

ISSN 2320-4168



VOL 6 | SPECIAL ISSUE 1 | SEP 2018

Shanlax International Journal of Commerce

A Peer-Reviewed, Refereed Scholarly Quarterly Journal
Globally Indexed with Impact Factor



International Seminar on
**RECENT TRENDS IN
MARKETING TECHNOLOGY**

Volume - 2



Organized by
PG & Research Department of Commerce

**MORAPPUR KONGU COLLEGE OF ARTS & SCIENCE
(Co - Education)**

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ISSN INTERNATIONAL
STANDARD
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NUMBER
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Contents

1	Secrets for Success in Business <i>Dr.K.Arul</i>	1
2	A Study on the Effectiveness of Services Provided to Private Banking Customers of ICICI Bank, Thiruvalla <i>V.Sudha</i>	6
3	Consumer Satisfaction in Himalaya Products <i>Mr.C.Vengan</i>	14
4	Challenges of E-Commerece in India <i>K.Megala</i>	19
5	Direct Marketing Channels and Strategy for Organic Products <i>K.Prabha & Dr.T.A.Tamilselvi</i>	24
6	Impact of Advertisements in Electronic Media <i>M.Govindan</i>	29
7	Environmental Sustainability through Green Banking <i>P.Saravanan</i>	33
8	A Study on Factors Affecting Consumer's Buying Behavior towards Home Loan with Special Reference to State Bank of India and Life Insurance Corporation, in Bargur Taluk <i>D.Pazhaniammal & Dr.R.Venkatesh</i>	37
9	Impact on Implementation of Cashless Economy <i>S.P.Murugan</i>	46
10	A Study on Entrepreneurial Satisfaction towards M-Banking Services in Hosur Taluk <i>K.Saritha & Dr.R.Venkatesh</i>	53
11	Impact of Jio Network Service among the Customers - A Study on with Special Reference to Dharmapuri District <i>Dr.R.Muruganandan</i>	59

A Study on Factors Affecting Consumer's Buying Behavior towards Home Loan with Special Reference to State Bank of India and Life Insurance Corporation, in Bargur Taluk

OPEN ACCESS

Volume: 6

Special Issue: 1

Month: September

Year: 2018

ISSN: 2320-4168

Impact Factor: 4.118

Citation:

Pazhaniammal, D & Venkatesh, R. "A Study on Factors Affecting Consumer's Buying Behavior towards Home Loan with Special Reference to State Bank of India and Life Insurance Corporation, in Bargur Taluk."

Shanlax International Journal of Commerce, vol. 6, no. S1, 2018, pp. 37-45.

DOI:

<https://doi.org/10.5281/zenodo.1461432>

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Abstract

Everybody wants to own a home. The person gets shelter in the home to take rest and feel comfortable. Many commercial banks and financial institutions give a loan for the home to the people who want to own a home. To attract consumers, banks provide home loans at the cheaper rate. Currently, banks offer the cheapest loan for homes, as a gesture of a customer-friendly attitude. The present study was undertaken with the intent to investigate after examining the literature reviewed and noticed that their exit gap regarding consumer factors affecting perception towards the home loan disbursed by banks. Accordingly, the problem of the study focuses on customer views towards the housing loan schemes of the bank. An attempt has also been made for the study of banks delivery and disbursement of loan leading to consumer buying behavior.

Keywords: Home Finance, factors of SBI and LIC.

Introduction

The housing finance sector in India has experienced the unprecedented change in its structure since its formulation stage of being a solely a government undertaking to a very competitive sector with a large number of financing entities all over India. The paper aims to study the various factors that influence the decision of the consumer for taking Home Loan. The paper focuses on the Home loan offered by LIC and SBI and makes a comparative analysis of the factors that affect the consumers. The paper has a practical implication both for the academicians and for the readers regarding their concern with the aspect issues regarding factors influencing the buyer behavior towards Home loans. The paper is original and the highlights of the paper can be used for further research purpose and provide the knowledge base to the readers.

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The concept of housing finance and the housing finance systems have been evolved to Loic Chiquier and Michael Lea, "Housing finance brings together complex issues that are driven by constantly changing local features, such as a country's history or culture, economic makeup, regulatory environment, or political system." Housing finance plays an important role in housing has increased day by day. Housing finance prevents slum and equitable economic growth though the reduction of poverty and prevents the economy. To meet the growing housing demand the government needs to provide the housing to the people. The housing finance sector in India has experienced the change in its structure since its formulation stage of being a solely a government owned very competitive sector with a large number of financing entities all over India. Home where we relax after coming back from our day's tiring work; it is the place where we go to our family and spend beautiful moments with them. After years of thinking, anticipation and research, we finally decide to build our dream house. At the time, finance is the main which pull back everyone from moving towards the cherished goal.

To acquire a home which can be christened as our 'Own House' is a life-time decision to be made with efficient planning and requires huge finance. Our Dream Home is not far away Home Loan which will fulfill our dream into a reality. Home Loan is a Secured Loan offered bank against the security of a house/property which could be a personal property or a commercial one. It is a loan collected by a borrower from a bank issued against the property/security of the property. i.e., If the borrower has failed to pay back the loan, the banker can retrieve the finance by selling the property.

History of Home Loan

Own a home. There will probably be changes, especially in such areas as interest rates, because the housing market changes at different times, depending on the national economy. Real estate is currently one of the fastest growing sectors in India. The banking sector is also regarded as the profitable business for the last few decades, with the growth of real estate. Majority of the banks are also offering easy home loans at attractive rates to their customers. Now that getting a home loan is so easy, it seems everyone can fulfill his / her long-cherished dreams of purchasing a house and expanding their homes. A home loan, or mortgage, is a secured loan where borrowers obtain to purchase a home. As a home is the largest purchase many individuals will ever make, most borrowers prefer home loans. Most loans paid for promptly result For many years, the only way to obtain money to purchase a home was to apply for a conventional home loan. This type of loan was obtained through a bank, credit union or other private, non-government-affiliated financial institution. In 1938, the Federal National Mortgage Association, better known as "Fannie Mae," was created and established as a federal agency by the President Mr. Franklin Roosevelt as a part of his New Deal. This made it possible, even during those days, when most people had little income were still be able to afford a home. In 1970, the Federal Home Loan Mortgage Corporation, known as "Freddie Mac," was created to lessen the "monopolization" of home lending that Fannie Mae enjoyed. Both Fannie Mae and Freddie Mac, once considered as "government" auspices, are private establishments now. World War II came along, and hundreds of citizens went to war. When it ended, they returned home to pick up their lives where they had left off, or to start a new life. These people needed places to live, so the Serviceman's Readjustment Act of 1944, Public Law 78-346, was enacted. This made it possible for veterans to borrow money for the purchase of a home. Several major changes to the Act have been made in the years since the war. When involved in subsequent wars, such as Korea, Vietnam and

the same advantages in obtaining home loans. All home loans—conventional, VA, Faunie Mae, and Freddie Mae—accomplished the same goal: they allowed people to become homeowners. The Vietnam's Administration, Faunie Mae and Freddie Mae, however, provided a level of protection for the loans and those involved with them that other financial institutions might not necessarily have. Having different types of home loans to choose from allow more people to be able to own their own home. Depending on the terms and conditions, it may be easier to obtain a loan from one entity than from another. As long as there are financial institutions that will make home loans, there will be the opportunity for people to in a positive notation on credit reports, meaning that borrowers may be able to qualify for larger loans at better interest rates after having successfully made loan payments. Different types of home loans are tailored to suit the heterogeneous requirements of the customers. The description of some of the most common types of home loans is given below.

Types of Home Loans

Home Purchase Loans: This is the basic home loan for the purchase of a new home.

Home Improvement Loans: These loans are given for implementing repair works and renovations in a home that has already been purchased.

Home Construction Loan: This loan is available for the construction of a new home.

Home Extension Loan: This is given for expanding or extending an existing home. For instance, a customer may apply for a loan for the addition of an extra room in his/her home and similar cases.

Home Conversion Loan: This is available for those who have financed the present home with a home loan and wish to purchase and move to another home for which some extra funds are required. Through home conversion loan, the existing loan is transferred to the new home including the extra amount required, eliminating the need for pre-payment of the previous loan.

Land Purchase Loans: This loan is available for the purchase of land for both construction and investment purpose.

Bridge Loans: Bridge Loans are designed for people who wish to sell the existing home and purchase another one. The bridge loans help finance the new home.

Balance Transfer Loans: Balance transfer loans help to pay off an existing home loan and avail the option of a loan with a lower rate of interest.

Features of Home Loan

Home loans are available on the fixed rate of interest as well as floating rate of interest. In fixed rate loans, the interest rate remains fixed over the life of the loan, irrespective of the interest rates in the open market. The plus point of fixed-rate loans is that they remain steady over the years. However, the flip side is that the lenders charge a higher rate of interest for fixed-rate loans because if interest rates shoot up, they lose the opportunity to make more money on the funds they are lending. In floating rate loans, the rate of interest changes according to a set formula as interest rates fluctuate in the open market. The plus point is that lenders charge a lower rate for such loans because the borrower takes the interest-rate risk. The downside is that interest rates may rise anytime and one can end up paying more than fixed-rate loans. Hence the type of interest one opts for will entirely depend on one's personal preferences.

General Information about Home Loan

The loan amount is based on the repayment capacity of the customer. However, it cannot be more than 85% of the cost of the property (including the cost of the land).

The minimum term of the home loan is five years, while the maximum duration for the home loan is 30 years, subject to the retirement age of the applicant. Home Loans can be applied either individually or jointly, with a spouse, children (son or daughter) and even earning parents (father or mother) but if staying with the applicant and having the regular income.

Home loan eligibility can be enhanced by repaying the outstanding loans, clubbing the loans, increasing the home loan tenure and opting for a step-up loan. The amount of loan granted varies from bank to bank. Generally, the maximum loan amount granted to the applicant is 80% to 85% of the cost of the home.

Review of Literature

Gudadhre (2013) discussed the customer perception towards products and services of SBI Bank of India. The author has focussed on research by taking into account the branches of Maharashtra. The article discussed the SBI Bank Group-wise perception and satisfaction level of customers. The author concluded that the customer expects higher quality services from banks which, if fulfilled, could significantly improve customer satisfaction levels. 99.27% customers expressed their satisfaction towards the services.

Rao T. S. (2013) discussed the perception and problems of home loan takers in Andhra Pradesh. The author has focused on research by taking into account the HDFC and SBI bank. The article discussed the Housing Policy frame work, trends and progress in Housing Finance, the performance of HDFC and SBI about providing housing finance to individuals, perception and problems of home loan takers in the State of Andhra Pradesh. The author concluded by stating that the Housing Finance in India faced some set-back in decades but the designing of shelter and the organization of the housing finance market, the introduction of fiscal incentives have helped about some changes in the housing finance. The services and product innovations are the key for success.

Mittal (2014) discussed the demographic profile of the customers and their choice of a particular type of bank. The author has focused on research by taking into account the customers of SBI and ICICI bank. The paper discussed the customer needs, preferences and usage rate, understanding service quality perception of customers towards retail banking services. The author concluded by stating that age, occupation and education significantly influence the customer's choice of a particular type of bank. There was a significant difference between the age-wise, education-wise and occupation-wise distribution of the two types of banks. The income of the customers and choice of a particular type of bank were independent of each other.

Kumaraswami M. and Nayan J. (2014) discussed the importance of housing finance institutions providing housing finance. A detailed discussion of the marketing strategies and by financing institutions has been discussed by taking into account the loan criteria eligibility amount, interest rate, security, loan tenure, margin and processing fee. Finally, the paper highlighted the performance of the housing sector, major findings and suggestions to improve the marketing of housing finance for both public and private sector banks.

Gupta J. and Jain S. (2012) focused on the various practices adopted by cooperative banks in India and made a comparison of the cooperative banks concerning their efficiency of lending practices. The major findings of the study showed that majority (32% as per the respondent) was having housing loan for the bank under study, most (64% as per the sample) people prefer to take long-term loan which is more suitable for the customer's selection of a bank for loan, easy repayment, and the bank's reputation.

bank is catering to a small segment only and the customers are properly dealt with, customers are satisfied with the mode of repayment of installments, average time for the processing of loan is less i.e. approx 7 days. The authors also suggested measures to improve the efficiency of the Cooperative banks.

Ghosh S.(2012) in his study mainly focused on the guidelines followed by commercial banks in India regarding the appraisal process of housing loans with specific reference to Indian Overseas Bank.

Hingorani P. and Tiwari P. in the paper evaluated the present issues and challenges in the Indian urban housing market and gave suggestions for tools and approaches that can guide movement towards a more holistic approach.

Mishra A.K.(2011) discussed the overall resources invested by housing finance company in India since their incorporation and identified the area where efficiency can be improved and cost reduction is possible for optimum and effective utilization of resources.

Sridharan S. (2014) in the paper analyzed the Indian demographics and how, correspondingly, the housing finance sector has evolved. According to the author "Although there are various Government of India initiatives as well as schemes of institutions like World Bank and its members like the International Finance Corporation (IFC), there still exists a challenge at the ground level: the simple availability or production of affordable housing projects."

The Objective of the Study

To study the various factors affecting the consumer's decision towards the purchase of home loan of SBI and LIC.

Research Methodology

Type of Study: The study is Descriptive.

Area Of Study: Bargur Taluk

Sample Size: N = 100 respondents

Sampling Process: Random sampling technique was used for the study.

Data Type: For the study both primary as well secondary data was used.

Data Collection Tools: For the collection of primary data structured Questionnaire was used consisting of both open and closed-ended questions. Secondary data was obtained from research journals, books, and websites and published records.

Statistical Tools Used: Frequency percentage, the t-test was applied for data analysis.

Data Analysis and Interpretation

Demographic Profile of Respondents

It was found in the research that out of the total respondents, 84% were Male and 16% were female respondents. Regarding the age category, it was found in the research that 33% of the respondents were in the age group of 18-30 years, 40% of the respondents were in the age group of 31-40 years, 18% were in the age group of 41- 50 years, 08% were in the age group of 51-60 years and 01% were in the age group of 61-70 years. Out of the total respondents, 76% were married and 24% were unmarried.

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Type of Home Loan Taken by Respondents

Table 1 Type of Home Loan Opted

S.No	Category of Home Loan	LIC(%)	SBI(%)
1	Home Purchase	42	48
2	Home Improvement	16	22
3	Home Construction	22	22
4	Home Extension	02	---
5	Land Purchases	18	08

As shown in Table No:1, it was found in the research that out of the total respondents of LIC, 42% of the respondents had opted for "Home Purchase", 16% of the respondents had opted for "Home Improvement", 22% had opted for "Home construction", 02% had opted for "Home extension" and 18% had opted for "Land Purchase - category regarding the Home loan. In the case of the total respondents of SBI, it was found in the research that regarding the Home loan category, 48% of the respondents have opted for Home purchase" option, 22% of the respondents had opted for Home Improvement", 22% of the respondents had opted for Home construction and 8% had opted for Land purchase.

Interest Rate Opted by the Respondents

Table 2 Interest Rate Opted by the Respondents

S.No	Category	LIC(%)	SBI(%)
1	Fixed Interest Rate	98	100
2	Floating Interest Rate	02	---

As shown in Table No: 2, out of the total respondents of LIC, it was found in the research that 98% of the respondent had opted for "Fixed interest rate" and 02 % had opted for "Floating interest rate." In the case of the total respondents of SBI, it was found in the research that 100% of the respondents had opted for "Fixed interest rate."

Reason for Selecting SBI or LIC for Taking the Home Loan

The t-test was conducted to compare the reasons for selecting SBI or LIC by respondents for taking the home loan.

Table 3 Reason for selecting SBI or LIC

Reason	Mean LIC	Mean SBI	t-value LIC	T-Value SBI
Low-Interest Rate	4.0000	4.1300	52.915 ***	56.563***
Accessibility in Easy	4.2600	4.3200	32.684***	32.654***
Status/Reputation of the Institution	4.3000	4.4400	55.894***	54.401***
Quick Service by the Company	4.3200	4.1200	55.433***	49.058***
Scheme Offered by the Company	4.1600	4.2400	57.734***	53.973***

As shown in Table No:3, it was found that the mean value for SBI (4.32) is higher as compared to the mean value for LIC (4.32).

Accessibility factor. The mean value for SBI (4.44) was higher as compared to the mean value of LIC (4.3) regarding the „Status Reputation of the institution factor. The mean value for LIC (4.32) was higher as compared to the mean value of SBI (4.12) regarding the „Quick service by the company factor. The mean value for SBI (4.24) was higher as compared to the mean value of LIC (4.16) regarding the „Schemes offered factor. Thus there was a significant difference found between the variables regarding the respondent's reason for selecting SBI or LIC as an option for taking the home loan.

Factors Influencing the Decision to Take Home Loan

The test was conducted to compare the factors that influenced the respondents to take home loan from SBI and LIC

Table 4 Factors that Influenced the Respondents to Take Home Loan from SBI and LIC

Factors Influencing the Decisions	Mean LIC	Mean SBI	T-Value LIC	T-Value SBI
Longer repayment period	2.4000	2.2600	22.450***	28.304***
Easy Documentation formalities	1.9000	1.9800	14.778***	15.697***
Fast processing of loan	2.3400	2.1600	18.495***	18.145***
Good communication	2.3000	2.1200	16.020***	17.667***
Cooperative staff	2.2800	2.3000	16.998***	16.020***
Easy installments	1.7400	1.8000	18.523***	19.922***
Suggestion by Friends/Relatives	1.8200	1.7400	17.216***	13.040***
Trust of Institution	1.6400	1.5800	15.474***	16.606***

P < .05 = * P < .01 = ** P < .001 = ***

As shown in Table nos.4, it was found in the research that regarding the „Longer repayment period” and „Easy documentation” factor, the mean value of SBI (2.26, 1.98) was found to be higher than LIC (2.40, 1.90) respectively. Regarding „Fast processing of loan” and „Good Communication” factor, the mean value for LIC (2.34, 2.30) was found to be higher than the mean value of SBI (2.16, 2.12) respectively. Regarding the factor of „Cooperative staff and „Easy installments,” the mean value for SBI (2.30, 1.80) was found to be higher than the mean values of LIC (2.28, 1.74) respectively. Regarding „Suggestion by friends/relatives” and „trust on institution” factor, the mean value for LIC (1.82, 1.64) was found to be higher than the mean values of SBI (1.74, 1.58). Thus, there was a significant difference found between the variables regarding the factors that influence the respondents to opt for the home loan from SBI or LIC.

Major Findings

- Maximum percentage of the respondents had opted for „Home Purchase” category of Home loan, both in LIC (42%) and SBI (48%)
- „Fixed rate of interest” is the most preferred option by the respondents regarding the purchase of Home Loan.
- „Low Rate of Interest” „Easy Accessibility”, „Status/Reputation of the institution” and „Scheme offered by the company”, were the major factors that the respondents consider as the reason for selecting SBI as an institution for taking Home Loan, whereas the factor of Prompt service was found to be a major factor that the respondents consider as the reason for selecting LIC as an institution for taking Home Loan.
- „Longer repayment period”, „Easy documentation formalities”, „Cooperative staff and „Easy instalments” are the major factors that had influenced the respondents to opt for Home Loan

Decision-Making Style of Purchasing Fashion Apparels among Rural Youth

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Abstract: *The purpose of this study is to examine and analyze the decision making styles of rural youth in Dharmapuri District towards fashion apparels and also tried to find out the factors influencing decision making styles. For this study the survey was conducted during 1st February to 31st March 2019. The data was collected from respondents through scheduled containing questions. The study result concluded that gender is not affecting the decision making styles. Six reliable factors of consumer decision-making styles on purchasing fashion apparels were identified in this study, which are quality, fashion, enjoyment and happiness, price, brand and familiarity. The findings in this study were useful in helping marketer to reallocate their marketing strategies and provide information to marketers about the consumer's decision-making profile of rural youth in Dharmapuri District.*

Keywords: Decision making styles, fashion apparels, buying behavior

1. Introduction

In today's society even the apparel customers like fashion trend seekers are influenced by journalists, celebrities, bloggers, magazines and brand advocates and they are regarded as “the most powerful force in the fashion marketplace.” They impact customers purchasing decisions based on their personal opinion, ability and position and are often considered experts in their field by consumers. Fashion is of great importance to many consumers, it is defined as “the process of social diffusion by which a new style is adopted by some group of consumers.” Fashion influences many aspects of our lives, it has both economic and social value and provides individuals with a tool to express themselves and create an identity. It is therefore important to understand the process of decision making within the fashion industry.

2. Scope of the Study

Philip Kotler's consumer decision making process is taken as a model. By collecting data from consumers' point of view, fresh insights can be gathered. The research also aims to serve as an indicator to potential readers of how they can tap into the decision making process influencers. Since it studies mainly the effect that blogs have on buying behaviour, which something all retailers should be aware of in order to be able to understand how behaviour patterns of modern buyers can be affected by other people's opinions.

3. Review of Literature

Fashion is one of the important factors in consumer decision-making (Gutman and Mills, 1982; Kim, 1988; King and Ring, 1980; Sproles, 1979; Sproles and Kendall, 1986). According to Kim (1988), fashion conscious consumers of the late of 20th century had strong fashion sense from the mass media and always considered before shopping. Fashion conscious consumers also tend to ignore about the quality, brand, and never compared the price.

McCracken's (1989), through his study observed that a celebrity endorser is an individual who enjoys public recognition and who uses this recognition on behalf of a consumer good by appearing with it in an advertisement.

Conner and Armitage (1998) observed that when a person decides his/her future purchase with the help of his/her past experiences of purchases, one can predict the intention of that person in the future too.

Muhammad Irfan Tariq et al. (2013) elucidated purchase intention concerning four behaviors of consumers comprising the absolute brand purchase the brand, thinking clearly to buy the brand, when someone considers to purchase the brand in the future, and to purchase the particular product absolutely.

Sedeke, (2013) explains fashion is a consistently changing industry with new products and trends being created and new designers itching to be publicized around the world at any given moment, making identification with loyal consumers and their preferences vital to any amount of success. As a low-cost form of distributing online media, specifically important to new designers whose budgets remain at lower capabilities, bloggers spend their time searching for high-quality information, including products and trends, to supplement a blog post to attract the largest audience possible.

Research Objectives

To achieve the goal of the study, the following research questions were addressed as research objectives.

- 1) To examine the association between gender and their decision making styles of buying fashion apparels in Dharmapuri District.
- 2) To analyze the decision making styles of rural youth in Dharmapuri District towards fashion apparels.

4. Research Methodology

Research methodology states what procedures were employed to carry out the research study. The technical facts about the study are given below.

This study focused on rural youth of Dharmapuri district's decision-making styles associated with fashion apparel purchases. The interview schedule was used and 114 consumers were selected from the three taluks namely Dharmapuri, Palacode and Pennagaram. A non-probability sample was used. In order to achieve the accuracy of result, a fair numbers of 65 male consumers and 49 female consumers were selected using the Quota sample based on the sex ratio. The consumer decision-making characteristic were measured by the variables are framed for this study.

Factor analysis was used to identify the highly influencing factors of decision making styles. According to Vogt (1999), factor analysis is often used in survey research questions or statements. An evidence of research in Huck (2000), he suggests that factor analysis also provides a measure of construct validity. For this purpose, factor analysis in this study was used to confirm the Consumer decision- making style and applied to convert the data into more manageable

factors about consumer decision-making styles relating to fashion apparels. In factor analysis, Varimax rotation and Kaiser-Meyer-Olkin (KMO) were used to summarize the items and to measure the sampling adequacy. KMO was extremely useful and assessed while the factor analysis was run. Generally, KMO varies from 0 to 1.0, but according to Hair et al (2006), the acceptable values of KMO statistics should higher or at least equal to 0.5 for a satisfactory factor analysis to proceed. In this study the KMO value is 0.891. At the same time, the use of varimax rotation was to achieve loadings of ones and zeros in the columns of the component matrix. Furthermore, to assess the internal consistency of each factor group, reliability test and Cronbach's alpha were used in this study. According to Sproles and Kendall (1986), the acceptable Cronbach's alpha coefficient was 0.4 or above. In our study Cronbach's alpha coefficient is 0.967.

5. Result and Discussion

This section deals with the testing of hypotheses by using appropriate statistical tools. SPSS 20 software has been used for the purpose of analyzing responses gathered.

