH METHODOLOGY

2.1 INTRODUCTION

The purpose of the current study is to find out the impact of Digital transformation on attitude of teachers during this pandemic and envisaging whether the educational values which are met through the objectives of teaching, are achieved or not? Attitude of teachers, defined with ABC model of attitude where affect (feels), behaviour (action) and cognition (belief) will the three variables considered and the impact of digital transformation which was brought due to change in mode of teaching in education system i.e. reliance on complete online from face-to face teaching.The emphasis would be given the impact of digital transformation on attitude of teachers. The various tools used for online teaching would be selected one selected one for this study.

2.2 RESEARCH DESIGN

In the first stage of study, pilot study is carried out. Initially content validity and reliability tests is done which suggest that the instrument with different items and scale is appropriate. Research framework isdesigned on the basis of purpose of study. Data is collected from the teachers of private professional Institute of educational hub i.e. Pune to measure

impact of Digital transformation on teachers' attitude. Further impact on educational value is measured which has three objectives to achieve i.e., character building, social welfare and

knowledge.

The Indicative Objectives Research Methodology:

1. To describe the research methodology used in study.

2. To justify the research methodology of research.

3. To explain and demonstrate how research design and data collection and analysis can be utilized in this study to answer the research questions.

The study area for this research will be teachers of various colleges of Pune city (Maharashtra, India). This would encompasses the entire research methodology incorporating research design, research type, research approach, scales used for the measurement, population, sample, tools and techniques etc.

2.3 TYPE OF RESEARCH

This research measures the impact of digital transformation on teachers' attitude. This study employed a combination of research approach or could be called mixed method approach. Problem of this study was explored after going through different literature on changes in practices of teaching and impact on teachers' attitude during pandemic. Thus initially the exploratory research was taken in consideration (Exploratory research aims at gaining information about issue in hand). This further will allow the formulation of working hypothesis. The sample design is done on the basis of scientific and statistical method. The information about population of teachers is gathered. Sample designing was done with the scientific and statistical method. Sampling method is established based on scientific method. The different variables for the study is distinctively defined and the objectives will be set. Also the hypotheses is formulated on the basis of results found in pilot study. Further data collection, tabulation editing and coding is done. Processing and analysis of Data is done using statistical tools and the hypotheses will be statistically tested. This will make the study descriptive (aims to describe social events, relation and events) in nature. Also, this study will measure the impact of different variables on one variable thus employs cause and effect research as well.

2.4 RESEARCH APPROACH

The approach of this research is qualitative and quantitative both in nature. The different independent variables like different value dimensions of education and digital transformation and the component of attitude will be measured on five-point scale and will be converted into quantitative values. Since this research aims to collect an in-depth understanding of human behaviour and the reason that governs that behaviour and so the change in attitude of individual, thus suggests the qualitative approach in research as well.

2.5 SCALES USED FOR THE MEASUREMENT OF VARIABLES

Impact of different Digital Transformation and objectives of educational values on the different components of attitude which measures the teachers' attitude. An electronic questionnaire was used and contains two parts:

First Part: Questions about socio-demographic and occupational data of the participants as age, gender, marital status, residence, work sector (academic or clinical), current employment status, years of teaching experience, whether they have taught an online course before or not, and their experience duration.

Second Part: Questions on faculty perceptions and experiences of online courses adapted from a previous study. The questions are rated on a 5-point scale ranging from strongly disagree = 1 to strongly agree = 5 by which the staff member could express their agreement levels.

2.6 POPULATION AND SAMPLE SIZE

Information for population for the teachers teaching in private professional Institute in Pune is collected through possible secondary data available. Sample size is determined by using scientific method.

2.6.1 SAMPLING METHOD

Since the population is not very large and list of entire population is known, the sampling method used for this can be probability sampling. To select the sample from the population, sampling technique will be used.

2.6.2 SAMPLE DERIVATION

Researcher wishes to evaluate sample size assuming the known population, and understands the variability in the proportion

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that will adopt the practice; therefore some variability say x, p=X (some scientific variability). Furthermore, the researcher may assume the confidence level and precision. The resulting sample size is then be the result.

Total sample size:350

III.DATA COLLECTION AND INTERPRETATION

3.1 DATA COLLECTION METHOD

Data collection isdone very scientifically and systematically. Data which includes facts, figures and other relevant material of past and present which serves the purpose of research will be detailed in following fashion:

3.2 SOURCES OF DATA COLLECTION

Primary and Secondary data is collected for the research.

3.2.1 PRIMARY SOURCES

To find the actual description of characteristics of population and the phenomenon being studied, primary data is collected. Primary source of data is the original source and is collected first hand by researcher through different processes like interviews, observation, discussion and mailing and will be the one not done previously collected.

A questionnaire is developed based on various literature review and keeping under consideration the objectives of the research. Further, the questionnaire is administered to the teachers in the private professional institute of Pune.

The questionnaire was tested on 10 staff members. The necessary modifications, changes, and corrections were done to ensure ease of understanding and clarification of all questions. For testing the questionnaire reliability, Cronbach's alpha test was used and was >0.70 for most of the items.

Questionnaire developed from validated structure designed in the study of Zalad, Hamed(2020).

3.2.2 SECONDARY SOURCE

Secondary source of data contains the data which is already available i.e. which has been already collected and compiled by somebody else for some other purpose. This source consists of readily available data which has already been compiled with statistical statements and reports and which may be used by researches for the study. The different research papers will be referred for the study and will bee collected from different research journal and e-database like Proquest and Ebesco. Moreover different Books, Magazines and Company publications such as advertisements and websites will alsoreferred.

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1.1 ANALYSIS AND INTERPRETATION

A questionnaire is prepared to address the research questions. This questionnaire incudes socio demographic question and analyses the perception of teachers towards the disruption in education which led to digital transformation in education. This further discusses the attitude of teachers towards this digital transformation which comprises of their affective, behavioural and cognitive approach and disposition towards this transformation.

	Faculty of Management Institutes
Age	40+-8
Gender:	
Male	50 (12.1)
Female	300 (87.9)
Marital status:	
Single	84(24.0)
Married	252 (72.0)
Widowed	14 (4.0)
Residence:	
Awayfromworkplace	84 (24.0)
Inthesamecityofworkplace	266 (76.0)
TeachingExperiences(years)(Mean±SD)	20+-5
Worksector:	
Basicsciencedepartments	224 (63.9)
Clinical departments	126(36.1)
Rank:	
lecturer	14 (4.0)
Assistantprofessor	69 (19.9)

Associateprofessor	84 (24.0)	**Ifyes,inwhichareas?**	
Professor	180 (52.0)	Practicalsessions	23 (3.8)
Haveyouhighinternetspeedathome:		Theoreticalsessions	56 (16.2)
		Both	70 (20.2)
No	28 (8.1)	**Ifyes,whatistheduration?**	
Yes	318 (91.9)	<1year	42 (12.1)
Have youever taught a course online beforeCovid-19?		1–2years	28 (8.1)
No	207 (59.8)		
Yes	139 (40.2)	>2years	83 (24)

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	Faculty of Management Institutes (346)No.(%)				
	Stronglyagree	Agree	Neutral	Disagree	Stronglydisagree
Digital transformation makes teaching flexible	98(28.3)	206(59.5)	28(8.1)		14(4.0)
Physical classroom setting over online teaching is favoured due to transformation in teaching mode	166(48.0)	124(35.8)	42(12.1)	14(4.0)	
Experiential learning was difficult to impart	69(19.9)	179(51.7)	70(20.2)	28(8.1)	
Initially Difficulty in adapting online tools for teaching	125(36.1)	221(63.9)			
Theoreticalcourses shouldbeofferedonline	180(52.0)	97(28.0)	27(7.8)	42(12.1)	
Onlinecoursesattractlearnersbecausethereisnoneededsetupfortheclassroom	111(32.1)	165(47.7)	42(12.1)	28(8.1)	
Thelackofstudent-to-studentcontactinanonlineclasswillminimizetheirexperienceoflearning.	56(16.2)	192(55.5)	14(4.0)	84(24.3)	
Conducting and Proctoring exam is difficult	55(15.9)	83(24.0)	83(24.0)	111(32.1)	
Onlinecourses enable contentself-learningmore than "classic"face-to-facecourse	27(7.8)	221(63.9)	56(16.2)	42(12.1)	
Thetechnicalskillsofanonline courseimprovetheeducationalefficiency ofthecollegestaff'sexperience.	194(56.1)	111(32.1)	27(7.8)	14(4.0)	
Morediscipline fromstudentsmorethaninconventionalcourses.	95(27.5)	168(48.6)	42(12.1)	41(11.8)	
Learning and teaching in new mode due to disruprtion and digital transformation taught resilience	194(56.1)	111(32.1)	27(7.8)	14(4.0)	
Perceivedusefulness in terms of learning and increased productivity	111(32.1)	165(47.7)	42(12.1)	28(8.1)	
Acceptance towards digital transformation	194(56.1)	111(32.1)	27(7.8)	14(4.0)	
Table 2: Perceptions and experiences of Faculty of Management Institutes towards digital transformation					

INTERPRETATION

The majority of the participants agreed (32.1%) and strongly agreed (56.1%) that the technical skills to of an online course improve the educational efficiency of the college staff's experience. Similarly, these findings from our research support the results of previous studies (Kleiman G. 2000). Most of our respondents agreed (59.5%) on the advantages of time flexibility of teaching the online course. In contrast, other previous studies (Bhardwaj A .et al , 2015)reported that faculty members considered that e-learning can take time and can lead to student one-to-one care difficulties and can reduce the interest in direct traditional teaching.

This study showed that 36.1% and 63.9% of the participants strongly agreed, and agreed respectively that the online course initially it was difficult to adapt with digital transformation.

Majority perceived usefulness of e-learning which means that faculty accepts that e-learning is valuable in improving and progressing the teaching and learning process and comfortable with e-learning as a tool for teaching and attributed this perception more resilience among faculty, and personal learning preference.

Majorty faculty staff assesses e-learning systems implemented by being profoundly simple to use and operate after collaboration and proper 66comprehension. This could be attributed to the fact that more digitalizationof population is progressing. New blended learning program (i.e. the combination of e-learning technology with the traditional face-to-face teaching) short times before the COVID-19 pandemic with intensive training for all staff members on the online courses, planning and designing the teaching materials before its formal application for students.

In some Institutes, both synchronous (live or in real-time) and asynchronous (recorded or self-paced) e-learning strategies are implemented through learning management systems (LMS) with their applications (e.g. Zoom and Microsoft Teams). These allowed the faculty to adopt of the new technology and its integration into their teaching activities. This study showed that the e-learning system was implemented with a high acceptance level. And faculty showed the resilience. Although there are many barriers and challenges such internet connectivity and skill development however resilience and adoption to the transformation is much appreciated.

As regards the factors predicting the acceptance of e-learning, the logistic regression analysis showed that digital transformation has positively impacted the teaching faculty of Higher education.

SCOPE OF THE STUDY

1. This study measures the impact of Digital Transformation.

2. Digital transformation will include various tools being used to teach during pandemic.

3. It measures the impact on attitude considering the ABC model of attitude.

4. This research studies on only the teachers of private professional institutes of Pune City.

CONCLUSION

Researcher observed that there was drastic transformation in the attitude of teachers. They became very resilient. Redefined, redesigned and restructure the entire system and adapted to the new change. This all happened due to pandemic when entire world got levelled ground and there was a new normal to run everything in online mode. Education sector even observed change and so the teachers. There was change in the attitude of teachers. The values of education system needs to achieve three objectives i.e. knowledge, character building and social welfare. This needs to be measured that what was the extent of transformation on the attitude of teachers and the values of education due to digital transformation during pandemic.

