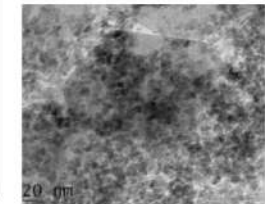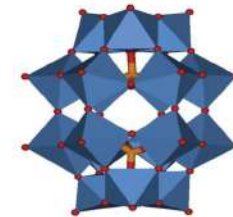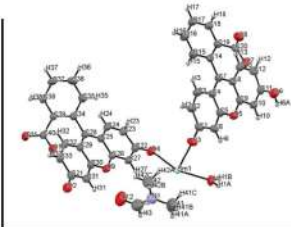# NEW NUMBERS & LETTERS

KURIAKOSE ELIAS COLLEGE
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NEW NUMBERS & LETTERS

$$H_{operator} = \frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2} + V_{(x)}$$

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Editorial Note

As a part of persistent pursuit for academic excellence, Kuriakose Elias College, Mannanam, publishes Volume XII, Issue 1 of the peer reviewed, interdisciplinary research journal, "New Numbers and Letters". This is an attempt to develop foresight and to map possible futures in the frontier areas of science, engineering, education, management and arts. The journal provides a platform for researchers, academicians and students to share their knowledge which cover all disciplines. Our previous editions are widely accepted and this year many prominent academicians have contributed their research endeavors to strengthen the research community. On behalf of the Editorial board, I would like to express my sincere gratitude to all contributors of this issue. We expect the same support and spirit from the academic fraternity for the coming editions.

Dr. Jesty Thomas

Chief Editor

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Impact of Inflation Rate and Exchange Rate on Money Supply in India

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Abstract

Money supply is a significant factor determining the economic growth of the country. It is the total stock of money circulating in the economy. There are different macro-economic variables which create fluctuations on the money supply. This paper makes an attempt to investigate the impact of CPI inflation rate and USD/INR exchange rate on money supply(M3) in Indian economy. This study considers the monthly average of CPI Inflation rate, USD/INR exchange rate and M3 measure of money supply for the past 10 years starting from 2009 to 2019. This study examines both short run and long run relationship. For testing the relationship between the variables, various econometric techniques applied such as: OLS, Johanson Cointegration test, Granger Causality test. Johanson cointegration test result shows that there is cointegration between variables under study and causality test reveals that there is a unidirectional relationship between money supply and inflation rate.

Key Words: CPI Inflation rate, Money supply(M3), USD/INR Exchange rate.

Introduction

Money supply is considered as the total stock of money circulating in the economy at a point of time. Money supply is considered as a key variable to analyse the current economic scenario. It is mainly controlled by the central bank through monetary policy. As per many theories of macroeconomics the increase in money supply will reduce the interest rate and this will accelerate the investment and economic activity. But this increase ultimately leads to an inflationary stage. Because of this reason the central bank will take appropriate action for controlling the money supply in the economy. The main ways for controlling the money supply are printing of more currency, changing of interest rates, setting bank reserve requirements and open market operations. Exchange rates is the rate at which one currency is exchanged for another. Simply it means, price of one currency expressed in the units of another currency. Exchange rate plays an important role in foreign trade and this will bring either a positive or negative result on the economy. Inflation means the situation of rising general price level. We have to pay more money for getting goods & services. Normally a moderate inflation is good for our economy because it boosts the spending habit and borrowing habit among the people since the interest rate is low at that time.

The association between money supply, inflation rate and exchange rate are discussed by the policy makers and economists. This study is an attempt to examine the relation and effect of exchange rate and inflation rate on money supply in India.

Objectives

1. To analyse the impact of exchange rate on money supply in India.

2. To analyse the impact of inflation rate on money supply in India.

Research problem

The fluctuations in the economic condition will affect the money supply of the country. Increase and decrease in money supply create changes in all sectors of the economy. Money supply is mainly controlled by the central bank through monetary policy and is also affected by many other macro-economic variables. Exchange rate and inflation rate are the important macro-economic variables which affect money supply. These three variables are inter-connected to some extent. In many circumstances these three variables are affected by one another that means an increase in money supply will leads to inflation, a hike in the inflation will leads to a decrease in the exchange rate. This paper is an attempt to find out the effect and implication of exchange rate and inflation rate on money supply in India.

Significance of the study

Money supply is very complex variable. The magnitude and velocity of money supply determines the rapidity of any economic activity. For the purpose of formulating better investments strategies and healthier financial policies the governments, banks and other institutional investors the macro-economic variables are taken as important indicators since these variables reflects the current trend in the

economy. Exchange rate has significant consequence on money supply because fluctuations in currency value affect export and import of the economy. This paper analyses the impact of exchange rate and inflation rate on money supply. Result of this study will be useful for the policy makers and economists for making strategic financial policies and also helpful for investors to choose better investment opportunities.

Research methodology

The present study is an Empirical Research and it uses quantitative analysis. Only secondary data's are used in the study. This study focusses on three variables they are Money supply (M3) Inflation and Exchange rate. The data collected from various sources:

- MONEYSUPPLY(M_3)-fortnightly data of every month. www.indiamacroadvisors.com

- Monthly average of CPI inflation- www.inflation.eu

- Indian Rupee/US Dollar monthly basis exchange rate- dea.gov.in

Reference period

The study covers a period of 10 years starting from 1st January 2009 to 31st December 2019. Data for the year 2020 were not considered for this study because the year 2020 is considered as an extraordinary year due to the outbreak of covid-19 pandemic. The impact of Covid-19 was a unique recession where 90% of countries are expected to experience a contraction of GDP per capita and frequent fluctuations in macro-economic variables.

Statistical tests

The present study uses quantitative analysis. Various statistics technique and econometric models were used in, which finds the strength of association and create a mathematical model between Money Supply, exchange rate and inflation rate.

(1) Descriptive statistics: To describe the basic features of data set under study. It provides a brief summary of the variables under study.

(2) Correlation test: To examining the direction and degree of the relationship between the variables.

(3) Unit Root test: To find out the stationarity of the time series. Stationarity is one of the necessary conditions for doing many of the statistical tests. In our study we employed Augmented Dickey Fuller test for checking the stationarity of the time series.

(4) Old Least Square Test: OLS is a type of linear least square method, which is used for estimating the value of dependent variables using the value of independent variables. In our study linear regression model is developed by taking inflation and exchange rate as the independent variable and money supply (M3) as dependent variable.

(5) Johanson Cointegration test: cointegration test is applied for analysing the long-term relationship between the variables under study. Johanson test are normally using where all the variables are integrated in the same order. Accordingly, unit

root test should be performed before applying Johanson cointegration test. The null hypothesis is under trace test is that no. of cointegration vectors is r=r*<k and the alternative is r=k. the null hypothesis for maximum eigen value is same as the trace test but the alternative hypothesis is r=r*+1.

(6) Granger Causality Test: Granger causality test is used for analysing whether one time series is suitable forecasting other time series. In our study pair wise granger causality test is employed for testing the impact of one variable on each other. The null hypothesis of the granger causality is x(t) doesn't granger cause y(t).

Hypothesis

H$_o$: There is no significant relationship between inflation and MONEY SUPPLY (M$_3$).

H$_o$: There is no significant relationship between exchange rate and MONEY SUPPLY (M$_3$)

Literature Review

Beheral in 2016 conduct a study to investigate dynamics of inflation, GDP, exchange rate and money supply in India for the period 1975 to 2012 in a multivariate autoregressive framework. The major findings of the study were that there is a long-run equilibrium relationship exist between these variables. The result also shows that exchange rate Granger causes both GDP and money supply at 10 percent level of significance.

Ifionu, Ebele and Akinpelumi, Omotayo F (2015) examined the impact of selected macro-economic variables on money supply(M2). The selected macro-economic variables are GDP, Exchange rate and Inflation rate. Various econometric techniques like O.L.S, causality test and co-integration test were used for testing the long-run and short run relationship between the selected variables and its causality. Findings of the study shows that money supply has a positive relationship with all the selected macro- economic variables except inflation.

Fitsum Sharew Denbel Yilkal Wassie Ayen and Teshome Adugna Regasa (2016) studied the relationship between inflation, money supply and economic growth in Ethiopia. They employed Johansen cointegration test and VECM to find the causality between inflation, money supply and economic growth. The major findings of the study are inflation is negatively and significantly affected by economic growth in Ethiopia. Based on this result monetary policy should be planned to retain price stability by regulating money supply in the economy.

Victoria Said Ayubu (2013) conducted a study titled as Monetary Policy and Inflation Dynamics: An empirical case study of Tanzanian economy. The study aimed at examining the impact of monetary policy on inflation in Tanzanian economy. For analysing the impact on inflation, they compared monetary policy effect with the effect of other determinants of inflation. The analysis was made using the economic metric models like Structural Vector auto-regression (SVAR) and the other is Vector Error correction model (VECM). The major findings of

the study revealed that all the selected variables have a vital implication on inflation. Among these variables the money supply is found to be the variables with smallest share.

Analysis and Interpretations

Table 4.1

Descriptive Statistics

	Money supply (M3)	Exchange rate USD/INR	CPI inflation rate
Mean	12.81515152	59.1636	0.64152
Standard Error	0.319604784	0.79864	0.07208
Median	12.4	61.9739	0.605
Mode	10.4	#N/A	0
Standard Deviation	3.671979412	9.17573	0.8281
Sample Variance	13.4834328	84.194	0.68575
Kurtosis	-0.322589588	-1.0861	4.30169
Skewness	0.383780269	-0.1907	0.8687
Range	16.1	39.265	6.23
Minimum	5.6	44.37	-1.65
Maximum	21.7	83.635	4.58
Sum	1691.6	7809.6	84.68
Count	132	132	132
Confidence Level (95.0%)	0.632254493	1.57991	0.14259

The descriptive statistics of MONEY SUPPLY (M$_3$), USD/INR exchange rate and CPI Inflation rate for the period 2009 to 2019 is shown in Table 4.1. The Mean or average is most commonly used measure of central tendency. The mean value of dependent variable MONEY SUPPLY (M$_3$) is 12.81515152. and the mean value of exchange rate and inflation rate are 59.1636, 0.64152 respectively. Median and mean are measure of positional average. Median is the middle item of a distribution and its value is 12.4 in case of money supply and 61.9739 for exchange rate and 0.605 for inflation variable.

Standard Deviation of the variable measures the variability of each value of a distribution from its mean value; higher variability means the greater is the standard deviation. The Skewness represents asymmetry, means lack of symmetry. A symmetrical or normal distribution will have a skewness of zero. **Positive Skewness** means when the tail on the right side of the distribution is lengthier. **Negative Skewness** is the tail of the left side of the distribution is longer. Both MONEY SUPPLY (M$_3$) and inflation are positively skewed and exchange Rate is negatively skewed one. The descriptive statistics from Table 4.1 revealed that the M3 distribution and exchange rate distribution are platykurtic since the value of kurtosis in these two distribution less than 3 and the inflation rate is leptokurtic.

Correlation Analysis:

Correlation is a bivariate analysis that measures the strength of association between two variables and the direction of the relationship. In this study Correlation analysis is conducted to know the degree of

relationship of MONEY SUPPLY (M$_3$) with inflation rate and exchange rate.

Table 4.2

Correlation Matrix of Money Supply (M$_3$) with Inflation and Exchange Rate

	Inflation rate	Exchange rate
Money supply	0.256075046	-0.81640642

Source: Computed Data

The correlation is said to be positive correlation if the value of two variable changing in same direction. The correlation is said to be negative correlation when the values of variables change in the opposite direction. The Correlation between money supply and inflation is positive; and the value is 0.256075046 it means that value of MONEY SUPPLY (M$_3$**)** and INFLATION change in the same direction and the correlation between money supply and exchange rate is negative and the value is -0.81640642.

Unit Root Test

In time series data analysis when we are directly applying simple linear regression to find out the relation between the dependent and independent variable it gives spurious results.it means that many of the macro-economic variables are not stationery at level. So, it is important to apply stationery test before doing a detailed analysis. The presence of unit roots of all the variables under study are tested by applying the Augmented Dickey Fuller test. ADF test are used in time series samples.

Table 3

ADF TEST -Results

Variable	Levels	C at Level	C at First Difference	Trend & C at Level	Trend & C 1st Difference	Remarks
Money Supply	**H0: M3 has a unit root.**					At 5% level of significance M3 is stationery at level under trend& intercept and stationery at level under intercept assumption
	Test Statistics	**-2.047776**	**-14.81026**	**-3.547967**	**-14.82811**	
	1% Level	-3.481217	-3.481217	-4.029595	-4.030157	
	5% Level	-2.883753	-2.883753	-3.444487	-3.444756	
	10% Level	-2.578694	-2.578694	-3.147063	-3.147221	
Exchange Rate	**H0: Exchange rate has unit root**					At 5% level of significance exchange rate is stationery at first difference under both intercept and trend& intercept Assumption
	Test Statistics	**-0.934728**	**-17.35044**	**-3.059112**	**-17.28573**	
	1% level	-3.481217	-3.481217	-4.030157	-4.030157	
	5% level	-2.883753	-2.883753	-3.444756	-3.444756	
	10% level	-2.578694	-2.578694	-3.147221	-3.147221	
Inflation	**H0: inflation rate has unit root**					At 5% level of significance the inflation is stationery at level under all assumptions.
	Test Statistics	**-9.201121**	**-8.345404**	**-6.382755**	**-8.516752**	
	1% Level	-3.480818	-3.485586	-4.033108	-4.036310	
	5% Level	-2.883579	-2.885654	-3.446168	-3.447699	
	10% Level	-2.578601	-2.579708	-3.148049	-3.148946	

From the above table 3, it can be infer that money supply and exchange rate are not stationery at levels under the intercept assumption and it becomes stationery at level under trend and intercept concept and

inflation is stationery at level under all assumptions. All the variables are integrated at order (1).

Model Specification

Regression is a statistical technique which is used to determine the linear relationship between two or more variables. Regression is largely used for prediction and casual inference. Regression will help to explain how variation in one variable affects another variable. Here multiple regression technique has been applied to find out the impact of exchange rate and inflation rate on money supply in India. The regression model of the study based on dependant and independent variable is stated as follows:

$$\gamma = \alpha + \beta 1 X1 + \beta 2 X2 + \varepsilon$$

Where,

Y - MONEY SUPPLY (M_3), α = Intercept, $\beta 1$ = Slope of exchange rate (sensitivity of supply of money to exchange rate), $\beta 1$= Slope of inflation rate (sensitivity of supply of money to inflation rate), X1= exchange rate, X2 = inflation rate , ε = error term

Old Least Square Test

 The Old Least Square Method is used for analysing the impact of USD/INR exchange rate and CPI Inflation rate on money supply (M3) in the economy. The table 4 shows the results of OLS test.

Table 4

Regression output

Dependent Variable: D_M3__NA				
Method: Least Squares				
Date: 08/09/20 Time: 16:52				
Sample: 2009M02 2019M12				
Included observations: 131				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D_I__NA	0.063668	0.091386	0.696698	0.4873
D_E_NA	0.005161	0.036802	0.140237	0.8887
C	-0.076423	0.095353	-0.801468	0.4243
R-squared	0.003862	Mean dependent var		-0.075573
Adjusted R-squared	-0.011702	S.D. dependent var		1.082667
S.E. of regression	1.088984	Akaike info criterion		3.031001
Sum squared resid	151.7933	Schwarz criterion		3.096845
Log likelihood	-195.5306	Hannan-Quinn criterion		3.057756
F-statistic	0.248139	Durbin-Watson stat		2.524122
Prob(F-statistic)	0.780626			

The above results show that both CPI inflation rate and exchange rate have a positive impact on money supply. Coefficients value shows that when one unit increase in inflation rate will rise 0.063 unit in money supply and in case of exchange rate increase in money supply of 0.005

unit. The value of R-squared is 0.003 percent it means that this model can predict only 0.003 percent of variance in money supply. Low R square means the model is insignificant. The value of F-Statistics is less than F-prob it indicates that model is statistically insignificant. Durbin-Watson statistic compute the degree of serial correlation in the residuals. As per the general criterion if the DW is greater than 2, it is sign of negative serial correlation. The DW statistic in our output shows that there is s serial correlation in residuals.

Johanson Cointegration Test

Generally Macro economic variables are non-stationery at level. In our study we are taken three macro-economic variables i.e money supply , inflation and exchange rate .sometimes these macro-economic variables doesn't have an association in short run but there may be long run relationship between these variables.

Table 5

VAR Lag Order Selection Criteria – Result

VAR Lag Order Selection Criteria					
Endogenous variables: TOTAL_MONEY_SUPPLY__M3____YOY_ INFLATION_RATE__IN___ EXCHANGE_RATE_INR_USD					
Exogenous variables: C					
Date: 08/14/20 Time: 20:26					
Sample: 2009M01 2019M12					
Included observations: 124					
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-837.7164	NA	155.4481	13.55994	13.62817	13.58766
1	-606.4796	447.5551	4.314205	9.975477	10.24841*	10.08635*
2	-593.7430	24.03523	4.063068*	9.915209*	10.39284	10.10923
3	-591.4370	4.239988	4.529445	10.02318	10.70550	10.30035
4	-586.6398	8.588528	4.853273	10.09096	10.97799	10.45129
5	-580.7557	10.24969	5.113736	10.14122	11.23294	10.58470
6	-577.3836	5.710789	5.616232	10.23199	11.52841	10.75863
7	-563.1977	23.33815*	5.186734	10.14835	11.64947	10.75814
8	-559.6879	5.604377	5.697755	10.23690	11.94272	10.92984
* indicates lag order selected by the criterion					
LR: sequential modified LR test statistic (each test at 5% level)					
FPE: Final prediction error					
AIC: Akaike information criterion					
SC: Schwarz information criterion					
HQ: Hannan-Quinn information criterion					

With a view to analyse the long run relationship of theses variables we employed Johanson cointegration test. Lag selection can affect the result of cointegration test. Lag length is selected by using the VAR (Vector Autoregressive Estimation) estimation. According to Schwarz information criterion and Hannan-Quinn information criterion one lag is appropriate. FPE and AIC criteria suggests two lags. In our study we are taking two lags for testing Johanson cointegration test. The result of the VAR estimation model presented in the table 5

Table 6

Johanson Cointegration Test - Results

Date: 08/14/20 Time: 23:00				
Sample (adjusted): 2009M04 2019M12				
Included observations: 129 after adjustments				
Trend assumption: Linear deterministic trend				
Series: TOTAL_MONEY_SUPPLY__M3____YOY_ INFLATION_RATE__IN___ EXCHANGE_RATE_INR_USD				
Lags interval (in first differences): 1 to 2				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.256883	48.09159	29.79707	0.0002
At most 1	0.066596	9.791306	15.49471	0.2971
At most 2	0.006960	0.901029	3.841465	0.3425
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.256883	38.30029	21.13162	0.0001
At most 1	0.066596	8.890277	14.26460	0.2954
At most 2	0.006960	0.901029	3.841465	0.3425
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

As indicated above the test assumes linear deterministic trend in the value of variables under study. In this test two types of test statistics are reported one is Trace statistics and the other is Max-Eigen statistics. H0 in the first case (None) rejected as the p value is less than 0.05, that means there is cointegration between the variables.

In second case (at most 1) the H0 accepted (p value>0.05) i.e. all the three variables are cointegrated in long run. It means that there exist one cointegrating equation at 5% level of significance. Under both the criterion we can say that these three variables (money supply, exchange rate and inflation rate) are move together in long run.

Granger Causality test

The cointegration test reveals only the existence of long run relationship between the variables but it doesn't specify the direction of the relationship. Granger Causality test helps to know whether one time series is helpful for predicting another time series. In our study we applied Granger causality test for analysing the structure of the

association between the M3, USD/INR and CPI Inflation rate. Table 4.7 shows the results of Granger Causality test.

Table 7

Granger Causality Test - Results

Pairwise Granger Causality Tests		
Date: 08/15/20 Time: 13:31		
Sample: 2009M01 2019M11		
Lags: 2		
Null Hypothesis:	F-Statistic	Prob.
INFLATION_RATE__IN___ does not Granger Cause TOTAL_MONEY_SUPPLY__M3____YOY_	0.09684	0.9078
TOTAL_MONEY_SUPPLY__M3____YOY_ does not Granger Cause INFLATION_RATE__IN___	3.92372	0.0223
EXCHANGE_RATE_INR_USD does not Granger Cause TOTAL_MONEY_SUPPLY__M3____YOY_	1.38217	0.2549
TOTAL_MONEY_SUPPLY__M3____YOY_ does not Granger Cause EXCHANGE_RATE_INR_USD	2.29945	0.1046
EXCHANGE_RATE_INR_USD does not Granger Cause INFLATION_RATE__IN___	3.20153	0.0441
INFLATION_RATE__IN___ does not Granger Cause EXCHANGE_RATE_INR_USD	0.90420	0.4075

As stated in the above result Lag length selected for conducting the granger causality is 2. If the probability value is less than the level of significance, we reject the null hypothesis. Here all the p values are

greater than 0.05 (5% level of significance) except in case of H0: money supply does not granger cause inflation rate, where the p value is less than 0.05 so we accept null hypothesis that means there is a unidirectional causality running from Money supply to inflation rate.

Summary of Findings

- There is a high positive correlation between MONEY SUPPLY (M3) and INFLATION, which means the variables move in same direction and its value is 0.256075046.

- Correlation between MONEY SUPPLY (M3) and EXCHANGE RATE is negative which means variables move in opposite direction and its value is-0.81640642.

- USD/INR exchange rate and money supply(M3) are non-stationery at level and CPI Inflation is stationery at level.

- The Johanson cointegration test shows that variables are cointegrated in the long run.

- There is a unidirectional causation between the money supply and inflation rate.