H0: There is no significant association between gender and their decision making styles of buying fashion apparels

Gender and Decision Making Styles of Buying Fashion Apparels

Gender	Decision Making Styles				Chi-Square	p Value	H0 Accepted/ Rejected
	Decision Making under Certainty	Decision Making under Risk	Decision Making under Uncertainty	Total			
Male	15	30	20	65	1.090 ^a	0.580	Accepted
	23.1%	46.2%	30.8%	100.0%			
Female	14	24	11	49			
	28.6%	49.0%	22.4%	100.0%			
Total	29	54	31	114			
	25.4%	47.4%	27.2%	100.0%			

Source: Primary Data

Inference

The above table exhibit that the p value is higher than 0.05. So the null hypothesis is accepted at 5% level of significance. Hence it is concluded that there is no significant association among gender and their decision making styles of buying fashion apparels.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.891
Bartlett's Test of Sphericity	Approx. Chi-Square	3119.813
	df	630
	Sig.	.000

Source: Computed Data.

From the above table, it is known that Kaiser-Meyer-Olkin measure of sampling adequacy is 0.891 and Bartlett's Test of Sphericity's approximate Chi-Square value is 3119.813 which are statistically significant at 5% level.

Communalities

Factors influencing decision making style	Initial	Extraction
q6.1 I am an experienced user of fashion clothing	1.000	0.728
q6.2 Fashion clothing is a significant part of my life	1.000	0.724
q6.3 I usually dress for fashion	1.000	0.644
q6.4 I am interested in fashion clothing	1.000	0.659
q6.5 I go shopping to keep up with the trends	1.000	0.560
q6.6 I am very familiar with fashion clothing	1.000	0.666
q6.7I feel I know a lot about fashion clothing	1.000	0.728
q6.8 I would classify myself as an expert on fashion clothing	1.000	0.597
q6.9 For me fashion clothing is an important product	1.000	0.736
q6.10 Shopping for clothing is not a pleasant activity for me	1.000	0.701
q6.11 Going shopping for clothing is one of the enjoyable activities in my life	1.000	0.656
q6.12 I enjoy shopping just for the fun of it	1.000	0.669

q6.13 I do my shopping quickly	1.000	0.753
q6.17 Shopping for clothing satisfies my sense of curiosity	1.000	0.629
q6.18 The higher the price of clothing, the better the quality	1.000	0.621
q6.19 Nice departments and specialty stores offer me the best clothing	1.000	0.782
q6.20 The most advertised brands are usually very good choices	1.000	0.682
q6.21 The well-known brands of clothing are best for me	1.000	0.690
q6.22 The more expensive brands of clothing are usually purchased by choice	1.000	0.755
q6.23 I prefer buying the bestselling brands of clothing	1.000	0.652
q6.24 I keep my wardrobe up to date with the changing fashion	1.000	0.707
q6.25 Fashionable, attractive styling is very important for me	1.000	0.660
q6.26 To get variety, I shop at different stores and chose different brands	1.000	0.666
q6.27 It's fun to buy new and exciting clothing	1.000	0.746
q6.28 It's fun to buy new and exciting clothing	1.000	0.613
q6.29 Getting very good quality is important to me	1.000	0.750
q6.30 When it comes to purchasing clothing, I try to get the best or make the perfect choice	1.000	0.749
q6.31 In general, I try to buy the best overall quality in clothing	1.000	0.730
q6.32 I make a special effort to choose the very best quality clothing	1.000	0.702
q6.33 My standards and expectations for clothing I buy are very high here are so many brands to	1.000	0.715
q6.34 Choose from that I often feel confused	1.000	0.523
q6.36 The more I learn about clothing, the harder it seems to choose the best	1.000	0.576
q6.37 All the information I get on different products confuses me	1.000	0.649
q6.38 I have favorite brands I buy over and over	1.000	0.721
q6.39 Once I find a brand of clothing I like, I stick to it	1.000	0.722
q6.40 I go to the same stores each time I shop for clothing	1.000	0.538

Extraction Method: Principal Component Analysis.

The communalities in the column labeled extraction reflect the common variance in the data structure. For example, it can be said that, 72.8% of the variance associated with question 1 is common or shared variance. Another way to look at these communalities is in terms of the proportion of

variance explained by the underlying factors. After extraction some of the factors are discarded and so some information is lost. The amount of variance in each variable that can be explained by the retained factors is represented by the communalities after extraction.

Total Variance Explained

Component	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	16.490	45.805	45.805	16.490	45.805	45.805	6.306	17.517	17.517
2	2.659	7.387	53.192	2.659	7.387	53.192	5.767	16.020	33.537
3	1.470	4.085	57.277	1.470	4.085	57.277	3.543	9.842	43.379
4	1.346	3.739	61.016	1.346	3.739	61.016	3.300	9.168	52.547
5	1.248	3.466	64.482	1.248	3.466	64.482	3.123	8.676	61.223
6	1.187	3.296	67.778	1.187	3.296	67.778	2.360	6.555	67.778
7	.941	2.615	70.392						
8	.899	2.497	72.890						
9	.806	2.238	75.127						
10	.726	2.018	77.145						
11	.689	1.915	79.060						
12	.677	1.881	80.941						
13	.627	1.741	82.682						
14	.574	1.595	84.277						
15	.527	1.464	85.741						
16	.477	1.326	87.067						
17	.471	1.309	88.376						
18	.424	1.177	89.553						
19	.387	1.076	90.629						
20	.368	1.022	91.652						
21	.333	.924	92.575						
22	.307	.853	93.428						
23	.291	.809	94.238						
24	.276	.765	95.003						
25	.253	.703	95.706						
26	.218	.604	96.310						
27	.203	.565	96.875						
28	.199	.551	97.426						
29	.170	.471	97.897						
30	.145	.402	98.299						

31	.139	.387	98.685						
32	.122	.338	99.023						
33	.114	.318	99.341						
34	.096	.266	99.607						
35	.088	.246	99.853						
36	.053	.147	100.000						

Extraction Method: Principal Component Analysis.

In the above table, it can be noted that six factors have been extracted on the basis of prior knowledge to describe the relationship among the variables. Further, the scree plot associated with this analysis is given in Chart xxx in the scree plot, it can be noted that a distinct break occurs at six

factors. Finally, from the cumulative percentage of variance accounted for, it can be seen that 67.778 percent of variance, as contributed by first component (17.517 percent) followed by second component (16.020 percent) the third (9.842 percent) the fourth (9.168 percent) the fifth (8.676 percent) and sixth (6.555 percent) of total variance.

Rotated Component Matrix^a

Factors influencing decision making style	Component					
	1	2	3	4	5	6
Quality						
q6.31 In general, I try to buy the best overall quality in clothing	0.774					
q6.32 I make a special effort to choose the very best quality clothing	0.740					
q6.39 Once I find a brand of clothing I like, I stick to it	0.739					
q6.30 When it comes to purchasing clothing, I try to get the best or make the perfect choice	0.717					
q6.33 My standards and expectations for clothing I buy are very high here are so many brands to	0.684					
q6.38 I have favorite brands I buy over and over	0.626					
q6.36 The more I learn about clothing, the harder it seems to choose the best	0.559					
q6.40 I go to the same stores each time I shop for clothing	0.557					
q6.34 Choose from that I often feel confused	0.529					
Fashion						
q6.71 feel I know a lot about fashion clothing		0.773				
q6.2 Fashion clothing is a significant part of my life		0.739				
q6.3 I usually dress for fashion		0.692				
q6.1 I am an experienced user of fashion clothing		0.680				
q6.4 I am interested in fashion clothing		0.671				
q6.8 I would classify myself as an expert on fashion clothing		0.666				
q6.9 For me fashion clothing is an important product		0.656				
q6.10 Shopping for clothing is not a pleasant activity for me		0.606				
q6.5 I go shopping to keep up with the trends		0.588				
Enjoyment and Happiness						
q6.26 To get variety, I shop at different stores and chose different brands						
q6.13 I do my shopping quickly			0.797			
q6.17 Shopping for clothing satisfies my sense of curiosity			0.724			
q6.18 The higher the price of clothing, the better the quality			0.604			
q6.12 I enjoy shopping just for the fun of it			0.521			
q6.28 It's fun to buy new and exciting clothing			0.515			
Price						
q6.11 Going shopping for clothing is one of the enjoyable activities in my life				0.716		
q6.29 Getting very good quality is important to me				0.578		
q6.27 It's fun to buy new and exciting clothing				0.536		
q6.22 The more expensive brands of clothing are usually purchased by choice				0.529		
q6.23 I prefer buying the bestselling brands of clothing				0.516		
q6.24 I keep my wardrobe up to date with the changing fashion				0.498		
Brand						
q6.21 The well-known brands of clothing are best for me					0.711	
q6.37 All the information I get on different products confuses me					0.657	
q6.25 Fashionable, attractive styling is very important for me					0.578	
Familiarity						
q6.19 Nice departments and specialty stores offer me the best clothing						0.715
q6.20 The most advertised brands are usually very good choices						0.615
q6.6 I am very familiar with fashion clothing						0.569

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.

Inference

From the above table, it can be noted that nine variables are grouped under the first factor named as “Quality”. The second factor also consisting of nine variables is named as “Fashion”. The third factor named as “Enjoyment and Happiness” is formed with five variables. The fourth factor consisting of six variables is named as “Price”. The fifth factor named as “Brand” consisting of three variables. The last factor named as “Familiarity” consist of three variables. This table reveals that the factor analysis results in

six predominant factors. The entire variable in these six factors are compounded into the demographic profile of the respondents with the help of appropriate statistical tools.

Friedman Rank Correlation factors influencing decision making styles of buying fashion apparels

H₀: There is no significant relationship among factors influencing decision making styles of buying fashion apparels

Table: Factors for Decision Making Style

Factors	N	Mean	Std. Deviation	Mean Rank	Rank	Chi Squire	p Value	H0
Quality	114	29.63	8.231	5.55	1	494.632	<0.001	Rejected
Fashion	114	27.11	7.681	5.20	2			
Price	114	19.76	5.400	3.71	3			
Enjoyment & Happiness	114	18.74	5.388	3.48	4			
Familiarity	114	9.68	2.734	1.56	5			
Brand	114	9.56	2.704	1.50	6			

Source: Computed Data

Inference

The above table indicates that p value is less than 0.05, the null hypothesis is rejected at 5% level of significance. Hence it is concluded that there is significant relationship between among factors influencing decision making styles of buying fashion apparels. Based on mean rank 8.231 **quality** is the most important factor for among factors influencing decision making styles of buying fashion apparels followed by **fashion** with mean rank of 7.681, **price** with mean rank of 5.4, **enjoyment & happiness** mean rank with 5.366, **familiarity** with mean rank of 2.734 and brand mean rank of 2.704.

6. Conclusion

Retailers in emerging markets face a challenge of growing consumer preferences for international brands with strong brand images in developed countries. Intense competition in retailing industry urges retailers to find new ways how to increase their profits and returns of investment. To do so they need to know their consumers better.

Six reliable factors of consumer decision-making styles on purchasing fashion apparels were identified in this study, which are quality, fashion, enjoyment and happiness, price, brand and familiarity. The findings in this study were useful in helping marketer to reallocate their marketing strategies and provide information to marketers about the consumer’s decision-making profile of rural youth in Dharmapuri District.

7. Scope for Further Research

This research is limited to Dharmapuri district only which may not be applicable to entire nation. Further research may be conducted in the different parts of the country with same title.

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ISSN No. 2394-2886

Impact Factor 6.1



SURAJ PUNJ JOURNAL FOR MULTIDISCIPLINARY RESEARCH

(A PEER REVIEWED/REFERRED JOURNAL)

Special Issue

February 2019



International
Organization for
Standardization

7021-2008



UGC S.No: 64786

Suraj Punj Journal for Multidisciplinary Research

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Contents

Sl.No.	Title of the Articles	Page No.
1.	Corporate Governance Practice in the State Bank of India - Dr. N. Rajavel	1 - 3
2.	Branchless Banking – An Overview - Dr. K. Gunasekaran	4 - 5
3.	Money Market in India – An Overview - Dr. K. Ramachandran	6 - 11
4.	A Study on Customer Satisfaction towards E-Banking Services on Selected Banks in Salem Dist. (Tamil Nadu) - Ismailamiya & Dr.P. Ashok Kumar	12 - 16
5.	E-Banking Scenario in India – A Study - Dr. N. Prabha	17 - 20
6.	A Study on Customer Preference towards E-Banking Services with Special Reference to Dharmapuri District - Dr. M. Raja	21 - 25
7.	Issues and Security Measures of Mobile Banking Apps – A Study - R. Seerangan	26 - 29
8.	Retail Banking Challenges and Latest Trends in Tamil Nadu - P. Vetriselvi & R. Ramprabu	30 - 35
9.	Mobile Banking In India - Dr. S. Gurusamy	36 - 38
10.	Mobile Banking-An Introduction - Dr. P. Sivakumar	39 - 41
11.	Mobile Banking Products and Rural India - D. Duraimurugan	42 - 44
12.	A Study on Recent Trends in Retail Banking - K. Nithiya	45 - 49
13.	Retail Banking Challenges and Recent Trends in India - D. Dhivya	50 - 52
14.	Banking Business Correspondence - B. Kiruthika	53 - 54
15.	Information Technology in Banking Sector - V. Maheswari	55 - 57
16.	Corporate Governance in the Banking Sector in India - M. Selvaraj	58 - 60
17.	Mobile Banking and its Benefits - P. Manikandan	61 - 63
18.	Impact and Risks in E – Banking - V. Nanthini	64 - 68
19.	A Study on Financial Performance Role of Tyre Manufacturing Companies in India - S. Kumar	69 - 73
20.	Retail Banking Challenges and Latest Trends in TN - L. Ravikumar	74 - 77

A STUDY ON CUSTOMER PREFERENCE TOWARDS E-BANKING SERVICES WITH SPECIAL REFERENCE TO DHARMAPURI DISTRICT

Dr. M. Raja¹

Abstract

The purpose of this paper today every banking organization are using. e –banking for better customer services, banking industry has suddenly witnessed a major boom. Being a globalized market, the customer seeks and demand has world class products. Electronic banking is one of the emerging trends in the Indian banking. a interview schedule has been designed to collect the data from the respondents. the sample size 150. the random sampling used. the study makes use of statistical techniques such as percentage analysis, chi-square test, weighted average rank method in analyzing the data for finding the result. there is no significant association between age of the respondents and their aware about e-banking services and there is a significant difference between gender of the respondents and their recommend others to adopt e-banking services.

Keywords: e-banking, customer perception, security, usage, Technology.

Introduction

E- banking means any user with a personal computer and a browser can get connected to his bank-s website to perform any of the virtual banking functions, in internet banking system the bank has a centralized database that is web enabled. all the services that the bank has permitted on the internet are displayed in menu. any service can be selected and further interaction is dictated by the nature of service.

Electronic banking is one of the emerging trends in the Indian banking. it has been in the form of e-banking or net banking or online banking or internet banking which is now replacing the traditional banking mechanism. e-banking involves information technology based banking under this system the banking services are delivered by way of a computer controlled system this system does involve direct interface with the customers. the customers do not have to visit the banks premises.

e-banking is a product designed for the purpose of online banking that enables you to have easy and safe access to your bank account. E-banking is a safe, fast easy and efficient electronic service that enables you access to bank account and to carry out online banking. banking services, 24 hours a day and 7 days a week with this service you save your time by carrying out banking transactions at any time from your home or office all you need is internet access.

The government of India encourages people to move towards cashless economy. this can be achieved by use of debit and credit cards, electronic payment gateway system such as national electronic fund transfer (NEFT) and real-time gross settlement (RTGS) in India.

Popular Services Covered Under E-Banking

The popular services covered under e-banking include

- Automated teller machines
- Credit cards
- Debit cards
- Smart cards
- Electronic fund transfer (EFT) system
- Cheques transaction payment system
- Mobile banking
- Internet banking
- Telephone banking

Advantages Of E-Banking

The main advantages of e-banking are:

1. The operating cost per unit services is lower for the banks
2. It offers convenience to customers as they are not required to go to the banks premises.
3. There is very low incidence of errors.

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- 4 The customer can obtain funds at any time ATM machines
- 5 The credit card and debit cards enables the customers to obtain discounts from retail outlets
- 6 The customer can easily transfer the funds from one place to another place electronically. It is updated online, real time, the system is updated immediately after every transaction automatically.

Services/Transactions

- Answering routine queries
- Bill payment service
- Electronic fund transfer
- Electronic clearing system
- Credit card customers
- Railway pass
- Investing through internet banking
- Recharging your prepaid phone
- Shopping

Review of literature

Gerrard and cunningham (2003) also identify of the factors of paramount importance in ensuring the success of e-banking, the ability of an innovation to meet users needs using different feature availability on the web site. for instance, the provision of interactive loan calculators, exchange rate converters, and mortgage calculators on the web sites draw the attention of both users and nonusers into the banks web site.

Boatenge and molla (2006) indicated that the operational constraints of internet banking is associated with the customer location, the need to maintain customer satisfaction and the capabilities of the banks main software to act as an influential factors in motivating the decision to enter electronic banking services and consequently influencing the usage experience and thus affecting the level of satisfaction.

Anita lifen zhao et al (2010) used empirical evidence to investigate the relationship between perceived risk and trust in adoption of internet banking services in china. the research was conducted on a sample of 432 young chines consumers who can be classified as internet banking service early adopters. the study results indicate that there is a significant relationship between trust and

that both are crucial in explaining the internet banking usage intention

Geetha k t & malarvizhi v (2011) investigates the factors which are affecting the acceptance of e-banking services among the customers and also indicates level of concern regarding security and privacy issues in Indian context. the finding depicts many factors like security and privacy and awareness level increased the acceptance of e-banking services among Indian customers

Objectives of the study

1. The study aims at identify the overall customer perception towards the e-banking services in Dharmapuri district.
2. The study also aims at know whether socio economic variables of the customer satisfaction in Dharmapuri district

Limitations of the study

1. There were several time constraints
2. The study is limited to areas of Dharmapuri only
3. The study is related to customers only
4. People were reluctant to go into details because of their busy schedules

Methodology and Sampling design

This present study will be used random to know the e-banking preference towards customers. It is planned to collect both primary and secondary data for analysis. The sample respondents cover Dharmapuri district. It is planned to collect data from the 150 respondents

Tools for data collection

Primary data and secondary data have been used. Primary data were collected through a structured questionnaire and the secondary data were collected from the books, journal, articles, newspapers magazines and websites. The primary data were collected was further analyzed by using various tools like 1. Percentage analysis 2. Chi-square independence test

Period of the study

The data were collected for the month of november 2018- January 2019.

Data analysis and interpretation:

Table - 1 : Demographic Profile of the Respondents

Category	Variable	Frequency	Percentage
1 Gender	Male	100	75
	Female	50	25
	Total	150	100.00
2 Age	21 – 30 years	80	53
	31 – 40 years	40	27
	41 – 50 years	25	17
	Above 50 years	05	03
	Total	150	100.00
3 Educational qualification	Illiterate	40	27
	School level	20	13
	Degree / Diploma level	55	37
	Professional level	35	23
	Total	150	100.00
4 Occupation	Government employee	30	20
	Private employee	52	34
	Profession	22	15
	Business	22	15
	Agriculture	24	16
	Total	150	100.00
5 Monthly family income	Below Rs.10000	33	68
	Rs.10001 – Rs.20000	41	42
	Rs.20001 – Rs.30000	22	25
	Above Rs.30000	8	15
	Total	150	100.00
6 Marital status	Married	18	12.00
	Unmarried	132	88.00
	Total	150	100.00
7 Name of the bank	State bank of India	62	41
	Indian overseas bank	34	23
	ICICI	34	23
	HDFC	20	13
	Total	150	100.00
8 E-banking service you think is more user friendly	Internet banking	40	27
	Telephone banking	10	06
	ATM	60	40
	Mobile banking	40	27
	Total	150	100.00

9 E-Banking services aware more	Internet banking	30	20
	Telephone banking	10	07
	ATM	80	53
	Mobile banking	30	20
	Total	150	100.00
10 Trust the security of e-banking services	Completely	54	36
	Somewhat	46	31
	Dubious	34	23
	Not at all	16	10
	Total	150	100.00

Table -7,8,9,10 analysis in e-banking services.

Table -7 relating to customer preference towards e-banking services

Table -8 relating to awareness of e-banking services, majority of 40% of respondents had awareness about e-banking services.

Table -9 relating to e-banking service you think is more user friendly, majority of the respondents think that ATM is more user friendly.

Table-10 relating to e-banking services aware more about ATM services

Chi-square test-association between age of the respondents and their aware about e-banking services

Research hypothesis: there is a significant association between age of the respondents and their aware about e-banking services

Null hypothesis: there is no significant association between age of the respondents and their aware about e-banking services

Table - 2

	Aware about e-banking services			Statistical inference
	Yes	No	Total	
Age	108	42	150	X ² = 2.072 df=3 558>0.05 not significant
21 to 30 yrs	61	20	81	
31-to 40 yrs	27	22	49	
41- to 50yrs	15	0	15	
51 yrs and above	05	0	05	

Findings : The above table reveals that there is no significant association between age of the respondents and their aware about e-banking services. hence, the calculated value greater than table value. so the research hypothesis is rejected and the null hypothesis accepted.

Summary of Findings :

1. Thus majority 55% of the respondents graduate only.
2. Thus majority 52% of the respondents are working in private concern
3. Thus the majority of the respondents annual income 10001-200000.
4. Thus majority 62 % of the respondents having an account state bank of india
5. Thus all the sample respondents have awareness about e-banking services

6. 88.3% of the respondents agree that their expectations are met through e-banking services 60% of the respondents opt that ATM service is more user friendly 7.78 % majority of the respondents agree that they definitely recommend others to adopt the e-banking services
7. majority of the respondents strongly agree that e-banking services provides
 - privacy of customer information

Suggestions:

The e-banking in india are using information technology not only to improve their own internal process but also to increases facilities and services to their customers. efficient use of technology of the increased transaction volume of banks of that comes with larger customer base. by designing and offering simple and, safe and secure technology, banks reach at doorstep of customer with delight customer satisfaction.

Conclusion

The usage of e-banking is all set to increase among the service class. the service class at the moment is not using the services thoroughly due to various hurdling factors like in security and fear of hidden costs. so banks should come forward with measures to reduce the apprehensions of their customers through awareness campaigns and more meaningful advertisements to make e-banking popular among all the age and income groups.

E -banking is an innovative tool that is fast becoming necessity it is a successful strategic weapon for banks to remain profitable in a volatile and competitive market place of today. in future, the availability of technology ensure safety and privacy of e-banking transactions and the RBI guidelines on various aspects of internet banking will definitely help in rapid growth of internet banking in India.

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A Comprehensive Study of Security Issues and Challenges in Big Data

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Abstract - Big data is a collection of data sets which is very large in size as well as complex. The amount of data in world is growing day by day. Data is growing because of use of internet, smart phone and some social network. Traditional database systems are not able to capture, store and analyze this large amount of data. As the internet is growing, amount of big data is continues to grow rapidly. Big Data is going to play important role in future world. Big data changes the way that data is managed and used in some of the applications are in areas such as healthcare, traffic management, banking, retail, education and so on. In the digital and computing world, information is generated and collected at a rate that rapidly exceeds the limits. However, the fast growth rate of such large data generates numerous challenges, such as the rapid growth of data, transfer speed, diverse data and security. This paper shows overview of big data, its characteristics, and stages involved, big data in cloud and security issues and challenges with big data, strengthen of big data security and some proposals to big data security.

Keywords --- *Big data, volume, velocity, variety, veracity, value, cloud, security.*

I. INTRODUCTION

Big data refers to large volumes of data in our everyday lives. Extraordinary growth in data, although predictable, continues to strain corporate resources and government sectors [1]. Data is growing because of use of internet, smart phone and social networks like face book, you tube, twitter and so on. Many organizations demand efficient solutions to store and analyze these big amount data that are preliminary generated from various sources such as high throughput instruments, sensors or connected devices. For this purpose, big data technologies can utilize cloud computing to provide significant benefits, such as the availability of automated tools to assemble, connect, configure and reconfigure virtualized resources on demand [5]. These make it much easier to meet organizational goals as organizations can easily deploy cloud services.