This study will further contribute to the understanding in education sector that to what extent by changing the mode of education will achieve the objectives of educational values. Also, what were the advantages and disadvantages by having the online teaching practices.

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Word Sense Disambiguation: A Supervised Semantic Similarity based Complex Network Approach

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*Abstract -*Lexical ambiguity in machine translation and information retrieval is the challenge. Lexical ambiguity is caused by polysemous words where the word has multiple meanings. In Natural Language Processing before processing human commands the disambiguation of ambiguous commands should be done. The existing disambiguation methodologies disambiguate ambiguous sentences with available context information. The main identified problem is what if an ambiguous sentence doesn't have enough information for disambiguation. The proposed model elaborates an adaptive sentence semantic similarity based complex network approach for identification of ambiguity and resolving it using semantic information. The discussed model represents the sentences of ambiguous documents as a vertex. The weighted complex network is constructed with respect to semantic similarities. The complex network is further processed for the ambiguous sentences having lack of context information. The main goal of this model is to provide an adaptive solution to lexical ambiguity of the paragraph or large document.

Keywords: Lexical ambiguity, Semantic Similarity, Complex network, Sense disambiguation.

1. Introduction

Word Sense Disambiguation(WSD) is the critical problem in Natural Language Processing(NLP). The WSD is mainly introduced by the polysemous word also known as ambiguous word. The ambiguous word has the same spelling and pronunciation but different sense values. The ambiguous words are disambiguated with available context information. A lot of research is done with word embedding and machine learning based classifiers for WSD. The important challenge is disambiguating ambiguous words without context information in large documents. A complex network is constructed by the S-3 model. The sense annotated data is further used for disambiguation. While processing large documents it is very important to store the information of the current sentence because the meaning of 28% sentences are dependent on the immediate adjacent sentences [1]. So while disambiguating sentences in the large document the information of adjacent sentences is required. This feature is provided by the Recurrent Neural Network(RNN) as it consists of Large Small Term Memory(LSTM) [2]. The proposed methodology is representing the ambiguous document in graphical representation, where individual sentence's are represented with vertex and based on semantic similarity the weight value is calculated. The weight value represents the closest meaning sentence to the ambiguous sentence so that the closest semantic similar sentence is considered for the disambiguation. The proposed adaptive model to resolve WSD mainly considers the context information of ambiguous words to discover its correct sense. If the ambiguous word doesn't have context information, then neighbourhood words (vertex) of the ambiguous sentence is considered for the disambiguation. The supervised RNN classifier is implemented with intelligent training and testing. The manual sense tagged data is used for the training. The proposed model uses adaptive word embedding technique for representing text into word vectors. The RNN model with LSTM used as a classifier. The goal of the research is disambiguating the ambiguous commands with correct commands to provide better communication between man and machine. The proposed Sentence Semantic Similarity S-3 based complex network approach for the disambiguation is invented for the ambiguous words or sentences having lack of context information.

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The article is classified into four sections as, section-2 elaborates the available literature for lexical ambiguity with word embeddings and machine learning based classifiers. Section-3 elaborates the proposed methodology with semantic similarity based complex network and supervised machine learning based classifier. Section-4 describes the comparative result analysis of WSD for single sentences and large documents. Section-5 elaborates the conclusion and future work in the field of WSD.

2. Related Work

The WSD problem is solved with two methodologies, knowledge based and Machine learning based. The knowledge based approach is also known as the traditional approach in which standard lexical resource WordNet is used for the disambiguation. It works in a linear manner for disambiguation. The second discussed approach is the machine learning approach.

The unsupervised models discussed by authors R. Navigli and M. Lapata are compared and contrasted with various parameters of edge connectivity that determine the comparative importance of vertices in the graph. Graph theory is full of such steps and tests have been performed in connection with studying the structure of networked environments and as part of the analysis of social networks. [3]

The experiment attempts to determine if some of these features are mainly relevant to graph-based WSD, and examine the role of the selected lexical resource and its impact on WSD. Such comparative research is novel; previous work is limited to only one lexical resource and a possible scale specially designed for WSD or accepted in network analysis [4]. Author's contributions are threefold: a graph-based WSD framework, a realistic comparison of a wide range of graph connection steps using standard test data sets, and WordNet'sense impact index and graph structure to WSD. Authors have proposed WSD for regional language with shallow parser [5]. A database labelled Part of Speed (PoS) has been created. PoS marking is done with a shallow parser. PoS taggers play a vital role in determining the exact meaning of ambiguous words in a sentence. A shallow parser identifies the meaning of a polysemous word and the same information is stored in the generated database. The POS of each value of the ambiguous word is stored. The problem here is multiple statements with more than one result value. Authors solved the problem of lexical ambiguity and semantic ambiguity using a graph-based centrality model [6]. An ambiguous sentence graph is built by giving a sequence of words with corresponding valid meanings. When disambiguating, the algorithm tries to identify ambiguous words in the graph vertices. If the selected vertex has no context information to resolve the ambiguity, the next closest vertex is considered.

The methodology discussed is divided into preprocessing, PoS marking and normalization, and ambiguous word detection and disambiguation. We use the Stanford parser for PoS tagging. The result is a set of semantic values that can be used to assign values from WordNet and BabelNet lexical resources. The WSD discusses a sentence with available contextual information by the author [7]. An ambiguous command is being processed. An ambiguous sentence word was found. The available context information of the semantic word is stored in a locally generated database. The WSD procedure initiates by determining the similarity between a set of ambiguous words for each meaning and a sentence containing the ambiguous word. The cosine method is used for word embeddings because it takes the closest possible value of the ambiguous word. Considering the same moment, the number of meanings of the polymorphic words decreases. The problem lies in the function. Algorithm ShotgunWSD 2.0 proposed by the authors [8] of ShotgunWSD does WSD at the document level with three categories:

The first is to generate a list of possible configurations for every window using the WSD brute force algorithm in the short context of the window selected in the document. The second is to combine the local discovery configuration into a longer one by combining the prefix and the appropriate suffix. In the third step, the meaning of each ambiguous word is selected based on a mass voting system that measures the resulting construct by length and considers only the higher constructs in which the correct meaning appears.

Existing methods discussed are for one-sentence WSDs. One hot encoding, Word2Vec, Glove, BERT models are discussed for embedding in Word. Given the shortcomings of one hot encoding because it creates a large vector for ambiguous words. Word2vec, where two words with the same meaning are used to identify synonyms. BERT generates multiple word vectors for the same word. All methods can be applied to a single sentence containing contextual information. The proposed adaptive word embedding is used for WSD of large documents.
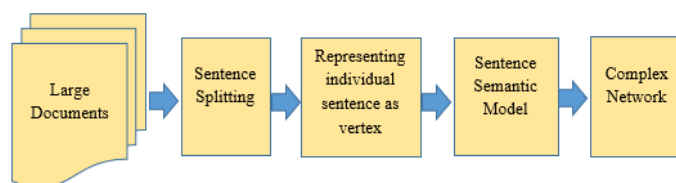
3.   Methodology
I.   Graph Construction

Figure 1- Functional Blocks of Methodology

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Figure-1 shows the functional blocks of the proposed model. The ambiguous document is input to the model. The sentence splitting is performed on the input document and every sentence is separated. The dot separated comment is prepared from the input document. The local generated dot separated file is further taken for processing. Every sentence of the file is now represented as a vertex of Graph. Randomly the vertex with id is created and the same information is stored into the database with node and id. Once vertices are created the next task is to draw the edge. The edges are drawn with respect to the S-3 model. The semantic value of every vertex with every other vertex is calculated and based on semantic similarity the edges are drawn. Here some vertex may be isolated vertex because not a single sentence of the document is semantically similar with it. The output of this stage will be the complete annotated graph with weights and weights are nothing but the semantic similarities of sentences.

II. Sentence (Vertex) Processing
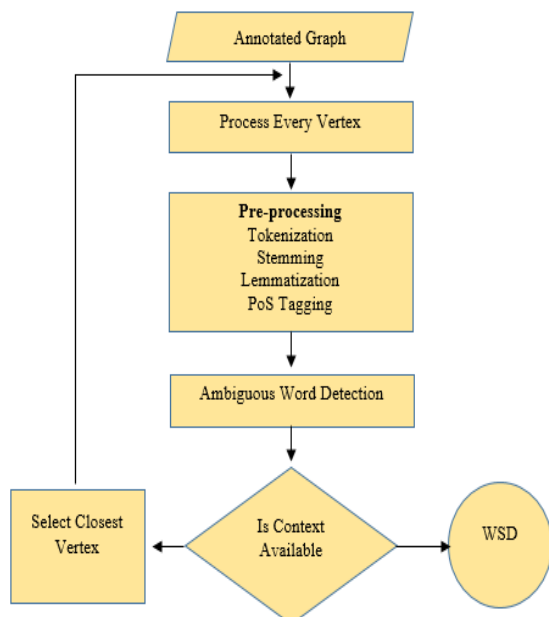
Figure 2- System Flow diagram

The system flow diagram shown in fig-2, describes the actual processing of the vertex. Here every vertex of the graph is considered for the processing. The sentence data associated with vertex is taken from the local generated database. The sentence is now pre-processed with tokenization stemming lemmatization and Part of Speech Tagging. The ambiguous/pronouns word from the sentence is identified. If the ambiguous word is having enough context information for disambiguation, then disambiguation will be done. If ambiguous words don't have enough information for disambiguation, then the next closest semantic similar node who is having less weight to the vertex is taken into consideration for disambiguation.
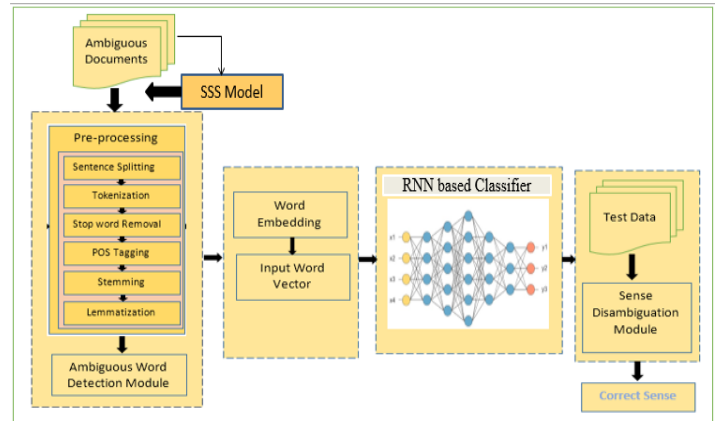
III. System Architecture

Figure 3- System architecture

Figure-3 shows the proposed WSD system architecture. If the ambiguous word has context information, select and configure the word vector. To represent an ambiguous word in word vector, the word vector with 897 features is constructed. The word vectors are provided as input to the RNN classifier. The output of the classifier will be the sense value. The sense values are further matched against freely available WordNet lexical resources to extract the exact meaning of ambiguous words.

IV. Sentence Semantic Similarity(S-3) Model

The Proposed Semantic Similarity model calculates the semantic similarity of two sentences by taking the depths of the two-synsets in the freely available lexical resource WordNet.