Conclusion

Money supply is one of the important measure of economic activity. The amount of currency in circulation is affected by various factors. The study made an effort to examining the impact of inflation rate and exchange rate on money supply in India. Various statistical tools used for analysing the relationship between the variables and the result revealed that there exists a long run association between these

variables. By applying Granger causality test we find that there exists a unidirectional causality among money supply and CPI inflation rate. The result therefore confirms to the possibility that these variables are move together in long run.

Recommendation

☐ Money supply is affected by many other factors, so we should consider the aggregate influence of other such factors for getting a better result.

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Gold Jewellery Market in Kerala and Marketing Strategies

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Abstract

As per Indian culture, gold is a symbol of health, wealth and prosperity. Jewelry has not only traditional and aesthetic value, but is also considered as a source of financial security. The study tends to understand the influence of various marketing strategies on consumers of gold ornaments in Kerala. Various marketing strategies are followed by jewelers to boost the sales of gold in Kerala. It includes product related, price related, place related, promotional and people-oriented strategies. There is no significant difference between the marketing strategies of gold jewelers of Kerala based on the consumer's interest in purchasing gold jewellery. There is no significant difference between involvement of consumers in gold ornament purchasing plans based on educational qualification.

Keywords: Gold, Jewelry, marketing, Quality, BIS Hallmarking, quality analyzer etc.

Introduction

The art of adornment is old as life on earth, and this fascination is incomplete without the most precious, expensive, glittering metal-Gold. Symbolizing prosperity, gold has occupied a special position in the common lives of Indian people. The historical significance of Indian jewellery takes us back to around 5000 years ago. The charm of Indian jewelry and the beauty of Indian women by adoring it were never separated. It is rarely found a woman in India who is not loved to decorate herself with charming gold jewelry. In India, jewelry is also considered as a source of security in times of financial crisis. The amount of jewelry owned by a woman also signifies her status. Jewelry has covered its journey since the beginning as an evolving art form. The beauty of Indian jewelry lies in the uniqueness of its design and the efforts of the workmanship involved in creating the intricate designs. Gold is the most precious and invaluable metal ever discovered by man. It is to be stressed that no other earthly material has so fascinated his/her imagination.

Statement of Problem

The relationship between a Keralite and gold starts right from the very infancy. The age-old custom of feeding a new born with a drop of honey mixed with a speck of grated gold has not yet died out totally from Kerala. Kerala women purchase gold ornaments not only for wearing them during social functions and festivals but also for the purpose of using them on a regular basis and also as savings. It is axiomatic that Keralites, especially women, have an almost morbid obsession with the yellow metal. To understand the influence of these

marketing strategies on consumers of gold ornaments in Kerala, the researcher has made an attempt to give a detailed presentation of the existing marketing strategies employed by the jewelry retailers in the gold ornament market of Kerala.

Significance of the Study

The significance of jewelry in the life of women in India is evident from the jewelry gifts they receive from their own birth to the birth of their babies. Some ornaments like mangal sutra, nose ring and toe ring are considered to be integral parts of the makeup of a married Indian woman. Since ancient times, the tradition of gifting jewelry items has continued. The only difference is in the designs of the contemporary jewelry which has become modern in design to cater to the needs of the twenty first century women. Jewelry presented as gift to Indian women at the time of marriage is called 'stridhan' which refers to the wealth of women. Whether in traditional or contemporary designs, gold has always been the most widely used metal for creating ornaments. In the past few decades, the fashion of gold jewelry ornaments being studded with diamonds and other precious stones has gained a lot of popularity. Both traditional and modern jewelry shops are available to cater to the needs of the people according to their requirement for various occasions. The usage of jewelry is not only limited to highly affluent classes, but it is also adorned by low-income groups for whom ornaments made of semi-precious stones are readily available at affordable rates.

Gold jewelry market in Kerala is significant. The latest trends are all the rage at Kottayam, Ernakulum and Alappuzha. People from

Thiruvananthapuram are also crazy for new designs. However, they are penny – pinchers. People of Calicut and Kannur purchase gold as an investment rather than as a matter of snobbery. Jewelry retailers are using their own unique suitable marketing strategies, operating structures and systems for acquiring new consumers and retaining the existing ones. Jewelers try out many marketing strategies to boost their sales. These strategies are product related, price related, place related, promotional and people-oriented strategies.

Review of Literature

Kalimuthu .M. and Madhu Shree (2021) The importance of this study is to examine the consumer level of buying behaviour towards Gold Jewellery in Coimbatore city. The data has been collected by survey methods through questionnaire with 120 respondents. Tools used in this project were simple percentage analysis and Likert scale analysis. On the basis of the study, it is found that customers are .willing to buy gold Ornaments. Most of the consumers are interested in Gold Loan. The only thing the consumer expects is its discount on schemes. These are some findings of the study. Thus, the study concluded that consumers are satisfied with the buying behaviour of Gold Jewellery.

Kiran Babu Raj T and Arun C (2018) The Gems and Jewellery sector plays a significant role in the Indian economy contributing around 6-7 per cent of the country's GDP. The sector is witnessing changes in consumer preferences due to adoption of western lifestyle. Consumers are demanding new designs and varieties in jewellery, and branded jewellers are able to fulfil their demands better than the local

unorganized players. The retail jewellery business in India is largely segmented into organized and family-owned jewellery businesses. The family-owned jewellery businesses inherit major share of the market include the small and medium family run standalone and multi store jewellery shops. Established brands form the organized market and they are growing day by day. Increasing penetration of organized players provides variety in terms of products and designs. The study focuses on strategies followed by gold retail MSMEs in Kerala.

Dr. K. Chitra Chellam (2018) Indian jewellery is unique in its workmanship, quality and design. The art of making beautiful ornaments has been developed throughout India since historical times. Jewellery is made for almost all the parts of the body and it is also designed to match with our attire.   Indian jewellery inspires passion unlike any other object of desire. Every woman in India loves to wear at least a small piece of gold jewellery either in the form of glittering neckwear ornament, or dangling earrings or exquisitely crafted bangles. Indian men also wear gold ornaments like bracelets, rings and chains. Everyone in our country has been moved by the beauty of gold has become a part of our culture and tradition.

Mary Honey O J (2013) tries to find out how the various incentives introduced could encourage the people to invest in gold and also measure the awareness level of investment in gold. In addition, the researcher gives attention to uniqueness in consumer behavior towards selection and choosing of ornamental gold. The finding revealed that the demand for gold by the buyers is because of their strong belief that gold is best investment option, especially in Cochin and Delhi. The

study makes it clear that gold price is sensitive at low prices but it is insensitive when price increases, especially in Kerala.

Bhavani and Jebanesen (2007), pointed out that companies could strive only if they could get, retain and add more customers by delivering appropriate products and service. They should be capable of creating unbreakable lifetime relationship with customers. Therefore, the companies are to be sensitive to the acquisition of the feedback on satisfaction level and the potential of future expectations.

Sasikanth Prabhu (2006) suggested that an effective strategy was the unique formula for success that forms the foundation of a business plan as well as governing day to day operations. He stressed that strategy is all about long term goals, resource allocation utilization and about actions to achieve the goals. He also added that the relationship between strategy and time is obvious.

Ndubisi, Oly, Nelson and Moi, Tung, Chiew (2005) in their study evaluated the impact of sales promotional tools, namely coupon, price discount, free sample, bonus pack, and in-store display, on product trial and repurchase behavior of consumers. The moderation role of fear of losing face on the relationship between the sales promotional tools and product trial was also examined. The results of study show that price discounts, free samples, bonus packs, and in-store display are associated with product trial. Coupon does not have any significant effect on product trial.

Keller, (2003) in order to create brand loyalty, consumers experience with the product must, at least, meet, if not actually exceed, their

expectations. Customer satisfaction is determined by exceeding customer's expectations.

Stephen S. Bell and Gregory S Carpenter (1992), pointed out that two brands in the same market may use different decision rules for selecting their objectives, have different objectives as a result, and thus compete in a fundamentally different way. The optimal multiple-objective defensive advertising differs qualitatively. Furthermore, their analysis shows that the process of formulating defensive marketing strategy differs according to the objectives sought.

Objectives of the Study

1. To analyze the significance and scope of gold jewelry market in Kerala.

2. To identify the marketing strategies used by gold jewelers in Kerala.

3. To test the relationship between the marketing strategies of gold jewelers of Kerala based on the consumer's interest.

4. To test the relationship between involvement of consumers in gold ornament purchasing plans and their educational qualifications.

Research Methodology

The study is conducted to know the impact of marketing strategies used by gold jewelers in Kerala. This section dwells at length on the methodology used for the study. The primary data is used for the present study. Questionnaire was the tool used to collect pertinent data from the selected sample respondents. For this purpose, a structured

questionnaire was framed. The data collected using questionnaire is tabulated on different basis. The sample size used for the study is 100. For collecting the first-hand information from respondents, respondents were chosen by convenience sampling method. Data collected was presented using tables and analysis of data was done by using SPSS 20. One way ANOVA test, and t test were used for testing the hypothesis. Secondary data was used for gaining knowledge about gold jewelry market. For this, journals and articles on the topic were reviewed and online websites were used.

Hypotheses

1. There is no significant difference between the marketing strategies of gold jewelers of Kerala based on the consumer's interest in purchasing gold jewellery.

2. There is no significant difference between involvement of consumers in gold ornament purchasing plans based on educational qualification.

Testing of Hypotheses

1. Influence of marketing strategies based on consumers interest in purchasing gold ornaments.

The influence of marketing strategies based on consumer's interest in purchasing gold ornaments is computed, and its mean score and standard deviation are given below.

Table 1

Influence of marketing strategies based on the consumers interest in purchasing gold

Interest in purchase	N	Mean	Std. Deviation
No	10	3.5571	.27314
Yes	90	4.0397	.44357

Source: Primary Data

As per the analysis it is very clear that the mean value of the influence of marketing strategies on consumers having interest in purchasing is more than that of consumers having no interest in purchasing gold ornaments. The mean value of influence of marketing strategies in case of consumers having interest is 3.55 with a standard deviation of .27314, whereas in case of consumers having no interest the mean value is 4.03 with a standard deviation of .44357.

Ho: There is no significant difference in the influence of marketing strategies based on the consumer's interest in purchasing gold ornaments.

H_1: There is significant difference in the influence of marketing strategies based on the consumer's interest in purchasing gold ornaments.

T test at 5 percent level of significance was used to test the null hypothesis. The details are given below in the following table

Table 2

T test - Influence of marketing strategies based on the consumers interest in purchasing gold ornaments.

Influence of strategies based on interest	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	3.78	.055	-3.36	98	.001
Equal variances not assumed			-4.91	14.918	.000

Source: Primary Data

The value of test statistic t -3.36 and its corresponding significance value .055 make it clear that there is no significant difference between influences of marketing strategies based on consumer's interest in purchasing gold ornaments.

2. Involvement in the gold ornament purchasing plans based on the educational qualification

The involvement in the gold ornament purchasing plans based on the educational qualification is computed, and its mean score and standard deviation are given below.

Table 3

Average scores based on educational qualification

Involvement in gold purchasing plans	N	Mean	Std. Deviation
up to Matriculation	11	.5455	.52223
secondary to graduation	46	.5870	.49782
post-graduation	24	.6250	.49454
professional degree	19	.5263	.51299
Total	100	.5800	.49604

Source: Primary Data

Analysis shows that the consumers involvement in the gold ornament purchasing plans differs based on the educational qualification. The average score post-graduation is more (.6250). But the variability is highest in case of those having qualification up to matriculation (.52223) when compared with others. At the same time variability in case of post-graduation is lesser (.49454) when compared with others. But it is not possible to say whether the difference in the educational qualification will result in a significant difference in the consumer's involvement in the gold ornament purchasing plans. So, the following hypothesis s proposed for testing.

One way ANOVA was executed to analyze whether there is any significant difference in the involvement of consumers in the gold ornament purchasing plans based on their educational qualification. The details are furnished below.

Ho: There is no significant difference between the involvements of consumers in the gold ornament purchasing plans based on the educational qualification.

H_1: There is significant difference between the involvements of consumers in the gold ornament purchasing plans based on the educational qualification.

Table 4

One way ANOVA based on educational qualification

Sources of variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.119	3	.040	.157	.925
Within Groups	24.241	96	.253		
Total	24.360	99			

Source: Primary Data

The above table presents the test results of the hypothesis. The significance value is greater than .05 (.925). Therefore, the difference in the involvement of purchasing plans based on educational qualification is not significant.

FINDINGS

1. The jewelry market in Kerala is significant and jewelers use various marketing strategies to boost their sales.

2. There is no significant difference between influences of marketing strategies based on consumer's interest in purchasing gold ornaments.

3. There is no significant difference between the involvements of consumers in the gold ornament purchasing plans based on the educational qualification.

SUGGESTIONS AND CONCLUSIONS

The love for jewelry in India can be judged from the presence of jewelry shops with plethora of designs in every city of India. People of the country consider gold as a symbol of health, wealth and prosperity. While looking at the case of Kerala, gold is significant both as a status symbol and also as a tool for permanent savings. Jewelers use various strategies to effect customer decisions and influence their buying. These strategies should focus on bringing unique designs for matching individual needs. Rather than choosing from the available designs, customers need jewelry that matches their individual desires. Government should closely watch the gold market, as the increasing crimes and fraud in the market is increasing day by day. As the general public cannot test purity on their own, standard authorities in our country must act effectively on maintaining the purity of the metal.

Kerala women are highly obsessed towards the yellow metal. They purchase gold ornaments not only for wearing on special occasions, but also for the purpose of using them on a regular basis and also as savings. Marketing strategies have influenced the buying intensions of customers, but it is evident that gold market sustains even without any marketing strategies.

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Family Businesses (FBs) and Non Family businesses (NFBs): A Conceptual Comparison

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Abstract

Although researchers devoted much academic attention on the question as to whether family businesses are significantly different from non-family businesses, studies focused on this topic produced contradictory results. Although it has been long asserted that family businesses hold advantages over non- family businesses, to date, there have been very few studies conducted as to exactly what and why family businesses different from nonfamily businesses. This article tries to understand the basic differences and unique dynamics attributed to family businesses that determine differences in their growth and performance based on a literature survey. Based on the available literatures, this study introduces a new concept, the family point of view, and provides theoretical arguments resulting in the following hypotheses: Specifically, this article suggests that family businesses with high levels of family capital possibly do hold a sustained competitive advantage over family businesses with low levels of family capital and/or nonfamily businesses. The study not only highlights the importance of moral infrastructure in family firms but also helps clarify components of family social capital.

Keywords: Family Business, Non-Family Business

Introduction

The growing body of family business literature has begun to explain how family businesses are different from their non-family counterparts. (Sultan, de Waal, & Goedegebuure, 2017) found that the main difference between a family business and other types of businesses is that the former needs to deal with two, sometimes conflicting, reference systems: the family (the emotional) and the company (the professional) system.

Prior studies clearly indicate that differences between FBs and nonfamily businesses (NFBs) may exist because of their corporate environment (Smith, 2018). (Nordqvist, 2005) found that, may be more than the concept of family control, the concept of family involvement explains the differences of family businesses from non-family businesses. While considering the influence of family involvement, (Sirmon, Arregle, Hitt, and Webb, 2008) are of the view that family involvement avoids negative outcomes resulting from strong family control and leads to unique and valuable resources, such as asymmetric information held by family managers, lower agency costs and patient and survivability capital (Sirmon & Hitt, 2003; Sirmon David et al., 2008).

Family business members may have to play several roles simultaneously, causing role ambiguity and inter-role conflict. There is often an overlap between ownership, the board and top management because the same people from the family are present in all three forums (Mustakallio, 2002) which is unusual in other types of organizations where separation of roles is the norm. Besides differentiating between

definitions that focus on components of family business, the present study contributes to the existing literature by analyzing the various aspects of family and non-family businesses such as governance, ownership, management, and transgenerational succession, and those focused on what is a family business, including, firm behavior, the intent of the family to keep control and the idiosyncratic resources that arise from family involvement in order to compare both. These aspects are explored in detail in the study. Regardless of the efforts made, no set of distinct variables separating family and non-family businesses have yet been uncovered.

Governance & Strategic Management

The main dissimilarity between family and non-family businesses is that family business owners are also managers, while in non-family business, the owners can be family members but managers cannot (Avrichir, Meneses, & dos Santos, 2016). In a family business, managers decide on, among others,the strategic decisions including the organisation and distribution of organisation's resources and a manager (CEO) will not tolerate 'altruism' in non-family business(Singla et al., 2014).

In the case of nonfamily firms ownership is dispersed and non kinship based, whereas in family firms ownership is concentrated and kinship based (Achmad et al., 2009), and there is no wedge between cash flow and ownership rights in the case of nonfamily firms while in family firms, there is wedge between cash flow and ownership rights (Morck et al., 2005). (Andres, 2008) shows that family firms are non-diversified while nonfamily firms are well diversified. With regard to governance in nonfamily firms, there is split between ownership and

control while ownership and control united in the case of family firms (Sirmon et al., 2008). (Parada et al., 2010) found that there are external influences on board in the case of nonfamily firms whereas there is internal dominance of board in the case of family firms. Nonfamily firms display transparency and disclosure, while opaqueness and secrecy is seen in the case of family firms (Gedajlovic et al., 2004). Chrisman et al. (2010) is of the opinion that returns are economically defined to a greater extent in the case of nonfamily firms, whereas family firms consider noneconomic outcomes as more important. (Anderson and Reeb , 2003a) report that private benefits are accrued for family firms whereas no private benefits are accrued in the case of nonfamily firms. (Martínez et al., 2007) found that minority shareholders are protected in the case of non-family firms while minority shareholders are exploited in the case of family firms.

(Ingram and Lifschitz, 2006) found that non-family firms form external ties based on business whereas in family firms, networks are embedded in kinship. (Greenhalgh,1994) show that management of a nonfamily firm is achieved through delegation to professionals, but in the case of nonfamily firms, autocratic style is followed in family firms. The nature of management in a nonfamily firm is rational as well as analytical, whereas it is emotional and intuitive in family firms (Zellweger and Astrachan, 2008). Management is formalized, commanding and controlling in the case of nonfamily firms whereas it is organic, resort to mutual accommodation in the case of family firms (Zhang and Ma, 2009). (Astrachan, 2010) & (Warsini and Rossieta, 2013) stated that family businesses are more oriented to reputation and long-term sustainability and do not merely fulfill financial goals, so

that the business strategy of a family company is different from the business strategy followed by non-family companies.

(Menéndez-Requejo, 2005) found that eventhough family firms usually have more flexible strategies, still the decision process is very concentrated in the family nucleus because the effect of the decisions greatly and directly influences family-owners which ultimately affect the concentration of wealth in the family firm. The family firm geneally resist management professionalisation, because they intent to maintain their independence and the control of decisions. Indeed, the drivers and long-term orientations are to be more prevalent among FBs and entirely absent in non-FBs.(Le Breton-Miller & Miller, 2006).

Family businesses tend to place more importance on market orientation and neglect the R& D function(Moores & Mula,1998; Romano et al.,1999). Family businesses are more satisfied with the majority of business issues rather than their non-family counterparts (Zahra etal.,2004; Heck and Kay,2004) and tend to express a higher level of satisfaction with business issues such as employee satisfaction, market orientation and customer care, autonomy,control over the future and care for family members while non family businesses pay more consideration to profits, revenue, market share, exploitation of other business opportunities etc.(Vadnjal, 2008).

(Schwerzler, 2014) suggest that successful family businesses tend to have the family values and culture that are deeply embedded into their business policies, strategies and practices and that their employees do act accordingly. (Chami, 2005) found trust as important factor in successful family businesses, which distinguishes them from other

non-family businesses. (Davis, 1983) is of the opinion that the level of trust and altruism, commitment, long-range planning, and love for the firm distinguishes successful family firms from other non-family business firms. And while dealing with a moral hazard problem, the way family businesses react to it, is fundamentally different from the way non-family businesses and other families react to it.

Entrpreneurial orientation

Usually family firms may be more conservative and risk averse in taking entrepreneurial activities (Zahra, 2005) and in making business decisions than are non-family firms (e.g., Basu, Dimitrova, & Paeglis, 2009; McConaughy, Mathews, & Fialko, 2001). A higher degree of risk-aversion may be due to the concentration of personal wealth (Menéndez-Requejo, 2005).Thus, while family business tends to preserve family habits, traditions, and they are more risk-adverse and control freaks, non-family businesses are growth oriented, more opportunistic, and not risk-adverse. While comparing with non-family businesses, family businesses are less likely to take an anticipated risk because of their 'survival thinking'.

Internationalisation

(Abdellatif, Amann, & Jaussaud, 2010) found that family businesses establish fewer joint ventures than non-family businesses, and prefer more to remain independent when compared with non-family businesses. Secondly, contrary to a priori expectations, the expatriation policies do not differ significantly between family businesses and non-family businesses. Also differences in the strategic behavior of family

businesses and non-family businesses do not appear in every aspect of the internationalization process.

Socio economic orientation

(Hiebl, 2013) is of the view that, family businesses cannot be neglected in its continuous contribution to society's development. eventhough, family businesses tend to keep anonymous by keeping a low profile in the society, from the socio-economic perspective.Family businesses are considered as job creators that develop the society's welfare (Hacker and Dowling, 2012; Welsh et al., 2013; Ramadani, 2015; Ramadani and Hoy, 2015). (Esparza Aguilar, 2019) show that family MSMEs develop CSR practices mainly on societal and environmental dimensions to a higher extent than non-family ones, which is consistent with results of other studies which states that CSR practices are developed to a greater extent by family businesses than those that are not family owned (Graafland, 2002; Jo and Harjoto, 2011; Bingham et al., 2011; Cabeza García et al., 2014. (Muntean, 2009) show that non family firms engage in social responsibility endeavors impersonally while it is personalized in the case of family firms.