Day by day, the security of confidential information is gaining more and more attention. According to 2016 Trust wave Global Security Report; nearly 97% of applications had at least one security vulnerability. By this, the security is extremely high ranked priority for any enterprises. However, with the ease of adoption of web-based, smart phones and cloud-based applications, the confidential information has become easy to access from various platforms. Such platforms are highly vulnerable to hacking, especially if they are not maintained properly. Unlike earlier, companies are now collecting and using lots of customer data. A lack of data security can bring some serious security issues and organization's reputation will be at stake [3]. The challenges include analysis, capture, search, sharing, storage, revelation, and privacy violations.

A. Big Data- Where is it?

Big data surrounds us, although we may not immediately realize it. Part of the problem is that, except in unusual circumstances, most of us don't deal with large amount of data in our everyday lives. Lacking of this immediate experience, we often fail to understand both opportunities as well as challenges presented by big data. There are two types of Big Data: structured and unstructured.

Structured data are numbers and words that can be easily categorized and analyzed. These data are generated by things like network sensors embedded in electronic devices, smart phones and global positioning system (GPS) devices. Structured data also include things like account balances, sales figures and transaction data.

Unstructured data include more multifarious information, such as customer reviews from feasible websites, photos and other multimedia, and comments on social networking sites. These data cannot be separated into categorized or analyzed numerically.

II. BIG DATA CHARACTERISTICS

A. Data Volume:

Data volume measures the amount of data available to an organization, companies, government, financial, medical institution, educational institution which are producing data in order of terabytes every day. Some applications are used to handle the data [2].

B. Data Velocity:

Data velocity measures the speed of data creation, streaming and aggregation. Data is generating at very fast rate [2]. Data velocity measures large data in short period of time. It deals with the pace at which data flows in from sources like business process, machines, networks and human interactions with things like social media sites, mobile devices, etc. The flow of data is massive and continuous.

C. Data Variety:

Data variety is a measure of the richness of the data representation – text, images, videos, audio, etc. At present data comes in different forms including data streams, text, picture, audio, video, structured, semi structured, unstructured. Unstructured data is difficult to handle with traditional tools and techniques.

D. Data Veracity:

Data veracity refers to the biases, noise and abnormality in data [4]. Is the data that is being stores and mined meaningful to the problem be analyzed. Data veracity is the degree to which the data is accurate, precise and trusted.

E. Data Value:

Data value measures the usefulness of data in making decisions. It has been noted that “the purpose of computing is insight, not numbers”. Data science is exploratory and useful in getting to know the data, but “analytic science” encompasses the predictive power of big data.

Nowadays data comes from different sources. And it is still an undertaking to link, match, cleanse and transform data across systems. However, it is necessary to connect and correlate relationships, hierarchies and multiple data linkages or data can quickly spiral out of control. These are certain characteristics of big data from normal data.



Figure 1: 5 V's of BIG DATA

III. STAGES INVOLVED IN BIG DATA

A. Data Acquisition:

The first step in Big Data is acquiring the data itself. With the growing medium the rate of data generation is rising exponentially. With the introduction of smart devices which are used with a wide array of sensors continuously generate data. Most of this data is not useful and can be discarded, however due to its unstructured form; selectively discarding the data presents a challenge. This data becomes more potent in nature when it's merged with other valuable data and superimposed. Due to the interconnectedness of devices over the World Wide Web, data is increasingly being collated and stored in the cloud.

B. Data Extraction:

All of the data generated and acquired is not of use. It contains a large amount of redundant or unimportant data. The challenges presented in data extraction are two folds: firstly, due to nature of data generated, deciding which data to keep and which to discard increasingly depends on the context in which the data was initially generated. Secondly, a lack of a common platform presents its own set of challenges. Due to wide variety of data that exists, bringing them under a common platform to standardize data extraction is a major challenge.

C. Data Collation:

Data from a singular source often is not enough for analysis or prediction. More than one data sources are often combined to give a bigger picture to analyze. For example a health monitor application often collects data from the health –rate sensor, pedometer, etc. to summarize the health information of the user. Likewise, weather prediction software take in data from many sources which reveal the daily humidity, temperature,

precipitation, etc. In the scheme of Big Data convergence of data to form a bigger picture is often considered a very important part of processing.

D. Data Structuring:

Once all the data is aggregated, it is very important to present and store data for further use in a structured format. The structuring is important so queries can be made on the data. Data structuring employs method of organizing the data in particular schema. Various new platforms, such as NoSQL, can query even on unstructured data and are being increasingly used for Big Data Analysis.

E. Data Visualization:

Once the data is structured, queries are made on the data and the data is presented in a visual format. Data Analysis involves targeting areas of interest and providing results based on the data that has been structured.

F. Data Interpretation:

The ultimate step in Big Data processing includes interpretation and gaining valuable information from the data that is processed. The information gained can be of two types: **Retrospective Analysis** includes gaining insights about events and actions that have already taken place. For instance, data about the television viewership for a show in different areas can help us to judge the popularity of the show in those areas. **Prospective Analysis** includes judging patterns and discerning trends for future from data that is already been generated. Weather Prediction using big data analysis is example of prospective analysis.

IV. BIG DATA IN CLOUD

Big Data in Clouds is a new generation data intensive platform for quickly building the analytics and deploying over an elastically scalable infrastructure. Cloud computing is widely used in association with Big Data due to the numerous advantages it provides namely as on-demand/real-time service availability, widespread access, and sharing of resources [16, 17, 18].

However, usage of cloud computing comes with a huge number of security challenges since this technology includes multiple areas and principals like networking, resource sharing, databases, virtualization, operating systems etc., therefore security issues of these systems and technologies are applicable to cloud computing [21].

One of the main issues with the cloud is securing storage data. Henceforth, cloud service providers have suggested secure ways for sharing Big Data on the cloud platform. These providers assure that their clients do not face issues like data loss or theft, caused by user impersonation [19].Based on the services rendered to the end users, these are broadly classified into four types as described below

A. Public Big Data clouds:

Large scale data organization and Processing over the elastically scalable infrastructure. The resources are served over internet as pay-as-go computing models. The examples include Amazon Big Data computing in clouds, Google cloud platform of Big Data computing and so on.

B. Private Big Data clouds:

Deployment of Big Data platform within the enterprise over a virtualized infrastructure, with a greater control and privacy to the single organization.

C. Hybrid Big Data clouds:

Federation of public and private Big Data clouds for scalability, disaster recovery and high availability. In this deployment, the private task can be migrated to the public infrastructure during peak workloads.

D. Big Data access network and computing platform:

Integrated platform of data, computing and analytics delivered as serviced by multiple distinct providers. Big Data computing in clouds “Big Data Clouds” is data intensive analytics platform of large scale, distributed compute and storage infrastructures.

Integrated cloud and Big Data access networks on cloud infrastructure for analytics development. The content from several sources like social media, web logs, scientific studies, sensor networks, business transactions etc. are growing rapidly. Deriving useful information for decision making from such large data, fusing the information from several sources would be a challenging task.

V. BIG DATA SECURITY ISSUES AND CHALLENGES

There is an increasing need of research in technologies that can handle the vast volume of data and make it secure efficiently [5]. Current Technologies for securing data are slow when applied to huge amount of data. Big data is used by many enterprises, organizations for marketing and research but they may not have fundamental assets particularly for security perspective. If a security threat occurs to big data, it would become even more serious issues.

A. Top 10 security & Privacy Challenges:

- Secure computations in distributed programming frameworks.
- Security best practices for non-relational data stores.
- Security data storage and transactions log.
- End-point input validation/filtering.
- Real-time security monitoring.
- Scalable privacy-preserving data mining and analytics.
- Cryptographically enforced data centric security.
- Granular access control.
- Granular audits.
- Data provenance.

The above challenges are grouped into four broad components by Cloud Security Alliance (CSA). They are,

- Infrastructure Security.
- Data Privacy.
- Data Management.
- Integrity and Reactive Security

In most cases, the distributed system’s computations have a limited protection; say one or two levels [11]. At some or the other point, connections security and the encryption of access control will be ineffective and inaccessible. Automated data transforms needs extra security norms, which are frequently unavailable. Suggested detailed audits are not periodically done in Big Data because of the massive amount of data being involved. Because of the big data size, its stock is not always tracked or monitored.

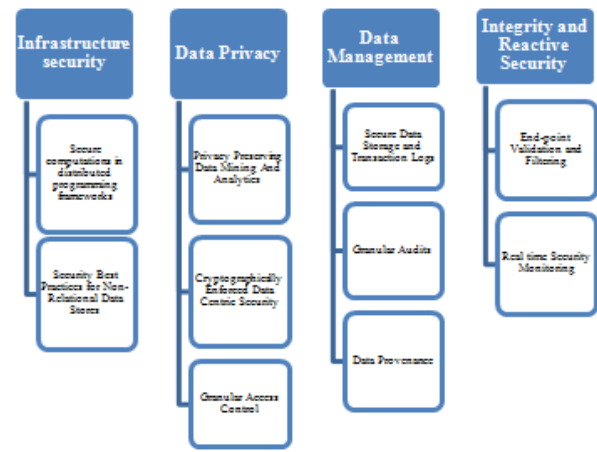


Figure 2: Classification of the top 10 challenges

B. Strengthen Big Data Security:

- By using cloud computing that the possible route of enhancing the security of Big Data is via the constant growth of the antivirus industry.
- Another way of protecting data is by using VPN.
- Concentrate on security of the application, rather than security of the device.
- Deploy real-time security information.
- Supply proactive and reactive security.

VI. PROPOSALS TO ADDRESS BIG DATA SECURITY

The basic and more common solution for this includes encrypting everything to make data secure regardless where the data resides (data centre, computer, mobile devices or any other). As Big Data grows and it’s processing gets faster, then encryption, masking and tokenization are critical elements for protecting sensitive data [15]. Due to its characteristics, Big Data projects need to take into consider the identification of the different data sources, the origin and creators of data as well as who is allowed to access the data. As recommendation, different security mechanisms should be closer to the data sources and data itself. In order to provide security right at the origin of data, and mechanism of control and prevention on archiving, data leakage prevention and access should work together.

CONCLUSION

This paper described the big data concept, its characteristics and importance. Effectively managing and prioritizing the volume, velocity, variety, veracity and value of data requires human insight, a multipronged approach and multiple layers of defence. Using big data tools to analyze the massive amount of threat received daily, and correlating the different components of an attack, allows a security vendor to continuously update the global threat intelligence and equates to improved threat knowledge and insight. It initiates a collaborative research effort to begin examining big data issues and challenges. Big Data is also changing things in the business world. Companies are using big data analysis to target marketing at very specific demographics. To accept and adapt to the new technologies, many challenges and security issues exist which need to be brought up right in the beginning before it is too late. All those issues and challenges have been described in this paper. These challenges and issues will help

the business organizations which are moving the technology for increasing the value of the business to consider them right in the beginning and to find the ways to protect them. By reducing risk, they avoid potential recovery costs, adverse brand impacts, and legal implications. The future of big data is unlimited and evolution is unimaginable. Hence the hope is to develop better and better techniques and technologies towards finding solutions for big data security.

ACKNOWLEDGEMENT

I would like to express my sense of gratitude to ST. JOSEPH'S COLLEGE OF ARTS AND SCIENCE FOR WOMEN, Hosur for their support and encouragement. And I also like to thank PERIYAR UNIVERSITY, Salem for providing me the opportunity to carry out the research work in Big Data. Finally I would like to thank my Research Supervisor Dr.P.MADHUBALA for her guidance and valuable suggestions.

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Investigation of Security Issues on Data in Triplet Levels of Cloud Environment

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Available online at: www.ijcseonline.org

Accepted: 24/Jul/2018, Published: 31/July/2018

Abstract— Data protection is a crucial security issue for most organizations. Before moving into the cloud, cloud users need to clearly identify data objects to be protected and classify data based on their implication on security, and then define the security policy for data protection as well as the policy enforcement mechanisms. For most applications, data objects would include not only bulky data at rest in cloud servers (e.g., user database and/or file system), but also data in transit between the cloud and the user(s) which could be transmitted over the Internet or via mobile media (In many circumstances, it would be more cost-effective and convenient to move large volumes of data to the cloud by mobile media like archive tapes than transmitting over the Internet.). Data objects may also include user identity information created by the user management model, service audit data produced by the auditing model, service problem information used to describe the service instance(s), temporary runtime data generated by the instance(s), and many other application data. Different types of data would be of different value and hence have different security implication to cloud users. For example, user database at rest in cloud servers may be of the core value for cloud users and thus require strong protection to guarantee data confidentiality, integrity and availability. Sensitive business data is more vulnerable today than ever before, putting reputations and the bottom line at risk. Corporate trade secrets, national security information, personal medical records, Social Security and credit card numbers are all stored, used, and transmitted online and through connected devices.

Keywords—Cloud Service Provider(CSP), Cloud Service Consumer(CSC), Data at Rest, Data in transit, Data in use

I. INTRODUCTION

Confidentiality, Integrity and Availability (CIA triad) are the three important properties of a data. Authentication, authorization and non repudiation are another three important properties associated with people who use the data [1]. Confidentiality is related to data privacy, where the data is not disclosed to unauthorized parties on any occasion [2]. Integrity of data refers to the confidence that the data stored in the cloud are not tampered by unauthorized parties. It is also applicable when the data are transit. Availability of data refers to assuring that whenever the CSC needs data, the data should be available to them immediately and can't be denied. These three basic data security properties are tested, highly in the public cloud deployment model. Authentication is the proof for a person to access his or her own data. Authorization is the process of finding out whether a person has the right to perform an activity on data. Non-repudiation is the assurance that an authenticated user cannot deny after performing a job. This survey is organized as follows, Section I contains the introduction of data security and its importance, Section II explores the different data stages,

Section III dedicated for the study of various security issues and Section IV concludes the paper with future directions.

II. DATA STAGES

The flow of data through a cloud or by another means goes through various distinct stages, with each stage requiring one or more of the previous properties to be maintained. These stages are as follows:

A. Data-at-Rest

In this stage, data is stored at CSP's infrastructure and data security and privacy becomes CSP's responsibility [3]. CSP need to insure CIA of the data. This is when data has been stored in the cloud infrastructure. The main issue with this stage for the CSC is their loss of control over the data. The onus of defending against attacks at this stage hence falls on the CSP. Typically data is at rest when it is stored on a hard drive (or SSD) somewhere. In this relatively secure state, information is primarily protected by conventional perimeter-based defenses such as firewalls, passwords and anti-virus programs. However, these barriers are not impenetrable.

Organizations need additional layers of defense to protect sensitive data from intruders in the event that the network is compromised.

Data at rest generally refers data stored in persistent storage such as database, file system, tape, disk etc. If we want data to be secure in transit or motion it has to be firstly secure in rest. There are many techniques by which we can secure our data at rest such as Encryption, Anonymization, data masking, and data erasure and so on. Data security at rest is important as enterprises start to use the data repositories for big data analytics and at same time realizes the value of such data. So data security at rest is a key concern for all the security administrators. Encryption is the leading edge for securing data at rest.

B. Data-in-Transit

In this stage, the data is in the process of transmitting from CSC (computing devices) to CSP (cloud infrastructure) or vice versa. Here, data can be intercepted and in turn can affect confidentiality [3]. Encryption is one of the methods used to protect the data while in transit. This is when data is in the process of being transmitted either to the cloud infrastructure or to the computing device used by the CSC. Here, data is most at risk of being intercepted, hence violating confidentiality.

Data is at its most vulnerable when it is in motion, and protecting information in this state requires specialized capabilities. Our expectation of immediacy dictates that a growing volume of sensitive data be transmitted digitally—forcing many organizations to replace couriers, faxes, and conventional mail service with faster options such as email. Today, more than 100 million business emails are sent every day, with over 95% of the data payload in file attachments.

The moment that data is set in motion, we are unable to fully control it, making it more susceptible to eavesdropping. From an organizational perspective, this requires the need for data encryption, thus rendering information unreadable to unauthorized personnel. Therefore, even if eavesdropping had occurred or a mobile device is stolen, the data remains confidential and secure, and renders any invalid authentication useless [4].

The term “Data Security in Motion” describes the security of data while data is transmitting from one place or node to another. Sometimes it is also called data in use. Although movement of data from disk to processor and RAM or Cache is also considered as moving data, particularly in big data scenario where the storage and processing of data and other resources are highly distributed. Protecting big data while it is in motion is important in big data implementations. Industries like retail, healthcare, supply chain, network intelligence and energy production brings exclusive and

unique requirements and standards for securing data in motion.

C. Data-in-Use

At this stage, data is accessed, processed and converted into information. The main problem at this stage is data can be corrupted while processing that is the data is being processed to information [3]. Here, the issues might lie with the corruption of data while it is being processed.

Data in use is more vulnerable than data at rest because, by definition, it must be accessible to those who need it. Of course, the more people and devices that have access to the data, the greater the risk that it will end up in the wrong hands at some point. The keys to securing data in use are to control access as tightly as possible and to incorporate some type of authentication to ensure that users aren't hiding behind stolen identities.

In addition to these three stages, the data left out in case of data transfer or data removal also needs to be considered, since it can cause severe security issues in the case of public cloud offerings since a CSC may end up gaining access to sections of data not properly deleted from a prior CSC.

D. Data-after-Delete

Another important and neglected issue with data is, data-after-delete (data remanence) [5]. Data remanence is the residual physical representation of data that has been erased [6]. After storage media is cleaned, there may be some physical characteristics that allow data to be reconstructed [6, 7]. It is the responsibility of the CSP that the data is safely deleted at the end of the data life cycle. Apart from the above four stages of data, tracing the data path (data lineage) is important for auditing in cloud computing especially in the public cloud.

III. SECURITY ISSUES IN DATA STAGES

Cloud systems have a layered architecture of different services and control levels for users. SaaS, PaaS and IaaS layers are considered for associated security risks and problems. The first part of this section briefs about the security issues related to SaaS, PaaS, IaaS and the later parts details about the security issues at different levels while transmitting data.

A. Security concerns for Software as a Service (SaaS)

SaaS is exposed by attacks on API's, publishers, web portals and interfaces. The attacks on the SaaS are categorized into two broad groups: attacks on development tools and attacks on management tools. Most popular services on SaaS are web services, web portals and APIs. Intruders' attempt unauthorized access and gain of services by attacking web portals and APIs. These attacks affect data privacy. Intruders try to extract the sensitive information of API Keys, private keys, and credentials of publishers via different kinds of attacks and automated tools. Another possibility of attack on

this layer is exposure of secure shell for extracting key credentials.

Data protection - in cloud computing applications are deployed in shared resource environments; therefore, data privacy is an important aspect. Data privacy has three major challenges: integrity, authorized access and availability (backup/ replication). Data integrity ensures that the data are not corrupted or tampered during communication. Authorized access prevents data from intrusion attacks while backups and replicas allow data access efficiently even in case of a technical fault or disaster at some cloud location. Data are shared and communicated at the common network backbone. Hence malicious attackers or intruders can deploy hidden proxy applications between the cloud provider and consumer to scavenge information of login credentials and session details [8]. An intruder can also perform packet sniffing or IP-spoofing as a middle-party and can access and/or alter the restricted or sensitive information. One possible solution for the data privacy in cloud computing is Cisco Secure Data Center Framework that provides multilayer security mechanism [8].

Attacks on interfaces of the cloud interfaces can result in a root level access of a machine without initiating a direct attack on the cloud infrastructure. Two different kinds of attacks are launched on authentication mechanism of clouds. The control interfaces are vulnerable to signature wrapping and advanced cross site scripting (XSS) techniques. First kind of attack is referred to as signature wrapping attack or XML Signature Wrapping attacks. Single signed SOAP message or X.509 certificate can be used to compromise security of customers' accounts through operations on virtual machines or resetting of passwords. Second type of attacks exploits the vulnerability in XSS. The particular vulnerability attack steals username and password pair information.

Attacks on SSH (Secure Shell) is the basic mechanism used to establish trust and connection with cloud services, are the most alarming threat that compromises control trust. According to Ponemon 2014 SSH security Vulnerability Report [9], 74 percent organizations have no control to provision, rotate, track and remove SSH keys. Cybercriminals take full advantage of these vulnerabilities and use cloud computing to launch different attacks. An organizations' cloud workload can be used host botnets if SSH access has been compromised. Attackers have hosted the Zeus botnet and control infrastructure on Amazon EC2 instances [8]. The different types of attack on SSH include attacks on API keys, attacks on user credentials, and attacks on publisher credentials.

B. Security concerns for Infrastructure as a Service (IaaS) and Platform as a Service (PaaS)

IaaS and PaaS layers are overlapped in the model due to their interdependency on each other. The attacks on these layers are grouped into three types: attacks on cloud services, attacks on virtualization, and attacks on utility computing. The security concerns for IaaS and PaaS are discussed below.

Hardware Virtualization - interconnectivity is the biggest security concern in the designing of cloud computing platform. VMs are linked using bridge and route virtual network configuration modes. The bridge mode works as a virtual hub shared among all the VMs, which may result in sniffing the virtual network by a compromised VM. In the route mode, where route works as a virtual switch, each VM is connected using a dedicated virtual interface. Any network intruder in a LAN segment of a network can access virtual environments by address resolution protocol (ARP) spoofing and MAC spoofing. ARP spoofing alters the ARP tables and management interfaces and systems. On the other hand, an intruder can mimic another host through MAC spoofing and also change address of host or guest Virtual Machine (VM) to gain access of restricted resources [10]. The attacks and exploitation of virtual environments are much diversified and they will increase in future since platforms are growing in number and complexity. Therefore, a mechanism for detecting attacks along with preventions is necessary.

Software Virtualization - attack may examine the VM images to launch an attack or steal of information, especially targeting development images, which are accidentally released [10]. It is also possible to provide a VM image having malware to cloud computing system resulting in theft and corruption of data. For example, cloud consumers are enticed to run tainted VM images contributed to image repository manipulating the registration process for first page listing.

Cloud Software's - Multi-tenancy in cloud computing requires multiplexing the execution of VMs from different consumer on the same physical server [8]. Softwares deployed on guest VM remain susceptible to attack and compromise. A malicious code in VM may interfere with the hypervisor or other VMs. Shortcomings in programming interfaces and processing of instructions are the main targets to uncover vulnerabilities [8]. This security concern also includes indirect attacks such as man-in-the middle during a live VM migration; insertion VM based rootkit during memory modification; a zero-day exploit in HyperVM; side-channel attack to gain information.

Utility computing - is the concept that emerged from grid computing, and it combines computation, storage and bandwidth to provide services on the demand through payment by the customer. It also provides two basic advantages of cost reduction and scalability. Security risk associated with utility computing is access by attackers who

want to utilize resources without paying [8]. Majority of hackers and crackers use the computing power or storage for the illegal use. The common use of public cloud includes e-commerce, web-application and Web site hosting making these services vulnerable to variety of attacks on possession, authenticity, integrity and utility. A compromised client may perform a Fraudulent Resource Consumption (FRC) attack by using the metered bandwidth of web-based service that results in a financial burden on the cloud consumer [11].

Service Level Agreement (SLA) - is an optimal way for ensuring security and trust. The implementation of SLA results in a well-designed contract of responsibilities between parties that can enhance security level. In cloud environment, SLA can be combined with the web service level agreement (WSLA) for mitigating security risks [8]. SLA defines the different levels of security and their complexity based on the services for the better understanding of the security policies to a cloud consumer. The existing cloud storage systems do not provide security guarantees in their SLAs effecting the adaptation of cloud services. A cloud storage service may leak private data, return inconsistent data or modify the data due to bugs, hacking, crashes, or misconfigurations. This security concerns require proper SLA guarantee models such as CloudProof [12].

C. Application and runtime security issues

There are a number of applications and runtime level security issues in cloud computing. Cloud computing applications are normally delivered through internet using web browsers. Cloud computing can host and run any type of applications from simple word processing software to any complex customized software with the appropriate cloud computing middleware. Any flaws in the web applications may reflect as vulnerabilities in the cloud computing service model especially in the SaaS model. Application security ensures that an application software is developed under secure Software Development Life Cycle (SDLC), deployed, managed and until decommissioned to protect it from threats and vulnerabilities in the cloud environment especially in the public cloud [13]. Application security is a challenge across all the three service models (IaaS, PaaS and SaaS) from attackers even if there is no vulnerability existing in the application. Application security in the IaaS and PaaS models are more challenging than the SaaS model because the application's security responsibility comes under the jurisdiction of CSC. The following are some of the important application and runtime stack security threats.