$SSS(V1, V2) = 2*depth\_LCS / (minimum \{depth\_lcs$ in $depath\_LCS\}(depth\_V1- depth\_lcs)) + minimum\{depth\_lcs$ in $depth\_LCS\}(depth\_V2 - depth\_lcs))$,

where $depth\_LCS(V1, V2) = arg\_max\{longext\_comman\_subsequence$ in $LCS(V1, V2)\}(depth\_lcs)$.

$SSS(cyclone\#n\#2 , hurricane\#n\#1) = 0.9565217391304348$

"T1 = D_Trees(cyclone#n#2) =[1] *ROOT*#n#1 < entity#n#1 < physical_entity#n#1 < process#n#6 < phenomenon#n#1 < natural_phenomenon#n#1 < physical_phenomenon#n#1 < atmospheric_phenomenon#n#1 < storm#n#1 < windstorm#n#1 < cyclone#n#2"

"T2 = D_Trees(hurricane#n#1) =[1] *ROOT*#n#1 < entity#n#1 < physical_entity#n#1 < process#n#6 < phenomenon#n#1 < natural_phenomenon#n#1 < physical_phenomenon#n#1 < atmospheric_phenomenon#n#1 < storm#n#1 < windstorm#n#1 < cyclone#n#2 < hurricane#n#1"

Depth_LCS = depth(cyclone#n#2) = 11

Depth_1 = minimum(depth({D_tree in T1 | tree contains LCS })) = 11

Depth_2 = minimum(depth({D_tree in T2 | tree contains LCS })) = 12

Sementic_Score = 2 * Depth_LCS / (Depth_1 + Depth_2) = 2 * 11 / (11 + 12) = 0.9565217391304348
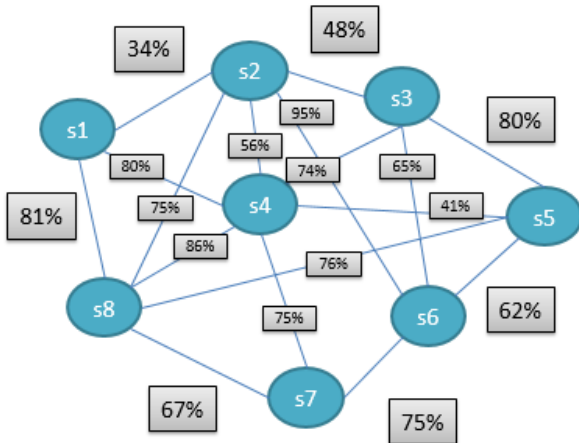
V. Complex Network

Figure 4- Complex Network Approach

Figure-4, shows the actual output of the S-3 model. For large documents or paragraphs, the complex network is constructed by considering individual sentences. The semantic similarity of every sentence with every other available sentence is calculated and based on the edge is drawn. The fully annotated graph is constructed with the weights. Weights describes the actual semantic distance of two sentences. If the vertex s1 does not have enough information for disambiguation so immediate vertex s-8 will be taken into the consideration for disambiguation sentence s1.

4. Results

The outcome of the proposed S-3 model is displayed in figure-5 as an output screen. The first output screen shows the semantic similarity for sentences or words. Output screen-2 shows the semantic similarity of all words of sentence-1 to all other words of sentence-2. Based on the semantic similarity the complex network is constructed. Figure-4 is the output with the ambiguous sentence that has been given as input, first ambiguous word detected in ambiguous sentence and finally available meanings of the ambiguous word with respect to context is shown

Output Screen:1 S-3 Model

The S-3 model initially starts with the sentence and finally goes for the paragraph or document.

	Eventually /RB	,/,	a /DT	huge /JJ	cyclone /NN	hit /VBD	the /DT	entrance /NN	of /IN	my /PRP$	house /NN	./.
Finally/RB	-	-	-	-	-	-	-	-	-	-	-	-
,/,	-	-	-	-	-	-	-	-	-	-	-	-
a/DT	-	-	-	-	-	-	-	-	-	-	-	-
massive/JJ	-	-	-	-	-	-	-	-	-	-	-	-
hurricane/NN	-	-	-	-	0.9565	-	-	0.2857	-	-	0.3158	-
attacked/VBD	-	-	-	-	-	0.8571	-	-	-	-	-	-
my/PRP$	-	-	-	-	-	-	-	-	-	-	-	-
home/NN	-	-	-	-	0.3529	-	-	0.6667	-	-	1.0000	-
./.	-	-	-	-	-	-	-	-	-	-	-	-

Output Screen:2 S-3 Model

For the sentence-1 and sentence-2 shown in output screen-2, the semantic similarity values are calculated for all the words of sentence-1 and sentence-2.

Figure 5- Result screen

Figure-5, shows the output screen where the sentence of paragraph or document is selected for the disambiguation. The command Lets go to the bank for translation is taken for processing because of ambiguity and ambiguity is introduced by the bank. According to WordNet bank is an ambiguous word having a sense value of 20. After pre-processing includes tokenization, stemming, lemmatization and PoS tagging ambiguous words are identified. Based on available context information of the polysemous word 'bank' the correct meaning as 'transnational unit' is extracted from the lexical resource WordNet.

5. Conclusion and future work

The proposed an adaptive sentence semantic similarity model to address the problem of lexical ambiguity in WSD. The result demonstrates that the disambiguated results for the paragraphs generated by the S-3 model can perform better for large documents with respect to the available context representations of polysemous words and semantic data of sentences. The proposed model calculates the dept_LCS and the semantic similarity of individual words of the sentence combinly helps to generate more accurate semantic keys. The S-3 model gives more accurate results for word documents with size 349 KB, but we still need enough data for the model to perform. Finally, further modifications to the model can provide the best performance, and we will explore

supervised learning using WSD for large documents in the future.

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Resource allocation in 5G network using Orthogonal Frequency Division Multiplexing-Hybrid Automatic Repeat Request

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Summary

Fading, interference, and collisions cause unpredictable data loss in a wireless channel. In the recent past, the use of polar codes for error detection and correction scaled downed the data error rate considerably. With the introduction of 5G mobile network, minimizing the data loss and enhancing the performance becomes imperative. Here, the use of polar codes based OFDM-HARQ mechanism with CRC is simulated and implemented. The proposed technique was tested for various fading channels. A bundling mechanism is used to attain the optimal number of retransmissions to accomplish better frame dropping ratio and throughput. It has been observed that the bit error rate of the proposed system has improved by optimizing Eb/No and bandwidth. At this optimum setting, the bit error rate has been enhanced by 25%. At the same time, the system optimizes retransmission count to a value of three, which improves frame error rate at the desirable bit error rate of 10^{-6}. Further, the use of the proposed optimized polar code reduces complexity computations from one third to one fifth as compared to conventional system modeling using turbo codes. An enhancement in frame dropping ratio by 8% to 12% as well as throughput by 10.23% to 14.33% is achieved. The work carried on the hardware system shows that data loss in the OFDM-HARQ communication system can be minimized by improving the bit error rate and throughput required for device-to-device communication in the 5G network.

KEYWORDS

CRC, FEC, FER, HARQ, OFDM, QoS, SC, SDN, WLAN

1 | INTRODUCTION

Wireless communications with mobility have enormously improved the user experience. Currently, video streaming is extensively used in the education and entertainment industry. All applications demand reliable transmission of data without packet loss. In a wireless medium, packets are lost due to interferences and attenuation. Hence, there is a need to implement an optimized resource allocation method to offer the necessary quality of service (QoS). The dynamic and unpredictable channel is the biggest challenge in achieving the required QoS. Further, the system also suffers from limited bandwidth. On the other hand, millions of mobile users are demanding higher data rates and large network capacity to meet intensive service requirements. Data traffic in the mobile network needs substantial bandwidth, which is a

scarce, valuable resource. However, various mechanisms are also used in mobile systems to improve link quality at the cost of system bandwidth. They are adaptive modulation, adaptive forward error correction (FEC), optimal power and coding allocation, and automatic repeat request (ARQ) to name a few.

Two important topics in communication are source coding techniques for compression and channel coding techniques for error detection as well as correction. Source coding facilitates data compression as well as bandwidth utilization. On the other hand, channel coding combines redundancies with data bits for reliability. Presently, turbo code as Channel FEC codes are adopted for cellular systems. However, three GPP standardization groups are currently proposing to consider LDPC or polar codes in 5G. Further, cyclic redundancy check (CRC) detector is used for error detection, and thereafter, the receiver requests for retransmission. This process of ARQ is used to enhance the BER as well as throughput performance. The introduction of redundant bits in FEC coding further increases the reliability of transmission. This mechanism of error detection and correction is called HARQ.[1,2] Further, suitable modulation techniques and coding schemes help to optimize the power and bandwidth resources for mobile systems. In general, the system is categorized as a power and bandwidth-limited system. In a power-limited system, a coding scheme saves power at the cost of bandwidth, whereas in a bandwidth-limited system, a spectrally economical modulation scheme utilizes bandwidth at the detriment of power.

Presently, the future-generation 5G network is well-thought-out as an ultra-high-speed technology. Further, the development of novel architectures as well as service management algorithms is needed to solve matters related to achieving desired QoS in terms of capacity, speed, and reliability. Cloud computing, software-defined networking (SDN), and Internet of things (IoT) are a few technologies for the 5G network. Cloud computing aims in providing well-organized solutions for wireless communications. It helps to reduce infrastructure costs to manage information, whereas SDN dissociates control and data channels. This, in turn, helps to support always shifting network architectures. Recent suggested technologies for 5G and beyond generations is described in brief below:

- **Millimeter waves:** The massive rise in data traffic gives a congested frequency spectrum. Hence, limited bandwidth is available for a user that is resulting in a leisurely as well as unreliable connection. One way to resolve this difficulty is by utilizing millimeter waves for wireless communication.
- **Terahertz wave**: Terahertz wave has a frequency higher than millimeter waves. Further, the globalization of 6G networks is intensifying the wireless market hastily. Hence, researchers are also proposing to use this band for wireless communication. It provides the benefits of miniaturizing antenna size, reduced power consumption, and enhanced security.
- **Massive MIMO**: The thought of ultra-massive MIMO has to stand up in current years. It uses plasmonic materials to design and fabricate antennas as well as transceivers. Hence can provide better spatial multiplexing and beamforming. It helps to enhance data rate and communication range.
- **Small Cells or Heterogeneous Networks**: These are low power and small base stations. They are located at 100 m. It covers moderate geographical territories. It also helps to prevent signal dropping in dense areas. Hence, can deliver broadband services with high-speed as well as latency required for 5G.
- **Beamforming**: The base station can adjust the antenna radiation pattern. Further, millimeter waves are having a shorter wavelength and are not able to infiltrate through obstacles. Hence cannot disseminate to larger distances. Thus, beamforming helps the user to receive a strong signal. It also enables the base station to find an appropriate route for the distribution of data to the mobile user. Hence reduces interference and enhances the utilization of channel bandwidth.
- **Device Centric Architecture**: Presently, densification in the network and use of millimeter waves for communication is demanding existing base station centrical architecture to evolve into a device-centrical architecture in upcoming networks. In this, the user device can communicate over several heterogeneous nodes for data exchange.
- **Full Duplex Technology**: It implies the concurrent transmission as well as reception across the identical frequency band as well as at the even time. 5G networks use full-duplex mode for signal transmission to increase two times network capacity. It helps to avoid interference.
- **Visible Light Communication:** It is foreseeable key empowering technologies to support smart city applications for 6G networks. It uses visible light for signal transmission over the petite distance. It does not stimulate electromagnetic radiation.