Financing & Resources Mobilization

Family businesses tend to rely on internal financial resources as sources of capital and are reluctant to use other sources of capital (Romano et al., 2001; Graves and Thomas, 2008; Vadnjal and Glas, 2008; Mandl, 2008). This highlights the aversion of FBs to debt. Family businesses lack not only critical resources and capabilities including human capital, financial resources, marketing resources (Graves and Thomas, 2006; Fernandez and Nieto, 2005), and

international experience but also the ability to make appropriate shedding decisions about resources, which may influence negatively their performance (Sirmon and Hitt, 2003) Family businesses, because of their desire to keep family control, may restrict their choice of financial resources (Blanco-Mazagatos, de Quevedo-Puente, & Castrillo, 2007).

Prior research have shown that family businesses perform better and enjoy a more sound financial structure than do non-family businesses (Astrachan & Shanker, 2003; Heck & Stafford, 2001; Sharma, 2004). An important characteristic that a family firm possess is the limits in new equity and debt financial resources, which restricts their capacity for growing and expanding abroad (Menéndez-Requejo, 2005). Similarly (Hutchinson, 1995) also reported that because of their desire to maintain the firm control in the family, which can determine limits for growth and internationalisation, they dislike new capitalist partners, and even avoid strategic alliances with other firms. Some researchers such as (Kotey, 2005) suggest that due to corporate governance issues, such as the lack of accountability and transparency in family businesses, these companies have less access to capital needed for growth and consequently often remain relatively small. Also (Jorrissen *et al*, 2005) found that once demographic differences are controlled for, family businesses face more long term financing problems than non-family businesses (Anderson and Reeb.2003; Zellweger,2006). (Menéndez-Requejo, 2005) report that family firms commonly prefer internal funding and retention of control. The concentration of personal wealth in the firm can determine a higher degree of risk-aversion, in such a way that family firms avoid obtaining new debt (Chittenden et

al., 1996; Wright et al., 1996). Although lower agency cost of debt is associated with family firms, a better access to debt is expected, given that creditors usually associate a lower financial risk with family businesses (Anderson et al., 2003). On the other hand, the family interest in maintaining the ownership and control, and their aversion to risk, can inhibit their desire to obtain debt (Menéndez-Requejo, 2005). On the contrary, (Sultan et al., 2017) show that family businesses consider more that the company's money is the family money, and as a result their investment and expenses strategies are more conservative thereby missing possible economic investment opportunities. This study by (Levie & Lerner, 2009) found that family and nonfamily businesses differ in the capital that they deploy and the way that they deploy it and revealed that opportunism, adverse selection, and niche marginalization are more prevalent among family business owner/managers than non family firms. However, family businesses are similar to nonfamily business in performance outcomes such as size and growth, which may be due to the fact that those weaknesses in financial and human capital choice are offset by strengths in the social capital possessed by family firms.

Employee Managemnt and Engagement

(Harris, Reid, & McAdam, 2004) show that family-owned establishments were much less likely to be engaged with the workforce through a range of consultation and communication approaches and these effects are absent in family-owned establishments. Number of recent researches argue that family firms are those that have better chance to achieve the synergy between strategic orientation and

corporate values due to their specific characteristics and values, such as humility, generosity, perception of trust, value of communication, and other elements that make family businesses differentiated from non-family businesses (Azoury et al., 2013). (Dilovic, Bico, Knezovic, & Palalic, 2018) examined the employee engagement in family and showed no difference between family and non-family businesses with regard to employee engagement and in tune with the findings propsed by (Saks, 2006),which report that managers in family businesses can influence employees to be more engaged by using antecedents of employee engagement such as perceived organisational and supervisor support, job characteristics, distributive and procedural justice, rewards and recognition. (Suhartanto, 2018) found that, due to the typical family firm behaviours, such as dual-roles, self-control, and altruism, that could interfere with formal business procedures and reduce employee perceptions of predictability, justice and transparency, the positive impact of professionalisation and Entrepreneurial Orientation factors on employee engagement is lower in family firms.

(Astrachan and Kolenko, 1994) found that family businesses have lagged behind their non-family counterparts, partly because of their limited organisational capacity in implementing HRM policies and practices and was supported by (R. S. Reid et al., 2006). Also the HRM practices adopted by family firms are different from their non-family counterparts (R. S. Reid et al., 2006). (R. Reid, Morrow, Kelly, & Mccartan, 2002) also suggest that family business practices within HRM are different than their non-family counterparts. (Astrachan and Kolenko, 1994) also noted that the volatility created by the overlap of

three systems; family, business and ownership makes employee selection and compensation difficult in family firms.

Nonfamily firms employ salaried managers, whereas family members are employed in a family firm. And career horizons are shorter term in a nonfamily firms, while longer term career horizons persists in the case of family firms. Leaders are formally educated in nonfamily firms, while family members are trained on the job in the case of family firms (Jorissen et al. (2005). Rewards are given on the basis of performance, achievement and is merit based while in the case of nonfamily firms whereas rewarding is based on ascription and nepotism in the case of family firms (Beehr et al., 1997). While rewarding employees nonfamily firms adopt a universalistic criteria and is based on performance while in the case of family firms, family members need to be rewarded using particularistic criteria and is indulged (Chua et al., 2009) and family firms show superior employee care and loyalty (Ward, 1988), (Neubaum, Dibrell, & Craig, 2012) suggest concern for employees is a potential powerful intangible resource for family firms not held by non-family firms.

Innovation

(Wang and Poutziouris, 2010; Hiebl, 2014) compared family businesses to a non-family businesses, and found that family businesses are less likely to engage in Research & Development, which, leads to weaker innovation and eventually weaker or none of new products and services in these family firms. Consequently,their growth is not evolving, but kept as constant due to business owners' risk-averse nature. (Fiegener,Mark K;Brown,Bonnie M.;Prince,Russ

Alan;File, 1994) also found differences between family and innovation which is contrary to conventional thinking that family firms are less innovative than non-family firms.(Llach & Nordqvist, 2010) found differences between family and non-family firms with regard to the role of human, marketing and social capital for innovation. Nonfamily firms are innovative whereas family firms are rent-seeking, and follows stifling innovation (Morck and Yeung, 2003).

Family Firm dynamics

In general, family businesses can be distinguished by their inward orientation (Cohen & Lindberg, 1974), commitment to family harmony (Trostel & Nichols, 1982), long-term commitment (Danco, 1975), superior employee care and loyalty (Ward,1988), maintenance of integrity (Habbershon & Pistrui, 2002), protecting and perpetuation of the reputation of the family (Sharma & Manikutty, 2005), and longer tenure of leadership (Ward, 1988). In addition, a family firm's increased concern for socio emotional wealth will pressure them to avoid damaging the family's good name and reputation and push the firm to pursue actions which bow to the concerns of external stakeholders (Berrone et al., 2010). Further due to the embeddedness of the family in the business (Aldrich & Cliff, 2003), family businesses are more likely than non- family businesses to behave clan-like (Moores & Mula, 2000). In clans, as opposed to market-based systems and bureaucracies, there is a fraternal relationship in which the members have a tendency to believe that they will be dealt with equitably (Kerr & Slocum, 1987; Ouchi, 1980). In family firms, an emphasis is placed on high trust, low conflict and low resistance to

change (Moorman, 1995), the development of shared organizational understanding and commitment through not centralized, participative, communication processes (Quinn, 1988; Quinn & Rohrbaugh, 1983), and interaction among members (Wilkins & Ouchi, 1983). Family firms are unique in the way they acquire, shed, bundle, evaluate, and leverage their resources and respond to external stakeholders (Sirmon & Hitt, 2003).

Although family businesses are important to most economies, the majority of these firms remains relatively small in size (Bjuggren, Johansson, & Sj¨ogren, 2011; Chang, Chrisman, Chua, & Kellermanns, 2008). Previous literature shows that family businesses tend to be smaller than non-family firms (Casillas et al., 2015). (Maacute rio & Heiko, 2012) confirm that for family businesses entering and being successful in co-operative relationships, loyalty and trust are even more important than for their non-family counterparts which implies that family businesses should invest in 'open' co-operative strategies.

Growth

(Moreno-men, 2021) suggest that older family businesses are more reluctant to grow than younger family businesses and this effect is not present in a non-family business which may be due to a more entrepreneurial behaviour in the family firms' initial life cycle stages. They found that family and non-family businesses, due to the effect of SEW and the different versatility of their resources, show different growth patterns. Family firms grow less than non-family firms in terms of sales but more in terms of employees. (Stenholm, Pukkinen, & Heinonen, 2016) show that family businesses benefit from innovative

orientation, which is both directly and indirectly associated with firm growth via entrepreneurial activity. This type of association does not exist in a nonfamily business. Moreover, risk taking does not influence family business growth even if it does in a non-family business. (Daily & Dollinger, 1992) and (Reynolds, 1995) show that non-family businesses are more likely to pursue aggressive growth oriented strategies than family businesses. Family businesses are less growth oriented than non-family businesses (Ward, 1997).

Performance

Academic research explicitly recognizes the prevalence and better performance of family businesses (FBs) around the world (e.g., Allouche & Amann, 2000; Astrachan & Shanker, 2003; Heck & Stafford, 2001; Sharma, 2004). Most empirical investigations find superior performance by FBs compared with NFBs. (Kurashina, 2003) found that family businesses perform better than non-family businesses as they employ a significant portion of total employees and record significant amounts of turnover, investments, added value and accumulated capital. Of these studies, the majority focus on financial performance (Anderson & Reeb, 2003; Dibrell & Craig, 2006), though others investigate both financial and non- financial (Levie & Lerner, 2009). (Amann & Jaussaud, 2012) found that family businesses achieve stronger resilience both during and after an economic crisis, compared with non-family businesses. They resist the downturn better, recover faster, and continue exhibiting higher performance and stronger financial structures over time.

There is little evidence that family businesses as an organizational type routinely underperform non-family businesses (Miller et al., 2008; Westhead & Howorth, 2006) and are ubiquitous in market economies (Astrachan, Zahra, & Sharma, 2003). In general, studies show that publicly quoted family businesses are more profitable and are likely to grow faster than non-family businesses (Anderson & Reeb, 2003; Kang, 2000; McConaughy, Matthews, & Fialko 2001; Villalonga & Amit, 2006) and also that publicly quoted family businesses may perform even better than non-family businesses if founding family members participate in management (Lee, 2006). (Levie & Lerner, 2009) found no differences in performance but found differences in resource mobilization between family firms and non-family firms.

The study by (Wakefield, Michael W; Castillo, José; Beguin, 2007) failed to find significant differences in subjective performance between family and non-family businesses. Also, (Miller et al., 2008) found no significant difference in subjective past or projected sales growth performance in Canadian small family and single-founder owner-managed B2B businesses. (Lee, 2006) found that businesses that were associated with high levels of family ownership and management were not significantly associated with weaker firm performance.

(Miller et al., 2008) report that family firms survive significantly longer than their nonfamily counterparts. Some studies have found family firms to out-survive their nonfamily counterparts by a factor of two or three (Ward, 2006). (Sirmon, D. G., & Hitt, 2003) identify "five attributes and resources of family firms that provide potential advantages over non-family firms." And the resources include human

capital, patient capital, social capital, and survivability capital. (McConaughy et. al.,1998) show that family firms seem to perform better than non-family firms that are similar in size, managerial ownership and belong to the same industry. He also found that in contrast to nonfamily businesses, family controlled firms are more efficient and valuable. Family businesses exhibit some disadvantages and shortcomings including institutional overlap between family and business norms and principles, low access to financial resources, confusing organization, nepotism, paternalism, altruism, conflicts, financial strain by unproductive family members, and succession problems (Mandl, 2008), which may lead to lower performance in comparison with non-family firms.

Customer Relationship Management

The way consumers perceive and relate to family and non-family business is different. They consider family business better in terms of service, frontline employee benevolence, and problem-solving orientation, and worse in terms of selection and price/value. Results further indicate that higher consumer trust in family business management policies and practices, frontline employee trust, and satisfaction but no differences in loyalty. (Poza, 1995)found that family businesses enjoy a competitive advantage in their ability to respond quickly to customers because of their management structure and size. Family businesses are believed to be more interested in building enduring relationships with suppliers and customers (Palmer & Barber, 2001) Such actions broaden the customer relationship and allow for a 'better knowledge of the client', while the personal, face-

to- face involvement between family members and customers can 'solidify connections, increase mutual understanding and boost loyalty (Miller, Le Breton-Miller, & Scholnick, 2008). (Carrigan & Buckley, 2008) found that family businesses play an important role in the purchase behaviour of consumers even though there is a tendency for the consumers to conflate family businesses with local, small businesses, they perceive them as a unique entity within the business environment.

Conclusion

The present study provides an in-depth investigation of FBs versus NFBs which opens up research avenues for further probing the areas of difference between family and Nonfamily businesses. From the literature review, it is evident that worldwide studies comparing family business and non-family businesses performance have given inconclusive results. Family businesses appear to be more susceptible than nonfamily businesses to adverse selection and opportunism among owner/managers. The fact that we found no performance differences between family and nonfamily businesses does not mean that adverse selection and opportunism are unimportant. Rather, family businesses need to carefully construct control systems that reward reciprocal altruism and punish nonreciprocal altruism, to capitalize on a potentially unique and inimitable resource—their family capital—without being handicapped by the downsides of familiness.

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Occupational Stress & Its Management among Nursing Staffs Working in Various Hospitals in Kottayam Municipality

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Abstract

The modern world is said to be a world of achievements and also a world of stress. The present Era is called the 'Age of anxiety and Stress'. Nurses are one of the foremost health care professionals. Hence, inherently, nursing is a stressful profession. Direct patient care makes this profession extremely stressful. Feeling helpless while watching a patient dying, multiple roles of home and job, unpredictable staffing and scheduling, lack of support from the management and colleagues were some of major stressors among nurses and the present study explored the level of occupational stress & its management among nursing staffs.

Keywords- Occupational stress, Stress management

Introduction

From birth till death, an individual encounters many stressful situations. Stress has been acknowledged as a vexing problem in the healthcare system. Nurses are one of the foremost health care

professionals. Every profession has its own stress, but in this study we focus on the work stress of nursing professionals and their management. Hence, inherently, nursing is a stressful profession. Due to an unhealthy environment, nurses are quitting from this noble profession, which leads to work overload and dissatisfaction for the existing nurses. The Indian health care system is dealing with an alarming nursing shortage, with the nurse-patient ratio out of balance (World Health Organization, 2000). Lack of experience, failing to meet the demands of patients and bystanders, heavy work load, unnecessary political interference, poor working conditions, poor salary, and job insecurity were some of the prominent stressors experienced by nurses in Kerala.

Research Problem

This study focus on addressing different questions related to occupational stress and its management among nursing staffs. The research problem here is to study various causes and kinds of occupational Stress experienced by nurses at work, various strategies followed by nursing staffs to overcome occupational stress, association between socio - demographic characteristics and type of stress experienced by nursing staffs etc…. This study is conducted among nursing professionals in various hospitals in Kottayam municipality.

Objectives

1. To ascertain the various types and result of occupational Stress experienced by nurses at work.

2. To know what are the various strategies adopted to overcome stress.

Methodology

It is both analytical and descriptive study based on both primary and secondary data. Secondary data were collected from various books, journals and internet. The primary data required for the study were collected from selected respondents by using a well-structured questionnaire.

Analysis

Type of stress experienced

Leading part of the respondents were of the view that they experience Physical stress during their work, followed by Thirty five percent with the opinion that they experience psychological stress and rest with the opinion that they experience Behavioural stress during their work. Survey details are given in Table 1

Table No 1

Type of Stress Experienced

Type of Stress	Frequency	Percentage
Behavioral	25	25
Physical	40	40
Psychological	35	35
Total	**100**	**100**

Source: Primary Data

Figure 1

Type of stress experienced

Source: Table 1

Leading part of the respondents (40 percent) were of the view that they experience Physical stress during their work, followed by 35percent with the opinion that they experience psychological stress and rest with the opinion that they experience

Behavioral stress during their work.

Table No 2

Result of occupational Stress

Result of occupational Stress	Frequency	Percentage
Reduce Efficiency	25	25
Increased Rigidity of Thoughts	15	15
Lack of concern for organization and colleagues	55	55
Loss of Responsibility and loyalty to Organization	5	5
Total	**100**	**100**

Source: Primary Data

Figure 2

Result of occupational stress

Source: Table 2

Result of occupational stress

Leading part of the respondents (55 percent) was of the opinion that Occupational stress results in lack of concern for organization and colleagues, Followed by 25 percent of the respondents with the opinion that occupational stress results in reduced efficiency. 15 percent with the opinion that Occupational stress results in increased rigidity of thoughts and rest 5 percent opinioned that occupational stress results in loss of responsibility and loyalty to organization.

Table No 3

Strategies adopted to overcome Stress

Stress Management Strategies	Frequency	Total
I Resort to my Hobbies	15	15
I Identify the Source of Stress and Avoid Unnecessary Stress	25	25
I Manage my Time Better	35	35
I Adjust My Standard and Attitudes	15	15
I Express my Feelings Instead of Bottling them Up	10	10
Total	**100**	**100**

Source: Primary Data

Figure 3

Strategies adopted overcome to overcome stress
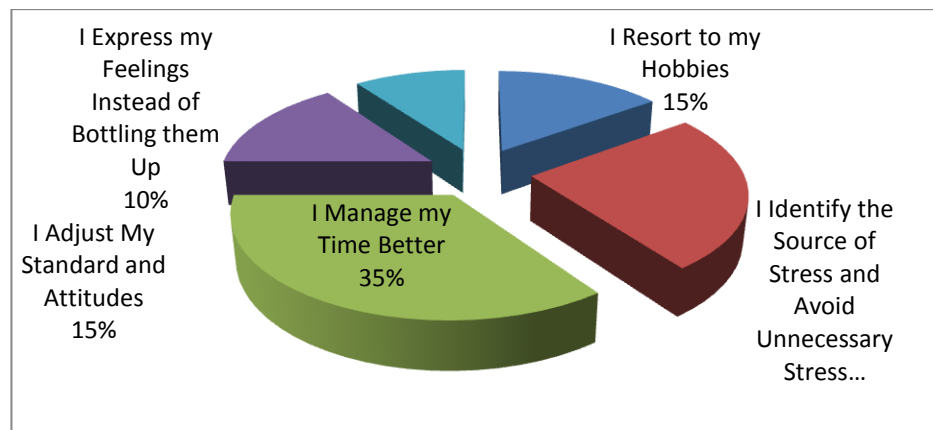
Source: Table 3

Majority of the respondents (35 percent) were of the opinion that they overcome their stress by Managing their time better, followed by 26 percent of the respondents with the opinion that, they identify the

source of stress and avoid unnecessary stress followed by 15 percent each with the opinion that they Resort to their hobbies and also 15 percent adjust their standards and attitudes and 10 percent with the opinion that they express their Feelings instead of bottling them up.

Testing of Hypothesis

Table No 4

Combined Table showing Age wise awareness level about IPPB services

	21 – 40	41 – 50	50 & above	Total
High	24	8	8	40
Moderate	14	8	10	32
Low	10	-	18	28
Total	48	16	36	100

H0: Age of respondents and their level of awareness about IPPB services are independent

H1: Age of respondents and their level of awareness about IPPB services are dependent

Table No. 5

Chi-Square Test

Test	Sig. Level	D.o. F	P value	Statistic value	Decision
Chi square	0.05	2	0.624441	0.9418	Accept H0

The result is not significant at $p < 0.05$. So, the null hypothesis is accepted. i.e. there is no association between age of respondents and their level of awareness about IPPB services.

Findings

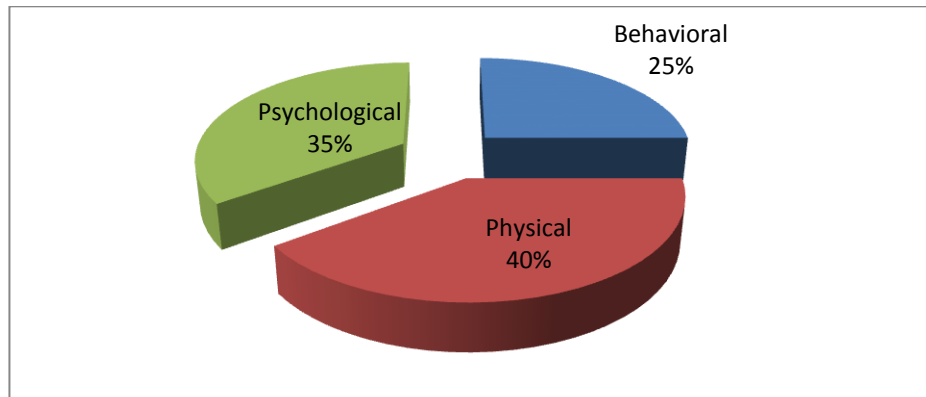- Regarding the type of stress experienced, leading part of the respondents (41 percent) were of the view that they experience Physical stress during their work, followed by Thirty three percent with the opinion that they experience psychological stress and rest with the opinion that they experience Behavioral stress during their work
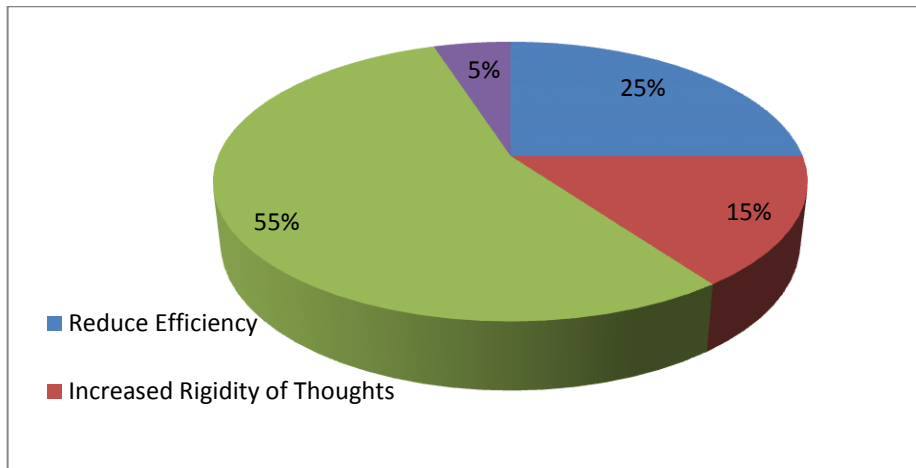
- Leading part of the respondents (55 percent) was of the opinion that Occupational stress results in lack of concern for organization and colleagues

- There is no association between age of respondents and their level of awareness about IPPB services.