Command injection attacks - according to Open Web Application Security Project (OWASP), injection attacks are the top most application security threat in the web application and also in cloud computing [14]. There are a number of command injection attacks that can happen at the

application stack. They are SQL injection, Lightweight Directory Access Protocol (LDAP) injection and eXtensible Markup Language (XML) injection attacks. .

Cross-Site Scripting (XSS) attack - happens whenever an application takes an untrusted data and sends it to a web browser without a proper validation. This allows the attacker to execute scripts in the victim's browser which can hijack user sessions, deface websites or redirect the user to malicious sites [14]. There are two types of XSS attack namely, stored attack and reflected attack.

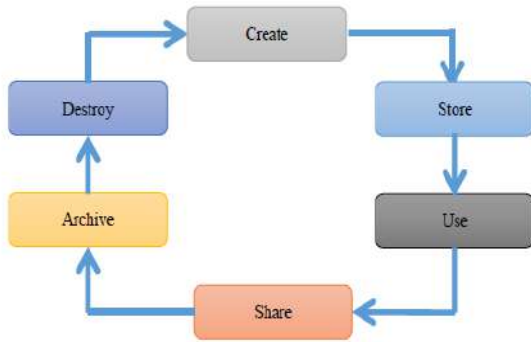
Cross-site request forgery (XSRF) attack - takes advantage of the trust established between an authorized user of a website and the website itself.

Using components with known vulnerabilities - Components such as libraries, frameworks and other software modules, run with the same privileges as application are generally classified as components with known vulnerabilities [14]. If a vulnerable component is exploited, this can lead to serious data loss or server takes over. Applications and APIs using components with known vulnerabilities may pull down the application's defence mechanism and enable to various attacks and impacts.

Under protected APIs - are essentially software interfaces, generally standards based, that cloud providers make it available to their customers for the purpose of managing cloud services. Insecure or under protected APIs can pose a variety of risks related to confidentiality, integrity, availability and accountability. Whatever vulnerabilities exist for applications also applies to APIs.

Cookie poisonings - are small files which contain information on a user's identity related credentials and are stored on the user's computer. There are many types of cookies created for various purposes. Cookies can be accessed by either from the server or from the client's computer. Here, attackers can access the cookies illegally and can change or modify the cookies to impersonate like an authorized user [6]. Once the attacker gets the user's credentials, then he can access the entire user's data and can do anything with the data.

Hidden field manipulation - is a part of the data manipulation attack [15]. There are certain fields hidden in web sites and they contain page related information and are generally used by the developers. These hidden fields are highly prone to attack by hackers and these fields can be easily modified and posted back on the web. This leads to severe security violations [6].



Backdoor and Debug Option - is a hidden entrance to a computer system that can be used to bypass security policies [16]. Application developers generally enable the debug option while publishing a website so that they can make developmental changes in the code and get them implemented in the website [6]. Sometimes these debugging options are left enabled and no one notices. Attackers can make use of this to get into the application for gaining access to sensitive information.

D. Security threats in the data level

In the traditional enterprise computing, the data is stored within the enterprise computing and it is subject to its physical, logical and personnel security and proper access control policies [4]. But in the cloud computing, the data is stored outside the customer's place, i.e., in the CSP side. Consequently, the cloud computing must employ additional security measures apart from the traditional security checks to ensure that data is safe and there are no data breaches due to security vulnerabilities in the cloud computing. There are a number of data related security issues in cloud computing, especially in SaaS model because the CSC has no control over the data and it is stored at the CSP's server. There are six stages in the data life cycle [15] as shown in Fig. 1. Once data is created, the data security is very important until the data is destroyed. The following data security issues are more prevalent in cloud.

E. Security issues related to CIA triad

In this section, all security issues related to the CIA are discussed. When data is read or copied by someone who is not authorized to do so, this situation is called as loss of confidentiality [1]. When data is modified in an unpredicted way, this situation is called as loss of integrity [1]. When data is lost or become inaccessible, this situation is called "loss of availability" [1]. All these three losses can make a big impact in cloud computing because data is the core component for any business process. Data integrity is the assurance that digital information is not corrupted and only be accessed by the authorized users. So, integrity involves maintaining the accuracy, consistency and trustworthiness of data over its entire life cycle [17]. CIA triad can be easily maintained in a standalone computing system and it can be

maintained with proper security measures in enterprise computing but in cloud computing, it requires additional efforts to protect data due to the distributed nature of the infrastructure and multi-tenant architecture of the cloud computing.

Integrity should be checked at data as well as computation level [8]. To maintain the integrity in computation, only the authorized applications are allowed to access the data and use it for computation. Do not allow users to deviate from normal computing. An effective Identity and Access Management (IAM) can avoid loss of confidentiality and integrity. Loss of data and data inaccessibility can attribute to loss of availability. Cloud computing employs techniques like scalability and high availability at the architecture level to address the data loss. The following are some methods and procedures to improve data security related to the CIA triad at different stages of data life cycle.

Security issues related to authentication, authorization and accounting - Authentication, Authorization and Accounting (AAA) is the process of identifying a user, enforcing policies, confirmation on user's identity to connect, to access or use the cloud resources and monitor them. A simple authentication scheme is, user enters a login name and password and they are verified against the credentials stored in the computer. If the credentials are matched, the user is allowed to enter into the system. In certain scenario, it is called as Authentication and Access Control (AAC). Authentication identifies a user and access control authorizes what are the resources the user can access in the cloud. If it is a standalone computer, the credentials are stored locally in the computer itself. In enterprise computing, the credentials are stored in the server in the form of Active Directory (AD) or LDAP. In a private cloud, the authentication is done same as the enterprise computing via a virtual private network. In public cloud, internet is used by customers to connect to CSP, applications from different users can co-exist with the same CSP (resource pooling) and CSC can access the applications from anywhere through any devices. So, the authentication in public cloud is more subject to vulnerability than private cloud [15]. Password based authentication does not provide effective security measures in public cloud. Passwords can be easily cracked using many methods, like a brute force attack, dictionary attack, phishing or social engineering attack. So, CSP should include highly secured authentication methods in public cloud. In cloud computing, customers connect to cloud services through APIs and these API's are designed to accept tokens rather than passwords [15].

In cloud computing, along with users, machines also need to be authenticated because certain machines are used in automated actions like online backup, patching and updating systems and remote monitoring systems [18]. Since the cloud

applications are accessed through various devices, there should be a strong authentication methods like RSA token, OTP over the phone, smartcard/PKI, biometrics, etc., for the original identity confirmation and determine the type of credentials [15]. This will enable identifiers and attributes with a strong level of authentication to be passed on to the cloud application and the risk decisions can be made for access management. According to Cloud Security Alliance (CSA) [15], there are different types of authorization models, namely Role-based, Rule-based, Attribute-based, Claims-based and Authorization-based access control. If attackers can hack user credentials, then confidentiality, integrity and availability of data will be affected. Most of the CSP includes some form AAC or Identity, Entitlement and Access management (IdEA) [15]. In some cases, authentication and authorization are delegated to CSC's user management system through federation standard (authenticate users using corporate credentials in public cloud) [15].

Broken authentication and session management - is security threat is part of the AAA. This type of threats occurs due to incorrect implementation of authentication and session management in the application domain. Weak account management functions, user credentials are not properly protected, session IDs are exposed in the URL, etc., are examples of this type of threats. Attackers generally target the privileged accounts, take advantage of the situation and can compromise passwords, keys, session tokens or to exploit other implementation flaws to assume the privileged account identities [14].

Broken Access Control - threat occurs when there is a lack of enforcement on restriction of what authenticated users are allowed to do. Using this loophole, attackers can access another user's accounts, view sensitive files, modify another user's data, change access rights, etc., [14].

Sensitive data exposure

This flaw occurs when web applications and APIs do not properly protect sensitive data [14] such as financial, healthcare and Personally Identifiable Information (PII). Here, attackers can steal or modify such weakly protected data and can indulge in credit card fraud, identity theft or other crimes. The data include data at rest, in transit and in use.

Other data related security issues

There are other minor data related security issues which can occur through data location, multi-tenancy and backup in cloud computing. In cloud computing, data is stored in diverse geographic location and they are bound to different legal jurisdictions [15]. If the data location is not safe physically and logically then there is always a threat to the CSC's data. In this type of situation, data is vulnerable to external hackers as well as malicious insiders. In cloud

computing with multi-tenant architecture, a user can intrude into another user's data location because multiple users can store their data in the same location using physical or virtual storage concept [4].

All data, especially the sensitive data should be regularly backed up and tested in cloud computing for proper data recovery in case of disasters. It is recommended to use strong encryption techniques to protect backup data if the data is sensitive [4]. In cloud computing, depending on the cost, business and data, two types of back up can be done, namely, on-site backup and cloud-based backup. On-site backup is cheaper, easier to set up and runs faster. Here, the backup and the production environments are the same and if any natural disasters happen then all the data including the backup are lost. In cloud-based backup, CSC's data is stored off-site and if any natural disasters happen on the CSC's site then the data is still available with the cloud. Cloud-based backup is expensive, slower for large backups [20].

F. Security threats in the middleware level

According to Techopedia [19], a middleware is a software platform that sits between an application/device and another application/device. It makes the connection between any two clients, servers, databases and applications. In cloud computing, middleware lies between operating system and application stacks and provides a number of functionalities to the user. Middleware services are handled by CSP in PaaS and SaaS and in IaaS, it is handled by CSC. CSP is responsible for any security issues related to middleware in PaaS and SaaS and CSC is responsible in IaaS. The following are some of the important functions of middleware in cloud computing [19]:

- Helps the user to create business application.
- It facilitates concurrency.
- It helps to perform transactions.
- It facilitates threading and messaging.
- It provides a service component architecture framework for creating Service-Oriented Architecture (SOA) applications.

Web servers, application servers and databases are examples of cloud middleware. Middleware programs generally provide communication services and serve the purpose of a messenger so that different applications can send and receive messages within cloud computing. In cloud computing, different applications situated at different physical locations and cloud middleware are used to interface all these applications to perform their job.

Since middleware interacts between any applications/devices, they are bound to security issues which can occur due to applications, devices and also at the interface stage. Since most of the data transmission and operation occurs through middleware, the security is a vital issue in middleware [21]. If middleware is running sensitive

applications or the middleware is on a platform where sensitive information is processed or stored then the middleware is under high risk. In this scenario, middleware can create a secondary path through which applications and data can be compromised [22]. To address the security issues in middleware, firstly the developers should establish an Application Lifecycle Management (ALM) practices to impose middleware security; secondly the developers should optimize network security and lastly add incremental security to middleware tools and interfaces [22].

G. Security issues in the operating system level

Operating System (OS) services are provided by CSP in PaaS and SaaS and it is provided by CSC in IaaS. So, CSP is responsible for providing defence against any OS's related security issues in PaaS and SaaS. CSC is responsible for IaaS security. OS is one of the important services to support the underlying complexity of well managed cloud computing resources [47]. Apart from providing basic OS services, cloud OS should provide the essential cloud characteristics like scalability, interoperability and portability. In addition, cloud OS provides a desired level of security and ensures Quality-of-Service (QoS). The following four elements are important for creating an operationally sophisticated cloud computing environment [23]:

- Abstract and well defined interfaces that conceal implementation details.
- Support for security at the core.
- Capability to manage virtualized workloads and.
- Workload optimization to offer superior performance and QoS.

Every OS comes with some form of security vulnerabilities and cloud computing has multiple operating systems of heterogeneous type and the vulnerability complexity also increases in the cloud environment. When security is implemented as a framework within the OS, it improves the overall security of both virtualized and non-virtualized environments and the same OS services can be applied to on premise, private cloud or public cloud environments [24]. Operating systems are susceptible to a number of internal and external attacks due to un-patched vulnerabilities, disgruntled employees or misconfigured server settings [24].

H. Security vulnerabilities in the virtualization level

Virtualization is provided by the CSP in all the three delivery models, namely IaaS, PaaS and SaaS. So, CSP is responsible for providing defence against vulnerabilities related to virtualization. Virtualization is the process of creating a virtual version of something such as a server, storage device, network, application or even an OS where the framework divides the resource into one or more execution environments. In other words, virtualization is a technique, which allows sharing a single physical instance of a resource or an application among multiple customers or organizations.

Virtualization is not a new concept. It was actually started with mainframe computing decades ago and continues in the personal computing (dividing the physical hard disk into logical partitions). As virtualization becomes more popular with the introduction of cloud computing. Network virtualization, Storage virtualization, Server virtualization, Data virtualization, Desktop virtualization and Application virtualization are the six areas in I.T. where virtualization can be applied [24].

The general benefits of virtualization are multi-tenancy, better server utilization and data centre consolidation. Virtualization benefits enterprises to reduce capital expenditure on server hardware and improves operational efficiency [15]. Even though virtualization brings many benefits to cloud computing, they also bring some security issues related to guest operating system, hypervisor (software, firmware or hardware that creates, runs and manage virtual machines, it is also called as a virtual machine monitor) and Virtual Machines (VM). The following are some security issues related to virtualization.

VM Side-channel attacks – This attack occurs when the attacker is in another virtual machine of the same physical hardware with the victim and both sharing the same processor and cache. When the attacker alternates with the victim's VM execution, the attacker can get some information about the victim's behavior and in turn can get some sensitive information about the victim or the CSP itself [8, 24]. Timing side-channel attack [24] is a type of side-channel attack where the attacker tries to get information through the time needed by various computations.

VM Image sharing – In VM, there is a shared image repository which is used to share VM images of users. Through this shared image repository, a malicious user can inject code into VM to create problems [7, 8, 24].

VM Shared resources – VMs on the same server can share CPU, memory, I/O and others. Because of these shared resources, a malicious VM can gather some information from other VMs through shared memory and other shared resources [7].

VM Rollback – VMs are able to roll back to their previous states if an error happens. This can re-expose VMs to security vulnerabilities that were patched or re-enable previously disabled accounts [8, 24].

VM Escape – In VM, a malicious user or a VM can escape from the VMM monitoring and can interfere with hypervisor or other guests without being noticed [8, 24].

VM Migration – Due to fault tolerance, load balancing and maintenance, a VM can migrate from one physical machine to another [7, 8, and 24]. The data and the code of the VM

are exposed when transferring through a network between two physical hardware locations and are vulnerable to attackers [24]. Also, it is possible for an attacker to transfer a VM to a vulnerable server and then can compromise it [8].

Hypervisor Issues – The Hypervisor or VMM is responsible for managing and isolating VMs from each other. It is responsible for proving, managing and assigning resources because it is the interface between physical hardware and the VMs. A malicious attacker can compromise a hypervisor in order to get full control of it [8].

I. Security issues related to server level

Security in the server level is CSP's responsibility because the server stack is provided by CSP. A cloud server is a logical or physical server that is built, hosted and delivered through a cloud computing platform over the internet. A cloud server is considered as logical when it is delivered through server virtualization, i.e. the physical server is logically distributed into two or more logical servers; each one can have a separate OS, user interface and applications by sharing the underlying physical hardware from the server. A physical server is generally a dedicated cloud server and is also accessed through the internet [24]. Security misconfiguration and insufficient attack protection are some security issues that can be related to the server stack [14]. The following are the characteristics/functionality of a cloud server [24].

- Computing infrastructure can be physical, virtual or a mix of the two and can be scaled up or down accordingly (scalability and flexibility).
- Cloud server has the capabilities of an on-premises server.
- It enables high intensive workloads for users and store huge data.
- All the services are automated and can be accessed on demand through APIs.
- More reliable than traditional servers.
- Supports pay-as-per use approach.

J. Security issues related to storage level

Security in the storage stack is CSP's responsibility because the storage stack is provided by them. Amazon, Microsoft and Google are the three major cloud providers in the storage-as-a-service solutions.

Cloud Data Storage Threats threats are identified from the client's perspective, mainly due to the loss of physical control and the abstract nature of the cloud [24], as follows:

Data exposure – stored on remote cloud servers, out of the control of their owners, data are more likely exposed to potential adversaries. That is, the anytime/anywhere access increases the number of attackers, such as unauthorized insiders, revoked group members or even malicious cloud

administrator. Additionally, due to law enforcement, when cloud servers are located in other countries, client's data may be accessed by enforcement agencies without permission or knowledge of their owners. Providing data confidentiality, in multi-tenant environments, becomes challenging and conflicting. This is considerably due to the fact that users outsource their data on remote servers, under the control and management of possible untrusted Cloud Service Providers (CSPs). It is commonly agreed that data encryption at the client side is a great alternative to relieve such data confidentiality concerns [18,19], as the cloud client preserves the deciphering keys out of reach of the provider. Nonetheless, this approach gives rise to various security and privacy issues. On one side, it increases key management concerns, such as, storing and maintaining keys' availability at the client side. The confidentiality preservation is even more complicated when flexible data sharing among a group of users is needed [20]. First, it requires efficient sharing of deciphering keys between authorized users. The challenge is to define a smooth group revocation which does not require updating the secret keys of the remaining users, so that the complexity of key management is minimized. Second, access control policies have to be versatile, flexible and distinguishable among users with different access rights. That is, data sharing may be realized among different users or groups, and users may belong to several groups. On the other side, the protection of the user's privacy requires more than just encryption of transmitted and stored data. For instance, the fact that a user invokes a specific content, or communicates with a specific client may already provide enough information to an adversary [24]. In addition, user identity information can contain Personally Identifiable Information (PII) which is of high critical to the user privacy.

Unauthorized Access – in cloud environments, access control is a highly non trivial matter of granting and revoking rights to specific users or dynamic groups. That is, access control policies needs flexibility and distinguishability among users having different access rights. In fact, data can be shared by different users that may belong to several groups. In addition, these groups may be highly dynamic. Thus, the challenge is to define an efficient revocation mechanism, at an arbitrarily fine granularity.

Data loss and manipulation – cloud providers generally claim storing data files with redundancy to protect against data loss. Additionally, they often disperse these data across multiple storage placements. Such distribution provides resilience against hardware failures. However, for storage capacities saving and operating costs reduction, dishonest providers might intentionally neglect these replication procedures, thus resulting in unrecoverable data errors or even data losses. This dishonest trend might be amplified as a large amount of "cold" data are accessed on rare occasions. Therefore, the data integrity checking is considered as a

relevant concern, especially as it is tightly linked to data availability. Data integrity verification might be operated in three ways:

Between a client and a cloud provider – a cloud customer should efficiently perform periodical remote integrity verifications, by not keeping the data locally. It means that solutions should take into consideration the constrained storage and computation capabilities of the customer and the large size of outsourced data.

Within a cloud infrastructure – it is important for a cloud provider to mitigate byzantine failures and drive-crashes by checking the integrity of data blocks stored across multiple storage nodes.

Between two cloud providers – in the case of the cloud of clouds scenarios [22, 24], data fragments are dispersed on multiple cloud platforms. Thus, a CSP, through its cloud gate, should periodically check the authenticity of the data blocks hosted in another cloud infrastructure.

SLA violation – the Service Level Agreement (SLA) relies on a contract signed between the client and the service provider including functional and non-functional requirements of the service [23, 25]. SLA considers obligations, service pricing, and penalties in case of agreement violations. However, due to the abstract nature of clouds, SLA violation with regards to data is multifold [44, 16]. First, for securely managing outsourced data, the cloud provider has to disperse clients' data across multiple storage capacities. Such distribution provides resilience against hardware. Nevertheless, to save storage capacities and reduce operating costs, dishonest providers might intentionally disregard these replication procedures, thus leading to unrecoverable data errors or data losses. Even if a fault tolerant policy is supported by the cloud providers, clients have no technical means for verifying that their data are safe, for instance, with regard to possible drive-crashes [24].

Second, SLA violation concerns also privacy preservation. That is, the U.S. Patriot Act [24] gives the government unprecedented access to outsourced data which are either physically hosted in the U.S. or generated by an American entity (i.e. an American enterprise or an enterprise having economic stakes in the U.S.).

Cheap and lazy provider – this threat model is widely considered in data auditing schemes [24], such that the cloud provider wants to save resources by storing fewer redundant data than necessary. In addition, this lazy provider pretends to perform some computations to provide the challenger with the expected answer.

Malicious users – malicious users are entities that attempt to deviate from the protocol or to provide invalid information,

in order to disclose data outsourced by other legitimate clients or to learn extra information about another entity's inputs [24]. For example, in a sharing scenario, an attacker can be either a revoked user with valid data decryption keys, an unauthorized group member or a group member with limited access rights. As such, the attacker targets to get access to the outsourced shared data. The objective of this malicious user is to convince the cloud server that he is a legitimate group member.

K. Security issues related to network level

The Network is one of the important levels in cloud computing because the users are connected to the cloud through the network stack and the data are also transferred using this level. One of the important success of cloud computing depends on how secured it's underlying network infrastructure. According to Arup Chakravarty [25], networks are no longer the traditional packet switching platforms, it is the heart and soul of the intelligence which integrates with other smart applications to differentiate the multitude of services (voice, video and data) that can be enabled over a medium. CSP provides this network stack as part of the infrastructure and they are also responsible for any network related security issues. Cloud networking adds new security challenges to the cloud computing security issues due to additional networking capabilities [24]. Network security issues are one of the biggest challenges in cloud computing [64]. Public cloud suffers more vulnerabilities than private cloud due to the nature of the public cloud (Internet, changing topology, etc.) [6]. Network security is one of the services provided by Security-as-a-Service (SecaaS), a standardized third party security framework for cloud computing which benefits both CSP and CSC [8].

Browser Attacks – is the top most network attacks and it happens through the Internet by tricking the users to download malware that is disguised as a software or application. Hackers can exploit the vulnerabilities in the OSs or applications and launch the attack [26]. These attacks can be thwarted by regular updates to browser and related applications [26].

Brute Force Attacks – is the next top most network attack which is used by hackers to get the password or pin number by trial and error [26].

Denial-of-Service (DoS) attacks – is the third top most network attack where the attacker prevents legitimate users from accessing services or information. This attack succeeds when the attacker overloads a server with many superfluous requests than the server can process [26].

Secure Sockets Layer (SSL) attacks – establishes an encrypted link between a browser or an email server and a client. When a website is secured with SSL, the URL begins

with https. In this, the attacker intercepts an encrypted data before it can be encrypted and giving access to the sensitive data to the attackers [26].

Scans– port scans are pre stage before an attack. It helps the attackers to find out which ports are open in a computer and identify the OS vulnerabilities to launch for future attacks.

Domain Name Server (DNS) attacks– in this attack, the attacker takes advantage of the vulnerabilities in the DNS. DNS is used to translate the domain name into an IP address. There are a number of DNS attacks like DNS hijacking, DNS spoofing (DNS cache poisoning), DNS hijacking, DNS amplification attack, DNS flood, etc. [27].

Backdoor attacks– happen when cloud applications allow computers to connect remotely. Some of these attacks are designed to bypass IDS. Port binding, connect-back and connect availability use strategies can be used through backdoor [26].

Jamming adversaries - attacks on wireless devices in cloud and IOT target deterioration of the networks by emitting radio frequency signals without following a specific protocol [24]. The radio interference severely impacts the network operations and can affect the sending and receiving of data by legitimate nodes, resulting in malfunctioning or unpredictable behavior of the system.

Insecure initialization- A secure mechanism of initializing and configuring IoT cloud at the physical layer ensures a proper functionality of the entire system without violating privacy and disruption of network services [24]. The physical layer communication also needs to be secured in order to make it inaccessible to unauthorized receivers.

Low-level Sybil and spoofing attacks- The Sybil attacks in a wireless network are caused by malicious Sybil nodes which use fake identities to degrade the cloud functionality. On the physical layer, a Sybil node may use random forged MAC values for masquerading as a different device while aiming at depletion of network resources [24]. Consequently, the legitimate nodes maybe denied access to resources.

Insecure physical interface - Several physical factors compound serious threats to proper functioning of devices in IoT. The poor physical security, software access through physical interfaces, and tools for testing/debugging may be exploited to compromise nodes in the network [23].

Sleep deprivation attack - The energy constrained devices in cloud and IoT are vulnerable to “sleep deprivation” attacks by causing the sensor nodes to stay awake [24].