This paper is categorized into different sections. Section 2 presents a look at the literature review. In Section 3, a test engine model for polar code-based OFDM-HARQ scheme is developed with a list of parameters used for simulation of

the proposed work. In Section 4, implementation of the scheme for device-to-device (D2D) communication is presented by an algorithm. The results are drawn in Section 5 followed by a discussion with conclusions in Section 6.

2 | LITERATURE REVIEW

In HARQ, the receiver requests retransmission to decode data. A HARQ scheme with polar code is suggested in Tavildar[3] with the help of a joint decoding technique. HARQ technique is used in the LTE system to reduce the effect of multipath fading in the downlink channel.[4] It is observed that more than one HARQ retransmission improves the LTE system performance. The performance of turbo, LDPC, and polar code is assessed in a previous work,[5] where turbo code accomplishes the frame error rate (FER) of 10^{-3} at Eb/No of 1.9 dB as compared to 1.6 dB of polar code. The overall polar decoder performance with CRC is comparable to current codes that are considered in present-day wireless standards. Polar codes and spatially coupled LDPC codes are considered for future coding standards is mentioned in Arıkan et al.[6] The authors have discussed the trade-off between complexity and data rate in time-varying channels. The code that is designed by unrolling the decoding tree algorithm is presented in Sarkis et al.[7] It significantly reduces the latency by adopting a list decoder. It achieves the enhanced throughput as well as comparable FER. Here, considerably shorter codes are considered for experimentation. In Arikan et al.,[8] Analog Digital Belief Propagation decoding algorithm is introduced for spatially coupled LDPC codes. It is seen that complexity is not a function of alphabet size. Deng et al.[9] have a claim that the combined technique of detection and decoding reduces the complexity of polar coded OFDM-IDMA system. Matary et al.[10] have investigated variables that influence the effectiveness of ultra-wideband channels in a multiuser environment. It is shown that the polar-coded system is less complex than the LDPC-based system. The performance of numerous permutation graph theory-based polar-decoder is proposed in Elkelesh et al.[11] The encoding process using polar code is presented in Bioglio et al.[12] for the 5G standard. It is seen that the polar codes have low hardware complexity. Further, it can be designed for a varied range of block lengths. The successive cancelation (SC) decoding presented in Abbas et al.[13] achieves fewer computations as compared with current belief propagation (BP) decoding. However, the SC decoding has long latency because of its sequential nature. In Zhao et al.,[14] it is observed that low SNR polar codes are flexible to design as compared to LDPC codes for the AWGN channel. This contribution leads to substantial enhancements in performance against the hardware complexity required in practical applications. The roadmap of channel coding starting with Hamming codes to present available Capacity-achieving codes is explained in Costello and Forney.[15] Krishna et al.[16] claim that the 64 QAM modulation technique used in LTE Air Interface provides better data speed with given spectral utilization. It is suggested that a hybrid OFDM-MIMO system overcomes fading effects and achieves data speed near 100 Mbps.

The working principles, advantages, and disadvantages of several FEC codes are discussed in Xinyu.[17] It is found in Costello et al.[18] that channel codes are playing a vital role in a mobile system supporting multimedia services. A correlated source coding configuration is proposed in Slepian and Wolf,[19] configuring independent encoders of every source. The ensemble message with a finite set of members used for optimum coding is described in Huffman.[20] The modified iterative polar decoding methodology proposed in Jadhav et al.[21] requires one iteration to attain a bit error rate (BER) of 10^{-4}, whereas the Gauss elimination method needs two to three iteration cycles. This system minimizes complexities as it has adopted a lookup table-based memory codebook. Polar code construction for specific SNR along with modified sum-product decoding algorithm is presented in Marne and Mukherji.[22] The proposed system supports M2M communication in 5G with high link reliability. Improved error resilience is achieved by transmitting a partial redundant copy of the present frame along with the primary encoded future frame.[23] The information about the offset between the current N^{th} frame and future $N + K^{th}$ frame is attached with the partial copy. If the Nth frame is lost, de-jitter buffer is checked for availability of the $N + K^{th}$ frame for the extraction of the lost frame. The offset can be set dynamically depending on the packet loss. The performance of polar codes is compared with convolutional codes, and authors have shown that polar codes perform slightly better in terms of different block sizes and rates that were used.[24] LDPC and polar codes have been compared based on reliability, decoding complexity, energy efficiency, encoding complexity, and security. Authors claim that LDPC codes have less encoding-decoding complexity but are less reliable. There exists a tradeoff and the suitability of the code depends upon the application. LDPC codes for data channels and polar code for control channels have been suggested.[25]

Researchers exploited issues of performance versus complexity and measures of complexity to be redefined by future generations of technology. Further, the influence of the HARQ mechanism on the LTE system is studied for various channel conditions. Some improvements have also been suggested by the researchers to reach an optimal

retransmission count for each instance of channel qualities.[26] The precipitous growth of the 5G network is demanding transmission speed as well as guarantee QoS. A different resource allocation technique employing deep learning is presented in Huang et al.[27] to crush the advantages of resource utilization. A neural network is designed using channel information to decide the optimization of resources. Here, a fast-changing channel environment is considered for simulation. Observed results achieve lesser time computations. Resource management enhances heterogeneous 5G networks' performance. A genetic algorithm is presented in Kao et al.[28] that provides user association and effective allocation of the resource block. Here, throughput and fairness are considered as QoS measures based on channel quality indicators. The results show enhancement in total throughput by 32.7% and 37.6%. In Xu et al.,[29] important information on the heterogeneous network is presented. It utilizes small cells into macro-cells coverage to improve QoS. Two techniques such as learning and control-based resource allocation structure are elaborated. HARQ is a favorable link adaptation system in the 5G network that provides reliable data communication. A chase combining technique is explored in Bedoui and Et-tolba[30] with a deep learning approach to reduce channel impairments. 5G networks are having dense structures and has high data rates, which causes high interference and thus reduces spectral efficiency. A soft frequency reuse technique is presented in Huo and Jiang[31] to reduce interference with the OFDM used at base stations. Resource allocation required for television to provide multimedia service in the 5G cloud is presented in Yu et al.[32] A long short-term memory model is presented to create to cater dynamic traffic. A framework is presented in Bashir et al.[33] to control spectral resources as per the user requirements as well as network behavior for cloud access in 5G. The results can achieve a 15% improvement in optimization as well as QoS. Decoupled cell association approach helps to mitigate interference issues is described in Khan et al.[34] and handles network traffic problems. It employs an outer approximation set of rules to attain near-optimal results. High reliability, as well as low latency, are required QoS to support machine-to-machine applications in wireless communications. Here, a HARQ scheme is presented in Kaneyama and Ochiai[35] that combines low rate coded OFDM and ARQ to enhance throughput. Exhaustive information on HARQ methods to integrate them with wireless techniques in a 5G network is presented in Al-Dweik et al.[36] Here, computations, power efficiency, throughput, and delay are considered as QoS measures. Performance of channel estimation of the OFDM-IDMA system is enhanced with a combination of the lion as well as group search optimization algorithm. The optimal choice of pilot tone positions in Marne et al.[37] attains a minimum value of mean square error. In Saxena and Sindal,[38] several long-term evolution propagation models are proposed. Further, throughput and SNR are measured and compared on various Doppler frequencies. It is observed that channels at lower SNR values have a small effect with higher values of Doppler frequencies.

With the comprehensive literature review, it is jotted down that some improvements are still needed to achieve optimum retransmission count for proper utilization of transmission power and bandwidth. The proposed polar code-based OFDM-HARQ system is based on a bundling mechanism for channel estimation. It is shown that polar code for error correction helps to enhance throughput and BER.

3 | SIMULATION MODEL FOR POLAR-CODE BASED OFDM-HARQ SCHEME

The proposed scheme adopts a retransmission mechanism to provide better resource utilization. A hybrid combination of polar code as FEC with CRC to implement the HARQ mechanism is presented. Figure 1 illustrates a block diagram of the system to achieve error-free communication in the existence of distortion, noise, and interference. The model consists of polar encoder-decoder, MQAM modulator-demodulator, and IFFT-FFT blocks. It leads to generating versions of the signal that arrives at the receiver with various delays and results in poor detection performance. Hence, the number of errors increases and generates intersymbol interferences (ISI). Polar code as FEC adds redundant bits for detection as well as correction of these errors. The construction of the generator matrix is done by adopting Bhattacharya bounds of bit channels at the designed SNR. The insertion of cyclic prefixes and performing IDFT operations are two important steps of OFDM at the transmitter. Thus, the transmitter maps all encoded bits into a string of QAM symbols. It is later translated into parallel streams. Thus, each symbol is put on distinct subcarriers. At the OFDM receiver, N-point DFT is performed to get received OFDM symbols. A maximum likelihood sequence estimation is used for symbol recovery based on the knowledge of channel parameters. Further, the equalizer helps to compensate for this effect at the receiver.

The state diagram of the modified iterative decoder (mID) is presented. Further, received bits are arranged in increasing magnitudes. It uses bit magnitudes of received words to generate a sub- parity check matrix by espousing the
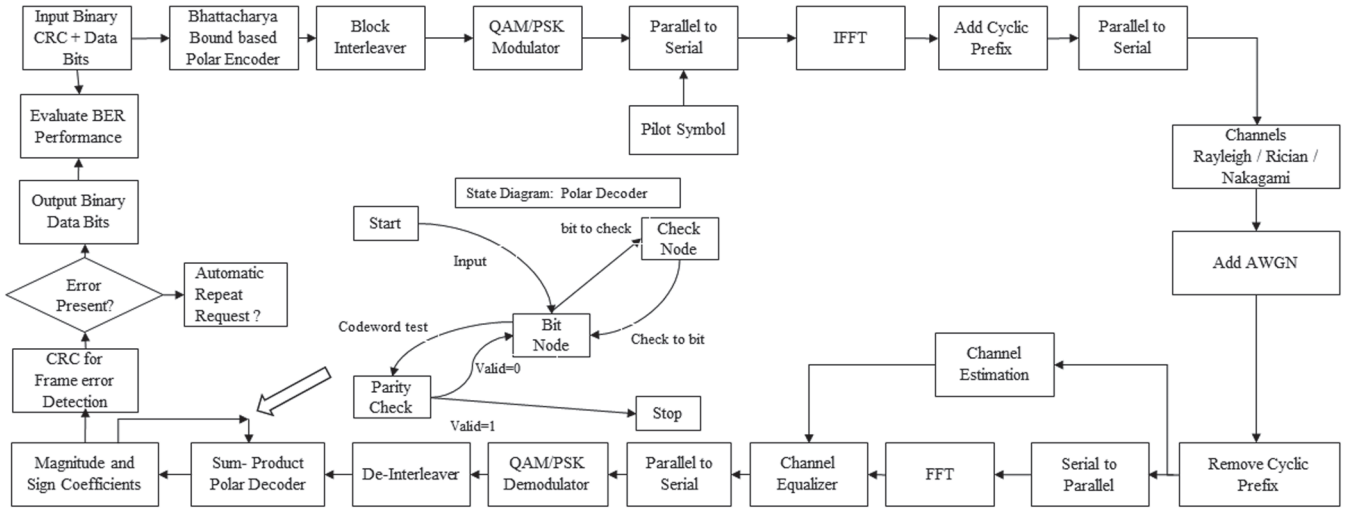
FIGURE 1 Simulation model of polar-code based OFDM-HARQ scheme

Gauss elimination scheme. Here, rows of matrix designate bit nodes, whereas check nodes are matrix columns. The zero-start state initiates intrinsic values of the received word, whereas the nonzero start state helps to execute the algorithm iteratively to locate the code-word. Thus, a maximum likelihood decoder selects code words close to the received words based on soft decisions and having minimum Euclidian distance. A transmission time interval bundling mechanism is used to transmit the same data three times. The occurrence of every bit for three iterations is detected after decoding. If the count value is less than two, then that bit is set to zero, or else it is set to one. After decoding, the CRC bits are removed. The input bitstream and estimated data bitstreams are compared to estimate the BER performance. In this article, Rayleigh, Rician and Nakagami fading channels were considered for performance evaluation. The performance is plotted for different SNR values and modulation techniques.