Conclusion

Stress and Stress Management can be said as the two sides of the same coin. From this study it is evident that nursing professionals is a group that always experience stress due to various stressors related to their profession such as Poor attitude of doctors, inadequate pay, Posting in busy departments etc… They overcome those stress using various stress management techniques such as Managing their time in a better way, by identifying the stressors and avoiding them, by expressing their feelings without bottling them up etc.

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Co-mingling of the Traditions in Christianity: A Study of the *Acts of Judas Thomas* and *Māṟgamkaḷipāṭṭu*

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Abstract

The paper discusses about the co-mingling of various traditions related with the history of early Christianity. These traditions can be used as the major sources to reconstruct the history of pre-modern Christianity in Kerala. One of the important Christian traditions in Kerala is Margamkalipattu. More or less, this tradition is the local adaptation of the Acts of the Judas Thomas, which is a popular romance written in Syriac language. It is significant to analyse the way how this adaptation happed, what are the similarities and differences of this co-mingling, how this adaptations strengthen the cultural heritage and community feeling of the Syrian Christians in Kerala.

Key words: Christianity, Malabar, *Margamkalipattu, Acts of the Judas Thomas,* tradition

Introduction

The history of Christianity in Kerala is entwined with traditions. The Christian traditions were not only developed from their own cultural and historical background but also drew upon the regional, religious and social contexts of other traditions which existed in different historical periods. So, the more or less adaptation of different traditions

by the Christians occurred during its comingling with different cultures in different periods in and outside Kerala. So, it is important to analyse the historical process of this adaptation. One of the major adaptation and co-mingling of the traditions can be visible in the *Acts of Judas Thomas* and in *Māṟgamkaḷipāṭṭu.*

The analysis of traditions in *Māṟgamkaḷipāṭṭu* and the *Acts of Judas Thomas* is an important exercise to understand how and why adaptations occur within traditions. *Māṟgamkaḷipāṭṭu* was compiled in sixteenth century after the arrival of the Portuguese, but probably, it was transmitted orally from twelfth or thirteenth century, while the *Acts of Judas Thomas* was probably written in fourth century C.E. The historical background of both the traditions is entirely different, but the contents are very much similar.

Acts of Judas Thomas and the Missionary Activities of the Apostle

The earliest account about the missionary activities of St. Thomas is referred to in the *Acts of Judas Thomas*. It was a popular romance, possibly written in Syriac language in the fourth century CE and later translated into Greek, Ethiopian, Latin, and Armenian. The intention behind this work is to provide information about the character of Christian life of that period. The writer of the *Acts* delivers very little evidence about fellowships and Church life. He was concerned with the salvation of Christian life. This work has given major importance to celibacy as a means to salvation and highlights miracles.[1]

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[1]   Harold W Attridge (ed. & trans.), *The Acts of Thomas*, Polebridge Press, 2010; William Logan, *Malabar Manual*, Printed by R. Hill, at the Government Press, Madras, 1887, Reprinted, Vol. I, Asian Educational Services, New Delhi, 1989, p. 200; K.P. Padmanabha Menon, *History of Kerala: Written in the form of*

The *Acts* describes the story of the disciples of the Christ, who were sent to different parts of the world to which they were designated for preaching the Gospel. According to this work, St. Thomas, the apostle, was designated to go to India as his work for preaching the Gospel, but he was doubtful about his assignment. He complained that he could not preach Gospel in India and evangelize the people, because he came from a Jewish background. Jesus himself intervened in this condition and he met Abban (Habban). Abban was a minister of an Indian king Gundaphorus. He was searching for an architect to build a palace for the king. Jesus sold Thomas to Abban, because the apostle was a carpenter and in return Jesus collected a slave price from Abban.[2]

Abban and Thomas went to Andropolis and finally they reached the capital city of Gundaphorus. Thomas was treated well by the king and Gundaphorus wished his new court and palace to be built. Thomas agreed to begin the work and received an advance sum for the materials to build the palace. He spent his payment for preaching and ministering and travelling in the name of Christ. He also distributed the money to the poor. After some days, the ruler desired to see the progress of the work on his palace. He was very angry because Thomas did not keep his word to build the palace. Thomas responded that he built a palace for the ruler not on earth but in heaven. The king threw Thomas and Abban into prison. At the same time the brother of the ruler, Gad died and saw the magnificent palace in heaven built by Thomas for Gundaphorus. The king's brother was allowed to go back

Notes on Visscher's Letters from Malabar, Edited by T.K. Krishna Menon, Vol. II, Asian Educational Services, New Delhi, 2001, p. 453.

2   Samuel Hugh Moffett, *A History of Christianity in Asia: Beginnings to 1500*, Vol. I, Orbis Books, New York, pp. 26-27.

to the palace of Gundaphorus to tell his brother what he had seen. This miracle changed the mind of the ruler and he accepted Christianity. The next chapters of the *Acts* describe a series of miracles performed by Thomas, like dead people rising and animals speaking.[3]

Adaptation of *Acts of Judas Thomas* in the Traditions of Kerala

The Christian traditions in Kerala adapted the story mentioned in the *Acts of Judas Thomas*. The first version of the tradition is contained in a song, which is sung on socio-religious events like marriages, known as the *Tōmma Paṛvam* or *Thoma's Song*. The legend, according to this song, is given below.

> "Thomas, the apostle, left Arabia and reached Maliankara near Kodungallur. He converted some Jews at Tiruvancikuḷam (Kodungallur). The king also became a Christian and was given the name of Andrew, and his nephew, newly named as Keppa, was ordained priest. Thomas later went to the southern part of Malabar and preached the way (*Māṛgam*) for a year in Kollam. He converted fourteen hundred persons there and built a cross for them to worship. Later, he went to Palayur in the northern part where he also erected a cross. Then, Thomas went to the domain of the *Cōḷa* king in the eastern part. The king ordered him to build a palace at Mylapore. From the king, Thomas received the payment in advance to build the palace and distributed it to the poor people. When the ruler asked about the

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[3] Ibid; Leslie Brown, *The Indian Christians of St. Thomas; The Account of the Ancient Syrian Church of Malabar,* Cambridge University Press, Cambridge, 1956, pp. 43-45.

progress of palace building, Thomas said that he already built a glorious palace in heaven. The king was very angry and he put St. Thomas into prison. At the time, the brother of the ruler rose from the dead and told him about the splendid palace built for the *Cōḷa* king by Thomas. The apostle then went to Thiruvithamcore and visited the Churches he had established there. He also preached Gospel in other places and built Churches. Through miracles, he won over seventeen thousand souls; most of them were *nabūtiri brāhmaṇas*. Then, Thomas went to Mylapore. There, he was ordered by *brāhmaṇas* to worship goddess *Kāḷi* in a sacred grove. But Thomas refused to do it and suddenly the grove was consumed by fire and the sculpture of *Kāḷi* disappeared. Because of this incident, the infuriated *brāhmaṇas* stabbed Thomas with a spear and he died. Twenty-seven days after his death, Thomas appeared in front of his disciples and founded a feast of remembrance known as *dukhṟāna*."[4]

The best-known expression of the local adaptation of the *Acts of Judas Thomas* is the *Māṟgamkaḷi Pāttu*. The main content of this traditional Christian song is the same as the *Acts of Judas Thomas*. But *Māṟgamkaḷi Pāttu* is set against the social, political and cultural background of the society of early medieval Kerala. The term

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[4]   *Thoma Parvam*, as cited in, Leslie Brown, *The Indian Christians of St. Thomas,* pp. 49-50.

"māṛgam" which means 'way' in *Māṛgamkaḷi* denotes the Christian religion.[5]

The *Māṛgamkaḷi Pāttu* described the story of St. Thomas like how Jesus sold Thomas to Avan (Habban) to build the palace for the *Cōḷa* king, and so on. The content of the story is as almost the same as in *Tōmma Paṛvam.* The story in the song is as follows;

> "Thomas accepted the work of building the palace for the king and went to take his tools. He received the advance payment and preached the Gospel first in the *Cōḷa* country and then in other parts of the region. He performed many miracles and was in touch with the local ruling houses. Thomas went to Malacca and China to spread the Gospel and the next year he came back to the *Cōḷa* country. Then Thomas heard about Kerala and went there. He arrived at Maliankara and preached the way to the *brāhmaṇas* in Kodungallur. Then the apostle went south and erected crosses at Kollam, Niranam, Kotamangalam, Kottakayal, Cayal, and Palayur. At this time the *Cōḷa* ruler was very excited to see his newly built palace by Thomas. He sent for Thomas and the apostle told him that he built a palace for the king in heaven. The angry ruler put Thomas into prison. At the same time the brother of king died and he saw the palace in heaven which was built by Thomas for the king. The brother came back to the court and told about this to the ruler. Because of this miracle, the king, his brother, Habban and others were baptized. Because of the spread of the faith, the *brāhmaṇas*

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5   Chummar Choondal, *Margamkali* (Malayalam), National Book Stall, 1973, pp. 15-16.

were very jealous. Then the apostle went to Mylapore. There, Thomas refused the order of the *brāhmaṇas* to worship goddess Kāḷi. The grove of Kāḷi was consumed by fire and burned. The *brāhmaṇas* were very angry and they killed Thomas with a pointed stick. The king took the body and buried it in Mylapore."[6]

Conclusion

There are similarities in the story with both the *Acts of Judas Thomas* as well as *Māṛgamkaḷi Pāttu*. Most of the incidents mentioned in the *Acts* were repeated in the *Māṛgamkaḷi Pāttu*. But, one of the main differences is in the background of the story. In the *Acts*, the incidents of the story took place at the court of the *Parthian* king Gundaphorus. The events of the story mentioned in the *Māṛgamkaḷi Pāttu* happened in the court of the *Cōḷa* king. The author of the *Māṛgamkaḷi Pāttu* was well aware of the history and culture of south India. That is why *Māṛgamkaḷi Pāttu* brings in the *brāhmaṇas,* goddess Kāḷi, trade centres like Kodungallur, and the earliest Christian settlements like Mylapore, Kollam, Niranam, Chayal, etc. It might be true that some parts of the *Māṛgamkaḷi Pāttu* prevailed before the arrival of the Portuguese. But this song was compiled during the Portuguese period. In short, *Māṛgamkaḷi Pāttu* is a cultural adaptation of the *Acts of Judas Thomas*.

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[6] Leslie Brown, *The Indian Christians of St. Thomas,* p. 51; Jacob Velliyan, *Keralathile Christava Paramparya Kalakal: Margamkali, Chavittunatakam, Parichamuttukali, Vattakkali* (Malayalam), Kottayam, 2013, pp. 5-7; Chummar Choondal, *Margamkali* (Malayalam), National Book Stall, 1973, pp.15-16.

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A Study on Social Media Marketing and Its Effect on Purchase Decision

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Abstract

Social media marketing act as one of the most significant platform by which a firm can reach millions of people and communicate about their product or service at a mouse click. It is an interactive method of keeping a long term relationship with the consumers, they can comment or message their grievances or doubts about the product or service in a social media platform under the official verified account of the firm which can be resolved immediately. The study mainly focuses on social media advertising, online consumer reviews and concerns faced by consumers in taking a purchase decision. Both primary and secondary data was used for the study. Primary data constitute the main source of information. Population was identified from college students (both graduation and post-graduation) studying within the geographical boundary of kottayam district. Convenience sampling technique was used for collection of data with a sample size of 90.

Keywords: Social media marketing, Purchase decision, social media advertising, online consumer review

Introduction

We live in a world in which everything is interconnected through different communication channels, the current era is witnessing the significance of social media which apart from a platform for interaction it had proven as a medium by which one can speak or

communicate with the world. Social Media plays a major role in connecting people and accelerating relationships. It provides a great opportunity to establish customer service by gathering input, answering questions and listening to their feedback. Today most of us spend a major portion of a day in social media were we get a reflection of the society and helps to understand the pulse of the people social media act as the most powerful tool by which firms can communicate towards the world.

Objectives of the Study

1. To analyze the most significant factors that stimulate purchase decision in a social media advertisement.

2. To study the effect of online consumer reviews in social media on purchase decision.

3. To understand the major concerns faced by the consumers while forming purchase decision on the basis of social media advertisements and reviews.

Significance of the Study

A study about social media marketing is highly significant because many firms and marketers are thinking over on how to get benefit over their competitor by effectively utilizing the social media. Social media marketing helps in improving brand awareness ,more engagement with the customers ,enhancing search result rankings etc. and from the costumers point of view as they are more accessible to the social networks so they can address grievances if any about the product or service as which demands faster solution. The study was based on the various factors that result in forming a purchase decision among the consumers with the proper use of social media marketing.

Review of Literature

(Simona Vinerean, 2013) conducted a study on "effect of social media on online consumer behaviour"the objective of the study is to identify the different types of respondents based on their online activity and develop a linear model for studying the impact upon positve reaction to online advertisement.The study is conducted among 236 students who use social media, from lucian blaga university of sibiu. An online consumer survey had been conducted using convenience sampling method and identified encagers, expressers, informals, networkers, watchers and listners are the segments of respondents based on their online activity. The study suggest that the firms wanted to create a buyer persona and develop an online marketing strategy according to the interest of consumers.

(Ismail, 2016) conducted a research on "The influence of perceived social media marketing activities on brand loyalty the mediation effect of brand and value consciousness" the study investigated the impact of social media marketing activities on brand loyalty brand consciousness and value consciousness.346 under graduate students are taken as sample using convenience sampling method. The findings indicated that the social media have significant impact on brand loyalty, brand consciousness mediate the relationship between social media marketing and brand loyalty. The study shows the significance to marketers that brand loyalty wanted to envision.

(Arshad, 2019)conducted a research titled as "influence of social media marketing on consumer behavior in Karachi" the study tries to identify the influence of different predictors that can control consumer behavior by identifying the behavior of social media marketing

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particularly face book and twitter .The predictors include information satisfaction ,vividness and entertaining content. A quantitative research methodology was used with questionnaire of 250 respondents using convenience sampling method which shows that all these content is found to be quite strong while vividness of social media marketing content is also having significant impact. It suggest to keep their social media posts as much as interesting colorful, entertaining and providing required information properly rather than only casual or plain content.

Social media marketing
a) Meaning:

Social media marketing is the usage of social media platforms to market and promote products and services of a company. It involves tailoring and customizing marketing activities particularly to each social media platforms. It connects with customers by helping them to get information about a product or a service.

b) Types of Social Media Marketing

1. Social media advertisement: Social media ads are one of the quickest and most effective ways to connect with your target audience. These ads provide numerous profitable opportunities and are considered as the best way to promote your digital marketing campaigns.

2. Online consumer reviews: User-generated online product reviews have become a natural part of the online marketplace experience for both retailers and consumers alike over the last few years.

3. Create a community for your audience : Marketers are involved in creating an online community through Facebook groups, what Sapp groups, You Tube community in which they can join and firms may be able to promote their product, service or event in a most optimum way.

4.Cross channel: For engaging your customers we can run cross-channel campaigns across all your social media channels. These kind of campaigns are run by virtually every company today, so we need to make modifications and innovations to be unique from others.

Analysis and Interpretation of Data

Table 1

Factors that stimulate purchase decision in a social media advertisement

Factors	*SA (5)	A (4)	N (3)	D (2)	SD (1)	Total	Mean	MPS
Creative design and innovative content	31	35	17	6	1	90	3.98	79.6
absence of exaggeration	12	40	28	6	4	90	3.55	71
short description of an offer or discount	22	26	27	13	2	90	3.58	71.6
frequency of the advertisement	14	31	19	18	8	90	3.27	65.4
uniqueness	21	28	23	14	4	90	3.53	70.6
Tailor made advertisements	15	41	22	10	2	90	3.63	72.6
Attractive colour grading	17	31	25	12	5	90	3.47	69.4
entertainment value of the social media advertisement	15	34	20	14	7	90	3.4	68

(Source: Primary Data),

* (SA-Strongly Agree, A-Agree,N-Neutral, D-Disagree, SD-Strongly Disagree)

From the above table 1 it is clear that majority of the respondents opted creative design and innovative content (MPS: 79.6) in a social media advertisement is the stimulating factor of the purchase decision and the least opted by the respondents was the frequency of the advertisement

(MPS: 65.4) as the stimulating factor of purchase decision in a social media advertisement.

Table 2

Effect of online consumer reviews in social media on purchase decision

statements	MjE (5)	MdE (4)	N (3)	MnE (2)	NE (1)	Mean	MPS
Review which contain sufficient information about the product	41	28	15	5	1	4.14	82.8
Responses to the review in the comment section	19	44	21	4	2	3.82	76.4
Realistic presentation and Trust worthiness	30	33	19	7	1	3.93	78.6
Previous reviews about the product and the reviewer	19	49	16	5	1	3.88	77.6
Reviewer exposure and his experience	28	34	18	6	4	3.84	76.8
Medium & quality of review	22	41	18	5	4	3.8	76
Total (Percentage)	159 (29.44)	229 (42.4)	107 (19.81)	32 (19.81)	13 (5.92)		

(Source: Primary Data), *(MjE-Major effect, MdE-Moderate effect, N-Neutral, MnE-Minor effect, NE-No effect)*

The table 2 shows that online consumer reviews have a moderate effect 42.40% in purchase decision. Review which contains sufficient information about the product have more effect on purchase decision rather than any other factor with mean 4.14 and MPS 82.8. Medium & quality of review have comparatively less effect than other factors of online consumer review with a mean 3.8 and MPS 76.

From the table no. 3 we understand that lack of security and online frauds (MPS is 86.6) is the most important concern of the respondents while forming a purchase decision. Excessive advertisement (MPS 77.6) is comparatively least significant concern opted by the respondents.

Table 3

Level of concerns faced by the consumers in purchase decision

Concerns	EC	MC	SmC	SlC	N	Mean	MPs
lack of security and online fraud	61	18	2	3	6	4.33	86.6
Excessive advertisement	23	48	9	6	4	3.88	77.6
intruding into privacy of customers	36	34	12	6	2	4.06	81.2
data sharing between social media sites and marketers	34	34	9	6	7	3.91	78.2

(Source: Primary Data), *(*EC-Extremely concerned, MC-Moderately concerned, SmC-Somewhat concerned, SlC-Slightly concerned, N-Not at all concerned*)

Testing of hypothesis

Hypothesis 1

H0: There is no significant difference between gender and the preference ofrespondents on best mode of user reviews

H1: There is significant difference between gender and the preference of respondents on best mode of user reviews

Table 4

Descriptive Statistics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Male	51	2.27	.827	.116	2.04	2.51	1	4
Female	39	2.46	.854	.137	2.18	2.74	1	4
Total	90	2.36	.839	.088	2.18	2.53	1	4

(Source: primary data)

The table shows the descriptive statistics of relationship between gender and the preference of the respondents on the best mode of user review .It is observed that the mean score of "female" is higher than that of other group i.e. male.

Table 5

ANOVA showing Gender and the preference of respondents on best mode of user reviews

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.773	1	.773	1.100	**0.297**
Within Groups	61.849	88	.703		
Total	62.622	89			

(Source: primary data)

The table shows the output of ANOVA stating whether there is no significant difference among the preference of respondents on best mode of user reviews. From the table it is clear that there is no significant difference between gender and preference of best mode of user review, as determined by one-way ANOVA (F= 1.100, P-value = 0.297). Here the probability value (0.297) is greater than the level of significance (.05). Hence, it is proved that the null hypothesis is accepted i.e. there is no significant difference between gender and the preference of respondents on best mode of user reviews.

Hypothesis 2

Table 6

Descriptive Statistics			
	Mean	Std. Deviation	N
Effect of OCR on purchase decision	3.9056	.75080	90
Average time that you will spend in social media in a day	2.48	.902	90

(Source: primary data)

H1: There is significant difference between average time spend in social media and the effect of online consumer reviews on purchase decision

Table 7

<table>
<tr><td colspan="4" align="center">Correlations</td></tr>
<tr><td></td><td></td><td>Effect of OCR on purchase decision</td><td>Average time spend in social media per day</td></tr>
<tr><td rowspan="3">Effect of OCR on purchase decision</td><td>Pearson Correlation</td><td>1</td><td>-0.101</td></tr>
<tr><td>Sig. (2-tailed)</td><td></td><td>.342</td></tr>
<tr><td>N</td><td>90</td><td>90</td></tr>
<tr><td rowspan="3">Average time spend in social media per day</td><td>Pearson Correlation</td><td>-0.101</td><td>1</td></tr>
<tr><td>Sig. (2-tailed)</td><td>.342</td><td></td></tr>
<tr><td>N</td><td>90</td><td>90</td></tr>
</table>

(Source: primary data)

The table shows the correlation between the average time spend in social media and the effect of online consumer reviews on purchase decision. There is no significant relationship between average time spend in social media and the effect of online consumer reviews on purchase decision as the Pearson correlation coefficient -0.101 .Since the sig value 0.342 is greater than 0.05 the correlation is not significant and it is negatively correlated. Which means if a person who spend more time in social media it create a negative effect on purchase decision on the basis of online consumer reviews. We can assume this

is because a person who spends more time in social media have more knowledge about the platform and he may seriously aware about the trust worthiness of the reviews. Here the null hypothesis is accepted and there is no significant relationship between average times spend in social media and the effect of online consumer reviews on purchase decision.