Replay or duplication attacks due to fragmentation - The fragmentation of IPv6 packets is required for devices conforming to the IEEE 802.15.4 standard which is characterized with small frame sizes. A reconstruction of the packet fragment fields may result in depletion of resources, buffer overflows and rebooting of the devices [24]. The duplicate fragments sent by malicious nodes affect the packet re-assembly, thereby hindering the processing of other legitimate packets [24].

Insecure neighbor discovery - The cloud and IoT deployment architecture requires every device to be identified uniquely on the network. The message communication taking place for identification must be secure to ensure that the data being transmitted to a device in the end-to-end communication reaches the specified destination. The neighbor discovery phase prior to transmission of data performs different steps including the router discovery and address resolution[24]. The usage of neighbor discovery packets without proper verification may have severe implications along with denial-of service.

Buffer reservation attack - As a receiving node requires to reserve buffer space for re-assembly of incoming packets, an attacker may exploit it by sending incomplete packets [24]. This attack results in denial-of-service as other fragment packets are discarded due to the space occupied by incomplete packets sent by the attacker.

RPL routing attack -The IPv6 Routing Protocol for Low-Power and Lossy Networks (RPL) is vulnerable to several attacks triggered through compromised nodes existing in the network [28]. The attack may result in depletion of resources and eavesdropping.

Sinkhole and wormhole attacks - With the sinkhole attacks, the attacker node responds to the routing requests, thereby making the packets route through the attacker node which can then be used to perform malicious activity on the network [28]. The attacks on network may further deteriorate the operations due to wormhole attacks in which a tunnel is created between two nodes so that packets arriving at a node reach other node immediately [29]. These attacks have severe implications including eavesdropping, privacy violation and denial-of-service.

Sybil attacks on intermediate layers - Similar to the Sybil attacks on low-level layers, the Sybil nodes can be deployed to degrade the network performance and even violate data privacy. The communication by Sybil nodes using fake identities in a network may result in spamming, disseminating malware or launching phishing attacks.

Authentication and secure communication - The devices and users in Cloud need to be authenticated through key

management systems. Any loophole in security at network layer or large overhead of securing communication may expose the network to a large number of vulnerabilities. For instance, due to constrained resources, the overhead of Datagram Transport Level Security (DTLS) requires to be minimized, and the cryptographic mechanisms ensuring secure communication of data in cloud must take into account the efficiency as well as the scarcity of other resources [30].

Transport level end-to-end security - The transport level end to end security aims at providing secure mechanism so that the data from the sender node is received by the desired destination node in a reliable manner [30]. It requires comprehensive authentication mechanisms which ensure secure message communication in encrypted form without violating privacy while working with minimum overhead [30].

Session establishment and resumption - session hijacking on transport layer with forged messages can result in denial-of service [30]. An attacking node can impersonate the victim node to continue the session between two nodes. The communicating nodes may even require re-transmission of messages by altering the sequence numbers.

Privacy violation on cloud-based IoT- Different attacks which may violate identity and location privacy may be launched on cloud or delay tolerant network based IoT [30]. Similarly, a malicious cloud service provider on which IoT deployment is based, can access confidential information being transmitted to a desired destination.

Data loss and leakage - The example of data loss is the deletion, alteration and theft of data without a backup of the original content, loss of an encoding key may also produce data loss, due to the productive and sharing nature of cloud computing. The main reason of data loss and leakage is lack of authentication, authorization, and access control, weak encryption algorithms, weak keys, risk of association, unreliable data center, and lack of disaster recovery. These Threats can affect the IaaS, PaaS, and SaaS service models. Secure API, data integrity, secure storage, strong encryption key and algorithms, and data backup are some prevention methods.

Service/Account hijacking - is a process, in which the client may redirect to a harmful website. This can be executed through fraud, phishing and exploitation of software vulnerabilities. The reuse of credentials and password are often leads to such attacks. In cloud computing, if an attacker can access someone's credentials, they can capture the activities, transaction data, manipulate data, return falsified information or redirect the client to illegitimate sites and the hacked account.

Risk profiling – due to the heavy workload cloud are less involved with ownership and maintenance of hardware and software. The cloud gives contract to organization to maintenance of software and hardware. This concept is good, but cloud does not know the organization internal security procedure, patching [30], auditing, security policies, hardening, and logging process. This unawareness comes greater risk and threats. For removal of threats cloud have an awareness of partial infrastructure details, logs and data, and cloud should have a monitoring and altering system.

Identity theft - is a type of trickery in which someone impersonate the identity, credits, associated resources and other service benefits of a legitimate user. Resulting from these threats, the victim suffers many unwanted results and losses. This threat can happen due to the weak password recovery method, phishing attacks and key loggers, etc.

IV. CONCLUSION AND FUTURE SCOPE

The cloud problems are mainly with the security and privacy of the data stored in the cloud. The cloud environments like heterogeneity, resource sharing, multi-tenancy, virtualization, mobile cloud computing and Service Level Agreement (SLA) that makes the cloud security more vulnerable. This paper provides the data stages and security issues at various levels. In future there is a plan to review about the solutions for maintaining the above discussed problem. Mean while, there are also new developments in cloud computing like Container-as-a-Service (CaaS), Software-defined networking, Software-defined-storage (abstracts the logical storage services and capabilities away from the underlying hardware) and Cloud-of-Things (CoT). All these new developments bring new challenges in cloud computing and they need to be addressed. When there is a change in technology, always review the security policies and procedures and update accordingly to protect the data and its privacy.

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Analysis of Factors that Challenges Theadoption of Cloud Computing

OPEN ACCESS

Volume: 6

Special Issue: 2

Month: August

Year: 2018

ISSN: 2321-788X

Impact Factor: 3.025

Citation:

Rajalakshmi, S., and P. Madhubala. "Analysis of Factors that Challenges the Adoption of Cloud Computing." *Shanlax International Journal of Arts and Science Humanities*, vol. 6, no. S2, 2018, pp. 135–38.

DOI:

<https://doi.org/10.5281/zenodo.3360384>

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Abstract

This paper deals with the challenging factors which are faced by the business sectors. Customers demand for both physical and virtual resources. While processing any one of the resource and it may gets failure (or) not responding, the resilient computing adopts the resource with in the same cloud (or) multiple clouds. Resilient computing provides the guidance for outstanding cloud adopters. It provides the storage of dynamic technical information with high security concern by analyzing the factors of cloud. Finally, this paper explores the analysis of Cloud market for technological, organizational and environmental affecting factors and improves business agility.

Keywords: Challenging factors, Resilient computing, Cloud adopters, business agility.

Cloud Computing

According to NIST (National Institute of Standard Technology), Cloud services may be classified in to SaaS (Software as a Service), IaaS (Infrastructure as a Service) and PaaS (Platform as a Service).

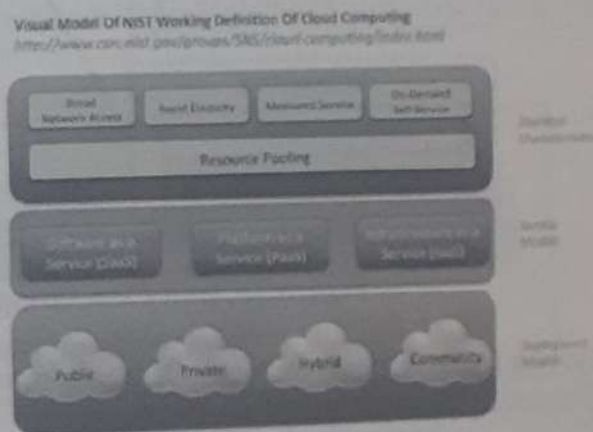


Figure 1 Cloud Deployment Model



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ANALYSIS OF FACTORS THAT CHALLENGES
THE ADOPTION OF CLOUD COMPUTING

Published in

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ARTS, SCIENCE AND HUMANITIES

Dr. N. Ayyanathan
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The Publisher

ANALYSIS OF FACTORS THAT CHALLENGES THE ADOPTION OF CLOUD COMPUTING

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ABSTRACT

This paper deals with the *challenging factors* which are faced by the business sectors. Customers demand for both physical and virtual resources. While processing any one of the resource and it may gets failure (or) not responding, the resilient computing adopts the resource with in the same cloud (or) multiple clouds. *Resilient computing* provides the guidance for outstanding *cloud adopters*. It provides the storage of dynamic technical information with high security concern by analyzing the factors of cloud.

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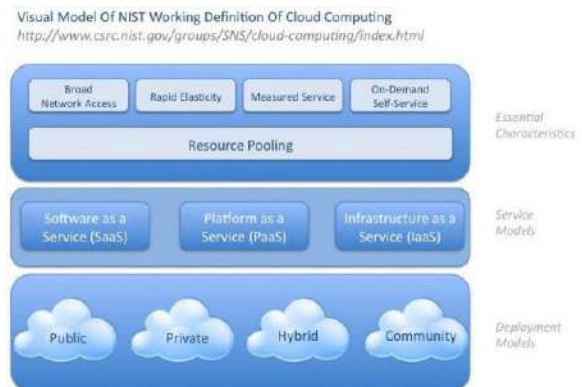


Figure 1: Cloud deployment model

2. TOE FRAMEWORK

The factors which affect to adoption of cloud computing are security, maintainability, performance, scalability and etc. It is distinguished into TOE framework.

T→Technological,

O→Organisational,

E→Environmental

TOE framework explains the context to find new innovation adoption of the cloud. It paves a way to find new IT innovations.

2.1 TECHNOLOGICAL FACTORS

It defines the internal factors and external factors of the business technology.

2.2 ORGANISATIONAL FACTORS

It defines the attributes that affects the technology adoption.

2.3 ENVIRONMENTAL FACTORS

It defines the company market, advertisement, competition and external factors.

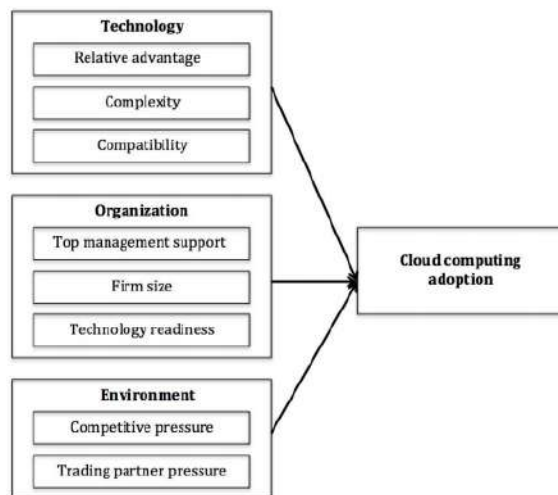


Figure 2: Cloud Computing Adoption

To analyse the Technological factors, Organisational factors and Environmental factors evaluate and measure the cloud adoption of services.

3. RESILIENT COMPUTING

Nowadays, *continuous service* in a business environment is a more challenging factor. This can be achieved and balanced by scalable and adaptable resilient computing.

Resilient computing has a speed recovery to provide continuous availability and consistent interaction of data. By the event of a disruption, resilient resumes the data by speed recovery with minimal data loss.

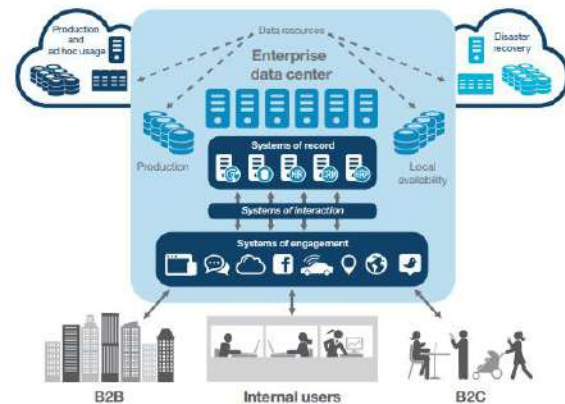


Figure 3: Continuous service by Resilient computing

3.1 Key resiliency metrics

There are two resiliency metrics to design of an effective resiliency program.

3.1.1 Recovery time objective (RTO).

It deals with the level of service and duration of time. The business operations are saved time to time for future reference. It maintains a stable state until the business operation gets completed.

3.1.2 Recovery point objective (RPO).

It deals with the recovery of failure time. It maintains a stable point of backup frequency of period.

4. BUSINESS AGILITY

It allow rapid changes to internal and external factors without affecting the market place value of the business. It defines the ability of a business which adapts the changes in the business environment according to cost effectiveness.

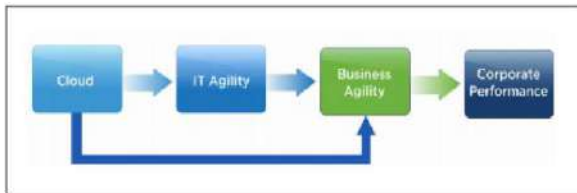
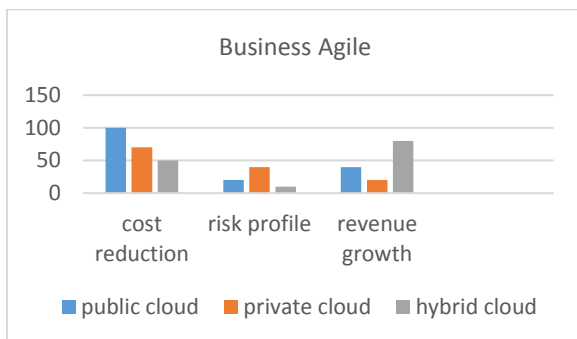


Figure 4: Business Agility linked with cloud.

It also responds to customer satisfaction on demand, introducing new products on all dimensions, managing the resources which results in high revenue profit, reduces risk profile.

Chart 1: Business Agile outcome of company



5. CONCLUSION

Thus concluding this paper by “Adopting the cloud services will not affect the factors of challenging the cloud”. Despite, there is no need to buy the new equipment to start the new business sectors. It also faces the challenges which integrates the different types of cloud services in to the existing infrastructure. Resilient computing provides uninterrupted service. Thus, it measures the availability, performance and responsiveness to deliver better business results. Business Agility provides effective cost reduction by minimizing the management risk and quickly adapts to market change.

In future, self-service computing capacity will be a challenging factor for new competition of IT organizations.

ACKNOWLEDGEMENT

I would like to express my sense of gratitude to GOVT ARTS COLLEGE FOR WOMEN, Krishnagiri for their support and encouragement. And also I like to thank PERIYAR UNIVERSITY, Salem for providing me the opportunity to carry out the research work in Cloud Computing. Finally I like to thank my Research Supervisor Dr. P. MADHUBALA for her guidance and valuable suggestions.

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THEME OF BLACK HUMOUR AND RESTRUCTURE JOHN BARTH'S THE FLOATING OPERA

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Abstract

Black Humor is essentially a theme in American literature which developed after the Second World War. But Black Humor fiction has its roots in early American Tradition and several major American novelists of the past have combined grimness and humor in their works. The trace of the root of the term records that "Black Humor" was first used by the surrealist writer Andre Breton in 1939 when he interpreted his "Anthologies de le humor noir". John Barth is essentially an academic-oriented literary figure. He is endowed with the accurate awareness of the psychosomatic complexities and the emotional problems modern man. In fact of all the eminent American Post Modernists like William Gass, John Hawkes, Donald Barthelme, Robert Coover, Stanley Elekin, Thomas Pynchon, Kurt Vonnegut Jr., John Barth alone could be identified as the one who has been instrumented for elaborating a second renaissance in the history of the Twentieth Century American Fiction. Barth's career as a versatile postmodern American novelist of phenomenal virtuosity began in early January of 1955 when he started to write his major work, The Floating Opera (1956). at this point, it ought to be noted that the present critical endeavor on Barth's The Floating Opera, The End of the Road, and Lost in the Funhouse explore and extract the elements of existentialism and black humor. In this novel, Todd Andrews is a protagonist. He is a fifty years old Maryland Lawyer who is writing in 1954 about the day in 1937 when he decided to commit suicide because there was no final reason for living.

Keywords: Black Humour, Existentialism, Postmodernism, Restructure

John Barth is the most important an academic-oriented literary character. He is provided with the serious consciousness of the psychosomatic convolutions and the emotional dilemmas modern man. Indeed, all the famous postmodern writers like John Hawkes, William Gass, Robert Coover, Donald Barthelme, Thomas Pynchon, Stanley Elkin, Kurt Vonnegut Jr., John Barth alone could be found as the one who has been influential for expanding a second renaissance in the history of the Twentieth Century American Fiction.

Creation Of The Floating Opera

Barth's first novel, *The Floating Opera*, is fairly express about the theoretical problem he is fascinated with so as to construct it the theme of the inquiry by his central character, Todd Andrews. The narrator asks the question is what Albert Camus called "the fundamental question of philosophy" in *The Myth of Sisyphus*, that is, man has lost his faith in God in the world. The book itself is seemingly an attempt by the narrator to explicate the process and the effect of his "Inquiry" about the problem of suicide, forced to one day in June seventeen years ago. In the face of the murky subject matter, Todd's remembrance is full of a comic performance of life. The answer Todd come back with at the end of the novel is naturally Barthian, which is in two minds and ambiguous; "There's no final cause for existing or for suicide." (23)

Black Humour And Restructure

The Floating Opera is an excellent introduction to John Barth's career as a black humor novelist and as a parodist. Restored to its original ending in the revised edition of 1967, the novel firmly establishes Barth as a black humorist. The novel's title is from the name of showboat that used to travel around the Virginia and Maryland tidewater areas with the banner reading "Adam's Original and Unparalleled Floating Opera". Todd Andrews the narrator, the hero of the novel gives the following reason for choosing the part of the name of the showboat as the title of the book in page number seven. Once it was tied up at Long Wharf, this is changed his mind in 1937. That is the root cause to choose it as a title *The Floating Opera*.

However, *The Floating Opera* is symbolic of life itself. Todd explains that how much of life functions; our friends drift past; we become evolved them; they drift on gossip or lose trace of them wholly. This way of life has collapsed and containing a series of broken anecdotes, lacking any logical meaning and unable to understand and discipline is obviously a great aspect one. Discussing the meaning of the title of the novel Jac Tharpe asserts thus the universe is depended on nothing important that can be discovered. It nearly moves, spins, dips, and escapes in the very large ocean universe. Since we cannot identify what reality is, we shall plainly make one to serve. Generally, the effect of this process was either belief or myth. In Barth's point of view, it is to make a word of fiction, not an artifice world. (36)

This dark and miserable view of life imbues the whole view of a novel which is very comedy. The most famous of black humor novelists are immersed with the idea of life. The idea of death is a major asset for the dark view in their novels. While other present writers dealing with death in a dark way as the seriousness of the matter, the black humor writers employ the fear of death from an ironic and comic view. They analyze that death is the great absurdity which rejects all meaning from human existence. If all the sort of human beings direct to nowhere else but death besides which there is nothing, then all human acts get contradicted. As a result, the black humor writer shows a very dark and somber view of a human end. He believes that death is an absolute reality.

The main attitude moves through almost all black humor novels. The heroes of the novels are always visited by the fear of death; they also form strategies for survival. Thus Le Clair notes: Laughter does not remove the death, but it does make for the reader a literary circumstance in which death can be shown. (84)

The black humor in *The Floating Opera* rises extremely for the dominance of death and suicidal despair. The main character of Todd Andrews signifies death. He asserts that Todd Andrews is his name. We can pronounce it with one or two ds. In German Tod is signified for death. Here Todd is almost Tod that is almost dead. (FO, 3-4). We are not able to reject the physical truth of death either by connecting with others, giving life logically or by transforming it into religious faith; Todd Andrews turns fictional characters and leads to acting as his assistant. The great role is that of fiction. *The Floating Opera* takes as Todd's fiction. The book is a story of Todd's decision to commit suicide himself in June 1937 and his later invert of that decision. Attempting to contribute an exploration of his decision as unstable decision, Todd tells his life story as the inquiry into the account of human activity itself. Todd agonizes due to a horrible heartache called Myocardial infarction which becomes a very fact of his life. So he is agitated by the fear of death from the childhood stage of his life. Frank D. Mc Connell states him as, "A man who exists with that deep consciousness of personal death which the existentialists commended a proper understanding of human activity. (123)

With regard to contrary this dreadful fast of life, Todd initiates taking different attitudes guessing that he could identify the answer to his chaos. The rigid reality of attempting death at any time is comically expressed by Todd in the following attitude. Indeed, the humor is black and depressing the fact that he started to write this book, he may not exist to write its conclusion. And other incidents such as having the drink, he may not live to taste it, or that it may give a living man's mouth to burn dead man's stomach. Taking sleep he may not wake or have got up may again living to sleep this for thirty-five years of his life. There is a tremendous question arising from his mind. This is difficult in which has reasoned it twice before without correcting it. Todd said himself as he had woken up one day morning with the

answer to freely like that. This quest is the reality of his life, the reality of his book as well answered the question but not yet be explained all. (49-50)

Alike death, war is also important to which black humor writers inspired generally. War also shapes the backdrop of Barth's *The Floating Opera*. Todd assigns in the army and undermines the terrifying experience of defeating a German soldier. Though he takes part in the war, he is neither alert of the reasons for the war nor is he a nationalist baffling to protect the honor and territorial boundaries of his country. Todd Andrews analyses that he was not a patriot, he had no feelings at all about the matters, if there were any fact to identify that. (61)

The remedy of sex has prescribed the black humor novel its reputation. The black humor writers have broken all restraints about sex in their works. One of the attitudes adopted by the black humor novelists for distracting the reader is to collapse them. With regard to obtain this effect, they always take up such extreme measures. All sorts of sexual abnormality are discussed in the novels to disturb the readers. Barth's novel makes an appeal that Barth does not mock much value to sex as a value of satisfaction. For him, sex is no inspiring act which helps man attains the anxious situation in which he is placed. Todd's affair with Jane, the wife of his friend, is largely sexual.

It does not assist him to conquer his dread of death. Jacob Horner's false relationship with Rennie Morgan at *The End of the Road* also has a terrible act. It not only depicts Jacob Horner act less but runs Rennie to the horrible death. Barth hardly mocks at the animalistic urges of human sexual activities. Todd has his first sexual affair with his girlfriend Betty Jane on his birthday of seventeen years. The absurdity of human and animal is a strong piece of humor at *The End of the Road*. Todd giggles at "mating animals" and "Doublecross" because they repeat him of his first effort to create love for Betty Jane as a youth. While having sex with her, he sees a mirror and starts laughing excitedly. What he looks in the mirror is expressed by Todd. Then Betty Jane's face hidden in the pillow, her skinny small cheeks thrust upwards, his infertility as an overcomer and barking like an ass. Todd sounds with funny and reeled with the comedian. (123)

Indeed a famous black humorist John Barth horribly funs at the fallacy of sex and illustrates his points it through Todd. Thus he said that nothing is constantly, deeply, comically in the act of "mating animals." According to Readers point of view if you are young you fall in love; if the extreme of sex act you sense that you and your lover are examples for a Greek sculptor Phidias, For a mirror can show what it looks, and what it looks is absurd. (124)

The burlesque juxtaposition between the life and death entire novel, *The Floating Opera* fulfills for the much of the black humor voice of the novel. Similarly, William Faulkner in *The Sound and The Fury*, Barth in *The Floating Opera* affects a subtle combination of sex and death when he satirizes the animal mating on one side while the coffin is being seated on

the other side. In the manner, one strongly credits like William Faulkner, Nabokov and Cummings, John Barth initiates sex and death as superior attitudes. Old men on the point of death sentence of love and life. The public enjoys life in the showboat on the ship, thus Todd starts to move it. When he opened the door and the lamenters had come out with the coffin. Their way was arrested by the dogs. The dog moved the balcony, her lover still half mind of her, and took up a place near the casket. The couple then came back their romances in the shining sun, to the awkward situation of the company, who denied not informing them while the coffin's door was opened and the hearse lightly loaded on the ship.

Todd expects the perfect breasts' of Jane and at the same time her 'burned legs'. However, Barth technically expresses the "life in the face of death" dimension to curve the fact of human life in black and then he mocks it off. Yet another aspect of humor in the novel, The Floating Opera, is the satire of ancient romantic comedy. In a sort of comedy, a young couple is often attacked by a blocking character who is either one of the parents or a villain. In The Floating Opera, the young lovers are Jane and Mack Harrison and the blocking human being is Todd Andrews. However, unfair the common romantic comedy Todd is committed to becoming a blocking man by the pair of lovers themselves. After seducing him at Todd notes Jane, wife of Mack Harrison, analyses the circumstance to Todd. Jane talked about her husband's love affair and his thoughts about love in this world. Then Todd replied and accepted her concept of the love affair.