The signal with N subcarriers at the receiver side is given by Equation (1).[39]

$$z_m[k] = \frac{1}{N}\sum_{n=0}^{N-1} s[n]H[n]e^{j2\pi kn/N} + \text{w}[k] \quad k = 0, 1, ..., (N-1) \tag{1}$$

where $s[n]$ signal is input to IDFT. Further, $s[n]$ it represents in terms of $P_m[n]$ pilot tones and $C_m[n]$ as data vectors respectively as given by Equation (2).

$$s[n] = P_m[n] + C_m[n] \tag{2}$$

Substituting $s[n]$ gives Equation (3) as

$$z_m[k] = \frac{1}{N}\sum_{n=0}^{N-1}(P_m[n] + C_m[n])H[n]e^{j2\pi kn/N} + \text{w}[k], \quad k = 0, 1, ..., (N-1) \tag{3}$$

The ensuing signal vector $\widetilde{z_m}[n]$ as represented in (4) was obtained from the DFT.

$$\widetilde{z_m}[n] = \sum_{k=0}^{N-1} z_m[k]H[n] + \widetilde{\text{w}}[n] , \quad n = 0, 1, ..., (N\text{-}1) \quad m = 1, 2, ..., M \tag{4}$$

where $\widetilde{\text{w}}[n]$ represents $N \times 1$ the AWGN vector. Here, $H[n]$ denotes the CIR vector of the size $N \times 1$ that is associated with the fading channel. The channel estimate $\hat{H}$ is given by

$$\hat{H} = (P^H P)^{-1}P^H \text{W} = P^{-1}Z$$

where $(\cdot)^{-1}$ denotes pseudo-inverse matrix. The fitness function MSE for this channel estimate is specified with Equation (5) as

$$\text{MSE} = E\left\{\left(H - \hat{H}\right)^H \left(H - \hat{H}\right)\right\} \tag{5}$$

where $(.)^H$ symbolizes the Hermitian matrix.[40]

Polar codes are designed and developed on the characterization of nonuniversality property for binary transmission. It helps to construct codes at design signal-to-noise ratio, which was proposed by Arikan in 2009. The mathematical objectives of the polar code generator are as follows:

- Performance comparison of polar code constructions in fading channel;
- Selection of polar bit-channels at the design-SNR to achieve a desirable bit error rate;
- To reduce time and space complexity;
- Optimal polar code construction with minimum computational complexities.

The polar encoder and decoder are constructed by considering Bhattacharyya bounds of bit channels used in the work are described in Algorithm 1.

Algorithm1: Polar Code Generator Matrix

----

1. Initialize block length as N, message bit length as k, bit energy as Eb as well as noise spectral density as N0
2. Bhattacharya Construction Algorithm
   Input: Target Signal to Noise Ratio as TSNR
   Output: Bhattacharya parameter vector B
   A=TSNR /10 and B =2;
   Initially, Set $B[0] = \exp\{-10^{A/B}\}$
         for m = 1 to $\log_2(N)$
           $j = 2^{m-1}$
           for n = 0 to j-1
             c=B[n]
             $B[n]=2c-c^2$
             $B[n+j] = c^2$
           end
         end
3. Return Output vector B
4. Sort the vector from highest to lowest positions
5. Lowest K positions are constructed generator matrix
6. Generate binary stream of message bits as {rand(k,0) < 0.5}
7. Perform Encoding operation as enc: polar_encode(message bits)
8. Add Noise and Estimate the rec_bits as Y
9. Perform Decoding operation as dec: polar_decode(Y)
10. Compare decoded bits with message bits to evaluate BER as logical (sum (message bits = = dec))

Algorithm 2 explains the OFDM-HARQ system for resource allocation optimization to support D2D communication and compares the BER under similar constraints of SNR.

Algorithm 2: OFDM-HARQ system for resource allocation optimization to support device-to-device communication
Input: Define No. of Symbols and Type of Modulation: MPSK Define SNR values. SNR= [0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20] Define Size of Encoder N and K Define Rician Factor K, Nakagami-m distribution m=0.5
Output: Vector Z of final stage Bhattacharya parameters Plot the Graph of BER vs SNR

1. Start

2. Generate Data

3. Formation of Code Generator and Parity Check matrix

4. Encode the Data using Polar Encoder

5. Perform MQAM/MPSK modulation

6. Perform Serial to Parallel conversion

7. OFDM Transmission of MQAM/MPSK Signals

8. Apply IFFT to convert to time domain and add cyclic prefix

9. Perform Parallel to Serial conversion

10. Received Signal = Channel coefficients*OFDM Symbols

11. Signal= Received Signal[i] +AWGN and adjust SNR

12. If i= 1 jump to **Case 1:** Generate Rayleigh channel coefficients

    H1=1/sqrt(2)*(randn(2,2,1)+1i*randn(2,2,1));

    elseif i= 2 jump to **Case 2:** Generate Rayleigh channel coefficients

    H2=1/sqrt(2)*(randn(2,2,1)+1i*randn(2,2,1));

    Hrice=(sqrt(k/(k+1))+sqrt(1/(k+1))*H

    else   **Case 3:** Generate Nakagami m channel coefficients and phase for the

          creation of Nakagami channel coefficients

    Phase=unifrnd(-pi,pi,[2,2]);

    Generate gain for creation of Nakagami channel coefficients n=2*m;

    Gain=(1/n)*chi2rnd(n,[2,2]);

H3=sqrt(gain)*exp(li*phase)

13. Convert Serial to parallel Data conversion and discard tail bits

14. Apply FFT to convert to a frequency domain and apply equalization

15. Compute the decision metric based on ML rule to decide symbol from the noisy signal

16. Perform MPSK demodulation on OFDM symbol to get demodulated signal

17. Perform Sum-product Polar decoding on demodulated signal to get Data bits

Step 1: **Input:**
   1) The Parity-check matrix H
   2) Iteration L
   3) Intrinsic input value (Input from the channel)

Step 2: **Initialization:**

   1) For all H=1, $\lambda^{[0]}\left(z_{m,n}\middle|\{y_i : i \neq n\}\right) = 0$ for all (m,n) (Extrinsic information is 0 at initial).

   2) The intrinsic value should be set during $\lambda^{[0]}n$.

   3) Set loop counter $l = 1$;

Step 3: Check Node Update: For each (m,n) with $H_{m,n} = 1$, compute check-node (m) to bit-node (n) update message $\eta_{m,n}^{[l]}$ as (Here extrinsic information is being calculated).

$$(-1)^{|N_m|-1} * \left[\prod_{j \in N_{m,n}} S_j^{|l-1|} \right] * \phi\left[\sum_{j \in N_{m,n}} \left(M_j^{|l-1|} \right) \right]$$

Step 4: Bit Node Update: For each bit $n = 1, 2, ..., N$, compute message from check nodes for all which has $H_{m,n} = 1$, (addition of intrinsic and extrinsic information)

$$\left| \lambda^{[l]}\left(c_n\middle|Y\right) \right| = IntrinsicInformation + \sum_{m \in M_n} \eta_{m,n}^{[l]}$$

Step 5: Decision Making: each bit-node will have total information after every iteration.

Set $(S_n) = 0$ if $\lambda^{[l]}\left(c_n\middle|Y\right) \leq 0$

Otherwise Set $(S_n) = 1$.

If results of Set, $H.\left(S^T\right) = 0$ then stop decoding.

If the results do not match, the loop will continue until L-iteration.

Step 6: The euclidian-based decoding algorithm is based on finding minimum euclidian distance with the received bits and the codeword bits to correct decoded errors.

18. After decoding, the CRC bits are removed and then compared with the input bitstream to evaluate BER. Plot the graph of BER vs SNR.

19. Stop.

4 | IMPLEMENTATION OF OFDM-HARQ SYSTEM FOR D2D COMMUNICATION

D2D communication is one of such paradigms that appear to be a promising component in next-generation cellular technologies. In this section, an android application is developed with the help of socket programming in java language for mobile-to-mobile data communication using Wi-Fi-hotspot connectivity.

An endpoint socket acts sends and receives node data. Further, the network socket helps for flow control among programs that are running in a network. Thereafter, the socket application programming interface creates a set of sockets to be used for communication. The implementation of D2D communication based on the android application is designed and developed as shown in Figure 2. The aspect of socket programming with java language is an essential ingredient of this application. This application helps to communicate with server and client devices to directly communicate with each other with a handshaking mechanism. A half-duplex device-controlled link helps to transfer data between the devices. Here, both the end devices are isolated from the microcell tier with the help of airplane mode. Therefore, it will not create an interface with other nearby devices.

TCP server algorithm starts with the initialization by declaring the variables for the socket. This demand required an IP address of 192.168.43.1 and port number 82 of the server. The host address 52,690 is set for communication. It results in the creation and binding of a socket for connection establishment between the two end devices. The request from the concerned client device is accepted for the data transfer by reading the message in the following steps 1 to 5.

- Dialler system application named "wi-fi walkie talkie" is developed with Android device using MarshMello OS version 6.0.1.
- Java Application Programming Interface framework enables feature set of OS. It includes an activity manager to handle the port number and IP address of the server and client. File handling to calculate BER is also done at this step.
- The application framework helps to access libraries for android applications. Dalvik Virtual machine then converts java class files into executable codes
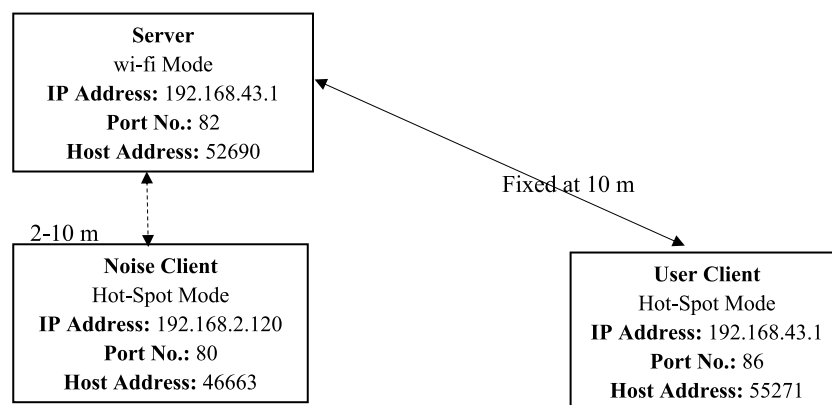
(A) Experimental Setup
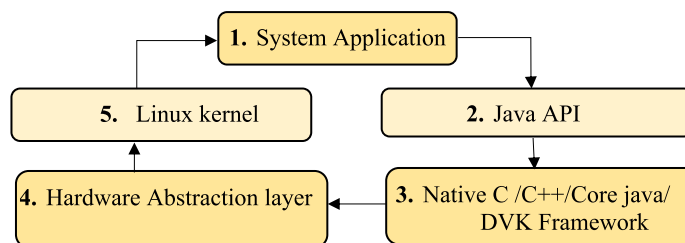
(B) Android Application Flow Diagram

FIGURE 2 (A,B) Implementation of device-to-device communication

- The Hardware Abstraction layer in android helps to communicate with the device driver for setting audio parameters.
- Linux kernel contains the drivers required to access Wi-Fi and audio drivers.