Findings

1. The study shows that creative design and innovative content in a social media advertisement with an MPS of 79.6 and mean of 3.98is the most stimulating factor that led to a purchase decision that particular factor in the advertisement wanted to be given more significance in designing a social media advertisement.

2. The study shows that online consumer reviews have a moderate effect42.40% in purchase decision, it's a common belief that the online consumer reviews are not much trustworthy as most of them are paid reviews. But during recent period many online review platforms had emerged which gives unbiased and trustworthy reviews about the product or service .So the emergence of this kind of online consumer review platforms will definitely have more effect on the purchase decision of users.

3. From the study its understood that lack of security and online frauds (MPS is 86.6) is the most important concern of the respondents regarding social media advertisements and reviews as we know that while watching social media advertisements and reviews we may fear that our private data will be shared among the marketers and will definitely get recommended related

advertisement so we people may be concerned about the security of data and one of major problem is chances of online frauds advertisements and reviews can be made by any marketer or reviewer so it is difficult to make confirmation about the trustworthiness of the review or the advertisement ,effective steps needed to be taken for avoiding this sort of concerns of the users

Conclusion

The present study is an attempt to study the effect of social media marketing on purchase decision, the major areas under study is social media advertisement, online consumer reviews and the concerns faced by the users in purchase decision on the basis of social media advertisement and reviews. From the study it is clear that social media marketing plays a very influential role in purchase decision. Creative design and innovative content in a social media advertisement is the most stimulating factor that led to a purchase decision. While studying the effect of online consumer reviews on purchase decision we found that online consumer reviews have a moderate effect in purchase decision. While studying the concerns faced by consumer's lack of security and online frauds is the most important concern of the respondents. However social media is nowadays the most accessible and penetrating marketing tool by which marketers can stimulate purchase decision among consumers, solving the concerns over it will accelerate the effectiveness of social media in purchase decision

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A Retrospective Study on the Importance of Order Statistics in Information Theoretic Measures

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Abstract

In the literature of information theory, Shannon entropy, Renyi entropy, Kullback-Leibler divergence measure, Kerridge's inaccuracy measure and Tsallis entropy plays an important role and in the context of reliability theory, order statistics and record values which were used for statistical modelling. We primarily consider a compact review of the existing works in information theory in the frame of reference of order statistics.

Key Words: Shannon's entropy, Renyi entropy, Kullback-Leibler divergence measure, Kerridge's inaccuracy measure, Tsallis entropy, Order Statisitcs

1 Introduction

In the last few decades, the theory of information has exponentially intensified in all subsidiary fields of science and technology. The history of quantitative measure of information in communication systems has established in 1920s. The basis for the advancement of information theory has originated by the works of Nyquist [13]. Later,

Shannon [19] proposed the concept of entropy namely Shannon's entropy. This entropy is regarded as a measure of uncertainty. Eventually many parametric and non – parametric measures have appeared in the literature. Researchers pay more consciousness to study these measures and properties in allied discipline.

Order statistics is the ordered arrangement of data according to their magnitude. Suppose X_i be a set of n independent and identically distributed random variables with a distribution function $F(x)$ and probability density function $f(x)$. The realization of $X_1, X_2, \ldots, X_n$ be $(x_1, x_2, \ldots, x_n)$. Accordingly, $X_{1:n} \leq X_{2:n} \leq \cdots \leq X_{n:n}$ are the variables arranged in ascending sequence of value. The probability distribution function and cumulative distribution function of the ith order statistics is given by $f_{i:n}(x)$ and $F_{i:n}(x)$, respectively.

$$f_{i:n}(x) = \frac{1}{B(i,n-i+1)} \big(F(x)\big)^{i-1} \big(1 - F(x)\big)^{n-i} f(x), \text{ for } 1 \leq i \leq n \quad (6)$$

where,

$$B(a,b) = \int_0^1 x^{a-1}(1-x)^{b-1} \, dx, \forall \, a, b > 0,$$

$B(a,b)$ is a beta function with parameters a and b respectively, Arnold et al. [2]. Due to the eminence of order statistics, it is used in sundry domains namely goodness-of-fit tests, characterization of probability distributions, reliability theory, quality control etc. and it also used in physics, as to construct median filters for image and signal processing.

Following the present introductory section, the paper is subdivided as follows: In Section 1 we outline the basic measures. Section 2 comprises of significance of order statistics in information theory with

the aid of a review. In the Section 3 a concise conclusion. In this paper we gave a compact review of the order statistics in frame of reference of classical measures.

2 Information Measures

2.1 Shannon's Entropy

Let X be a non-negative random variable admitting absolutely continuous distribution function $F(x)$ with probability density function $f(x)$. Then the Shannon's entropy is defined as

$$H(F) = - \int_0^\infty f(x) \log f(x) dx \qquad (1)$$

The equation (1) measures the amount of uncertainty contained in the random variable X. If the entropy increases, it is equivalent to more uncertainty in the density function which results in slighter capability in predicting X based on available information. Eventually, many parametric and non-parametric measures were evolved. After the definition of entropy, a tremendous growth has been visible in the theory of information. For some practical situations complete data may not be constructive, under this context we may censor the data under certain conditions, specifically residual or past form is preferrable. To measure the uncertainty concerning the remaining lifetime of the unit or namely the residual entropy was developed by Ebrahimi et al.[8].

2.2 Renyi Entropy

A parametric type generalization of Shannon's type of entropy is due to Rényi [18]. Let X be a non-negative continuous random variable admitting absolutely continuous distribution function, then (2.4.6) takes the form

$$H_\alpha(X) = \frac{1}{1-\alpha} \log\left(\int_0^\infty f^\alpha(x)dx\right); \; \alpha > 0, \alpha \neq 1 \qquad (2)$$

When $\alpha \to 1$ equation (1) reduces to (2). Hence the Renyi entropy is the Shannon's differential entropy.

2.3 Kullback-Leibler divergence measure

Later, to measure information involving two probability distributions associated with the same experiment Kullback-Leibler [11] have designed the K-L divergence measure also recognized as the relative entropy. The relative entropy finds lot of application in the field of information theory besides diverse spheres of science and technology comprising Probability Theory and Mathematical Statistics. This measure is more dominant due to its simplicity, applicability in model selection and coding, and also plays exceptional part in the problems of statistical theory, especially in large sample theories of estimation and testing and other numerous areas. Let X and Y be two non-negative random variables admitting absolutely continuous distribution function $F(x)$ and $G(x)$ respectively. Then the K-L measure of discrimination between X and Y can be obtained as follows,

$$D(F,G) = \left(\int_0^\infty f(x) \log\left(\frac{f(x)}{g(x)}\right) dx\right) \qquad (3)$$

This measures the expected uncertainty contained in g with respect to f or the degree to measure divergence of g with respect to f. If the divergence measure is negligible, the more alike the distribution of the two variables and conversely. To illustrate the current age of the system Ebrahimi et al. [8] have modified the K-L measure.

2.4 Kerridge's Inaccuracy Measure

The hypothesis of inaccuracy was coined by Kerridge [10], which is a non-parametric generalization of Shannon's entropy. This has been amply used as an efficacious aid for measuring the experimental errors. In phrasing assertions about probabilities of innumerable events in an experiment, there may have two sorts of errors, the one supervening from the deficit of adequate information or vagueness in experimental results (e.g.: insufficient data or missing observations) and the other from inaccurate information or by mis-specifying the model. The basic purpose of experiments is to draw inference concerned with formulating hypothesis, in some sense it may be imprecise in either or both of these methods. The error due to vagueness can be elucidated by Shannon's measure of uncertainty. Taking these two sorts of errors into reckon, Kerridge introduced the notion of inaccuracy measure. Let X and Y be two non-negative random variables admitting absolute continuous cumulative distribution functions $F(x)$ and $G(x)$ respectively. If $F(x)$ is the actual distribution function corresponding to the observations and $G(x)$ is the distribution function assigned by the experimenter and $f(x)$ and $g(x)$ are the density function of X and Y, the inaccuracy measure is defined as

$$K(F,G) = -\int_0^\infty f(x)\log g(x)dx. \tag{4}$$

2.5 Tsallis entropy

Tsallis entropy is a generalization of the Shannon entropy. The Tsallis entropy is defined for random variable X order α, which is given by

$$S^\alpha(X) = \frac{1}{\alpha-1}\left[1 - \int_{-\infty}^\infty f^\alpha(x)dx\right], \alpha \neq 1, \alpha > 0 \tag{5}$$

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In general, Tsallis entropy can be negative. By choosing an appropriate value for $\alpha,$ it can be nonnegative. Shannon entropy can view as a particular case of Tsallis entropy.

3 Significance of order statistics in classical measures

In the literature of information theory, Shannon entropy plays an important role and in the context of reliability theory, order statistics and record values which were used for statistical modelling. The study of theoretical measures using the order statistics was initially given by Wong and Chen [27]. There they discussed the entropy of a sequence of random variables under order restrictions. They study the amount of entropy reduction when the sequence is ordered is considered. Under certain conditions some upper and lower bounds to the entropy reduction are obtained. Some interesting properties of the entropy of the individual order statistics are also discussed. It has been shown that the difference between the average entropy of the individual order statistics and the entropy of a member of the original independent identically distributed population is a constant, regardless of the original distribution. The entropies of the individual order statistics are found to be symmetric about the median when the probability density function of the original population sequence is symmetric about its mean.

Park [14] has studied the entropy of consecutive order statistics. This provides some fundamental relations occurring in the entropy of consecutive-order statistics, which were very useful for computations. They contemplate the decomposition of the entropy of order statistics, and derive some recurrence relations for the first r order statistics.

They also establish a dual principle for the entropy of order statistics, which yields a dual relation from a given relation in the entropy of order statistics.

Ebrahimi et al. [8] has explored properties of the entropy, Kullback-Leibler information, and mutual information for order statistics. They provide bounds for the entropy of order statistics and some results that relate entropy ordering of order statistics to other well-known orderings of random variables. They showed that the discrimination information between order statistics and data distribution, the discrimination information among the order statistics, and the mutual information between order statistics are all distribution free and are computable using the distributions of the order statistics of the samples from the uniform distribution. They also discuss information properties of spacings for uniform and exponential samples and provide a large sample distribution-free result on the entropy of spacings. The results show interesting symmetries of information orderings among order statistics.

Baratpour et al. [6] gave some characterizations based on entropy of order statistics and record values. They characterize the parent distributions based on Shannon entropy of order statistics and record values. It has proved that the equality of the Shannon information in order statistics or record values can determined uniquely by the parent distribution. The exponential distribution is characterized through maximizing Shannon entropy of record values under some constraints. The results were useful in the modelling problems.

Baratpour et al. [4] have made characterizations based on Renyi Entropy of order statistics and record values. Two different distributions may have equal Rényi entropy; thus a distribution cannot be identified by its Rényi entropy. They have explore the properties of the Rényi entropy of order statistics. Several characterizations were established based on the Rényi entropy of order statistics and record values, including the characterizations of a distribution on the basis of the differences between Rényi entropies of sequences of order statistics and the parent distribution.

Zarezadeh and Asadi [28] explore properties of the residual Rényi entropy of some ordered random variables. The residual Rényi entropy of the kth order statistic from a continuous distribution function is represented in terms of the residual Rényi entropy of the kth order statistic from uniform distribution. The monotone behavior of the residual Rényi entropy of order statistic under various conditions were discussed. Analogues results for the residual Rényi entropy of record values were also given.

Abbasnejad and Arghami [1] discussed some properties of Renyi entropy and Renyi information of order statistics. Some bounds for Renyi entropy of order statistics were obtained. They considered Renyi entropy ordering of order statistics to Renyi entropy ordering and other well-known orderings of parent random variables. It has been proved that the Renyi information between order statistics and parent random variable is distribution free, and the expected distance is minimum for the median.

Thapliyal and Taneja [22] studied a generalized two parameters entropy of order statistics and derived bounds for it. The generalized residual entropy using order statistics has also been discussed. The two parameters generalized entropy plays a vital role as a measure of complexity and uncertainty in different areas such as physics, electronics and engineering to describe many chaotic systems. Using probability integral transformation, they have studied the generalized and generalized residual entropies based on order statistics and have explored some properties of these entropies for exponential distribution.

Thapliyal and Taneja, [23] considered a measure of inaccuracy between distributions of the i th order statistics and parent random variable. It has shown that the inaccuracy measure characterizes the distribution function of parent random variable uniquely and its average value is the entropy of the parent random variable. Also discussed some properties of the proposed measure.

Park and Kim [15] show a representation of the cumulative residual entropy of the first r order statistics as a single integral. Then they provide some related results including recurrence relations, identity and characterization property.

Park [16] considered a representation of the Kullback–Leibler information of the first r order statistics in terms of the relative risk, the ratio of hazard functions, and extended it to the progressively Type II censored data. Then they studied the change in Kullback–Leibler information of the first r order statistics accordingly and discussed its relation with Fisher information in order statistics.

Thapliyal and Taneja [24] proposed the measure of residual inaccuracy of order statistics and prove a characterization result for it. Further they characterized some specific lifetime distributions using residual inaccuracy of the first order statistics and also discussed some properties of the proposed measure.

Baratpour and Khammar [3] have studied the Tsallis entropy based on order statistics and record values. Hence proved that the parent distributions can be determined uniquely by the equality of Tsallis entropy of order statistics or record values. They have characterized symmetric distributions based on Tsallis entropy of order statistics and record values. Also proved that the Tsallis information between order statistics and parent random variable, and Tsallis information between record values and parent random variable are distribution free. The results are useful in modeling problems and testing statistical hypotheses.

Baratpour and Khammar [3] proposed the concept of Tsallis entropy in order statistics and obtain upper and lower bounds and some results on stochastic comparisons.

Toomaj and Doostparast [25] proved that the K-L information between distributions of mixed system lifetimes and the corresponding component lifetimes and also the associated order statistics are distribution free and depends only on the signature of the system provided that lifetimes of components are independent and identically distributed. The obtained results are used to find the closest and the farthest distribution of order statistics from the distribution of the system's lifetime which is useful to approximate stochastic behaviour

of mixed systems when the number of components is large. They also provide bounds and also used the results to obtain a more preferable system among all systems. Some illustrative examples were also given.

Sunoj et al. [20] has studied quantile-based entropy of order statistics and its properties. They proposed a quantile-based residual entropy of order statistics, an alternative method to measure the uncertainty of ordered observations for used items. Unlike distribution function approach, they have derived an explicit relationship between the quantile density function and quantile-based residual entropy of order statistics.

Kumar and Rekha [12] have studied the concept of quantile based Tsallis entropy using order statistics. They proved that the generalized quantile information between i^{th} order statistics and parent random variable is distribution free. Also the quantile version of Tsallis entropy for residual lifetime has been derived and its monotonicity property is studied. Some characterization results based on the Tsallis quantile entropy for residual and inactivity time for the series and parallel system have been studied. They have studied some characterization results for series and parallel system, using the relationship between the reliability measures and proposed measure.

Daneshi et al.[7] proposed a measure of weighted cumulative residual inaccuracy between survival function of the first-order statistic and parent survival function. They also considered weighted cumulative inaccuracy measure between distribution of the last- order statistic and parent distribution. For these concepts, they obtain some reliability properties and characterization results such as relationships with other

functions, bounds, stochastic ordering and effect of linear transformation. Dynamic versions of these weighted measures were considered

4 Conclusion

Order statistics have ample applications in numerous spheres. To study information theoretical measures using order statistics has become principal focus for many researches.

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Multivariate Linnik related distributions and their Applications in time series modelling

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Abstract

The Mittag-Leffler distribution and the Linnik distribution in univariate case are examined. Then multivariate Linnik distributions are considered and their properties are discussed. A matrix-variate Linnik distribution is discussed. Autoregressive processes with multivariate Linnik marginal distributions are developed. Multivariate Geometric Linnik Distributions are introduced and the corresponding autoregressive processes are discussed.

Key words: Autoregressive processes; Mittag-Leffler distribution; multivariate Linnik distribution;

Introduction

Mittag-Leffler functions and their generalizations have variety of applications in fractional reaction-diffusion problems in physical sciences and general input-output models in other disciplines. Mathai (2009) examined several pathways of exponential and gamma densities going to Mittag-Leffler densities and then Mittag-Leffler densities going to Lévy and Linnik densities and their multivariate and matrix variate extensions. A statistical distribution in terms of the Mittag-Leffler function $E_\alpha(x)$ was defined by Pillai (1990) in terms of its distribution function.

Pillai (1988) introduced the semi-Mittag-Leffler distribution which included the Mittag-Leffler distribution as a special case. Jayakumar and pillai (1993) introduced the first order autoregressive Mittag-Leffler process and studied its properties. Mittag-Leffler distributions can be viewed as the special case of Geometric Stable Laws. An estimation method for the parameters of Linnik and Mittag-Leffler distributions, based on fractional moments, is proposed by Kozubowski (2001). Algorithms for simulation of Linnik and Mittag-Leffler distributions, based on their representations as mixtures of Laplace and exponential distributions are also presented by Kozubowski (2001). Mathai et al. (2006) discussed various generalizations of Laplace distribution and their applications in different contexts such as input-output processes, growth-decay mechanism, formation of sand dunes, production of melatonin in human body, formation of solar neutrinos etc.

Linnik (1963) introduced Linnik distribution. Pillai (1985) refers to it as α-Laplace distribution. Anderson and Arnold(1993) discussed the properties of the Linnik distribution and developed Linnik processes to model time series data on stock price returns. Kuttykrishnan and Jayakumar (2008) introduced bivariate semi α- Laplace distribution, its characterizations and associated autoregressive models. Anderson (1992) proposed the extension of Linnik distribution in the multivariate case and proved that it is the general case of multivariate Laplace. Pakes (1998) introduced a generalized Linnik law, which is the generalization of Laplace distribution, Linnik and generalized Laplace distributions. Linnik distribution possesses heavy tails and therefore it has applications in financial modelling. Properties and applications of these distributions are studied by various authors. Kotz and Ostrovskii (1996) and Kozubowski (1998) discussed various mixture representations of Linnik distribution which allow efficient generation of the corresponding random variates. Jacques et al. (1999) discussed the estimation of parameters of Linnik distribution and proved that generalized Linnik laws belong to Paretian family.

Mathew and Jayakumar (2003) introduced the autoregressive processes associated with generalized Linnik distribution. Applications of Linnik distribution in modelling financial data, communication engineering and other fields are discussed by various authors. Sandhya (1991) characterized semi α-Laplace laws by stability of geometric sums and Sandhya and Satheesh (1996) characterized α-Laplace (Linnik) laws by the class-$\mathcal{L}$ property among semi-α-Laplace laws. Jayakumar et al. (1995) developed autoregressive processes with Linnik distribution as the marginal distribution. Seetha Lekshmi et al. (2003) discussed generalized Laplacian and geometric α- Laplace distributions with applications in time series modelling. Seetha Lekshmi and Jose (2004,2006) introduced various autoregressive models utilizing α-Laplace and Pakes distributions. Sabu and Pillai (1987) derived expressions for the density function of α-Laplace random variables in terms of Meijers's G-function and also obtained some multivariate generalizations.

Linnik distributions share some properties of the symmetric Laplace distributions. They are stable with respect to geometric summation and appear as limit laws of geometric compounds when the summands are symmetric and have an infinite variance. They are mixtures of stable laws and exponential mixtures and scale mixtures of normal distributions. Devroye (1990) derived the fundamental representation of a Linnik random variable in terms of independent exponential and symmetric stable random variables. The tail probabilities of these distributions are no longer exponential and the moments are governed by the parameter α. They have an infinite variance and the mean is finite only for $1 < \alpha < 2$. Kozubowski (2000) discussed the fractional moment estimation of the parameters of Linnik distribution. Linnik distribution has important role in non-Gaussian stochastic processes and time series. It finds applications in wide range of contexts such as modelling solar neutrino fluxes in cosmos, stress-strength analysis industrial productions etc.

Stable laws also called α-stable, stable Paretian or Lévy stable were introduced by Lévy (1925) during his investigations of the behavior of sums of independent random variables. Stable distributions can accommodate the fat tails and asymmetry, they often give a very good fit to empirical data. Mandelbrot (1963) and Fama (1965) proposed the symmetric stable distribution as a model for asset returns. Stable distributions allow independently and identically distributed returns and account for the observed leptokurtosis in the data. They are the only possible limits of sums of independently and identically distributed random variables. Most common applications of the multivariate Linnik and stable models are mainly on extensive data bases. An attractive feature of stable distributions, not shared by other probability distribution models, is that they allow generalization of financial theories based on normal distributions and, thus, allow construction of a coherent and general framework for financial modelling. Multivariate stable laws are only partially accessible. This is because of the lack of closed form expressions for densities, and the possible complexity of the dependence structures.

Mittag-Leffler distributions

A general Mittag-Leffler function is defined as follows:

$$
\begin{aligned}
E_{\alpha,\beta}^{\gamma} &= \sum_{k=0}^{\infty} \frac{(\gamma)_k x^k}{k!\,\Gamma(\beta+\alpha k)}, \ (\gamma)_k = \gamma(\gamma+1)\ldots(\gamma+k-1), (\gamma)_0 = 1, \gamma \neq 0, \alpha > 0, \ \beta > 0 \\
E_{\alpha,\beta}^{1} &= E_{\alpha,\beta}(x) = \sum_{k=0}^{\infty} \frac{x^k}{\Gamma(\beta+\alpha k)}, \ \alpha > 0, \ \beta > 0 \\
E_{\alpha,1}(x) &= E_{\alpha}(x) = \sum_{k=0}^{\infty} \frac{x^k}{\Gamma(1+\alpha k)}, \ \alpha > 0; \ E_1(x) = \mathrm{e}^x
\end{aligned}
$$

Saxena et al. (2004a,b) describe a number of applications of the Mittag-Leffler functions in statistical mechanics and astrophysics and obtained the general solution of kinetic equations in terms of Mittag-Leffler functions.