Barth has been involved in beautiful themes right from the starting of his profession as a novelist. They make one of the links between his first two novels and the others, with regard to perceiving the theme of art in The Floating Opera; one must detach Todd Andrews from Barth. The creator is the existentialist and absurdist and the latter has 'art' as an answer to man's dilemma. Barth creatively connects the order of art and the meaninglessness of life in the climactic act on the showboat. While Todd thinks for suicide, a performer performed Hamlet's soliloquy on suicide in a group of passive listeners. Todd does not understand that the change of it is valid even when its expression is quite sad and his reasons for rejecting suicide have nobody to do with a strange involvement to aesthetic issues. The Floating Opera, Barth's maturity of the different art starts with a picture, namely, the boat. The captain illustrates at length on the treatment and skill of its creators. The allusion which Todd does not design is that any well-made thing examines itself. This cliché is also related to the showboat that makes rude entertainment.

Conclusion

As a result, he becomes conscious of the fact that his character as the author by itself creates his life meaningful. Finally, the research tries to demonstrate the antithetical relationship between the sense of reality and absurdity in the writings of John Barth.

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Retrieval of the Mythical and Dalit Imagination in Cho Dharman's *Koogai: The Owl*

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Abstract

This paper presents the Dalit writing in Tamil, a late bloomer like its literary counterparts in other regions, especially Marathi or Kannada. Literary scholars opine Tamil Dalit literature has only emerged actively since the 1990s and developed into an important and vocal expression of Dalit rivalry and allegation. The English translation of Cho Dharman's *Koogai (The Owl)*, which was first published in Tamil in 2005, has now been released. The novel depicts a vibrant tapestry of human conditions and Dalit exploitation. The story includes descriptions of little traditions, folk deities, animist lore, aboriginal beliefs and faith in magic. The story narration is wed to Tamil Sangam literary canons associated with the close relations between the land and the human condition. *Koogai* is a novel set in *karisal nilam*, the black cotton-growing soil region of southern Tamil Nadu, in the early post-independence years. Modernity is raising its head and agrarian communities are transferring to the city, Brahmins and Dalits alike. The earth is a tough thing in the narrative, demanding labour and loyalty, not offering easy gifts like the fertile delta of the Thanjavur provinces. Here, it yields grains, fruits and trees, only due to the enormous hardships its people go through - the Dalits who work hard on these lands, the Pallars, Parayars and Chakkiliyars of Chithirampatti, Subramaniapuram, Kovilpatti and Tirunelveli.

A re-emerging feature in the novel is the *koogai*. An owl-like bird with fiery eyes, it pays its visits at important moments, reappearing as a guardian spirit and a magical messiah. The Pallars worship this ancient bird as *Koogai Sami*. Dharman expresses that the wise bird is a real *yogi*, and a metaphor for the difficulty of Dalits: "flying free and having their rights over the forest" but compelled to "live an invisible life". His writings, he says, are an entreaty to allow the *koogais*, or Dalits, to appear from their areas of segregation into open spaces. This paper investigates the author's personal life and the mythical traces of the people's beliefs.

Keywords: Cho Dharman, *Koogai*, Dalit exploitation, landless farmers, leather workers, sweepers, village drummers, caste discrimination, casteism

Introduction

Cho Dharman is one of the famous Dalit novelists in Tamil literature. Born in 1953, he hails from the village of Urulaikkudi a recurrent place name in his fiction, including *Koogai*. Dharman was born into the caste of Pallars, or Devendrakula Vellalar as they now call themselves. He trained at an industrial training institute and worked for a few years in a fireworks factory. After working for about a quarter of a century, like many contemporary writers, he took voluntary retirement in the year 2000 to pursue a full-time writing career.

This paper presents the Dalit writing in Tamil, a late bloomer like its literary counterparts in other regions, especially Marathi or Kannada. Literary scholars opine Tamil Dalit literature has only emerged actively since the 1990s and developed into an important and vocal expression of Dalit rivalry and allegation. The English translation of Cho Dharman's *Koogai (The Owl)*, which was first published in Tamil in 2005, has now been released. The novel depicts a vibrant tapestry of human conditions and Dalit exploitation. The story includes descriptions of little traditions, folk deities, animist lore, aboriginal beliefs and faith in magic. The story narration is wed to Tamil Sangam literary canons since they are also associated with the close relations between the land and the human condition. *Koogai* is a novel set in *karisal nilam*, the black cotton-growing soil region of southern s Nadu, in the early post-independence years. Modernity is raising its head and agrarian communities are transferring to the city, Brahmins and Dalits alike. The earth is a tough thing in the narrative, demanding labour and loyalty, not offering easy gifts like the fertile delta of the Thanjavur provinces. Here, it turns fertile, yielding grains, fruits and trees, only due to the enormous hardships its people go through—the Dalits who work hard in these lands, the Pallars, Parayars and Chakkiliyars of Chithirampatti, Subramaniapuram, Kovilpatti, Tirunelveli and other places.

Koogai is unflinching in detailing the cruelty the Dalits face. From the higher castes' "saliva-laden" dining leaves (like the banana leaves) they are asked to eat from, the separate tumblers at the tea shacks, women begging for water for their infants from the caste women at the common well, to the rape and violation of Dalit girls and women, their very physical presence in non-Dalit areas of villages provoking violent thrashing and abuse, and the exploitation of Dalit peasant labour—Dharman pens the details – the raw wounds of the inhumanity and humiliation without flinching.

The novel hints at the tragedy of progress and migration that propels Dalit communities to move by the truckloads from farmlands to neighbouring towns to work in matchbox and ginning factories, and as stone-breakers in quarries when they are cheated of their rights to the land.

Dharman's storytelling strength lies in the characters he etches and the beauty of the landscape he evokes. There is Old Seeni, the elder farmer who shows the way with grit; the playful Muthukkaruppan and Mookkan, who defy reviled traditions and try and wolf down a meal at the "club house", nothing more than a shack where intermediate castes congregate for a meal; the raw courage of Appusubban; and the doggedness of Ayyanar. Feisty and brave Pechi is not easy to forget. She is a witness to the rapid changes that move her people to new areas, newer forms of oppression, religious conversions, a new greedy political class that needs the numbers of her people for elections.

At one level, *Koogai* appears to be a work of historical fiction set in the middle decades of the last century, when wave after wave of agrarian and industrial changes began to sweep over the country. While a few castes' communities have managed to ride the crest, most of those who suffered inhuman exploitation in pre-modern times have been buoyed up by egalitarian rhetoric, only to be subsequently cast into other horrific conditions of deprivation and anomie. Anyone who has watched the trajectory of any Dalit family's history in the last years would recognize the pattern - one which their finest leaders have striven to change and which their enemies seize upon as proving the rationale of caste. As Peichi says at the end of

the novel, in those days, in the old backyard place, they had nothing in their hands. And what they hold their hands now, she says, are a bottle of arrack and a party flag.

Such irony leavened with flashes of fierce humour, as in the episode of the youths daring to eat with other castes in a ‘club-shop’, and in the anecdote about jailers ‘releasing’ Dalit prisoners to steal pigs for them to feast on, makes *Koogai* stand apart from today’s ponderous works of historical fiction. It differs, too from magical realist novels, where it is a whimsical sleight of hand that dazzles the reader.

Koogai shows how the so-called ‘untouchable’ communities have been up for grabs by vested interests and are subjected to what is known in Tamil as chiththira vadhai- a grotesque medley of torments. The novel describes age-old divide and rule stratagems that keep popping up under the nose of the law and the survival strategies of men, women, and the transgender in a society where gender violence and contempt for labour have received sanction under perceived notions of destiny. Some of these responses, of individuals and of groups, are valiant and ingenious. When Seeni insists that the Pallars’ work of cremation be treated with ceremonious respect as the contribution of mourners and not as the task of menials, he not only puts the upper castes to shame, he gives them notice that his people will no longer be available for such work. Some responses are desperate and abject, as when Karuppi offers herself to Muthaiya Pandian in place of her young daughter.

Authentic myth has a certain dispassionate quality. Yet, it sings and shouts truths that are sometimes tangential, sometimes right on target, in a range of voices compelling the attention even of iconoclasts and cynics. The last pages of this novel reveal the competitive fury fed by ancient animosities used by modern manipulators. The myth in the making could revive the flagging spirit of all those who have been wearied by the repeated failure of negotiated and compromised egalitarianism. Peichi grieves, but then wipes her tears; not all can be vanquished.

It is difficult to imagine the awe and wonderment that Latin American writers, especially Gabriel Garcia Marquez evoked among Tamil writers. The confluence of social realism and magical realism created a kind of literary sensation. Magical realism was recreated, mimicked, and aped, choosing our own words. Rising above these jejune experiments, Cho Dharman’s *Koogai* is a genuine creative mutation of both literary modes, well adapted to the existential reality of contemporary Tamil Nadu and to the karisal nilam region in particular.

Owl as an Icon

Koogai’s recognition has several reasons. First, it is in tune with the Dalit oral lore and is entirely different from the mainstream modernist writing. Secondly, it foregrounds positive Dalit values like reverence for nature and reveals the hidden power of the community instead of portraying them as just miserable beings fit only for sympathy and charity. Thirdly, it is multi-layered as against the one-dimensional, mostly autobiographical, Dalit writing that most of us are familiar with. Fourthly, it raises koogai, the owl, to the level of a symbol and an icon; the old man Seeni considers it a god with rare powers to appear anywhere and turn from a stone bird to a real bird and back and guide its followers in crises. It is a metaphor for all the oppressed communities, especially Dalits, as it is mostly unsung and underrated, considered dark and ugly, hardly a bird at all. In classical Tamil writing as well as in popular belief, the owl is the bird of death, an ominous, hateful bird whose very hooting is inauspicious. It is teased and attacked during the day even by sparrows as it cannot see in the overpowering sunlight and hence prefers invisibility. But it is really strong, as it realises at

night when it is left to itself. The neglect of the Koogai temple leads to the community's decline, though its devotees like Seeni always find the god's help and support, and there comes a day when even Gengiya Naicker, an upper caste man, begins to respect the bird. Fourthly, it is as much about resistance as about suffering and is genuinely radical in its attitude to the status quo. Fifthly, it has all the qualities of a serious work of fiction: innovative structure, fresh idiom, memorable characters and episodes, deep sociological and psychological understanding, a profound awareness of the kinship between man and nature demonstrated several times through diverse episodes and captivating narration.

Here, too, Dharman's chosen region for depiction is the *karisal* land whose lower-caste reality he understands in all its complexity. Dalits here were regularly beaten up for dressing or behaving like the upper-caste people; even eating at a proper hotel was considered an act of arrogance. The novel begins with such an incident where Muthukaruppan and Mookkan are beaten up by Muthaiya Pandian, the Thevar village watchman, as the two Dalits had dressed in clean dhotis and shirts and gone to the new eatery "the club-shop" run by Nachiyamma where they ate a meal of the white rice—"club-food"—sitting on a bench rather than squatting on the floor as they should have done. Dalits are supposed to take only "inferior" grains. If at all they wanted to eat that food, the watchman feels, they should have bought the food in a rice-pot and eaten it sitting under a tree. Only Seeni's intervention and put-on humility finally save the "sinners". But the same Muthaiya Pandian has no hesitation in sleeping with Karuppi, the Chakkiliyar woman, wife of Shanmugam Pagadai who is sent out by the watchman with a rupee to have a bottle of arrack. Karuppi meekly submits to this daily rape out of fear: she lies huddled on a mat "like a chick hiding from a hawk".

Seeni's devotion to the Koogai god even after the fall of the temple, which he wants to restore, and the Pallars' growing resistance to oppression are central to the narrative. The Pallars of Chithiraikkudi rebel against their tormenters who have been denying them every human right and regularly violating their women. This drives them to the slums of the neighbouring Kovilpatti, an industrial town, where to their dismay they discover that the owners of the factories and the mills too are from the same upper caste that had been exploiting them in the village. The novelist does not use terms like feudalism and capitalism, but it is evident that the landlords have now invested in factories in the cities, as has happened throughout the country in the last century. Nataraja Iyer, a Brahmin lawyer and land owner, however, comes to their rescue by leasing them his family land for cultivation and later, as he leaves the place, giving them each the ownership of the land that they had been cultivating. This is not an innocent act of charity; he wants to empower the Dalits to fight the intermediate castes who were now rising up against the old landlords. There are also other contradictions that come into play in the novel like that between the Paraiyars, for whom conversion to Christianity was an act of protest, and the Chakkiliars, for whom it becomes another form of enslavement.

Pallar Resistance

Some of the most exciting episodes in the novel are scenes of resistance, like the Pallars refusing to dig the grave for and announce the death of the upper-caste man Pandi Mama or Seeni standing up to the zamindar – landlord (Jameen, as he is called) and saying his people can no more work for him as they have to work on their own land. Each act of resistance brings punishment, and these acts slowly strengthen the Pallars' resolve. The vengeful landlord even tries to poison the only source of water the villagers had. It is in fact a ruthless class-caste struggle where the subaltern classes move forward and backward in their attempt to emancipate themselves. This struggle, however, is interspersed with poetic passages that reveal the beauty

and harmony in nature: birds and beasts—owls, parrots, falcons, drongos, mynahs, cranes, yellow-billed babblers, crows (a crow even helps the brave woman Peichi by attacking the police), deer, cows, oxen—as well as trees are an important presence in the novel. Even hills like the Guru Malai and Kazhugu Malai come alive and gain the stature of characters.

Seeni is aware not only of the kinship between man and nature, but also of the different communities in the village: “However many castes there may be, there’s a very thin net that is binding all of them together. We mustn’t tear it. We have to take out the tangles in that net, that’s all.” There is a sense of the sacred that informs the whole narrative: a community is ruined when it loses that link with the larger universe and with other communities as well as trees, creepers, birds and beasts. The owl also represents that bond as the many legends about it scattered across the novel demonstrate. Seeni represents this spirit.

He also instils self-respect among his people, as when he leads the ceremonial cavalcade of Pallars and Paraiyars to pay tributes to the Headman Gurusami Thevar led by the drummers and offers him garlands and many measures of paddy. The novelist comments: “In Seeni’s gait was the glee of a Yayati who has regained his youth, the exultation of an Ekalavyan who has recovered his lost thumb.”

Another memorable character is Peichi, the proud wife of the late Kaali Thevar, a strong and intelligent woman who saves Appusubban from the police and finds legal help for him. Her story runs in almost a parallel narrative. The lyrical passages on the divine owl that frequent the text and the life of Seeni together create another parallel narrative, along with the *siddhans* and the alchemists and a whole world of myth and magic. *Kusumabale* and *Koogai* in their different ways go beyond the established canons, not only of Dalit narratives, but of the Indian novel in general and point to the future course of the genre where it frees itself from Western models— both realist and modern—and creates its own narrative modes and critical norms.

Conclusion

The paper follows to unfold this narrative in full through the tales exchanged by the Jothammas, the House Lamp Spirits. Here is a Dalit novel that is free from sloganeering, magically capturing the Dalit spirit in its imaginative vitality and linguistic creativity.

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Language in India www.languageinindia.com ISSN 1930-2940 18:10 October 2018

R. Rajalakshmi, Editor: *Reading the Nation – The Global Perspective*

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Retrieval of the Mythical and Dalit Imagination in Cho Dharman’s *Koogai: The Owl*

Edge Odd Graceful Labeling of Some Special Graphs

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Abstract

The concept of Edge Odd Graceful Labeling was studied from Edge –Odd Graceful Labeling of the Complete Bipartite Graph. It is a special type of labeling of a graph G that is if there is a bijection f from the edge of G to the set $\{1,3,5, \dots, (2q - 1)\}$ so that the induced mapping $f^*:V \rightarrow \{0,1,2, \dots, 2q\}$ given by $f^*(u) = \sum\{f(uv)/uv \in E\} \pmod{2q}$ with p vertices. This paper deals with the edge odd graceful labeling of some special graphs like Dutch Windmill Graph D_5^m , D_4^m and Circular Ladder Graph CL_n .

Keywords

Circular Ladder Graph, Dutch Windmill Graph, Edge, Odd.

1. Introduction

Graph labeling[1] plays an important role in research now a days. Graph Labeling is an acting tool which contribute a lot in various field and makes very easy to handle many areas such as communication network, circuit Layout etc. A graph labeling is a map which carries graph elements (vertices or edges) to the integers subject to certain conditions .In 1967 Rosa introduced the concept of graph labeling methods. Then Lo introduced edge graceful graphs, Dr.A.Soliraju and K.Chithra introduced Edge-Odd graceful labeling (EOGL). In this paper the Dutch Wind mill graph D_5^m , D_4^m and Circular Ladder Graph CL_n are shown as EOGL graph.

2. Definition

2.1 Dutch Windmill Graph

The Dutch Windmill graph D_n^m [10] is the graph consisting m copies of complete graph K_n with a vertex in common .

2.2 Circular ladder graph

Circular ladder graph CL_n [2] is the Cartesian product of a cycle of length $n \geq 3$ and an edge. It is denoted as $C_n \times P_1$.

2.3 Edge Odd Graceful Labeling (EOGL)

A graph Labeling is said to be a EOGL [5,6,7,8,9,10] if there exists a bijection $f: E \rightarrow \{1,3,5, \dots, (2q - 1)\}$ so that the induced mapping $f^*:V \rightarrow \{0,1,2, \dots, 2q\}$ given by $f^*(u) = \sum\{f(uv) \setminus uv \in E\} \pmod{2q}$ with p vertices.

3. Theorem

Every D_5^m (m is odd) is an Edge Odd graceful Labeling Graph.

Proof

Let the vertex set of D_5^m be $V = V_1 \cup V_2$ where $V_1 = \{u\}$ common vertex and other vertices be $V_2 = \{u_i/i = 1 \text{ to } 4m\}$.

Edge set $E = E_1 \cup E_2 \cup E_3 \cup E_4 \cup E_5 \cup E_6$, where

$E_1 = \{uu_i/i = 1 \text{ to } 4m\}$, $E_2 = \{u_i u_{i+1} / i = 1,3, \dots \text{ to } (4m - 1)\}$, $E_3 = \{u_{4i-3} u_{4i}/i = 1 \text{ to } m\}$,

$E_4 = \{u_{4i-3} u_{4i-1}/i = 1 \text{ to } m\}$, $E_5 = \{u_{4i-2} u_{4i}/i = 1 \text{ to } m\}$, $E_6 = \{u_{4i-2} u_{4i-1}/i = 1 \text{ to } m\}$

First the edges are labeled as follows

$f(uu_{4i}) = 20i - 17$ for $i = 1 \text{ to } m$

$f(uu_{4i-1}) = 20i - 1$ for $i = 1 \text{ to } m$

$$\begin{aligned}
 f(uu_{4i-2}) &= 20i - 3 \text{ for } i = 1 \text{ to } m \\
 f(uu_{4i-3}) &= 20i - 19 \text{ for } i = 1 \text{ to } m \\
 f(u_{4i-3}u_{4i}) &= 20i - 15 \text{ for } i = 1 \text{ to } m \\
 f(u_{4i-3}u_{4i-1}) &= 20i - 5 \text{ for } i = 1 \text{ to } m \\
 f(u_{4i-3}u_{4i-2}) &= 20i - 13 \text{ for } i = 1 \text{ to } m \\
 f(u_{4i-2}u_{4i}) &= 20i - 7 \text{ for } i = 1 \text{ to } m \\
 f(u_{4i-2}u_{4i-1}) &= 20i - 11 \text{ for } i = 1 \text{ to } m \\
 f(u_{4i-1}u_{4i}) &= 20i - 9 \text{ for } i = 1 \text{ to } m
 \end{aligned}$$

Now, the vertex are labeled by induced mapping as follows ,

$$\begin{aligned}
 f^*(u) &= 0 \\
 f^*(u_{4i-3}) &= [f(uu_{4i-3}) + f(u_{4i-3}u_{4i-2}) + f(u_{4i-3}u_{4i-1}) + f(u_{4i-3}u_{4i})](\text{mod } 20m), i = 1, 2, \dots, m \\
 f^*(u_{4i-2}) &= [f(uu_{4i-2}) + f(u_{4i-2}u_{4i-3}) + f(u_{4i-2}u_{4i-1}) + f(u_{4i-2}u_{4i})](\text{mod } 20m), i = 1, 2, \dots, m \\
 f^*(u_{4i-1}) &= [f(uu_{4i-1}) + f(u_{4i-1}u_{4i-3}) + f(u_{4i-1}u_{4i-2}) + f(u_{4i-1}u_{4i})](\text{mod } 20m), i = 1, 2, \dots, m \\
 f^*(u_{4i}) &= [f(uu_{4i}) + f(u_{4i}u_{4i-3}) + f(u_{4i}u_{4i-2}) + f(u_{4i}u_{4i-1})](\text{mod } 20m), i = 1, 2, \dots, m
 \end{aligned}$$

Now the edge labels and vertex labels are distinct in D_5^m (when m is odd)

So D_5^m (when m is odd) is an Edge Odd Graceful Labeling Graph.

3.1 Example

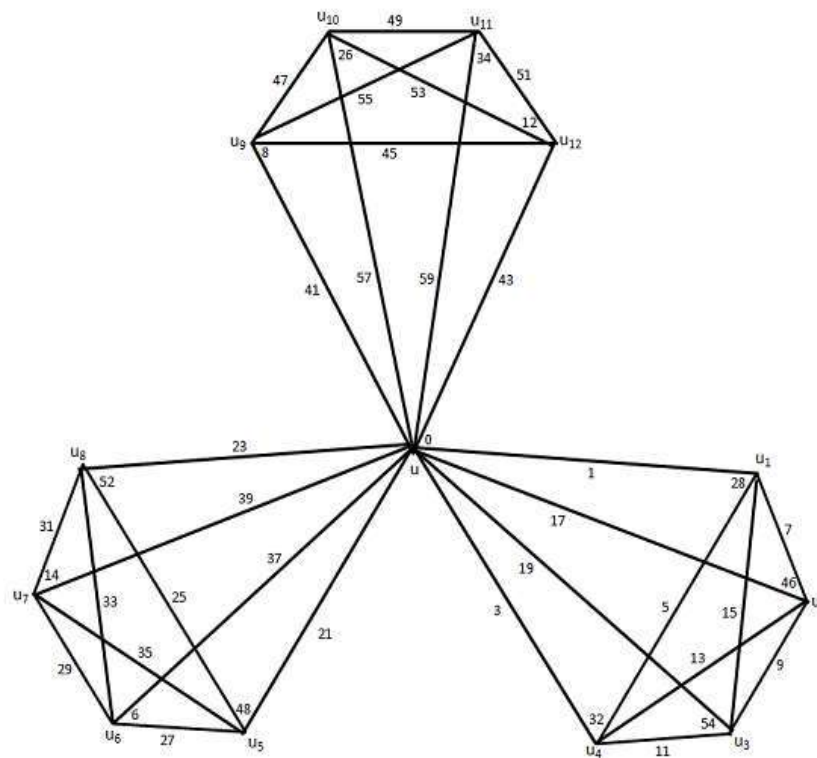


Fig 1 - Dutch Windmill Graph D_5^3

4. Theorem

The Dutch Windmill Graph D_4^m (m even) is edge odd Graceful Labeling Graph.

Proof

Let the vertex set of D_4^m be $V = V_1 \cup V_2$ where $V_1 = \{u\}$ common vertex and other vertices be $V_2 = \{u_i / i = 1 \text{ to } 3m\}$.

Edge set $E = E_1 \cup E_2 \cup E_3 \cup E_4$, where

$E_1 = \{uu_i / i = 1 \text{ to } 3m\}$, $E_2 = \{u_{3i-2}u_{3i-1} / i = 1, 2, 3, \dots, m\}$, $E_3 = \{u_{3i-1}u_{3i} / i = 1, 2, 3, \dots, m\}$ and $E_4 = \{u_{3i-2}u_{3i} / i = 1, 2, 3, \dots, m\}$.