Algorithm 3 describes the client–server architecture considered to implement D2D communication.

Algorithm 3: Client-Server architecture

- **At the Server Machine**

---

1. Declare the variables for the socket

2. Specify the family, protocol, IP address, and port number

3. Create a socket using the socket ( ) function

4. Bind the IP address and port number

5. Listen and accept the client's request for the connection

6. Read the client's message

7. Display the client's message

8. Close the socket

- **At Client End**

---

1. Declare the variables for the socket

2. Specify the family, protocol, IP address, and port number

3. Create a socket using socket ( ) function

4. Call the connect ( ) function

5. Read the input message

6. Send the input message to the server

7. Display the server's echo

8. Close the socket

- **Noise Generator**

---

1. Start

2. Initialization

3. On Data Received action

4. Do on Close connection

5. Stop

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5 | RESULTS AND DISCUSSION

This paper investigates the use of polar code and the communication system optimization based on the OFDM-HARQ mechanism with CRC in the presence of various fading channels. A bundling mechanism is used to attain the optimal number of retransmissions to accomplish better link utilization. The work is simulated to evaluate BER with MQAM modulation technique using MATLAB Simulation tool. Table 1 highlights the basic simulation parameters for the experimentation.

5.1 | Comparative performance

In this work, a polar code-based OFDM-HARQ system with CRC technique is simulated and implemented to enhance BER and throughput. The performance of the system is compared with Rician, Nagakami, and Rayleigh channel models. MQAM modulation techniques is considered. Simulated BER versus Eb/No results are as shown in Figures 3–5.

Figure 3 shows a comparative performance in terms of BER of uncoded and coded systems with M-QAM modulation. Here, QAM, 8 QAM, and 16 QAM techniques are considered for simulation in presence of the Rician channel. As it is observed in Figure 3, as modulation order M or Eb/No increases, there is a diminution in BER. To attain a BER of 10^{-6}, the achieved Eb/No for the coded system is 6.25, 13, and 15.7 dB, whereas for the uncoded system it is 11.5, 15.8, and 18 dB.

Figure 4 gives the results of BER versus Eb/No in the presence of the Nagakami channel. The results in Figure 4 replicate those in Figure 3. That is the rate of BER decrease with an increase in M or Eb/No is much more with 4, 8, and 16 QAM. It suggests that the system adds another layer of efficaciousness in reducing BER. To attain a BER of 10^{-6}, the achieved Eb/No for the coded system is 6, 10.25, and 15.85 dB, whereas for the uncoded system is 11, 16.5, and 20 dB. Figure 5 shows the plot of BER versus Eb/No in presence of the Rayleigh channel. It is observed that the results in Figure 5 match again with those in Figures 3 and 4 corroborating the inference of the system to enhance the usefulness of BER. It is also observed the gradual decrease in performance is for the value of M between 2 and 8. Further, a speedy rate of decrease happens for a range of M greater than 8 indicating that the OFDM-HARQ system is effective in reducing BER in Rayleigh as compared to Rician or Nagakami channels.

The BER performance attained of the coded system at Eb/N0 of 6 dB with 4 QAM technique is 2.8×10^{-6}, 1.5×10^{-2}, and 8×10^{-2} using Rician, Nagakami, and Rayleigh, channel models, whereas BER achieved is 2.5×10^{-3},

TABLE 1 Basic simulation parameters

FEC	Polar
Number of message bits (k)	128
Block length (n)	256
Modulation	QAM/QPSK
FFT size	256
Cyclic prefix length (FFT size/4)	64
Channel Bandwidth	20 MHz
Subcarrier spacing (Δf)	78.125 KHz
FFT period ($1/\Delta f$)	12.8 μs
Duration of Cyclic prefix (FFT period/4)	3.2 μs
Symbol period (T_s)	16 μs
Eb/No	0 to 24 dB
Channel	Rayleigh, Rician, and Nagakami
Number of multiple paths (M)	5
Number of samples to generate (N)	10^5
Doppler frequency (f_d)	100 Hz

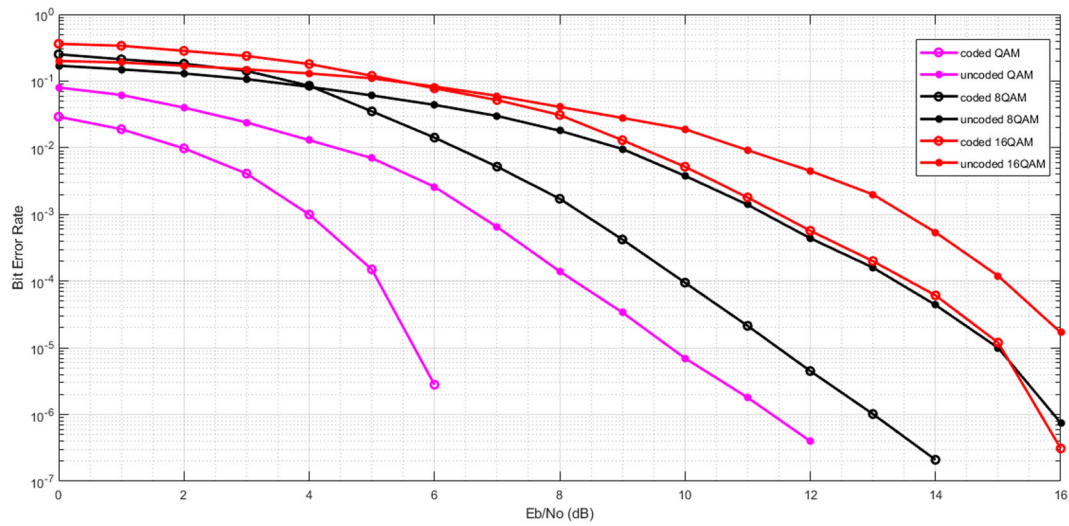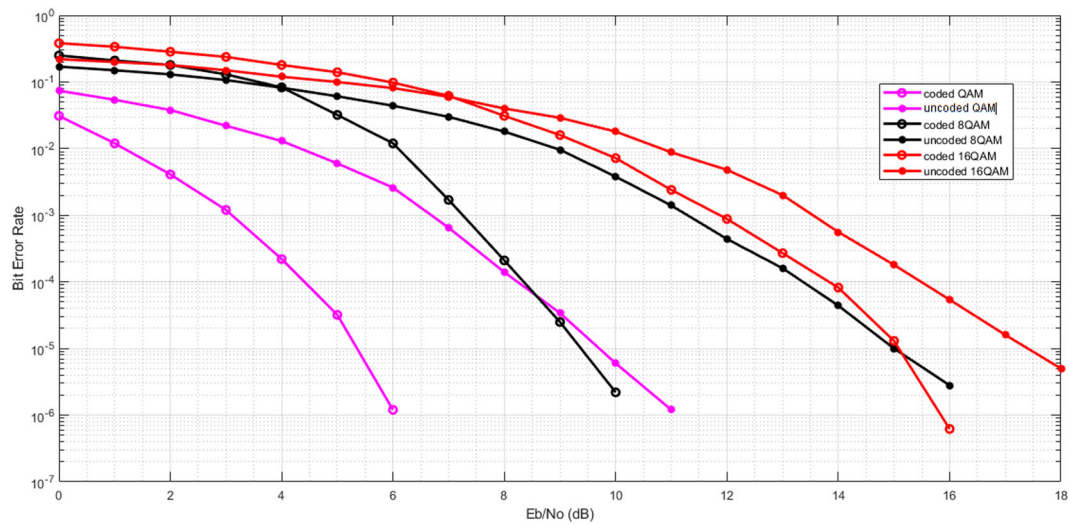**FIGURE 3**   Plot of BER versus Eb/No with M-QAM in presence in Rician Channel

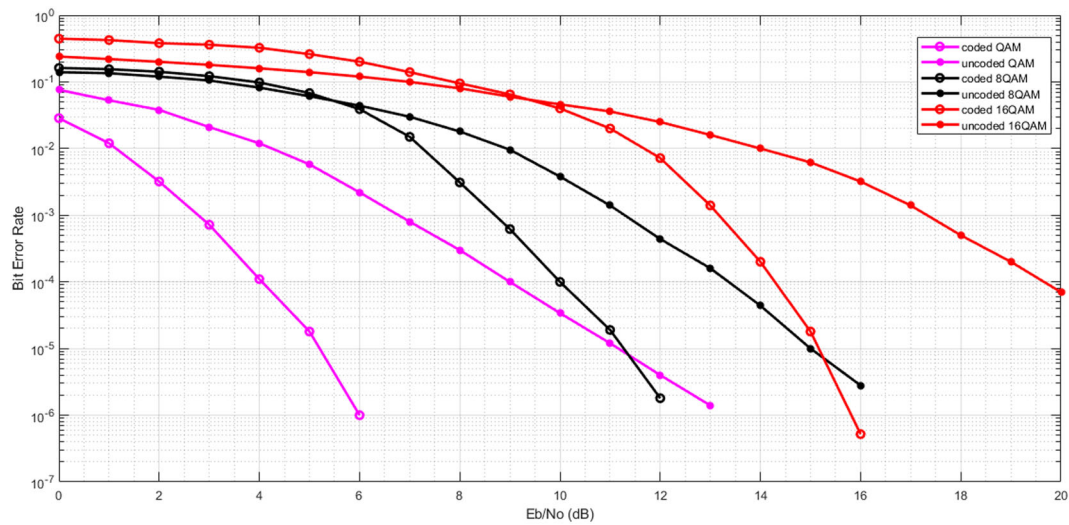**FIGURE 4**   Plot of BER versus Eb/No with M-QAM in presence Nagakami Channel

FIGURE 5   Plot of BER versus Eb/No with M-QAM in presence of Rayleigh Channel

3.2×10^{-2}, and 9×10^{-2} with the same set of arrangements for the uncoded system. Further, the system is also evaluated with 8 QAM and 16 QAM modulation techniques. The BER performance obtained for the coded system is 1.3×10^{-2}, 1.2×10^{-2}, and 1×10^{-1} at 6 dB Eb/No with 8 QAM, whereas it is 2.9×10^{-3}, 4.5×10^{-2}, and 8×10^{-2} for the uncoded system. Here again, Rician, Nagakami, and Rayleigh channel models are considered. In the end, with 16 QAM modulation techniques the BER performance attained of the coded system at Eb/No of 6 dB is 1×10^{-6}, 3.8×10^{-2}, and 2×10^{-1} using Rician, Nagakami, and Rayleigh channel models, whereas BER achieved is 2.1×10^{-3}, 4.5×10^{-2}, and 1×10^{-1} for the uncoded system.