Pillai (1990) defined a statistical distribution, through a distribution function, in terms of a Mittag-Leffler function as follows.

$$F_X(x) = 1 - E_\alpha(-x^\alpha) = \sum_{k=1}^\infty \frac{(-1)^{k+1} x^{\alpha k}}{\Gamma(1 + \alpha k)}, \ 0 < \alpha \leq 1, \ x > 0. \tag{1}$$

The density function of this distribution is directly obtained by differentiating the distribution function as

$$f(x) = \sum_{k=0}^\infty \frac{(-1)^k \alpha k x^{\alpha + \alpha k - 1}}{\Gamma(\alpha + \alpha k)} = x^{\alpha - 1} E_{\alpha,\alpha}(-x^\alpha), \ 0 < \alpha \leq 1, \ x > 0. \tag{2}$$

The Laplace transform of the Mittag-Leffler distribution is then available as

$$E[e^{-tX}] = \frac{1}{1 + t^\alpha}, \ |t^\alpha| < 1,$$

where $0 < \alpha \leq 1$, and reduced to that of an exponential random variable for $\alpha = 1$. The Mittag-Leffler distribution has a structural representation in terms of positive Lévy variable. A positive Lévy random variable $x > 0$ with parameter α is defined through the Laplace transform

$$E[e^{-tX}] = e^{-t^\alpha}.$$

When $\alpha = 1$ the random variable is degenerate at $x = 1$.

A Mittag-Leffler random variable X can be represented as $X = LG^{\frac{1}{\alpha}}$, where L is a positive Lévy random variable with parameter α and G is a gamma random variable with parameters δ and β, where L and G are statistically independently distributed. Then X has the Laplace transform $L_X(t) = [1 + \delta t]^{-\beta}$.

Mathai (2009) introduced a pathway going from the general Mittag-Leffler density to a positive Levy density. The path from Mittag-Leffler to positive Levy is described by the pathway parameter q. This additional parameter q allows increased flexibility for modelling purposes.

Linnik distribution

The characteristic function of a univariate Linnik distribution is given by

$$\psi(t) = \frac{1}{1 + |t|^\alpha}, \ \alpha \in (0, 2], \ t \in \mathbb{R}. \tag{3}$$

The parameter α is called the exponent or index of the distribution. For positive variable, (3) reduces to the characteristic function of a Mittag-Leffler variable.

When $\alpha = 2$, $\psi(t)$ becomes the characteristic function of Laplace distribution. Klebanov et al. (1984) introduced the concept of strict stability and showed that the characteristic functions of the probability distributions that are geometrically strictly stable are up to a scaling factor given by

$$\psi_{\alpha,\theta}(t) = \frac{1}{1 + e^{-i\theta\operatorname{sgn} t}|t|^{\alpha}}, \ \alpha \in (0,2], \ |\theta| \leq \left(\frac{\pi\alpha}{2}, \pi - \frac{\pi\alpha}{2}\right). \tag{4}$$

Pakes (1992) introduced the generalized Linnik distribution which have the characteristic function,

$$\psi_{\alpha,\theta,\nu}(t) = \frac{1}{(1 + e^{-i\theta\operatorname{sgn} t}|t|^{\alpha})^{\nu}}, \ \ \alpha \in (0,2], |\theta| \leq \left(\frac{\pi\alpha}{2}, \pi - \frac{\pi\alpha}{2}\right), \nu > 0. \tag{5}$$

This distribution has an important role in some characterization problems of mathematical statistics. Kotz et al. (1995) studied the analytic and asymptotic behaviors of the probability density function of the univariate symmetric Linnik distribution. When $\alpha \in (0,2]$ and $\nu > n/\alpha$, the dual distribution of the generalized Linnik distribution is the generalized Cauchy distribution, see Johnson et al. (1994). When $\alpha = 2$ and $\nu > n/2$, the generalized Cauchy distribution is the well-known Student's t distribution, see Kotz and Nadarajah (2004).

Multivariate Linnik distribution

The characteristic function of multivariate Linnik distribution denoted by $\psi(\mathbf{t})$ is given by

$$\psi(\mathbf{t}) = E(e^{i\mathbf{t}'\mathbf{X}}) = \frac{1}{1 + (\mathbf{t}'\boldsymbol{\Sigma}\mathbf{t})^{\alpha/2}}, \ \alpha \in (0,2], \ \mathbf{t}, \ \mathbf{X} \in \mathbb{R}^{p} \tag{6}$$

where $\boldsymbol{\Sigma}$ is a positive definite matrix of order p. It appears that any linear combination of components of $\mathbf{X}$ is distributed as a univariate random variable with tail index α. The various properties of this distribution was studied by Ostrovskii (1995). The generalization of multivariate Linnik distribution, known as multivariate generalized

Linnik, has the characteristic function

$$\psi(\mathbf{t}) = \frac{1}{(1 + (\mathbf{t}'\mathbf{\Sigma}\mathbf{t})^{\alpha/2})^{\nu}}, \ \alpha \in (0, 2], \nu > 0, \ \mathbf{t} \in \mathbb{R}^p. \tag{7}$$

The probability density function of a p-variate generalized Linnik distribution has a simpler form only when $\alpha = 2$,

$$f(\mathbf{x}, \nu) = \frac{1}{2^{p-1}\pi^{p/2}\Gamma(\nu)|\mathbf{\Sigma}|^{1/2}} \left(\frac{\sqrt{\mathbf{x}'\mathbf{\Sigma}^{-1}\mathbf{x}}}{2}\right)^{\nu - p/2} K_{\nu - p/2}\left(\sqrt{\mathbf{x}'\mathbf{\Sigma}^{-1}\mathbf{x}}\right), \ \nu > 0 \tag{8}$$

and $\mathbf{\Sigma}$ is positive definite, where K_ν is the modified Bessel function of the second kind of order ν given by

$$K_\nu(z) = \frac{\sqrt{\pi}}{(\nu - \frac{1}{2})!} \left(\frac{1}{2}z\right)^\nu \int_1^\infty e^{-zx}(x^2 - 1)^{\nu - 1/2}dx, \ \nu > -\frac{1}{2}$$

Theorem

Let $X_1, X_2, \ldots, X_n$ be independently and identically distributed multivariate Linnik random variables with parameters $(\alpha, \mathbf{\Sigma})$. Then the limiting distribution of $Y = \frac{1}{n^{1/\alpha}}(X_1 + X_2 + \cdots + X_n)$ is a multivariate symmetric stable distribution with characteristic function $e^{-(\mathbf{t}'\mathbf{\Sigma}\mathbf{t})^{\alpha/2}}$.

Proof.

The characteristic function of $X_i, i = 1, 2, \ldots, n$ be

$$\psi_X(\mathbf{t}) = \frac{1}{1 + (\mathbf{t}'\mathbf{\Sigma}\mathbf{t})^{\alpha/2}}, \ \ \alpha \in (0, 2], \mathbf{t} \in \mathbb{R}^p$$

Then characteristic function of $Y = \frac{1}{n^{1/\alpha}}(X_1 + X_2 + \cdots + X_n)$ is

$$\psi_Y(\mathbf{t}) = (\psi_X(\mathbf{t}/n^{1/\alpha}))^n = \left(\frac{1}{1 + \frac{1}{n}(\mathbf{t}'\mathbf{\Sigma}\mathbf{t})^{\alpha/2}}\right)^n$$

Taking limit as $n \to \infty$, $\psi_Y(\mathbf{t}) \to e^{-(\mathbf{t}'\mathbf{\Sigma}\mathbf{t})^{\alpha/2}}$, which is the characteristic function of a multivariate symmetric stable distribution. Therefore the limiting distribution of the multivariate Linnik distribution is a multivariate symmetric stable distribution.

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Theorem

Let $\boldsymbol{S}$ be a multivariate stable random vector with characteristic function $\mathrm{e}^{-(\boldsymbol{t}'\boldsymbol{\Sigma}\boldsymbol{t})^{\alpha/2}}$ where $\boldsymbol{\Sigma}$ is a positive definite matrix of rank n and let g be a univariate gamma random variable with parameter ν and S and g are independently distributed. Then the random vector $\mathbf{X} = g^{1/\alpha}\boldsymbol{S}$, where $\alpha \in (0,2]$ is distributed as multivariate generalized Linnik.

Proof.

$$
\begin{aligned}
\mathrm{E}(\mathrm{e}^{i\mathbf{t}'\mathbf{X}}) &= \mathrm{E}\left(\mathrm{E}\left(\mathrm{e}^{ig^{1/\alpha}\mathbf{t}'\mathbf{S}}\big|g\right)\right) \\
&= \mathrm{E}\left(\exp\left(-g[\mathbf{t}'\boldsymbol{\Sigma}\mathbf{t}]^{\alpha/2}\right)\right) \\
&= \frac{1}{\Gamma(\nu)}\int_0^\infty g^{\nu-1}\exp\left\{-g(1+[\mathbf{t}'\boldsymbol{\Sigma}\mathbf{t}]^{\alpha/2})\right\}\mathrm{d}g \\
&= \frac{1}{(1+[\mathbf{t}'\boldsymbol{\Sigma}\mathbf{t}]^{\alpha/2})^\nu}
\end{aligned}
$$

which is the characteristic function of a multivariate generalized symmetric Linnik distribution and hence a multivariate generalized symmetric Linnik random variable can be generated by using the above relation.

Matrix-variate Linnik distribution

A matrix variate analogue of the Linnik distribution is established in Mathai (2009). Let X be $m \times n$ matrix of full rank and T be $n \times m$ matrix of full rank. Then X will be called a real rectangular matrix-variable Linnik random variable if its characteristic function, denoted by $\psi_X(T)$, is given by

$$
\psi_X(T) = E[\mathrm{e}^{i\mathrm{tr}(XT)}] = \mathrm{e}^{-[\mathrm{tr}(T\Sigma_1 T'\Sigma_2)]^{\frac{\alpha}{2}}}, \; o < \alpha \le 2 \tag{9}
$$

where $\Sigma_1 > 0$ is $m \times m$ and $\Sigma_2 > 0$ is $n \times n$ positive definite constant matrices. It is clear that we can get a matrix-variate non-Gaussian density from (9) when $\Sigma_1 = \frac{1}{2}A^{-1}$ and $\Sigma_2 = \frac{1}{2}B^{-1}$ and $\alpha = 2$.

Multivariate Linnik processes

Consider the usual linear, additive first order autoregressive model given by

$$\mathbf{X}_n = a\mathbf{X}_{n-1} + \varepsilon_n, \quad 0 < a \le 1, \quad n = 0, \pm 1, \pm 2, \ldots, \tag{10}$$

where $\mathbf{X}_n$ and innovations ε_n are p-variate random vectors.

In terms of characteristic function, we have

$$\psi_{\mathbf{X}}(\mathbf{t}) = \psi_{\mathbf{X}}(a\mathbf{t})\psi_\epsilon(\mathbf{t})$$

The characteristic function of $\{\varepsilon_n\}$ can be obtained as

$$\begin{aligned}
\psi_\epsilon(\mathbf{t}) &= \frac{\psi_{\mathbf{X}}(\mathbf{t})}{\psi_{\mathbf{X}}(a\mathbf{t})} \\
&= \left[a^\alpha + (1 - a^\alpha)\frac{1}{1 + (\mathbf{t}'\mathbf{\Sigma t})^{\alpha/2}} \right].
\end{aligned} \tag{11}$$

Hence the innovation sequence $\{\varepsilon_n\}$ can be treated as a sequence of random vectors

of the form

$$\varepsilon_n = \begin{cases} 0, & \text{with probability} \quad a^\alpha \\ L_k, & \text{with probability} \quad 1 - a^\alpha \end{cases} \tag{12}$$

where L_k' s are independently and identically distributed symmetric multivariate Linnik random vectors. The following theorem summarizes the above results.

Distribution of sums When a stationary sequence X_n is used, the distribution of sums $T_r = X_n + X_{n+1} + \cdots + X_{n+r-1}$ is important. We have

$$\mathbf{X}_{n+j} = a^j \mathbf{X}_n + a^{j-1}\varepsilon_{n+1} + a^{j-2}\varepsilon_{n+2} + \cdots + \varepsilon_{n+j}$$

$$\begin{aligned}
\text{Hence} \quad \mathbf{T}_r &= \mathbf{X}_n + \mathbf{X}_{n+1} + \cdots + \mathbf{X}_{n+r-1} \\
&= \sum_{j=0}^{r-1}[a^j \mathbf{X}_n + a^{j-1}\varepsilon_{n+1} + \cdots + \varepsilon_{n+j}] \\
&= \mathbf{X}_n \left(\frac{1 - a^r}{1 - a} \right) + \sum_{j=1}^{r-1} \varepsilon_{n+j} \left(\frac{1 - a^{r-j}}{1 - a} \right)
\end{aligned}$$

The characteristic function of $\mathbf{T}_r$ is given by

$$
\begin{aligned}
\psi_{\mathbf{T}_r}(\mathbf{t}) &= \psi_{\mathbf{X}_n}\left(\mathbf{t}\frac{1-a^r}{1-a}\right)\prod_{j=1}^{r-1}\psi_\varepsilon\left(\mathbf{t}\frac{1-a^{r-j}}{1-a}\right) \\
&= \frac{1}{1+\left(\frac{1-a^r}{1-a}\right)^\alpha(\mathbf{t}'\boldsymbol{\Sigma}\mathbf{t})^{\alpha/2}}\times\prod_{j=1}^{r-1}\left[a^\alpha+(1-a^\alpha)\frac{1}{1+\left(\frac{1-a^{r-j}}{1-a}\right)^\alpha(\mathbf{t}'\boldsymbol{\Sigma}\mathbf{t})^{\alpha/2}}\right]
\end{aligned}
$$

The distribution of $\mathbf{T}_r$ can be obtained by inverting the above expression.

Joint distribution of $(\mathbf{X}_n,\mathbf{X}_{n+1})$ The joint distribution of continuous observation vectors $(\mathbf{X}_n,\mathbf{X}_{n+1})$ can be given in terms of characteristic function as

$$
\begin{aligned}
\psi_{\mathbf{X}_n,\mathbf{X}_{n+1}}(\mathbf{t}_1,\mathbf{t}_2) &= E[\exp(i\mathbf{t}_1'\mathbf{X}_n+i\mathbf{t}_2'\mathbf{X}_{n+1})] \\
&= E[\exp(i\mathbf{t}_1'\mathbf{X}_n+i\mathbf{t}_2'(a\mathbf{X}_n+\varepsilon_{n+1}))] \\
&= E[\exp(i(\mathbf{t}_1'+a\mathbf{t}_2')\mathbf{X}_n+i\mathbf{t}_2'\varepsilon_{n+1})] \\
&= \psi_{\mathbf{X}_n}(\mathbf{t}_1+a\mathbf{t}_2)\psi_{\varepsilon_{n+1}}(\mathbf{t}_2)
\end{aligned}
$$

$$
= \frac{1}{1+[(\mathbf{t}_1+a\mathbf{t}_2)'\boldsymbol{\Sigma}(\mathbf{t}_1+a\mathbf{t}_2)]^{\alpha/2}}\left[a^\alpha+(1-a^\alpha)\frac{1}{1+(\mathbf{t}_2'\boldsymbol{\Sigma}\mathbf{t}_2)^{\alpha/2}}\right] \tag{13}
$$

$$
\text{Here}\quad \psi_{\mathbf{X}_n,\mathbf{X}_{n+1}}(\mathbf{t}_1,\mathbf{t}_2)\neq\psi_{\mathbf{X}_n,\mathbf{X}_{n+1}}(\mathbf{t}_2,\mathbf{t}_1)
$$

Therefore the process is not time-reversible.

Applications

The models developed in this paper can be used for modelling multivariate time series data from financial contexts. In such cases, one has to consider data sets like exchange rate of a particular currency like Indian rupee with respect to various currencies like U.S. dollar, pound, euro etc at the same time. In biological and biostatistical modelling also, multivariate temporal data measuring the changes in various characteristics are very common. In the case of stock market analysis and option pricing also, financial modelers have to consider the prices of different stocks at a particular time, since most investors consider a portfolio of stocks for optimal investment.

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On Rees Matrix Semigroups

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Abstract

A semigroup is a pair $(S, \cdot)$ consisting of a set S and an associative binary operation $\cdot$ on S. The collection of all rectangular matrices of a given order $m \times n (m \neq n)$ will never form a semigroup under usual matrix multiplication. But by defining a sandwich operation, it can be developed into a semigroup. For that we define a binary operation $*$ on the set of all $m \times n$ matrices over the field F by $X * Y = XAY$ for all $m \times n$ matrices X and Y where A is a fixed $n \times m$ matrix. Rees matrix semigroups is an important class of such semigroups. This paper introduces Rees matrix semigroups and some related ideas.

1   Preliminaries

Definition 1.1. *A semigroup S is a pair $(S, \cdot)$ consisting of a set S and an associative binary operation $\cdot$ on S.*

That is,

   S is closed under $\cdot$ and satisfies

$$(x \cdot y) \cdot z = x \cdot (y \cdot z) \quad \forall \ x, y \in S.$$

Definition 1.2. *An element z in a semigroup S is called a left[right] zero of a subset $A \subseteq S$ if*

$$za = z \quad \forall \ a \in A \quad [az = z \quad \forall \ a \in A].$$

If z is both a left as well as a right zero of A, then it is called a [two-sided] zero of A. If the above condition holds for $A = S$, then z is a left/right/two-sided zero of S as the case may be. The zero of S, if it exists, is unique and will be denoted by o.

It is possible to adjoin a new left, right or two-sided zero to S.

Consider adjoining a new zero to S. This is done by extending the multiplication in S to $T = S \cup \{o\}$ as follows.

$$ox = o = xo \quad \forall \ x \in S \text{ and } oo = o$$

Given any semigroup S, we define S^o by

$$S^o = \begin{cases} S & \text{if } S \text{ has zero} \\ T & \text{if } S \text{ has no zero} \end{cases}$$

where T is the semigroup obtained by adjoining the zero o to S.

2 Rees-matrix Semigroups

The set of all square matrices of a given order over a field $\mathbb{F}$ under usual matrix multiplication forms a semigroup and is denoted as $(\mathcal{M}_n(\mathbb{F}), \cdot)$. A collection of rectangular matrices of a given order will never form a semigroup under usual matrix multiplication.

Let $\mathcal{M}_{mn} = \mathcal{M}_{mn}(\mathbb{F})$ denote the set of all $m \times n$ rectangular matrices over the field $\mathbb{F}$. Fix a matrix $A \in \mathcal{M}_{nm}(\mathbb{F})$. Define an operation $*$ on $\mathcal{M}_{mn}(\mathbb{F})$ by

$$X * Y = XAY \quad \forall \ X, Y \in \mathcal{M}_{mn}(\mathbb{F}).$$

Now $(\mathcal{M}_{mn}(\mathbb{F}), *_A)$ denoted by $\mathcal{M}_{mn}^A$ becomes a semigroup and is called a *sandwich semigroup*. $*$ is called a *sandwich operation* and A is called *the sandwich matrix*.

Now we will look at an important example of a semigroup whose elements are a particular type of rectangular matrices.

Rees-matrix semigroups are a special class of semigroups introduced by David Rees in 1940.

Let G be a group and G^o be the semigroup obtained by adjoining o to G. Now G^o is a group with o. Let Λ and I be sets and define a mapping P on $\Lambda \times I$ as follows.

$$P : \Lambda \times I \longrightarrow G^o \quad \text{is a } \Lambda \times I \text{ - matrix over } G^o.$$

We denote the value of P at (λ, i) by $p_{\lambda i}$. That is, $P = (p_{\lambda i})$.

Let $\mathcal{M}^o(G; I, \Lambda; P) = (G \times I \times \Lambda) \cup \{o\}$. Define a product $\cdot$ on $\mathcal{M}^o(G; I, \Lambda; P)$ by

$$(a, i, \lambda) \cdot (b, j, \mu) = \begin{cases} (ap_{\lambda j}b, i, \mu) & \text{if } p_{\lambda j} \neq o \\ o & \text{otherwise} \end{cases}$$

Let $(a, i_1, \lambda_1) \cdot (b, i_2, \lambda_2) \in \mathcal{M}^o(G; I, \Lambda; P)$. By the definition of product,

$$(a, i_1, \lambda_1) \cdot (b, i_2, \lambda_2) = \begin{cases} (ap_{\lambda_1 i_2}b, i_1, \lambda_2) & \text{if } p_{\lambda_1 i_2} \neq o \\ o & \text{otherwise} \end{cases}$$

We have $a, b \in G$ and $p_{\lambda_1 i_2} \neq o$ is an element of G.

Hence $(ap_{\lambda_1 i_2}b, i_1, \lambda_2) \in \mathcal{M}^o(G; I, \Lambda; P)$. Also $o \in \mathcal{M}^o(G; I, \Lambda; P)$. Therefore $\mathcal{M}$ is closed under $\cdot$.

Let $x = (a, i_1, \lambda_1)$, $y = (b, i_2, \lambda_2)$ and $z = (c, i_3, \lambda_3)$.

$$(x \cdot y) \cdot z = (ap_{\lambda_1 i_2}b, i_1, \lambda_2) \cdot (c, i_3, \lambda_3) \ \text{ if } p_{\lambda_1 i_2} \neq o$$

$$= (ap_{\lambda_1 i_2}bp_{\lambda_2 i_3}c, i_1, \lambda_3) \qquad \text{if } p_{\lambda_2 i_3} \neq o$$

$$x \cdot (y \cdot z) = (a, i_1, \lambda_1) \cdot (bp_{\lambda_2 i_3}c, i_2, \lambda_3) \ \text{ if } p_{\lambda_2 i_3} \neq o$$

$$= (ap_{\lambda_1 i_2}bp_{\lambda_2 i_3}c, i_1, \lambda_3) \qquad \text{if } p_{\lambda_1 i_2} \neq o$$

$(x \cdot y) \cdot z = x \cdot (y \cdot z) \ \forall \ x, y, z \in \mathcal{M}^o(G; I, \Lambda; P)$. Hence $\mathcal{M}^o(G; I, \Lambda; P)$ is a semigroup.