First the edges are labeled as follows

$$f(uu_{3i-2}) = 4i - 3 \text{ for } i = 1 \text{ to } m$$

$$\begin{aligned}
 f(u_{3i-2}u_{3i-1}) &= 4m + 4i - 3 \text{ for } i = 1 \text{ to } m \\
 f(u_{3i-1}u_{3i}) &= 4i - 1 \text{ for } i = 1 \text{ to } m \\
 f(uu_{3i}) &= 4m + 4i - 1 \text{ for } i = 1 \text{ to } m \\
 f(uu_{6i-4}) &= 8m + 4i - 3 \text{ for } i = 1 \text{ to } \frac{m}{2} \\
 f(uu_{6i-1}) &= 10m + 4i - 1 \text{ for } i = 1 \text{ to } \frac{m}{2} \\
 f(u_{6i-5}u_{6i-3}) &= 10m + 4i - 3 \text{ for } i = 1 \text{ to } \frac{m}{2} \\
 f(u_{6i-2}u_{6i}) &= 8m + 4i - 1 \text{ for } i = 1 \text{ to } \frac{m}{2}
 \end{aligned}$$

Now the induced vertex labels are

$$\begin{aligned}
 f^*(u) &= 0 \\
 f^*(u_{6i-5}) &= [f(uu_{6i-5}) + f(u_{6i-5}u_{6i-4}) + f(u_{6i-5}u_{6i-3})](\text{mod } 12m) \text{ for } i = 1 \text{ to } \frac{m}{2} \\
 f^*(u_{6i-4}) &= [f(uu_{6i-4}) + f(u_{6i-5}u_{6i-4}) + f(u_{6i-3}u_{6i-4})](\text{mod } 12m) \text{ for } i = 1 \text{ to } \frac{m}{2} \\
 f^*(u_{6i-3}) &= [f(uu_{6i-3}) + f(u_{6i-5}u_{6i-3}) + f(u_{6i-4}u_{6i-3})](\text{mod } 12m) \text{ for } i = 1 \text{ to } \frac{m}{2} \\
 f^*(u_{6i-2}) &= [f(uu_{6i-2}) + f(u_{6i-2}u_{6i-1}) + f(u_{6i-2}u_{6i})](\text{mod } 12m) \text{ for } i = 1 \text{ to } \frac{m}{2} \\
 f^*(u_{6i-1}) &= [f(uu_{6i-1}) + f(u_{6i-2}u_{6i-1}) + f(u_{6i-1}u_{6i})](\text{mod } 12m) \text{ for } i = 1 \text{ to } \frac{m}{2} \\
 f^*(u_{6i}) &= [f(uu_{6i}) + f(u_{6i-1}u_{6i}) + f(u_{6i-2}u_{6i})](\text{mod } 12m) \text{ for } i = 1 \text{ to } \frac{m}{2}
 \end{aligned}$$

Now the edge labels and vertex labels are distinct in D_4^m (when m is even)

So the Dutch Windmill Graph D_4^m (m even) is edge odd Graceful Labeling Graph.

4.1 Example

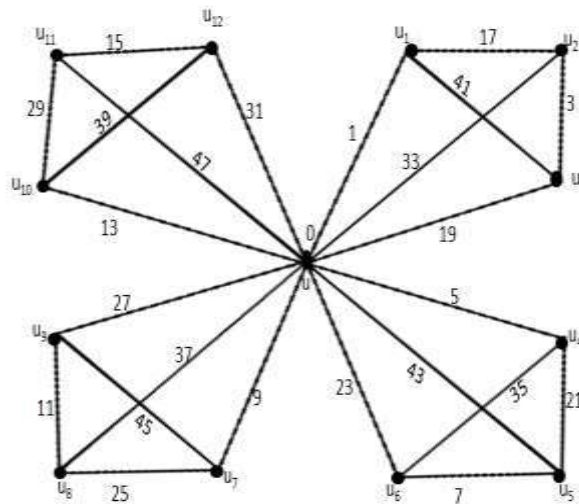


Fig 2 Dutch Windmill Graph D_4^4

5 Theorem

Every Circular ladder graph CL_n ($n \geq 3$) is edge odd graceful labeling graph.

Proof

Let the vertices of CL_n be $\{u_1, u_2, u_3, \dots, u_n, v_1, v_2, v_3, \dots, v_n\}$.

Edge set be $E = E_1 \cup E_2 \cup E_3 \cup E_4$, Where $E_1 = \{u_i u_{i+1} / i = 1, 2, \dots, (n-1)\}$, $E_2 = \{u_1 u_n, v_1 v_n\}$, $E_3 = \{v_i v_{i+1} / i = 1, 2, \dots, (n-1)\}$, $E_4 = \{u_i v_i / i = 1, 2, \dots, n\}$.

First the edges are labeled as follows

$$\begin{aligned}
 f(u_i u_{i+1}) &= 2i - 1 \text{ for } i = 1, 2, \dots, (n-1), \\
 f(u_1 u_n) &= 2n - 1 \\
 f(v_i v_{i+1}) &= 4n + 2i - 1 \text{ for } i = 1, 2, \dots, (n-1) \\
 f(v_1 v_n) &= 6n - 1 \\
 f(u_i v_i) &= 4n - 2i + 1 \text{ for } i = 1, 2, \dots, n
 \end{aligned}$$

Now the induced vertex labels are

$f^*(u_1) = 6n - 1$
 $f^*(u_{i+1}) = 4n + 2i - 1$ for $i = 1, 2, \dots, (n - 1)$
 $f^*(v_1) = 14n - 1 \pmod{6n}$
 $f^*(v_{i+1}) = 12n + 2i - 1 \pmod{6n}$ for $i = 1, 2, \dots, (n - 1)$
 Now the edge labels and vertex labels are distinct in CL_n
 So Every CL_n ($n \geq 3$) is an Edge Odd Graceful Labeling Graph.

5.1 Example

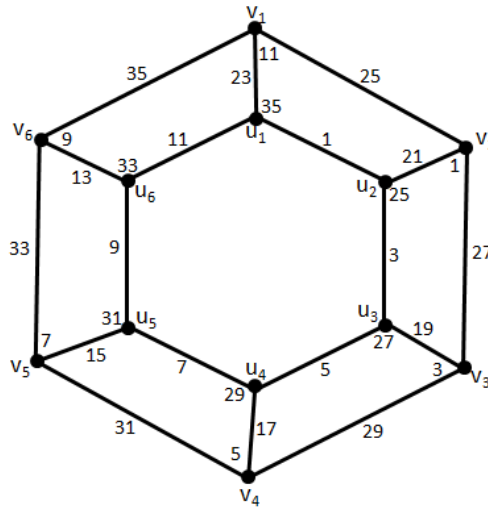


Fig 3 - Circular Ladder Graph CL_6

6 Conclusion

In this Paper Dutch Windmill Graph D_5^m when m is odd and D_4^m when m is even are proved as Edge - Odd Graceful Labeling Graphs are proved .Finally we Proved Every Circular ladder graph CL_n ($n \geq 3$) is edge odd graceful labeling graph.

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Study on Strong Binary Equivalent Decimal Edge Graceful Labeling

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Abstract

Let $G = (V(G), E(G))$ be a graph with n vertices is said to be Binary Equivalent Decimal Edge Graceful Labeling (BEDE) graph if the vertices are assigned distinct numbers from $0, 1, 2, \dots, n-1$ such that the labels induced on edges by the values obtained using binary coding of end vertices of each edge which are distinct. A graph $G = (V(G), E(G))$ be a graph with n vertices is said to be Strong Incident Binary Equivalent Decimal Edge Graceful Labeling (SIBEDE) if the vertices of G are labeled with distinct positive integers from $0, 1, 2, \dots, (n-1)$ such that the label induced on the edges by Binary decimal equivalent coding are distinct from the vertex labeling. In this paper some graphs such as cycle graph, path graphs, star graph, crown graph and middle graph of above said graphs are proved as Strong Incident Binary Equivalent Decimal Edge Graceful Labeling (SIBEDE).

Key Words: BED, binary, graceful, incident, labeling, middle, strong.

1. Introduction

This paper deals with finite, simple, connected graphs only. A Labeling of graph is an assignment of labels to the vertices or edges or both by some specific rule.

Labeling plays an important role in Communication network addressing, Circuit design, Data base management etc,. A useful survey on Graph labeling by J.A. Gallian (2010) can be found in [1]. To any Graph G there corresponds a $v \times e$ matrix called incident matrix of G [3]. Let us denote the vertices of G by v_1, v_2, \dots, v_v and edges by e_1, e_2, \dots, e_e . Then the incident matrix of G is the matrix $B(G)=[b_{ij}]$ where b_{ij} is the number of times that v_i and e_j are incident.

The Middle graph $M(G)$ [4] of a graph G is the graph whose vertex set is $V(G) \cup E(G)$ and in which two vertices are adjacent if and only if either they are adjacent edges of G or one is vertex of G and the other is an edge incident with it.

2. Strong Binary Equivalent Decimal Edge Graceful Labeling

2.1. Strong Incident Binary Equivalent Decimal Edge Graceful Labeling

2.1.1. Definition

A graph $G = (V(G), E(G))$ be a graph with n vertices is said to be Incident Binary Equivalent Decimal Edge (IBEDE) Graceful labeling, If f is a bijective mapping from vertices to the set of integers $\{0, 1, 2, \dots, (n-1)\}$ such that the induced map f^* from edge set to integers which is defined as

$$f : V(G) \rightarrow \{0, 1, 2, \dots, (n-1)\}$$

$f^* : E(G) \rightarrow \{1, 2, 3, 4, 5, \dots\}$ such that the values obtained from binary coding. It is also equivalent to

$e_k = (i, j) = 2^{n-1-i} + 2^{n-1-j}$ where $k = \{1, 2, 3, \dots, n\}$ and i, j are finite positive integer labeled for end vertices of e_k , n is the number of vertices in G .

2.1.2. Definition

A graph $G = (V(G), E(G))$ be a graph with n vertices is said to be Strong Incident Binary Equivalent Decimal Edge Graceful Labeling (SIBEDE) if the vertices of G are labeled with distinct positive integers from $0, 1, 2, \dots, (n-1)$ such that the label induced on the edges by Binary decimal equivalent coding are distinct from the vertex labeling.

2.1.3. Example

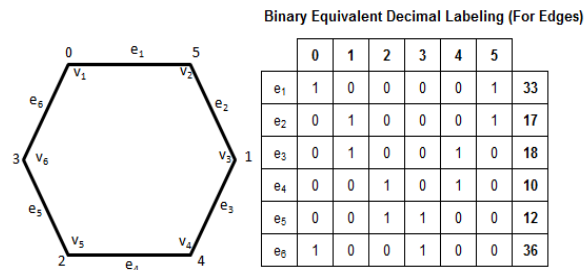


Fig.1. Cycle Graph C₆

Binary Equivalent Decimal Calculation (For Edges)

$$e_1 = 1x2^5 + 0x2^4 + 0x2^3 + 0x2^2 + 0x2^1 + 1x2^0 = 32 + 1 = 33$$

Equivalent Calculation using formula for Fig.1

$$\begin{aligned}
 e_1 &= (0, 5) = 33 & e_3 &= (1, 4) = 18 & e_5 &= (2, 3) = 12 \\
 e_2 &= (5, 1) = 17 & e_4 &= (4, 2) = 10 & e_6 &= (3, 0) = 36
 \end{aligned}$$

2.1.4. Example

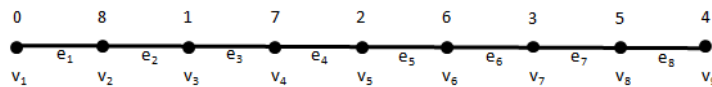


Fig.2: Path Graph P₉

Equivalent Calculation using formula for Fig.2

$$\begin{aligned}
 e_1 &= (0, 8) = 257 & e_3 &= (1, 7) = 130 & e_5 &= (2, 6) = 68 & e_7 &= (3, 5) = 40 \\
 e_2 &= (8, 1) = 129 & e_4 &= (7, 2) = 66 & e_6 &= (6, 3) = 36 & e_8 &= (5, 4) = 24
 \end{aligned}$$

2.1.5. Example

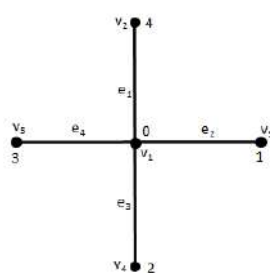


Fig.3: Star Graph K_{1,4}

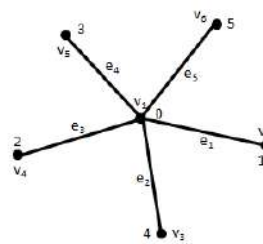


Fig.4: Star Graph K_{1,5}

Equivalent Calculation using formula for Fig.3 & Fig.4

for Star Graph $K_{1,4}$		for Star Graph $K_{1,5}$	
$e_1 = (0, 4) = 17$	$e_3 = (0, 2) = 18$	$e_1 = (0, 1) = 48$	$e_3 = (0, 2) = 40$
$e_2 = (0, 1) = 24$	$e_4 = (0, 3) = 20$	$e_2 = (0, 4) = 34$	$e_4 = (0, 3) = 36$
			$e_5 = (0, 5) = 33$

2.1.6. Theorem

Every cycle graph C_n ($n \geq 3$) is SIBEDE graceful labeling graph.

Proof

Let the vertices of C_n be v_1, v_2, \dots, v_n .

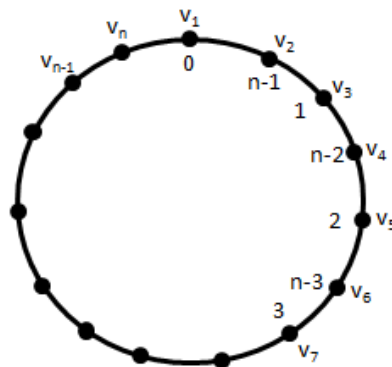


Fig.5: Cycle Graph C_n

First label the vertices of C_n as follows,

Define a bijective mapping $f : V(G) \rightarrow \{0, 1, 2, \dots, (n - 1)\}$

$$f(v_1) = 0$$

$$f(v_i) = n - \left\lfloor \frac{i}{2} \right\rfloor \text{ if } i \text{ is even,}$$

$$f(v_i) = \left\lceil \frac{i}{2} \right\rceil \text{ if } i \text{ is odd and } i > 1.$$

Now the vertices are labeled with distinct integers from 0 to n-1.

Define an induced function $f^* : E(G) \rightarrow \{0, 1, 2, \dots\}$

Edges are labeled with the binary code obtained from the incident vertex. It is also equivalent to

$$e_k = (i, j) = 2^{n-1-i} + 2^{n-1-j} \text{ where } k = \{1, 2, 3, \dots, n\} \text{ and } i, j \text{ are finite positive integer labeled for end vertices of } e_k.$$

This vertex labeling induces an edge labeling in which both labeling are distinct.

Therefore every cycle graph C_n is SIBEDE graceful labeling graph.

2.1.7. Definition

The crown is the graph obtained from a cycle C_n by attaching pendant edge at each vertex of the cycle and it is denoted by C_n^+

2.1.8. Example

The total number of vertices in crown graph C_4^+ is 8

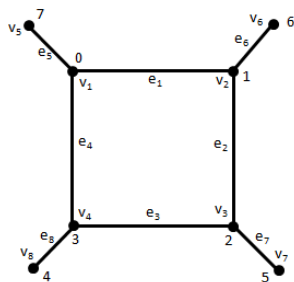


Fig.6. Crown Graph C_4^+

Equivalent Calculation using formula for Fig.6

$e_1 = (0, 1) = 192$	$e_3 = (2, 3) = 48$	$e_5 = (0, 7) = 129$	$e_7 = (2, 5) = 36$
$e_2 = (1, 2) = 96$	$e_4 = (3, 0) = 144$	$e_6 = (1, 6) = 66$	$e_8 = (3, 4) = 24$

2.1.9. Theorem

The crown C_n^+ are SIBEDE graceful labeling for all $n \geq 3$

Proof

Let the vertices of C_n^+ be v_1, v_2, \dots, v_{2n} and $e_1 = (v_i, v_{i+1})$ for $i = 1$ to $n-1$
 $e_n = (v_n, v_1)$ and $e_{n+i-2} = (v_{i-2}, v_{n+i-2})$ for $i = 3$ to $(n + 2)$ be the edges of C_n^+

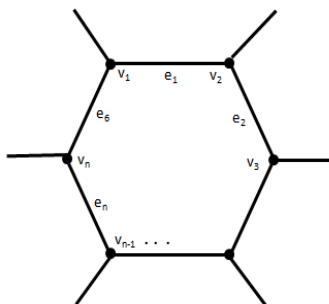


Fig.7: Crown Graph C_n^+

Equivalent Calculation using formula for Fig.7

The total number of vertices in crown graph is $2n$.

First label the vertices of C_n^+ as follows,

Define a bijective mapping $f : V(G) \rightarrow \{0,1,2, \dots, (2n - 1)\}$ $f(v_1) = 0$

$$f(v_i) = f(v_{i-1}) + 1 \text{ for } i = 2 \text{ to } n$$

$$f(v_{n+1}) = 2n - 1, f(v_i) = f(v_{i-1}) - 1 \text{ for } i = (n + 2) \text{ to } 2n$$

Now the vertices are labeled with distinct integers from 0 to $2n-1$.

Define an induced function $f^* : E(G) \rightarrow \{0,1,2, \dots\}$

Edges are labeled with the binary code obtained from the incident vertex. It is also equivalent to $e_k = (i, j) = 2^{2n-1-i} + 2^{2n-1-j}$ where $k = \{1,2,3, \dots, 2n\}$ and i, j are finite positive integer labeled for end vertices of e_k . This vertex labeling induces an edge labeling in which both labeling are distinct. Therefore every crown graph C_n^+ is SIBEDE graceful labeling graph.

3. Strong Incident Binary Equivalent Decimal Edge Graceful Labeling for Middle Graph

3.1.1. Definition

The Middle graph $M(G)$ of a graph G is the graph whose vertex set is $V(G) \cup E(G)$ and in which two vertices are adjacent if and only if either they are adjacent edges of G or one is vertex of G and the other is an edge incident with it.

3.1.2. Example

The total number of vertices in middle graph $M(P_5)$ of path graph P_5 is 9.

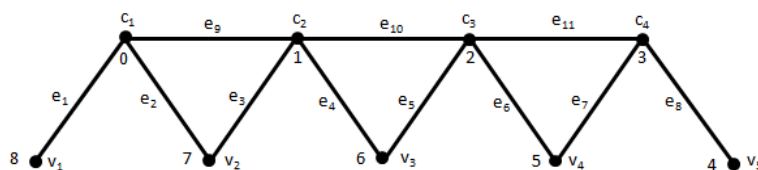


Fig.8: Middle Graph $M(P_5)$

Equivalent Calculation using formula for Fig.8

$e_1 = (8, 0) = 257$	$e_4 = (1, 6) = 132$	$e_7 = (5, 3) = 40$	$e_{10} = (1, 2) = 192$
$e_2 = (0, 7) = 288$	$e_5 = (6, 2) = 68$	$e_8 = (3, 4) = 48$	$e_{11} = (2, 3) = 96$
$e_3 = (7, 1) = 130$	$e_6 = (2, 5) = 72$	$e_9 = (0, 1) = 384$	

3.1.3. Example

The total number of vertices in middle graph of cycle graph $M(C_4)$ is 8

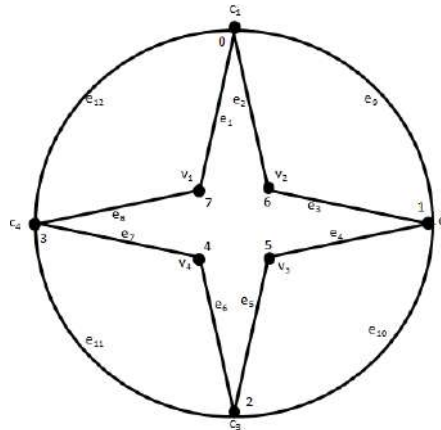


Fig.9: Middle Graph $M(C_4)$

Equivalent Calculation using formula for Fig.9

$e_1 = (7, 0) = 129$	$e_4 = (1, 5) = 68$	$e_7 = (4, 3) = 24$	$e_{10} = (1, 2) = 96$
$e_2 = (0, 6) = 130$	$e_5 = (5, 2) = 36$	$e_8 = (3, 7) = 17$	$e_{11} = (2, 3) = 48$
$e_3 = (6, 1) = 66$	$e_6 = (2, 4) = 40$	$e_9 = (0, 1) = 192$	$e_{12} = (3, 0) = 144$

3.1.4. Example

The total number of vertices in middle graph of star graph $M(K_{1,4})$ is 9.

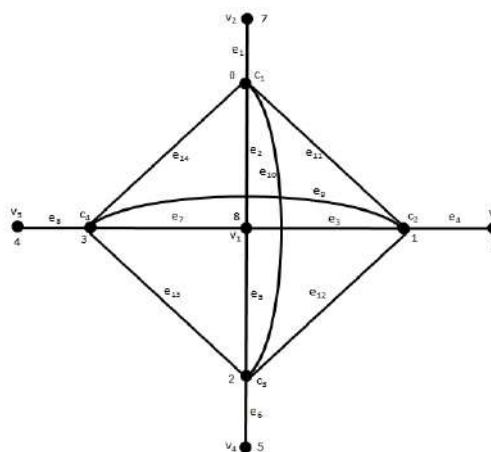


Fig.10: Middle Graph $M(K_{1,4})$

Equivalent Calculation using formula for Fig.10

$e_1 = (0, 7) = 258$	$e_5 = (8, 2) = 65$	$e_9 = (3, 1) = 32$	$e_{13} = (2, 3) = 40$
$e_2 = (0, 8) = 160$	$e_6 = (2, 5) = 72$	$e_{10} = (0, 2) = 320$	$e_{14} = (3, 0) = 288$
$e_3 = (8, 1) = 264$	$e_7 = (8, 3) = 33$	$e_{11} = (0, 1) = 384$	
$e_4 = (1, 6) = 132$	$e_8 = (3, 4) = 48$	$e_{12} = (1, 2) = 256$	

3.1.5. Example

The total number of vertices in middle graph of crown graph $M(C_3^+)$ is 12

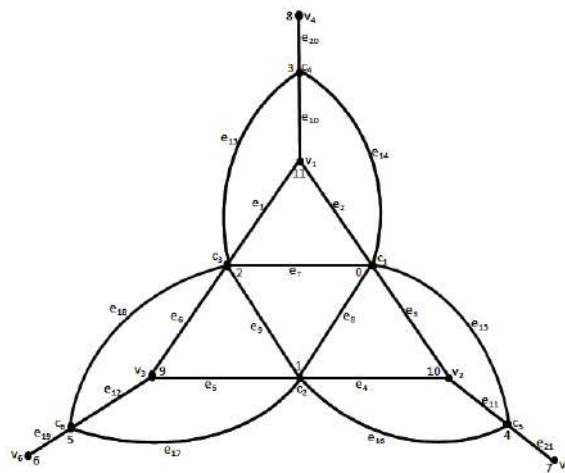


Fig.11: Middle Graph of C_3^+ is $M(C_3^+)$

Equivalent Calculation using formula for Fig.11

$e_1 = (2, 11) = 513$	$e_6 = (9, 2) = 516$	$e_{11} = (10, 4) = 130$	$e_{16} = (4, 1) = 1040$
$e_2 = (11, 0) = 2049$	$e_7 = (2, 0) = 2560$	$e_{12} = (9, 5) = 68$	$e_{17} = (1, 5) = 1088$
$e_3 = (0, 10) = 2050$	$e_8 = (0, 1) = 2048$	$e_{13} = (2, 3) = 768$	$e_{18} = (5, 2) = 544$
$e_4 = (10, 1) = 1026$	$e_9 = (1, 2) = 1536$	$e_{14} = (3, 0) = 2304$	$e_{19} = (5, 6) = 96$
$e_5 = (1, 09) = 1028$	$e_{10} = (11, 3) = 257$	$e_{15} = (0, 4) = 2176$	$e_{20} = (3, 8) = 264$
			$e_{21} = (4, 7) = 144$

3.1.6. Theorem

If $P_n (n \geq 2)$ is a path graph then the middle graph $M(P_n)$ of P_n is SIBEDE gracefulful Labeling.