In this subsection, frame error rate against change in Eb/No is calculated with the 16 QAM modulation technique. In this process, error correction is done at data bits with polar-code and error detection at frame level using HARQ. In this process, the frame size of 1032 bits used for transmission helps to compute the Frame Error rate as shown in Figure 6. In Hoydis et al.,[41] air interface is partly conceived by artificial intelligence. It facilitates optimization of communication resources in terms of physical aspects, radio natural environment, and application. BER is considered as a performance metric to evaluate a system with a machine learning approach. The significance of the MIMO scheme is described in Mane and Belsare[42] to enhance BER to achieve superior data speed by adopting the Reed Solomon code. Further, performance is evaluated in presence of multipath channels.

In this paper, simulations have been done for Rayleigh, Ricin, and Nakagami fading channels. The data rate on the 40-MHz channel can reach up to 600 Mbps. The channel coefficients for all channels are generated. Further, the Rayleigh channel is created by blending random signals with a Gaussian distribution. The magnitude of the generated complex signal is following the Rayleigh distribution. Thus, channel coefficients are demonstrated as independent as well as identically distributed random variables that have a variance of half for each dimension, whereas the Rician channel is shown by considering the occurrence of a clear line of sight. The phase and gain are generated to create coefficients for the Nakagami channel. Here, the gain has a chi-square distribution and the phase has a uniform distribution. This is required for wireless system to work consistency in diverse environments. It adds multipath fading and multiple access interference in the transmitted signals. Various diversity methods are the solutions to such impairments. In a multiuser wireless environment, BER and throughput are important QoS parameters. The performance is estimated in Rayleigh, Rician, and Nakagami channels.

Further, frame dropping ratio and throughput are also evaluated in the presence of Rayleigh channel with configuration settings shown in Table 2 using network simulator.

A plot of packet size and frame delivered in various scenarios with description is shown in Figure 7. It is observed that the total number of frames delivered successfully decreases from without HARQ to with HARQ scheme. Here, packet size is raised from 250 to 1250 bytes. The wireless channel is prone to time as well as frequency fading. This in turn gives rise to unpredictable frame losses.

Figure 8 represent the impact of change in packet size on frame dropping ratio. It is observed that packet size is crucial in determining the number of drop frames. The proposed system proactively renews the rate for the later transmission. Here, the frame dropping ratio stays stable between 7% to 4%. Figure 9 shows the behavior of frame dropping
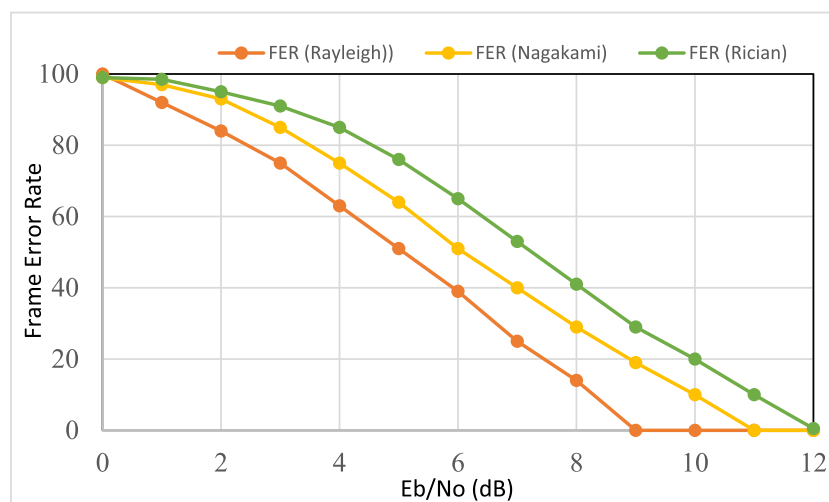

FIGURE 6 Plot of FER versus Eb/No of OFDM-HARQ system

TABLE 2 Configuration settings

Simulation time: 10–50 s
Node Density: 100–250
Packet Size: 250–1250 Bytes
Energy: 10 J
Mobility: 2–10 m/s
Reporting Rate: 10–50 packets/s
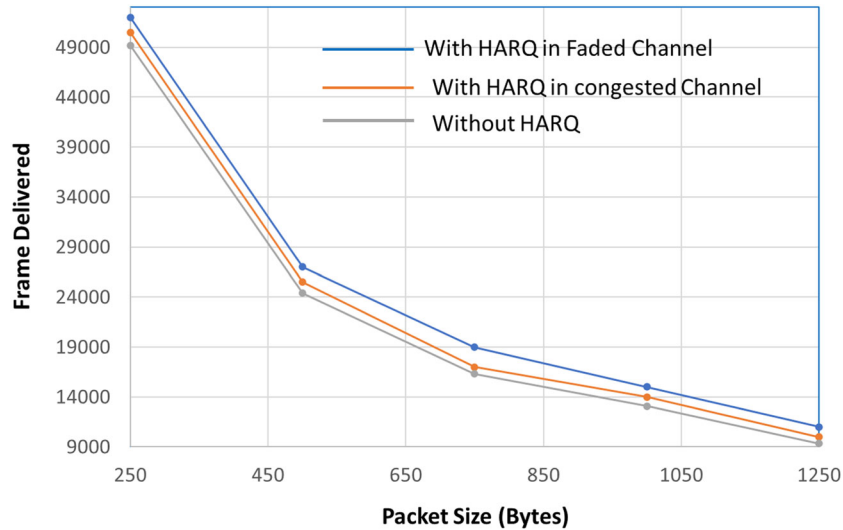**Adhoc Routing Protocol:** Aodv

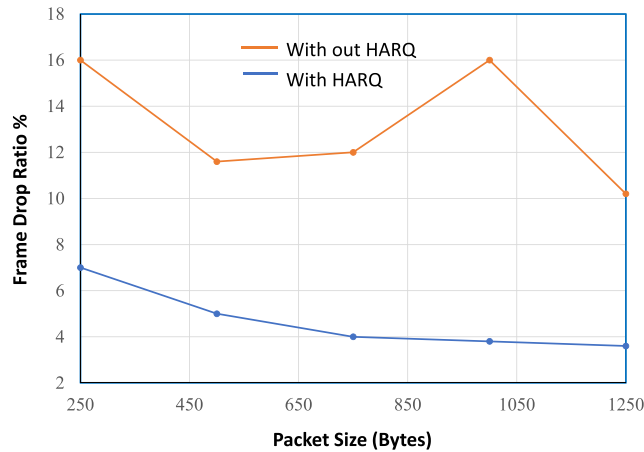**FIGURE 7**   Plot of frames delivered for varying packet size

FIGURE 8   Plot of frame drop ratio against packet size

ratio versus simulation time with and without the HARQ system in the fading channel. The HARQ system aggressively presses the data through the fading channel. The simulation results show that the proposed system attains the smallest dropping rate as well as the highest output. As simulation time is changed from 30 to 50 s, there is a decrease in frame drop ratio by 13% to 8% with the proposed system. Figure 10 represents the mapping of changing nodes on frame dropping ratio. The proposed system provides good performance improvement in frame dropping ratio by 8%.

Based on that, it can be concluded that multiuser communication is still an open issue. Presently, wireless communication is an integration of voice, data, and video. Hence, channel capacity as well as reliability to transfer data is a significant task. In a mobile network, many users are located at the cell edges. They receive weak signals yielding SNR less than 5 dB. Further, the area near the center of a cell has SNR greater than 10 dB. The results show that BER
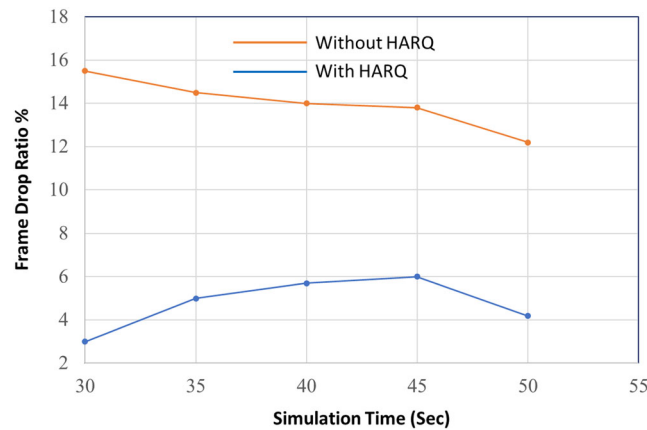
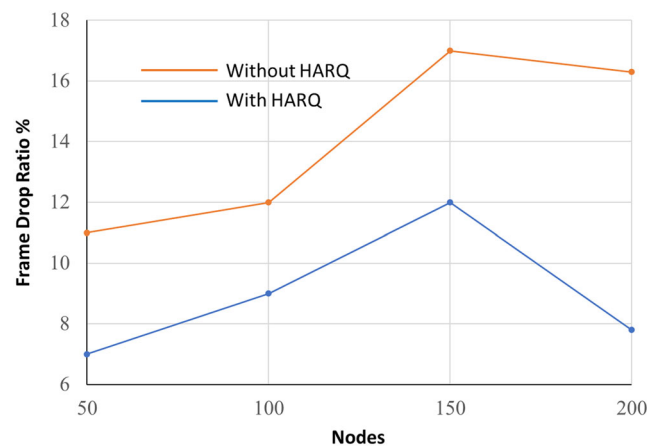**FIGURE 9** Plot of frame drop ratio against simulation time

FIGURE 10 Plot of frame drop ratio against nodes

performance is improved over the uncoded systems by 88% at SNR less than 5 dB, whereas 96% at SNR greater than 10 dB in the Rayleigh channel. A stream of 97,000 frames is sent from the transmitter. Thereafter, results are recorded in terms of throughput. It is observed against variation in packet size, intrusive nodes, and simulation time as shown in Figures 11–13, respectively. Here, packet size is changed from 250 to 1250 bytes. Due to fading, frame delivery is decreased. Further, an increase in nodes in the network increases collisions. It also decreases frame delivery further in the congested channel. Palpably, throughput increases with time. A throughput enhancement of 10.23% to 14.33% is achieved.

5.2 | Computation complexity

The BER performance of polar coded and turbo coded systems are compared with uncoded systems. Thereafter, performance is evaluated with QAM modulation considering Rayleigh as a fading channel. Results of the same are represented Figure 14. It is observed from the figure that as Eb/No increases the BER improves. A system with polar code as FEC shows better BER as compared with turbo code as FEC. From the graph, it is observed that the system with polar codes gives better results as compared to the system with turbo code. At a 10^{-4} bit error rate, polar codes are giving a 25% better signal-to-noise ratio than turbo code in the Rayleigh channel. The code rate considered for polar code is half, whereas for turbo, it is one third.