Non-zero elements (a, i, λ) of $\mathcal{M}^o(G; I, \Lambda; P)$ can be represented as $I \times \Lambda$ - matrices

$$(a, i, \lambda) = (a_{i\prime\lambda\prime})$$

in which

$$a_{i\prime\lambda\prime} = \begin{cases} a & \text{if } (i\prime, \lambda\prime) = (i, \lambda) \\ o & \text{if } (i\prime, \lambda\prime) \neq (i, \lambda) \end{cases}$$

Such matrices are called *monomial* or *Rees matrices*. The element o is treated as $I \times \Lambda$ zero matrix $\left[0\right]_{I \times \Lambda}$. Treating the elements of $\mathcal{M}^o(G; I, \Lambda; P)$ in this form, the product reduces to the row - column product

$$(a, i, \lambda) \cdot (b, j, \mu) = (a, i, \lambda) P(b, j, \mu).$$

Hence the semigroup $\mathcal{M}^o(G; I, \Lambda; P)$ is called the *Rees $I \times \Lambda$ - matrix semigroup over G^o and the matrix P is called the sandwich matrix of the Rees matrix semigroup.*

Definition 2.1. *The sandwich matrix P is said to be regular if every row and every column contains atleast one non - zero entry; that is, for each $\lambda \in \Lambda$ there is $i \in I$ such that $p_{\lambda i} \neq o$ and for each $i \in I$ there is $\lambda \in \Lambda$ with $p_{\lambda i} \neq o$.*

Theorem 2.1. *P is regular if and only if $\mathcal{M}^o(G; I, \Lambda; P)$ is regular.*

Definition 2.2. *A semigroup without zero is called a simple semigroup if it has no proper ideals. A simple semigroup without zero can be made into a 0-simple semigroup by adjoining a zero element. A semigroup is said to be completely 0-simple if it is 0-simple and has a primitive idempotent(idempotents e with the property that $ef = fe = f \neq 0 \rightarrow e = f$).*

Theorem 2.2. *[The Rees Theorem]Every completely 0-simple semigroup is isomorphic to a regular Rees matrix semigroup over a group with zero and every regular Rees matrix semigroup over a group with zero is completely 0-simple.*

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Image Forgery Detection System (IFDS) using Jpeg Image Analysis

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Abstract

Digital image, like any other technological advancement, supplements and supports study and is nowadays a great medium for communication. Often, image forgery imparts a negative impact instead of producing useful materials for the further enhancement of our branch of study. Powerful image editing tools are very common these days. Digital images can be easily tampered with editing tools. Therefore, the detection of tampering operations is of great importance.Modification of images is verycommon mostly for the purpose of forgery. A part of an imageis copied and pastedin another image. The focus of this paper is to detect a selected image is forged or not and to identify the forged region in case of detected forgery. Image, texture and pixel value based features are extracted and analysed from the image. The process consists of three phases: Image pre-processing, Edge Detection and Localization of the tampered part. This approach is effective for the detection of forgery on the given image and locating the tampered region.

Keywords- V-Channel image, Horizontal and Vertical Projection image, Image convolution.

I   Introduction

Digital image processing is the utilizing of computer algorithms to perform image processing on digital images. These days, a large

number of digital documents are produced by a variety of devices and distributed by websites, magazines, newspapers and television. By all these information channels, images become a powerful tool for communication. As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing. It allows a greater range of algorithms to be applied to the input data and can curb problems such as the build-up of noise and signal distortion during processing. As images are defined over two dimensions (even more) digital image processing can be modelled in the form of multidimensional systems. Unfortunately, it is reasonably easy to use computer graphics and image processing techniques to modify images. A person must be able to detect if an image has been altered. Image composition (or splicing) is one of the most important image manipulation operations when assessing the authenticity of an image, forensic investigators make use of all useful sources of tampering evidence.

Digital image processing focuses on two major tasks - improvement of pictorial information for human interpretation and processing of image data for storage, transmission and representation for autonomous machine perception.

The researcher uses the color model to represent the color information of digital images. A color model is an abstract mathematical model describing the way colors can be represented as tuples of numbers, typically as three or four values or color components like RGB and CMYK.

Digital images offer many attributes for tamper detection algorithm to take advantage of specifically the color and intensity of individual

pixels as well as an image's resolution and format. These properties allow for analysis and comparison between the fundamentals of digital forgeries in an effort to take an algorithm for detecting image tampering and implementing it. This paper checks whether a selected image is forged or not.

This algorithm is discussed to determine what information can be gathered about a digital forgery saved in this format. Other fundamental properties of any digital forgery are used to develop additional detection technique such as direction filter, which is used to detect the forgery region when the experiments are conducted on the grey level of photos.

In this paper, RGB color model transform to another colormodel,three options are given HSV, Gray Scale imageandV- channel to extract edge image.Canny edge detection method is used to identifying the location of tampered region.

II   Image Forgery Detection System (IFDS) using Jpeg Image Analysis.

Proposed system is Image Forgery Detection System Based on Direction Filter using Jpeg Image Analysis.Pre-processing – given RGB image is converted into HSV,Gray scale or V-channel image. Options provided to select one of the above image. Direction   Filter is applied to remove noises present in the images. Enhancement techniques are applied for edge crisping and sharpening and extracted edge image shown in the fig.5.4. Feature extraction – In the image analysis, the edges are analysed using canny edge detection (sobel method) in the NetBbeans IDE.

A.   Based on Direction Filter Using JPEG Image Analysis

Forgery detection methods generally are based on JPEG compression threshold which work for only JPEG image format. Today digital cameras support other image formats also.photo forgery detection based on standard deviation based edge detection that detects the edges present in all directions [14]. The main steps of proposed algorithms are based on Image Edge Detection and tampering localization. Horizontal and Vertical projections are calculated and with the help of horizontal and vertical thresholds other directional edges are removed. Horizontal and Vertical edges images are combined together and feature map is generated.

B. Overview of the proposed system
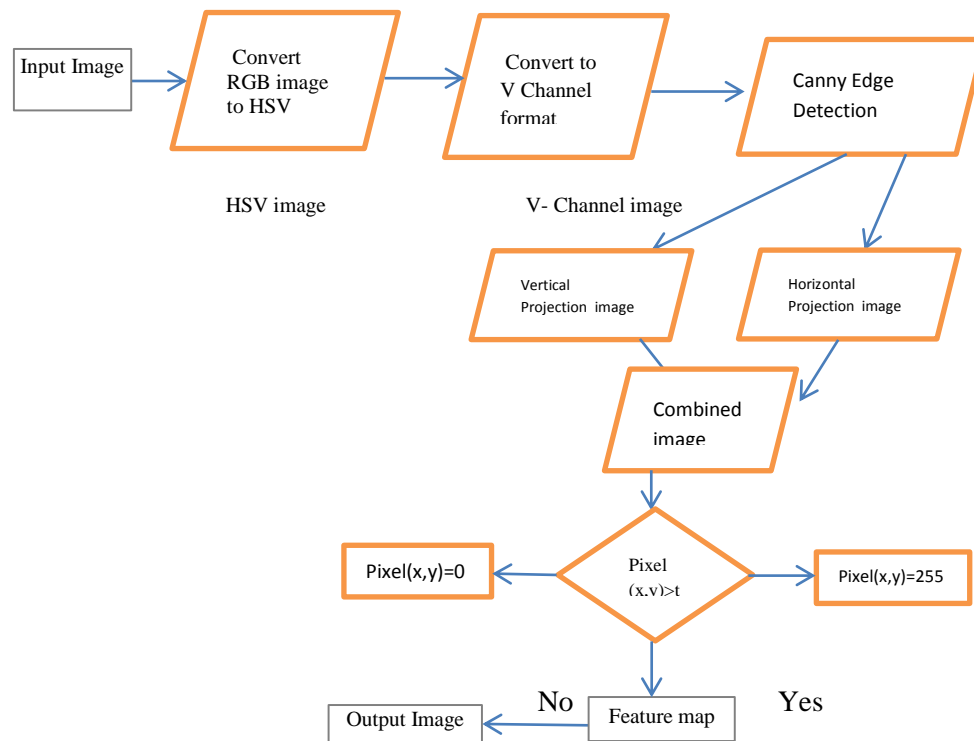
Fig1: Block diagram of Image Forgery Detection System

C.   The main steps of DIFDS

Step 1: Image Pre-processing: If the image data is not represented in HSV color space, it is converted to this color space by means of appropriate transformations. Our system only uses the intensity data (V-channel of HSV) during further processing. Here V Channel represents theintensity image.

RGB to HSV conversion formula

The *R,G,B*values are divided by 255 to change the range from 0..255 to 0..1:

R' =R/255 ,G' =G/255 , B' =B/255

Cmax= **max(*R',G',B'*)**

Cmin= **min(*R',G',B'*)**

Δ *=Cmax-Cmin*

Calculation

$$
\text{Hue} \quad H= \begin{cases} 60° \times \dfrac{G'- B'}{\Delta} \bmod 6, & Cmax = R' \\[2ex] 60° \times \dfrac{B'- R'}{\Delta} + 2, & Cmax = G' \\[2ex] 60° \times \dfrac{R'- G'}{\Delta} + 4, & Cmax = B' \end{cases}
$$

$$
\text{Saturation} \quad S = \begin{cases} 0, & \Delta = 0 \\[1ex] \dfrac{\Delta}{Cmax}, & \Delta \neq 0 \end{cases}
$$

Value: V=Cmax

Fig.2.1 **Input Image (Forged)**   Fig. 2.2 **H SV Image**   Fig. 2.3 **V-Channel Image**

Step 2: EdgeDetection:

This step focuses the attention to areas where tampering may occur. We employ a simple method for converting the gray-level image into an edge image. Our algorithm is based on the fact that the tampered image region possesses high standard deviation surrounds the tampered region.

Canny Edge Detection Steps:

1. Filter out any noise. The Gaussian filter is used for this purpose. An example of a

   Gaussian kernel of size=5 that might be used is shown below:

$$
B = \frac{1}{159}
\begin{pmatrix}
2 & 4 & 5 & 4 & 2 \\
4 & 9 & 12 & 9 & 4 \\
5 & 12 & 15 & 12 & 5 \\
4 & 9 & 12 & 9 & 4 \\
2 & 4 & 5 & 4 & 2
\end{pmatrix}
$$

2. Find the intensity gradient of the image. For this, we follow a procedure (Sobel)

   a) Apply a pair of convolution masks in x and y directions:

$$G_x = \begin{matrix} -1 & 0 & +1 \\ -2 & 0 & +2 \\ -1 & 0 & +1 \end{matrix}$$

$$G_y = \begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ +1 & +2 & +1 \end{pmatrix}$$

b) Find the gradient strength and direction with:

$$\mathbf{G} = \sqrt{\mathbf{G_x}^2 + \mathbf{G_y}^2}$$

$$\theta = \arctan\left(\frac{G_y}{G_x}\right)$$

The direction is rounded to one of four possible angles (namely 0, 45, 90 or 135)

3. Non-maximum suppression is applied. This removes pixels that are not considered to be part of an edge. Hence, only thin lines (candidate edges) will remain.

4. Hysteresis: The final step. Canny does use two thresholds (upper and lower):

  a)   If a pixel gradient is higher than the *upper* threshold, the pixel is accepted as an edge

  b)   If a pixel gradient value is below the *lower* threshold, then it is rejected.

  c)   If the pixel gradient is between the two thresholds, then it will be accepted only if it is connected to a pixel that is above the *upper* threshold.
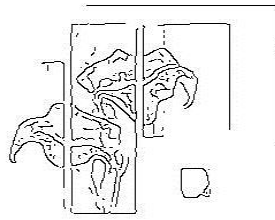
Fig2.4 *Edge Image*

Extracted the edge Image using Canny Edge detection method.

Step 2: Localization of tampered part

Horizontal and Vertical projections are calculated and with the help of horizontal and vertical thresholds other directional edges are removed. Horizontal and Vertical edges images are combined together and feature map is generated.

H -Threshold = Mean(Horizontal Projection)

V - Threshold = Mean(Vertical Projection)
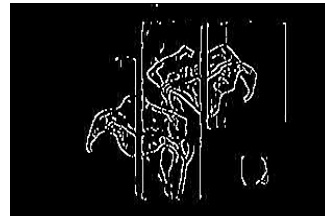
Fig 2.5Horizontal projection Image   Fig.2.6 Vertical Projection Image

Feature Map: It is a binary image same size as original image where high intensity indicates possibility of tampering.

Fig 2.7Feature map

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iii   Experimental Results

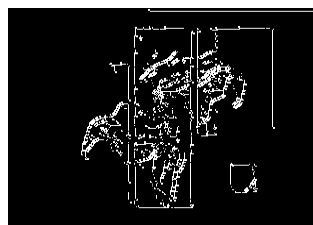The proposed method has been implemented using Net Beans IDE 7.31 and JAVA and executed on a computer of CPU 4.1.6 GHz with main memory 1 GB and secondary storage memory of 160 GB. Proposed approach has been evaluated and tests were conducted on such 50 images. System provide a selection for the transformation. Most of the images are copy moved forged images. First output is transformed HSV image. Then system only uses the intensity data (V-channel) of HSV image.
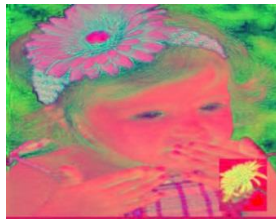

Fig.3.1 HSVImage   Fig.3.2 Gray Scale **Image**   Fig 3.3 **V-Channel Image**

In this paper the extracted V- channel image (Intensity image) is given to Edge detection. Edge image is extracted using Canny Edge detection method (Sobel method)
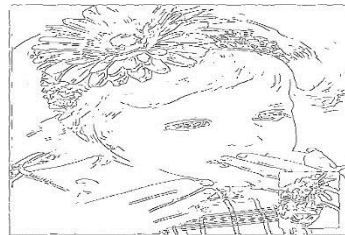
Fig 3.4 Edge   image

Fig3.5 Horizontal projection Image

Fig3.6   Vertical Projection Image

Fig 3.7 Final output(Feature map)

iv   Conclusion

This study gives an idea about digital image forgery. Image Processing plays a major role when compared to many other topics.Crimes due to forged images are of utmost significance in today's scenario. The threats posed by image forgery are rising rapidly. In this context, the objective was to give awareness about digital image forgery and also to detect the forged portions on an image. Specified algorithm and methods are being implemented properly and thereafter the concerning output is being generated. The remaining portion aims to implement some other features and techniques which I am planning to do for further researches. Further research will be focused on finding the part of the image where tampering is done.

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Trade-off between Urbanisation and Environmental Quality in Kerala

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Abstract

The growth of urban centres is inevitable for the economic development of any country. The southern state of India, Kerala is witnessing rising urbanization in its journey. This trend has emerged due to various facts and has made many positive contributions. But serious implications are visible in the environmental domain. It posses many health hazards and develop a potential threat to the ecological balance in the state. The trend of urbanization and its repercussions on environment are to be treated with utmost care.

Key words: urbanization, air pollution, health hazards.

Introduction

The massive and rapid urbanization emerging from the branches of modernization is a peculiar feature of the 20th century. The world is witnessing now a higher rate of urbanization in developing countries than in developed countries. But India is in a relatively low position in terms of urban growth compared to the other countries. The twentieth century has validated the slow but steady increase in urban population. Coming to the state scenario until 2001 the level of urbanization was low in Kerala but after a decade an expeditious increase was

visualized. This change brought by rapid industrialization and resulting economic development has led to deterioration of various environmental quality indicators such as soil, water and air. The recent decades are characterized by the contamination of soil, air and water due to various anthropogenic activities. Urbanization leads to degradation of the ecosystem affecting the existence of living and non-living organisms.

Review of literature

It is viewed that despite having lowest levels of fertility and mortality in the country, the population in Kerala is bound to increase for at least 40 years before attaining stability. This draws path for more congestion in urban areas and greater momentum for urbanization which will breach severe environmental damages in the state. The emissions of lethal gases from vehicles are considered the main source of atmospheric pollution. The presence of large number of slums is another cause for this.

Objective of the study

To analyse the trend of urbanisation in Kerala compared to India and the impact of environmental pollution.

Data description and methodology

The source of information for the study is based on secondary data. Census India report from 1961 to 2011 is used in this study.

Trends in urbanisation in kerala 1961-2011

Table 1: Urbanisation in Kerala and India, 1961-2011

Census Year	Degree of Urbanisation: Kerala	Degree of Urbanisation: India
1961	15.1	18.8
1971	16.2	19.9
1981	18.7	23.3
1991	26.3	25.7
2001	25.9	27.8
2011	47.7	31.2

Source: Census of India, 2011

The census data reveals that Kerala was seen as a low urbanisation state till 1991. Significant changes were observed in the same year when urban population in state reached 26.3% of the total population as compared to 18.7 % in 1981until then the state was below the national proportion of urban population. In 2001a slight decline can be observed as urban population has reduced to 25.9 percent. But in 2011 it is observed that urban population has doubled to 47.7 percent. This enormous hike in urban population has made Kerala the second most urbanized state in India after Tamil Nadu. In 2011, Kerala had 33.4 million inhabitants (16.0 million males and 17.4 million females). Nearly half of these people reported living in urban areas (47.7%). The contribution of census towns to this increase is nearly 93 per cent (Pradhan 2013).Therefore the crucial part of urban growth in Kerala took place during the period from 2001 to 2011 as a result of census

reclassification of rural villages as census towns. There was a reduction in the statutory towns from 60 to 59 in the same period and not due to growth of urban population in existing urban areas.

Threats of urbanisation: An overview

Currently half of the population lives in cities and by 2050, two –thirds of the world's population are expected to live in urban areas. The scope for employment opportunities, better living standards and prosperity are the pull factors for urban migration, but the two critical crisis of rising urban population will be poverty and environmental degradation.

The massive population and demands of urban environment leads to poor air and water quality, lack water availability, high energy consumption and waste disposal issues. The concentrated energy use in urban areas will lead to massive air pollution impinging threats to human health. A huge volume of uncollected wastes intensifies the crisis further. A study conducted indicates, that even if local air quality standards are met, a considerable health burden for the population living in urban Kerala can be assumed, which can be partly prevented by taking actions to reduce air pollution. (Myriam, et.al.2015). Sometimes urban development's can also magnify issues such as flash flooding. Serious repercussions are also felt on animal populations as they are confronted with toxic substances, vehicles and loss of habitat and food. The rising urban structures and pollution as its by-product leads to the loss of urban tree cover.

Conclusion

Elaborate and extensive city planning will be required to handle the problems arising in urban areas. The participation of local community must be ensured in local governance. Alternative transport systems and upgraded energy use must be adapted to reduce air pollution. Enabling private-public partnership is the best way to provide services such as waste disposal and housing. Imbibe the concept of green city spaces as a key element in urban planning.

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Azimuthal anisotropy of charmed mesons in Au+Au collisions at 200 GeV in STAR Experiment at RHIC

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Abstract

Heavy quarks are produced during the initial hard scattering process of the relativistic heavy ion collisions and they traverse the hot and dense medium created in these collisions – the Quark-Gluon Plasma (QGP). In non-central heavy ion collisions, the spatial anisotropy gives rise to anisotropy in momentum. A measurement of this anisotropic flow, can be an indicator of multiparticle correlations and collective phenomena in heavy ion collisions. Anisotropic flow corresponding to the second harmonic, called the elliptic flow (v_2) is sensitive to the early dynamics in QGP. Charm quark v_2 can tell the extent of thermalization in the medium created. Initial results after running a fine-tuned microvertexing code, for measurement of charmed mesons in Au+Au data at $\sqrt{s_{NN}} = 200$ GeV in RHIC collisions using the STAR-HFT data is presented here. Further, the preliminary results of anisotropic flow measurement of charmed mesons from STAR will also be presented.

Keywords: Quark Gluon Plasma, charm quarks, elliptic flow, thermalization, Heavy Flavor Tracker, RHIC, STAR.

Introduction

Solenoidal Tracker at RHIC (STAR) experiment is a state-of-the-art detector at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Lab, Upton, New York, USA. The STAR detector underwent an upgradation in 2014, whereby it added another subdetector close to the beam pipe – the Heavy Flavor Tracker (HFT), for the exclusive measurement of charmed particles. The HFT can topologically reconstruct all major charm carrying particles precisely [1]. Earlier measurements of charmed particles in STAR through semi-leptonic decay channel was ambiguous, since the measured non-photonic electrons (NPE) can come from both charm and bottom [2]. A direct measurement of charm was challenging with the resolution of the previous generation silicon detectors of STAR. Now, with the TPC-SSD-HFT detector configuration, STAR gives a pointing resolution of about 30 μm at 1 GeV [1]. This enables a direct measurement of charmed mesons and an unambiguous understanding of the observed suppression at high p_T, in central Au+Au collisions at $\sqrt{S_{NN}} = 200$ GeV.
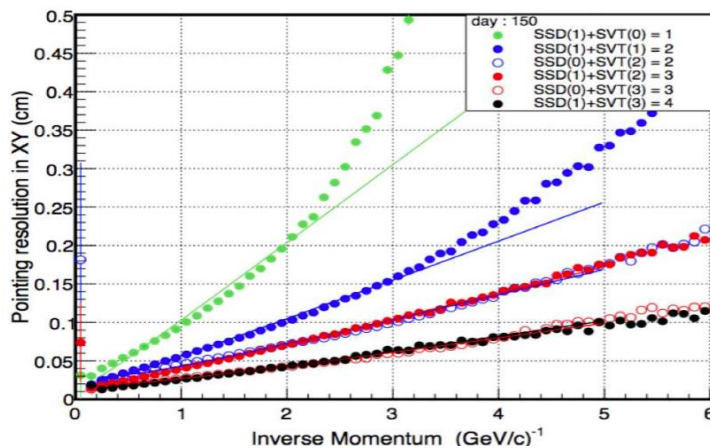
Fig. 1: Detector Resolution of older tracking detectors in STAR

A key measurement in the heavy quark sector is the flow parameters. The directed flow (v_1), elliptic flow (v_2) and triangular flow (v_3) of heavy quarks (c,b) are ideal probes since the mass of heavy quarks, $m_{c,b} \gg T_{QGP}$, the temperature of the QGP medium. The charm quarks are predominantly produced from initial hard scattering. Thus, the elliptic (v_2) and triangular (v_3) flow can indicate the medium properties. The elliptic flow (v_2) scales with the number of constituent quarks, indicating rapid thermalization at the partonic level itself. The directed flow parameter(v_1) will tell us about the interaction of heavy quarks with the huge electromagnetic fields created in Relativistic Heavy Ion Collisions.