Proof

Let $V = v_1, v_2, v_3, \dots, v_n, c_1, c_2, \dots, c_{n-1}$ be the vertex set and $E = E_1 \cup E_2 \cup E_3$ be the edge set of middle graph $M(P_n)$ where

$$E_1 = c_i v_i, 1 \leq i \leq n - 1, E_2 = c_i v_{i+1}, 1 \leq i \leq n - 1, E_3 = c_i c_{i+1}, 1 \leq i \leq n - 2$$

Let the total number of vertices of middle graph of path graph be $(2n-1)$.

Define a bijective mapping $f : V(G) \rightarrow \{0, 1, 2, \dots, 2(n-1)\}$

$$f(v_i) = 2n - 1 - i, 1 \leq i \leq n$$

$$f(c_j) = j - 1, 1 \leq j \leq n - 1$$

Now define an induced function $f^* : E(G) \rightarrow \{0, 1, 2, \dots\}$

Edges are labeled with the binary code obtained from the incident vertex. It is also equivalent to

$e_k = (i, j) = 2^{2(n-1)-i} + 2^{2(n-1)-j}$ where $k = \{1, 2, 3, \dots, (3n-4)\}$ and i, j are finite positive integer labeled for end vertices of e_k .

This labeling gives SIBEDE graceful labeling for middle graph $M(P_n)$.

4. Conclusion

In this work some graphs such as cycle graph, path graph, star graph, crown graph and middle graph of all the above said graphs are proved as strong Incident Binary Equivalent Decimal Edge graceful labeling with examples.

Acknowledgement

The authors would like to thank Dr. Ponnammal Natarajan, Former Director – Research, Anna University- Chennai, India and currently an Advisor, (Research and Development), Rajalakshmi Engineering College, Dr. E.Sampath Kumar Acharya & Dr. L. Pushpalatha, University of Mysore, Mysore, for their initiative ideas and fruitful discussions with respect to the paper's contribution.

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To cite this article: V Rajeswari and K Thiagarajan 2018 *J. Phys.: Conf. Ser.* **1000** 012078

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Graceful Labeling of Wheel Graph and Middle Graph of Wheel Graph under IBEDE and SIBEDE Approach

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Abstract. In this paper, we studied the Incident Binary Equivalent Decimal Edge Graceful Labeling (IBEDE) [1] and Strong Incident Binary Equivalent Decimal Edge Graceful Labeling (SIBEDE) [1] for Wheel Graph $W_{1,n}$ and Middle Graph of Wheel Graph $M(W_{1,n})$. Also we obtained the Wheel Graph $W_{1,n}$ and its Middle Graph $M(W_{1,n})$ for $n \geq 3$ are IBEDE Graceful Labeling. And the Wheel Graph $W_{1,n}$ for $n > 3$ and its Middle Graph $M(W_{1,n})$ for $n \geq 3$ are SIBEDE Graceful Labeling. Here the Ramsey number of IBEDE and SIBEDE Graceful Labeling for $W_{1,5}$ is 3 and the Ramsey number of IBEDE and SIBEDE Graceful Labeling for $M(W_{1,3})$ is 18.

1. Introduction

Graph labeling [2] is an interesting area of graph theory with ample range of applications in coding theory, communication networks, data mining, image processing, telecommunication systems, optimal circuits layout, graph decomposition problems, designing uncertainty in X-ray crystallographic analysis.

2. Binary Equivalent Decimal Edge Graceful Labeling

2.1. Incident Binary Equivalent Decimal Edge Graceful Labeling for Wheel Graph and Middle Graph of Wheel Graph

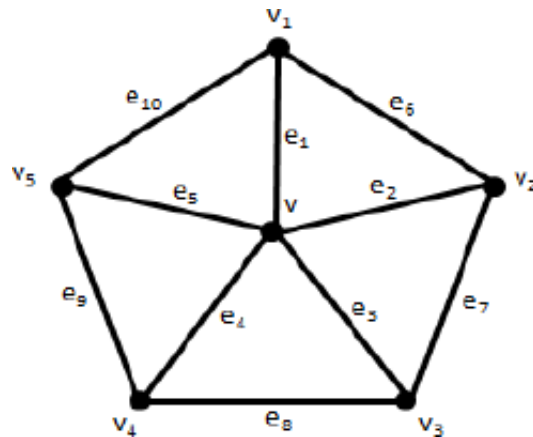
Definition 2.1. The Wheel graph $W_{1,n}$ ($n \geq 3$) [3] is a $n + 1$ -vertices graph obtained by connecting all the vertices $\{v_1, v_2, \dots, v_n\}$ of C_n to the center vertex v , now the vertex set is $V(W_{1,n}) = \{v, v_1, v_2, \dots, v_n\}$. Here v be the center vertex and other vertices v_1, v_2, \dots, v_n be on the rim and the edge set is $E(W_{1,n}) = \{e_1, e_2, e_3, \dots, e_n, e_{(n+1)}, \dots, e_{2n}\}$.

Example 2.2.

$\{v\}$ - Center vertex

$\{v_1, v_2, \dots, v_n\}$ - vertices on the rim



Figure 1: Wheel Graph $W_{1,5}$

Definition 2.3. [4, 5] The Middle graph $M(G)$ of a graph G is the graph in which the vertex set is $V(G) \cup E(G)$ and two vertices are adjacent if and only if either they are adjacent edges of G or one is vertex of G and the other is an edge incident with it.

Definition 2.4. A graph G with n vertices is said to be Incident Binary Equivalent Decimal Edge (IBEDE) Graceful labeling [6, 1], if there corresponds a $V \times E$ matrix called incident matrix and f is a bijective mapping from vertices to the set of integers $\{0, 1, 2, \dots, (n-1)\}$ such that the induced map f^* from edge set to integers which are defined as

$$f : V(G) \rightarrow \{0, 1, 2, \dots, (n-1)\}$$

$$f^* : E(G) \rightarrow \{1, 2, 3, \dots, m\} \text{ (} m \text{ is finite)}$$

such that the edges are labeled by the values obtained from binary equivalent decimal coding of the Incident vertices. It is also equivalent to $f^*(e_k = ij) = 2^{n-i-1} + 2^{n-j-1}$ where $k = \{1, 2, 3, \dots, q\}$ and i, j are finite positive integer labeled for the vertices of edge e_k , n is the number of vertices in G .

Example 2.5.

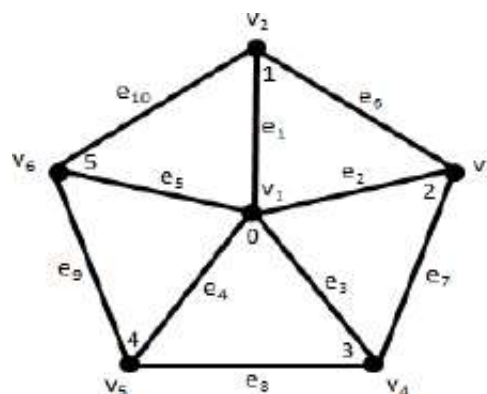
Figure 2: Wheel Graph $W_{1,5}$

Table 1: Incident Binary Equivalent Decimal Edge Labeling

	0	1	2	3	4	5	
e_1	1	1	0	0	0	0	48
e_2	1	0	1	0	0	0	40
e_3	1	0	0	1	0	0	36
e_4	1	0	0	0	1	0	34
e_5	1	0	0	0	0	1	33
e_6	0	1	1	0	0	0	24
e_7	0	0	1	1	0	0	12
e_8	0	0	0	1	1	0	6
e_9	0	0	0	0	1	1	3
e_{10}	0	1	0	0	0	1	17

Theorem 2.1. For $n \geq 3$, the wheel Graph $W_{1,n}$ is IBEDE Graceful labeling graph.

Proof. The vertices of $W_{1,n}$ be v_1, v_2, \dots, v_{n+1} and

$e_i = (v_1, v_{i+1})$ for $i = 1$ to n

$e_{n+i} = (v_{i+1}, v_{i+2})$ for $i = 1$ to $n - 1$, and $e_{2n} = (v_{n+1}, v_2)$ be the edges of $W_{1,n}$.

Here v_1 be the center vertex and other vertices v_2, \dots, v_{n+1} be on the rim.

First label the vertices of $W_{1,n}$ as follows:

We Define a bijective function $f : V(W_{1,n}) \rightarrow \{0, 1, 2, \dots, n\}$ such that the vertices are labeled as follows

$$f(v_1) = 0$$

$$f(v_i) = f(v_{i-1}) + 1, i = 2, 3, \dots, (n + 1)$$

An induced function is defined as $f^* : E(W_{1,n}) \rightarrow \{1, 2, \dots, m\}$

(m - finite and $m \neq n$)

Binary equivalent decimal code obtained from the incident vertices are labeled for the corresponding edges. It is also equivalent to $f^*(e_k = ij) = 2^{n-i} + 2^{n-j}$ here $k = \{1, 2, 3, \dots, 2n\}$.

This vertex labeling induces a edge labeling which are distinct.

Therefore every Wheel graph $W_{1,n}$ ($n \geq 3$) is IBEDE graceful labeled graph. \square

Example 2.6.

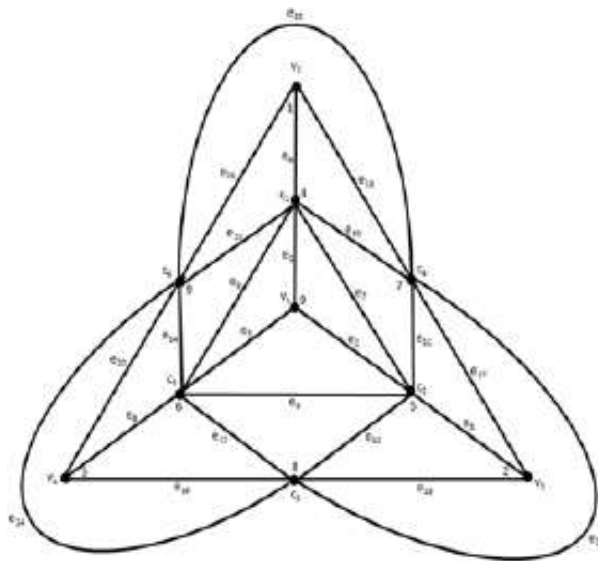


Figure 3: Middle Graph $M(W_{1,3})$

Table 2: Incident Binary Equivalent Decimal Edge Labeling

	0	1	2	3	4	5	6	7	8	9	
e_1	1	0	0	0	1	0	0	0	0	0	544
e_2	1	0	0	0	0	1	0	0	0	0	528
e_3	1	0	0	0	0	0	1	0	0	0	520
e_4	0	1	0	0	1	0	0	0	0	0	288
e_5	0	0	1	0	0	1	0	0	0	0	144
e_6	0	0	0	1	0	0	1	0	0	0	72
e_7	0	0	0	0	1	1	0	0	0	0	48
e_8	0	0	0	0	0	1	1	0	0	0	24
e_9	0	0	0	0	1	0	1	0	0	0	40
e_{10}	0	0	0	0	1	0	0	1	0	0	36
e_{11}	0	0	0	0	0	1	0	1	0	0	20
e_{12}	0	0	0	0	0	1	0	0	1	0	18
e_{13}	0	0	0	0	0	0	1	0	1	0	10
e_{14}	0	0	0	0	0	0	1	0	0	1	9
e_{15}	0	0	0	0	1	0	0	0	0	1	33
e_{16}	0	1	0	0	0	0	0	1	0	0	260
e_{17}	0	0	1	0	0	0	0	1	0	0	132
e_{18}	0	0	1	0	0	0	0	0	1	0	130
e_{19}	0	0	0	1	0	0	0	0	1	0	66
e_{20}	0	0	0	1	0	0	0	0	0	1	65
e_{21}	0	1	0	0	0	0	0	0	0	1	257
e_{22}	0	0	0	0	0	0	0	1	0	1	5
e_{23}	0	0	0	0	0	0	0	1	1	0	6
e_{24}	0	0	0	0	0	0	0	0	1	1	3

Theorem 2.2. For $n \geq 3$, the Middle graph of wheel Graph $M(W_{1,n})$ is IBEDE Graceful labeling graph.

Proof. Let the vertices of $W_{1,n}$ be v_1, v_2, \dots, v_{n+1} . Here v_1 be the center vertex and other vertices v_2, \dots, v_{n+1} be on the rim.

To form the middle graph of $W_{1,n}$, first subdivide each edge exactly once and join all the mid vertices of adjacent edges of $W_{1,n}$.

Now name the middle vertices on the edges v_1v_i of $W_{1,n}$ as c_{i-1} for $i = 2, 3, \dots, (n + 1)$, the

middle vertices on the edges $v_i v_{i+1}$ of $W_{1,n}$ as c_{n-1+i} for $i = 2, 3, \dots, n$ and the middle vertex on $v_{n+1} v_2$ of $W_{1,n}$ as c_{2n} .

So the vertices of $M(W_{1,n})$ is $v_1, v_2, \dots, v_{n+1}, c_1, c_2, \dots, c_{2n}$.

The number of vertices in $M(W_{1,n})$ is $(3n + 1)$.

First label the vertices of $M(W_{1,n})$ as follows:

Here we defined bijective function $f : V(M(W_{1,n})) \rightarrow \{0, 1, 2, \dots, n\}$ such that the vertices are labeled as follows

$$f(v_1) = 0$$

$$f(v_i) = f(v_{i-1}) + 1, \quad i = 2, 3, \dots, (n + 1)$$

$$f(c_1) = f(v_{n+1}) + 1$$

$$f(c_j) = f(c_{j-1}) + 1, \quad \text{for } j = 2, 3, 4, \dots, 2n$$

Induced function is defined as $f^* : E(M(W_{1,n})) \rightarrow \{1, 2, \dots, m\}$

(m is finite and $m \neq n$)

Such that the values obtained from binary equivalent decimal coding of the incident vertices are labeled for corresponding edges or using $f^*(e_k = ij) = 2^{3n-i} + 2^{3n-j}$ where $k = \{1, 2, 3, \dots, \frac{n(n+13)}{2}\}$.

Now the edges are labeled with distinct numbers, so for $n \geq 3$, the Middle graph of wheel Graph $M(W_{1,n})$ is IBEDE Graceful labeled graph. \square

2.2. Strong Incident Binary Equivalent Decimal Edge Graceful Labeling for Wheel Graph and Middle Graph of Wheel Graph

Definition 2.7. A graph G with n vertices is said to be Strong Incident Binary Equivalent Decimal Edge Graceful Labeling (SIBEDE) [7, 1], if the vertices of G are labeled with distinct positive integers from $\{0, 1, 2, \dots, (n - 1)\}$ such that the label induced on the edges by Binary equivalent decimal coding are distinct from the vertex labeling.

Example 2.8.

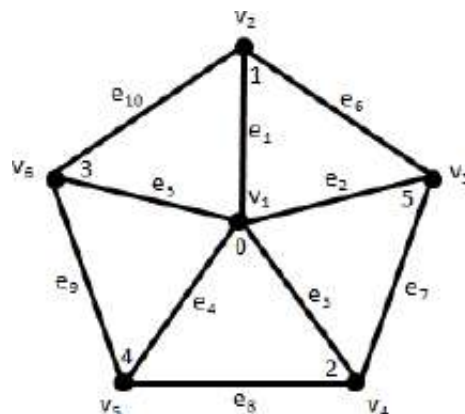


Figure 4: Wheel Graph $W_{1,5}$

Proposition 1. The Wheel graph $W_{1,3}$ is not a SIBEDE graceful labeling graph as the degree of every vertex on the rim is 3.

Theorem 2.3. For $n > 3$, the wheel Graph $W_{1,n}$ is SIBEDE Graceful labeling graph.

Proof. The vertices of $W_{1,n}$ be v_1, v_2, \dots, v_{n+1} and $e_i = (v_1, v_{i+1})$ for $i = 1$ to n $e_{n+i} = (v_{i+1}, v_{i+2})$ for $i = 1$ to $n - 1$, and $e_{2n} = (v_{n+1}, v_2)$ be the edges of $W_{1,n}$.

Here v_1 be the center vertex and other vertices v_2, \dots, v_{n+1} be on the rim.

Table 3: Strong Incident Binary Equivalent Decimal Edge Labeling

	0	1	2	3	4	5	
e_1	1	1	0	0	0	0	48
e_2	1	0	0	0	0	1	33
e_3	1	0	1	0	0	0	40
e_4	1	0	0	0	1	0	34
e_5	1	0	0	1	0	0	36
e_6	0	1	0	0	0	1	17
e_7	0	0	1	0	0	1	9
e_8	0	0	1	0	1	0	10
e_9	0	0	0	1	1	0	6
e_{10}	0	1	0	1	0	0	20

First label the vertices of $W_{1,n}$ as follows:

Define a bijective function $f : V(W_{1,n}) \rightarrow \{0, 1, 2, \dots, n\}$ such that the vertices are labeled as follows

$$f(v_1) = 0$$

$$f(v_i) = \frac{i}{2}, \text{ if } i \text{ is an even}$$

$$f(v_3) = n$$

$$f(v_i) = f(v_{i-2}) - 1, \text{ } i \text{ is odd and } i > 3$$

Now the induced function is defined as $f^* : E(W_{1,n}) \rightarrow \{1, 2, \dots, m\}$ (m is finite and $m \neq n$)

Edges are labeled with the binary equivalent decimal code obtained from the incident vertices.

It is also equivalent to $f^*(e_k = ij) = 2^{n-i} + 2^{n-j}$ where $k = \{1, 2, 3, \dots, 2n\}$ and i, j are finite positive integers labeled for the vertices of edge e_k .

This vertex labeling induces a edge labeling in which both are distinct.

Therefore every Wheel graph $W_{1,n}$ ($n > 3$) is SIBEDE graceful labeled graph. \square

Example 2.9.

Theorem 2.4. For $n \geq 3$, Middle graph of wheel Graph $M(W_{1,n})$ is SIBEDE Graceful labeling graph.

Proof. The vertices of $W_{1,n}$ be v_1, v_2, \dots, v_{n+1} . Here v_1 be the center vertex and other vertices v_2, \dots, v_{n+1} be on the rim.

To form the middle graph of $W_{1,n}$, first subdivide each edge exactly once and join all the mid vertices of adjacent edges of $W_{1,n}$.

Now name the mid vertices on the edges v_1v_i of $W_{1,n}$ as c_{i-1} for $i = 2, 3, \dots, (n+1)$, the middle vertices on the edges v_iv_{i+1} of $W_{1,n}$ as c_{n-1+i} for $i = 2, 3, \dots, n$ and the middle vertex on $v_{n+1}v_2$ of $W_{1,n}$ as c_{2n}

So the vertices of $M(W_{1,n})$ is $v_1, v_2, \dots, v_{n+1}, c_1, c_2, \dots, c_{2n}$ the total number of vertices in $M(W_{1,n})$ is $(3n+1)$.

First label the vertices of $M(W_{1,n})$ as follows:

Define a bijective function $f : V(M(W_{1,n})) \rightarrow \{0, 1, 2, \dots, n\}$ such that the vertices are labeled as follows

$$f(v_1) = 2n$$

$$f(v_i) = f(v_{i-1}) + 1, \text{ } i = 2, 3, \dots, (n+1)$$

$$f(c_j) = j - 1 \text{ for } j = 1, 2, 3, 4, \dots, 2n$$

Now induced function is defined as $f^* : E(M(W_{1,n})) \rightarrow \{1, 2, \dots, m\}$

(m is finite and $m \neq n$)

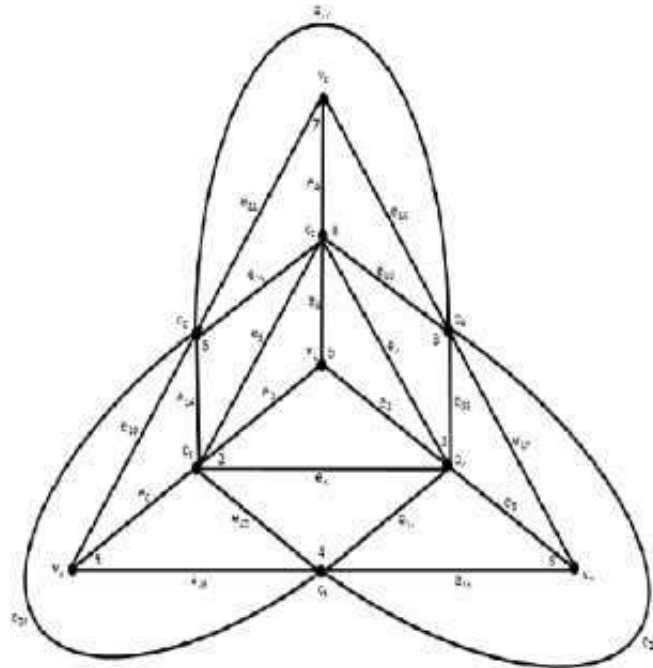


Figure 5: Middle Graph $M(W_{1,3})$

Table 4: Strong Incident Binary Equivalent Decimal Edge Labeling

	0	1	2	3	4	5	6	7	8	9	
e_1	1	0	0	0	0	0	1	0	0	0	520
e_2	0	1	0	0	0	0	1	0	0	0	264
e_3	0	0	1	0	0	0	1	0	0	0	136
e_4	1	0	0	0	0	0	0	1	0	0	516
e_5	0	1	0	0	0	0	0	0	1	0	268
e_6	0	0	1	0	0	0	0	0	0	1	129
e_7	1	1	0	0	0	0	0	0	0	0	768
e_8	0	1	1	0	0	0	0	0	0	0	384
e_9	1	0	1	0	0	0	0	0	0	0	640
e_{10}	1	0	0	1	0	0	0	0	0	0	576
e_{11}	0	1	0	1	0	0	0	0	0	0	320
e_{12}	0	1	0	0	1	0	0	0	0	0	288
e_{13}	0	0	1	0	1	0	0	0	0	0	160
e_{14}	0	0	1	0	0	1	0	0	0	0	144
e_{15}	1	0	0	0	0	1	0	0	0	0	528
e_{16}	0	0	0	1	0	0	0	1	0	0	68
e_{17}	0	0	0	1	0	0	0	0	1	0	66
e_{18}	0	0	0	0	1	0	0	0	1	0	34
e_{19}	0	0	0	0	1	0	0	0	0	1	33
e_{20}	0	0	0	0	0	1	0	0	0	1	17
e_{21}	0	0	0	0	0	1	0	1	0	0	20
e_{22}	0	0	0	1	0	1	0	0	0	0	80
e_{23}	0	0	0	1	1	0	0	0	0	0	96
e_{24}	0	0	0	0	1	1	0	0	0	0	48

Such that the values obtained from binary equivalent decimal coding of the incident vertices are labeled for the corresponding edges or using $f^*(e_k = ij) = 2^{3n-i} + 2^{3n-j}$ where $k = \{1, 2, 3, \dots, \frac{n(n+13)}{2}\}$ and i, j are finite positive integers labeled for the vertices of edge e_k . Here vertex labeling induces an edge labeling in which both are distinct so for $n \geq 3$, $M(W_{1,n})$ is

SIBEDE Graceful labeled graph. □

Observation 1.

- (i) In IBEDE labeling the Ramsey number [8] for $W_{1,5}$ is $r(3, 2) = 3$ which is the minimum value of edge labeling. (Ref Fig. 2).
- (ii) In SIBEDE Labeling the Ramsey number [8] for $W_{1,5}$ is $r(3, 2) = 3$ which is twice the minimum value of edge labeling. (Ref Fig. 4).
- (iii) Total number of vertices in $M(W_{1,n})$ is $(3n + 1)$, here $(n \geq 3)$.
- (iv) Total number of edges in $M(W_{1,n})$ is $\frac{n(n+13)}{2}$, here $(n \geq 3)$.
- (v) In IBEDE labeling and SIBEDE labeling the Ramsey number [8] for $M(W_{1,3})$ is $r(4, 4) = 18$.

3. Conclusion

In this paper wheel graph and middle graph of wheel graph are proved as Incident Binary Equivalent Decimal Edge graceful labeling graph and Strong Incident Binary equivalent decimal edge graceful labeling with examples.

4. Acknowledgement

The authors like to extend their gratefulness to Dr. Ponnammal Natarajan, Former Director - Research, Anna University - Chennai, India and currently an Advisor, (Research and Development), Rajalakshmi Engineering College, Dr. E. Sampath Kumar Acharya & Dr. L. Pushpalatha, University of Mysore, Mysore, for their inventive and productive ideas with respect to outcome of this paper.

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