Further, in this subsection, the computational complexity for the proposed polar code-based OFDM-HARQ scheme is discussed by counting summations and multiplications. The encoder with N bits requires N^2 computations, whereas FFT operation requires $2N^2$ operations. The decoder takes 11N computations for one iteration and modulation demands $\log_2 M$ computations. Therefore, the computational complexity with α iterations for the proposed scheme is
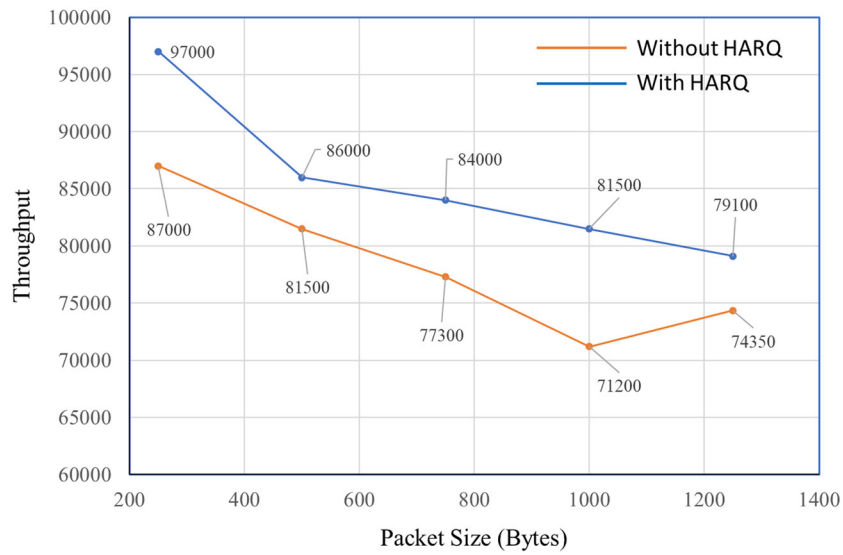
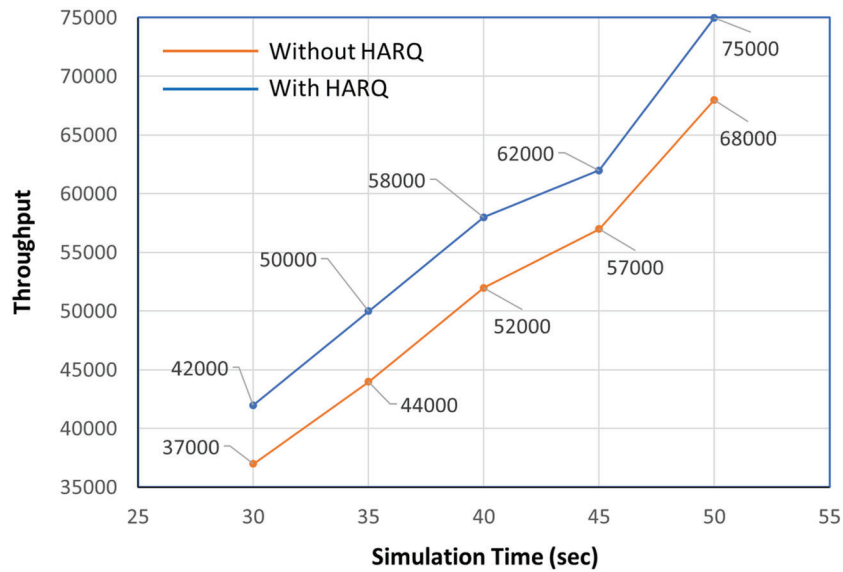**FIGURE 11**   Plot of throughput measured against the packet size

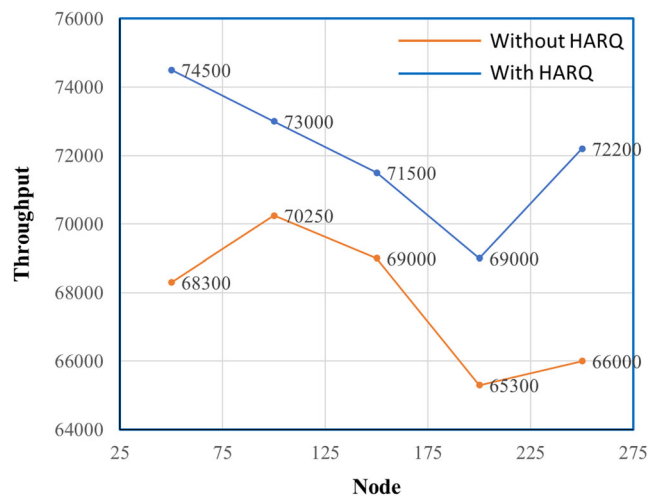**FIGURE 12**   Plot of throughput measured against the simulation time

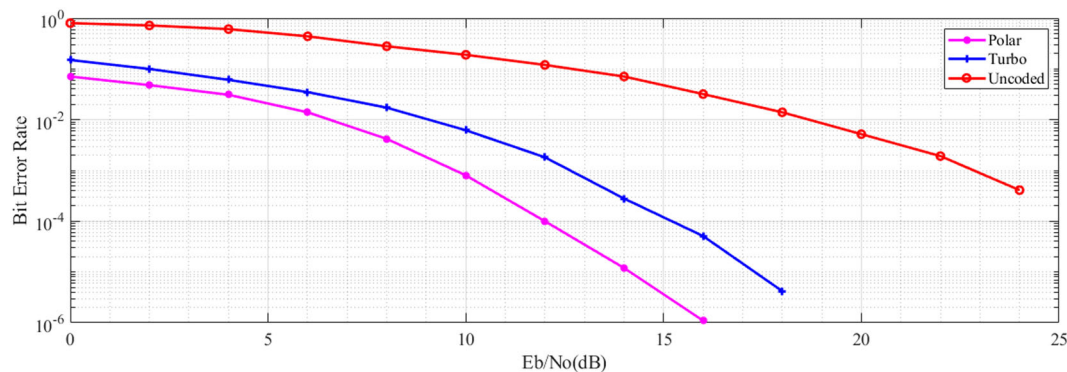**FIGURE 13**   Plot of throughput measured against the interfering nodes

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FIGURE 14   Plot of BER versus Eb/no for turbo and polar system in Rayleigh channel

TABLE 3   Comparative performance analysis

Particulars	Hoydis, J., Aoudia, F. A., Valcarce, A., & Viswanathan, H. (2021)[41]	Mane, P. B., & Belsare, M. H. (2020)[42]	Proposed resource allocation in 5G network using OFDM-HARQ
Eb/No		BER	
8	8.00E−2	4.00E−02	9.13E−3
9	6.90E−2	2.92E−02	6.82E−3
10	5.85E−2	1.57E−02	3.29E−3
11	4.78E−3	3.82E−03	1.08E−3
12	7.12E−3	1.22E−03	3.00E−4
13	2.37E−3	5.45E−4	1.12E−4
14	1.95E−4	8.9E−5	5.23E−5

expressed by $[\alpha * (2N^2 + 11\,N) + \log_2 M]$. As expected, the polar code-based OFDM-HARQ scheme operates 1/3 to 1/5 reduced complexity as compared with turbo code-based scheme.

5.3 | Coexistence of Wi-Fi with 5G

5G and Wi-Fi are next-generation high-speed wireless internet connections. They have existed so far with a separate customer base and applications. Wi-Fi and 5G could be merged to overcome challenges posed by an increase in frequency and critical QoS requirements in terms of latency, throughput, and data rate. It is suggested that outdoor 5G coverage can be supported with indoor Wi-Fi deployment.

To support the concept, we have carried out calculations for implementations of the OFDM-HARQ system for both technologies. In this context, Wi-Fi and 5G network are considered using the Hata model for signal strength prediction. The frequency considered for Wi-Fi is 2.4GHz, whereas for 5G it is 6 GHz. The distance to be covered to support D2D communication is 500 m. The path loss for Wi-Fi is 20 dB less as compared to the 5G base station. It is observed that 5G coverage for outdoors can be supported by Wi-Fi coverage for indoors.

To compare results of recently published articles in a similar area, common data points are selected for Eb/No for the QoS parameter as bit error rate. From this tabular analysis, as shown in Table 3, with an increase in Eb/No the error performance decreases exponentially in the range 10^{-2} to 10^{-5}. The results obtained are at par with the two referred paper results. It is observed that there is a slight variation in the result because of the variation in technique deemed for the experimentation However, it can be concluded that the results shows enhancement in BER by 41.57%.

6 | CONCLUSIONS

In this work, we have focused on the BER improvement of the OFDM-HARQ system for D2D communication. A comparative study is carried out for Rayleigh, Rician, and Nagakami channel models. A combination of a hybrid scheme

comprising error correction at data bits and error detection at frame level can enhance BER performance. This reduces retransmission count and improves the overall throughput of the system. It is shown that 5G and Wi-Fi can coexist and work together for a better user experience.

FUTURE SCOPE

In this paper, the HARQ-based scheme is evaluated for mobile applications. The effectiveness of the proposed system can be further evaluated for dense networks against varying traffic patterns. Further, we plan to optimize 5G parameters for indoor connections.

FINANCIAL AND ETHICAL DISCLOSURES

This work is not supported fully or partially by any funding organization or agency.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Improving 5G network performance for OFDM-IDMA system resource management optimization using bio-inspired algorithm with RSM

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Abstract

The OFDM-IDMA system is a new era in the wireless domain. It is affected by the MAI and CFO effects. There are no specific CFO reduction techniques that have been identified as the best solution for a multicarrier multiuser system. This paper proposes a bio-inspired scheme for optimizing the performance of an OFDM-IDMA system. To improve BER performance in the presence of CFOs in a multiuser environment, the SIC-MUD and SIC-MUD with SU-LA algorithms are presented. The MAI effect is mitigated by the SIC-MUD technique. The SU-LA algorithm, on the other hand, improves channel estimation performance by optimizing pilot positions. The combination of these algorithms contributes to the reduction of estimation errors and, as a result, ensures the achievement of 0.0472 MSE. The CFO values used in the simulation are 0, 0.1, and 0.2, and the users are 1, 4, 8, with 16 QAM over the Rayleigh channel. When compared to the SIC-MUD algorithm, the proposed algorithm improved the BER by 41.17 percent and can tolerate 0.1 CFO in the presence of 8 users. The analysis's second-order mathematical regression RSM model has an R2 value of 91.35 percent and accurately predicts the system response. It has been discovered that the proposed SU-LA method outperforms the HS bio-inspired algorithm.

Introduction

The Orthogonal Frequency Division Multiplexing-Interleave Division Multiple Access (OFDM-IDMA) system is used in current wireless technologies. Orthogonal frequency-division multiplexing (OFDM) is a type of digital transmission and a way of transmitting digital data on multiple carrier frequencies. OFDM has increased in number as a wideband digital communication method, with applications ranging from digital television and audio broadcasting to DSL internet access, wireless networks, power line networks, and 4G/5G mobile communications. Whereas, Interleaved-division multiple access (IDMA) is a CDMA progression that includes forward error correction (FEC). The concatenation of an FEC code, a spreading operation (unique for each user), and an interleaver constitute a CDMA with an FEC system. However, the Bit Error Rate (BER) of the system suffers from high sensitivity to Carrier Frequency Offset (CFO) as well as Peak Signal-to-Average Power Noise Ratio (PAPR), and Multiple Access Interference (MAI) [1]. One of the most well-known OFDM disruptions is carrier frequency offset (CFO). It causes inter-carrier interference (ICI) and impairs the performance of OFDM. CFO is frequently assessed and corrected properly during OFDM reception in order to reduce the detrimental impact. Hence, it is essential to design a channel estimation algorithm to evaluate the effect of CFO and MAI on a multiuser receiver. Intracellular and intercellular interference are two types of multiple access interference (MAI). It severely degrades performance and may render the system worthless for even modest user loads with equal power received from each user. Various pilot tone optimization methods and channel estimation techniques are evaluating and enhancing the BER performance. In an OFDM system, channel estimation is extremely critical. It is used to boost the capacity of orthogonal frequency division multiple access (OFDMA) systems by improving the system's bit error rate.