With the HFT precession we will be clearly able to distinguish the two scenarios where; (1) charm quark flows or (2) charm doesn't flow. A direct charm reconstruction, its energy loss and anisotropic flow measurement will help in understanding the properties of the strongly interacting QGP state.

STAR Experiment

RHIC is a giant particle accelerator, capable of colliding heavy ions at relativistic speeds. RHIC has two large experiments. STAR is a large experiment to study the behavior of strongly interacting matter at high energy density and also to look for the production of QGP. STAR is a large acceptance detector with full azimuthal coverage and pseudorapidity of $|\eta| < 1$.

STAR-HFT uses active pixel sensors and silicon strip technology. It is designed for a precise measurement of charmed particles through their hadronic decay channel. HFT can measure neutral and charged

particles that decay 100 μm or less from the primary vertex by direct topological reconstruction of D mesons. The HFT replaced the decommissioned Silicon Vertex Tracker (SVT) using drift technology, with active pixel technology. The HFT consists of two subdetectors: a silicon pixel detector (PIXEL) and an intermediate silicon tracker (IST). The PIXEL is composed of two layers placed at 2.5 cm and at 8 cm from the beam axis. Its very thin layers minimize the multiple coulomb scattering. The IST layer placed at 14 cm and the SSD placed at 23 cm can link tracks from the TPC to the PIXEL. The SSD-IST-PIXEL detector serves the purpose of graded resolution from the TPC to the interaction point.

Table 1: Characteristics of each detector layer of STAR Experiment

Detector	Radius (cm)	Hit Resolution R/ϕ - Z (μm)
TPC	50 – 200	3327 – 2918
SSD	23	30 – 857
IST	14	170 – 1700
PIXEL	2.5, 8	8.6 – 8.6

Data Analysis and initial Results

The code to reconstruct the charmed mesons was fine tuned to run over the HFT dataset - 2014 Au+Au data at $\sqrt{S_{NN}} = 200\ GeV$. Various quality cuts were imposed in the code to reject background. These cuts were optimized using simulated data and applied to 3.16 Million real collision events. The primary vertex distribution is concentrated from -

40cm to +40cm, and no further cuts were imposed at the event level such as Trigger ID, vertex position or primary vertex resolution.
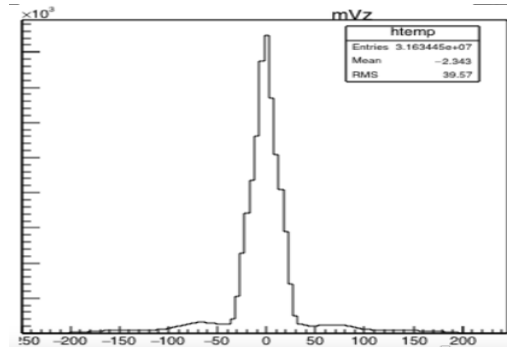
Fig. 1: Primary vertex distribution along z-axis

For the event plane calculation for flow parameters and at the track level, cuts were applied as given in Table.1 and the information is saved in the output root file for further offline analysis. Particle identification (PID) is achieved using information from the Time of Flight (TOF) detector. The product of the charge of the kaon and pion tracks is required to be negative to select oppositely charged particle tracks. The tracks were also required to have hits on all layers of HFT layers (HFT hits =4)

Table 2: Cuts used in the Reconstruction of $D^0 / \overline{D_0}$ Mesons

Cut Level	Cut Parameter	Value
Event Level		No cuts were applied at Event Level
Event Plane Calculation Level	Transverse Momenta DCA of Tracks to Event Vertex Pseudorapidity Track hits in TPC Ratio of number of hits fitted to max fit points	$0.2 < pT < 2.0$ $DCA < 2.0$ $|\eta| < 1.0$ $15 < Hits < 50$ $0.52 < HitsRatio < 1.05$
Global Track Level	Transverse Momenta Pseudorapidity Track hits in TPC Ratio of number of hits fitted to max fit points	$0.2 < pT < 2.0$ $|\eta| < 1.0$ $15 < Hits$ $0.52 < HitsRatio < 1.05$
PID Cuts	Time of Flight Cuts	$\lvert\frac{1}{\beta} - \frac{1}{\beta_\pi}\rvert < 0.04$ ((with $p_T > 0.5$)) $\lvert\frac{1}{\beta} - \frac{1}{\beta_K}\rvert < 0.04$ (with $p_T > 0.5$)
Track Loop	Kaon/Pion Tracks	$DCA > 0.005$ Silicon Hits $= 4$ Charge Kaon $\times$ Charge of Pion < 0
Decay Vertex	DCA between daughters DCA to primary vertex Decay Length	$DCA\_Kpi < 0.01$ $DCA\_PV < 0.01$ $DL > 0.005$

After the track level and PID cuts, the secondary vertex reconstruction is done using a Kalman Fitter machinery, which accounts for multiple Coulomb scattering (MCS) as the tracks pass through the detector layers. It also ensures that helix manipulation of a track is correct. After reconstruction of secondary vertex, we get various cut variables such as decay length, Distance of Closest Approach (DCA) between the daughter tracks, DCA of selected tracks to the event vertex etc. These cut variables can effectively remove the background from signal candidates. After running this cut set, the $D^0/\overline{D^0}$ particle is reconstructed with all the necessary variables saved in a TTree structure in an output root file, including event plane information for further offline analysis. Fig. 4 shows the invariant mass distribution obtained with this analysis.
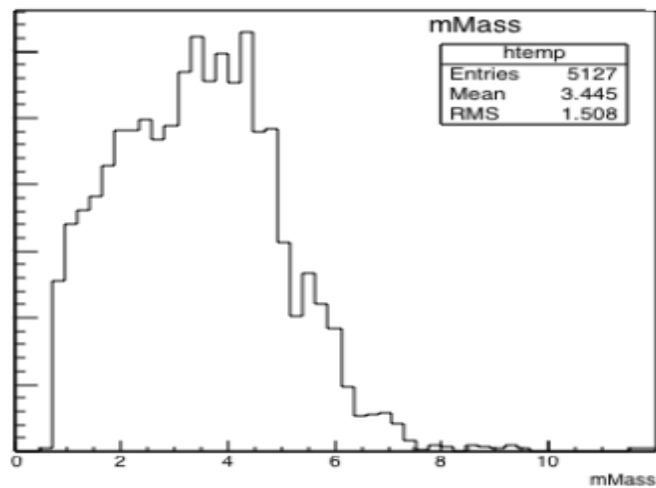
Fig. 4: Invariant mass distribution of the reconstructed $D^0/\overline{D^0}$ particles.

Preliminary Results from STAR

Recent measurements at RHIC, based on 2014 data, have shown that D^0 mesons in heavy-ion collisions exhibit significant elliptic flow [4]. The flow magnitude follows the same number-of-constituent-quark (NCQ) scaling pattern as observed for light-flavor hadrons in mid-central collisions. Fig. 2 shows the preliminary D^0 v_2 resutls from STAR. The blue solid markers in the left panel of Fig. 2 present the NCQ-scaled v_2 as a function of NCQ-scaled transverse kinetic energy $(m_T - m_0)$ for D_0 mesons in 10-40% central Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV.
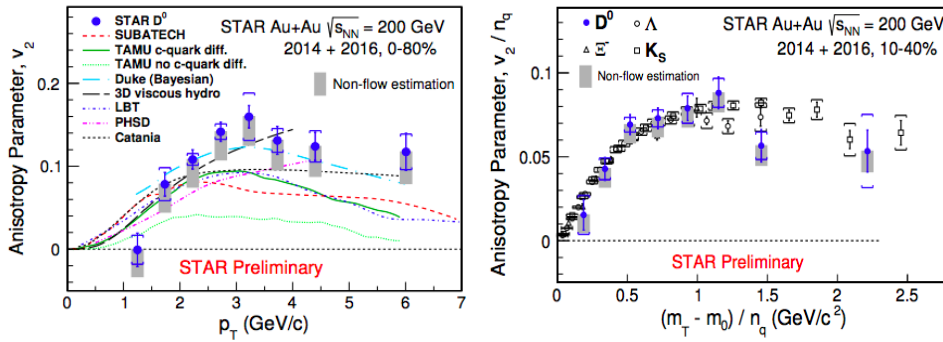
Fig. 2: Preliminary D^0 v_2 results from STAR Experiment

The results are compared to light hadron species, namely the K_S meson and the Λ and Ξ baryons [3]. The NCQ-scaled D_0 v_2 is compatible within uncertainties with those of light hadrons for $(m_T - m_0)/n_q < 2.5$ GeV/c^2. This observation suggests that the charm quarks exhibit the same strong collective behavior as light-flavor quarks, and may be close to thermal equilibrium with the medium in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV. The right panel in Fig. 2 presents the D^0 v_2 results in

0-80% central Au+Au collisions, and compared to different model calculations.

Conclusion

Results from STAR confirms substantial elliptic flow signals for a large variety of particle species, including the massive, multistrange hadrons in RHIC collisions [4]. The D^0 v_2 result suggests that the charm quark may be close to thermal equilibrium with the medium and it flows[3]. If charm quarks flow, then it would be the confirmative evidence of thermalization of the QGP medium. Studies are now in progress in determining the D^0 v_2 in the peripheral collisions (40-80%), with an enlarged pseudorapidity gap to reduce non-flow effects

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Low Temperature NIR Reflective Nano Pigments for Cool Roof Applications

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Abstract

The energy used to heat or cool buildings leads to the consumption of primary energy by 40% in most of the countries. The main concern of the researchers is to formulate exterior building paints as smart coatings with high IR-reflectance to decrease the use of energy for cooling buildings. A benefit of this approach is that it expands the palette of colours that the urban aesthetic needs requests to the dark ones, replacing the present white-cool solutions. Temperature is one of the main factors that contribute to coating ageing, and lowering temperatures has indirect benefits that include reducing binder degradation as well as cyclic thermal expansion of structures, encouraging overlaid coatings with high resistance, increasing the longevity of their properties, and lowering maintenance requirements and costs. This review focus on non-toxic, cheaper and easily synthesizable, high NIR Reflective cool nano pigments that help in energy savings.

Keywords: NIR reflectance, Cool nano pigments, Low temperature

Introduction

Solar energy comprises of 5% of ultraviolet,46% visible and about 49% of Near-infrared (NIR) radiation (wavelength ranging 750-2500

nm). These Near-infrared (NIR) radiation are responsible for thermal characteristics of solar radiation. It has been reported that coating a building's exterior walls and roofs with NIR reflecting pigments reduces energy consumption and provides a cooling effect. Besides, NIR reflective pigments have been applied in the military, construction, plastic etc [1]. Roofing materials possessing high solar reflectance garnered special attention in the current scenario of increasing global temperature and the demand of air-conditioned buildings. A study revealed that by increasing the heat reflectivity of the roof, homeowners can save an average of 23% of their cooling costs. According to the U. S. Department of Energy the colour of the building can significantly affect the interior temperature of the building and also shows an effect on the cost of electricity due to the usage of high power consuming electric equipment like air conditioner to reduce the interior temperature.

NIR reflective pigments are mainly metal oxides, and they are primarily useful in two major applications: (i) visual camouflage and (ii) reducing heat build-up (e.g., on a surface). These pigments absorb the visible and reflect the NIR portion of incident radiation. The authors report that using nanocrystalline TiO_2 leads to better IR reflectance and better radiative cooling properties compared to macrocrystalline TiO_2. TiO_2 rutile, a white pigment with a high NIR solar reflectance of 87%, is the best pigment used for roofing materials [2]. Despite the highest solar and heat reflectance of white pigments, coloured pigments are mostly preferred due to the disadvantages possess by the white pigments such as light pollution, poor stain resistance and monochromatic nature.

A wide range of different coloured pigment with high NIR reflectance have been reported. However, many of coloured pigments (chromium green, cobalt blue, cadmium yellow, nickel titanate yellow and lead chromate) contain toxic metal ions and hence their use is being restricted [3]. Recently there have been a few reports of coloured rare earth based NIR reflecting pigments as viable alternatives to existing toxic NIR reflecting coloured pigments. Thus, there is a strong incentive to develop novel coloured, environmental benign NIR reflecting pigments, both in its synthetic pathway and application. This review focuses on the synthesis and applications of low temperature NIR reflective nano pigments.

Yellow pigments

The synthesis of the yellow pigments in the last decade was focused on high cost-effective processes such as sol-gel method, solid-state route method, precipitation, and hydrothermal method. The sol-gel methods employed for yellow pigments synthesis, are characterized by low processing temperature but long time, usually not less than 24 h. Jose et al. (2018) improved this procedure using a relatively low temperature (150 $^\circ$C) sol-gel method, thus becoming a potential candidate for an environmentally benign process for cool pigments [4]. The sol-gel synthesis method used for synthesis of bismuth doped cerium oxide yellow nano-pigments, was based on the realization of a $Ce(OH)_4$ precipitate obtained from 0.2 M $Ce(NO_3)_3 \cdot 6H_2O$ solution in water (500 mL) and 20–30% of ammonia. The precipitate was dispersed in 1000 mL of water and 10% of HCl was added to maintain pH 2. A weighed amount of bismuth nitrate was added to ceria sol and

resultant bismuth-doped ceria sol was treated into an autoclave at 150°C for 24 h, followed by a 150°C drying process. The yellow hue of the pigments increases with increase in Bi^{3+} concentration in Ce based structure, up to the 15 mol% of Bi. From 20 mol% there is a decrease of *b** value from 52.26 to 40.12 indicating a decrease in the yellow intensity. With the increasing amount of Bi^{3+}, the rise in NIR reflectance values confirms this cation's active role in increasing saturation.

Bismuth vanadate ($BiVO_4$) gathered great attraction as a yellow inorganic pigment which could replace the conventional chrome and cadmium yellow. $BiVO_4$ particles are allowed to grow on white pigment surface through a citrate-gel method followed by a single stage firing by Thejus and Nishanth, (2019) [5]. Remarkable impact on the economic viability of the new complex pigment. The developed complex inorganic pigment exhibited excellent greenish-yellow colour (a* = −6.28, b* = 76.45), which is similar to pure $BiVO_4$. An exceptional near infrared reflectance has been recorded, which is estimated as high as 90%. High reflective coatings of developed complex pigment displayed significant response for temperature shielding experiment, could achieve reduction of 8.4°C in the interior temperature, compared to the commercially available yellow coating.

A pale-yellow color nano pigment $Bi_4Ti_3O_{12}$ (BTO) with impressive infrared (IR) reflectance (R = 95%)(Fig.1a and b) was synthesized using a simple hydrothermal method by Meenakshi and Selvaraj, (2018)[6]. BTO was synthesised by mixing acidic solution of bismuth nitrate (4 mmol) and butyl titanate (3 mmol) under constant stirring

and heated on a hot plate for 1 h. Then the NaOH solution was added drop wise to the solution till the precipitation formation ceases. Then the precipitate was hydrothermally heated to the temperature of 180 °C. The resulting powders were centrifuged and dried in an oven for 24 h at 80 °C and calcined at 600 to 800^0C. The band gap of the synthesized BTO nano pigment increases from 2.74 to 3.05 eV whereas reflectance value decreases from 99% to 95% by increasing the calcination temperature from 600 °C to 800 °C. The thermal study using IR lamp exposure showed that BTO coated steel substrate reduces the interior temperature by almost 10 °C while the TiO_2 coated steel substrate reduces the interior temperature by almost 7 °C confirms the application of BTO as "cool pigment".
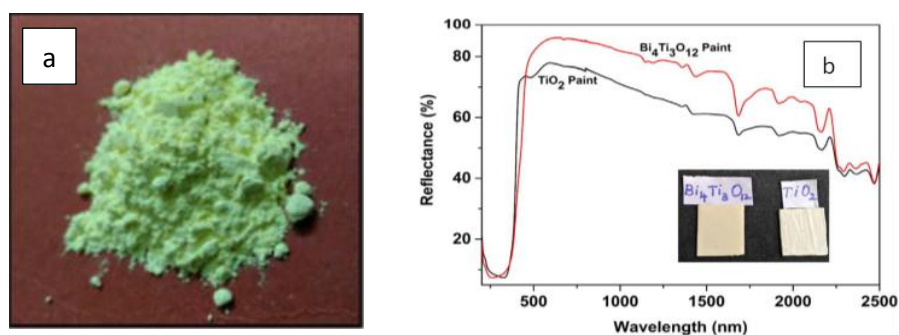
Fig.1 a) Picture of a pale yellow BTO nano pigment. b) IR reflectance graph for BTO and TiO_2 coated on glass. (inset) Photographs of BTO and TiO_2 coated glass substrate

Blue pigments

An intense blue nano-pigment (particle size: 180 nm) with impressive NIR reflectance (79% at 1100 nm) was derived from 1:1 mixture of $YIn_{0.9}Mn_{0.1}O_3$ and ZnO by a solgel combustion method at relatively lower temperatures (850^0C) was synthesised by Jose et al. (2016) [7].

The synthetic pathway of $YIn_{0.9}Mn_{0.1}O_3$-ZnO involves the addition of stoichiometric amounts of yttrium oxide (1.66 mmol), manganese (III) acetate (0.33 mmol), indium oxide (1.49 mmol) and zinc oxide (3.33 mmol) in 4.0 M nitric acid (100 mL) with constant stirring along with heating on a hot plate. The molar ratio of citric acid to metal was maintained as 3.5:1. The resultant pale-yellow solution was then dried to gel and then heated at 250 ^{0}C for 2 h. The typical blue colour of the sample was obtained only when the dried gel was calcined at 850 ^{0}C for 2 h. They found that the developed blue nano-pigment powder sample exhibits excellent solar reflectance (R* = 67%) (Fig.2), when coated onto an aluminium roofing sheet and has potential applications as "Cool materials" used for building roofing materials with energy saving performance.
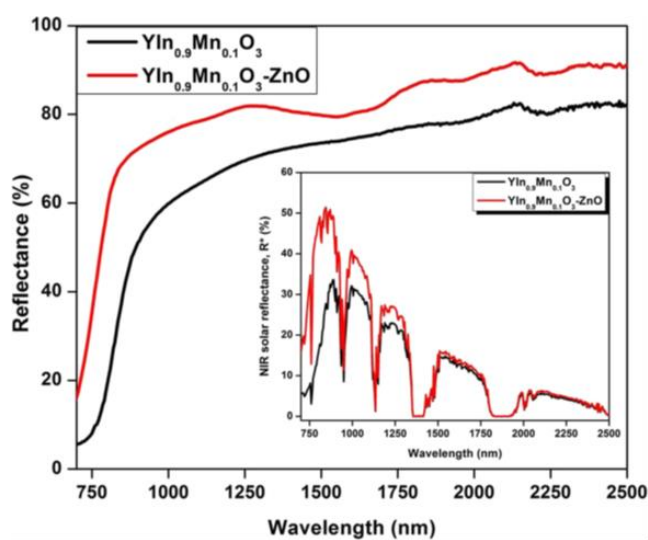
Fig.2. IR reflectance spectra of the blue pigment powders. The inset shows the corresponding solar reflectance spectra.

Red pigment

It is found that that various colour can be achieved by incorporating different amounts of metal ions into the $BiFeO_3$ lattice to tune the band gaps. A new series of NIR reflective inorganic pigments with general formula $Bi_{1-x} La_x FeO_3$ (x = 0, 0.1, 0.2, 0.3, 0.4) were fabricated via sol-gel route [8]. The samples are similar in morphology and have the average particle size of about 60 nm. The pigments display in colour from dark brown to reddish brown. The absorption edge of the pigment samples shifts to higher wavelengths (492 to 531 nm) with increasing of La^{3+} replaced for Bi^{3+} in $BiFeO_3$. These pigments exhibit higher NIR solar reflectance than conventional pigment, both in powdered form (R* > 53.1%) and in coating form (R* > 42.2%, coated on the concrete cement substrate).

Conclusion

The goal of the current effort is to prevent buildings from overheating in the summer by creating exterior building paints with unique qualities of improved reflectivity in the infrared band. The study has demonstrated that the replacement of standard white pigments with environment begin, NIR-reflective coloured pigments synthesised at low temperature are effectively used as cool materials for building roofing materials. Coloured rare earth based NIR reflecting pigments as potential substitutes for currently used, harmful coloured NIR reflecting pigments.

Acknowledgment

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Delhi Air Pollution cause and consequences- A Critical Analysis for the last Few Years

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Abstract

Delhi is the fifth most populated metropolis in the world with around 19.3 million inhabitants as per the report of year 2022. The environmental problems in Delhi are really a threat to the well-being of both rural and urban inhabitants as well as to the flora and fauna. It is one of the most heavily polluted cities in India with a reported high concentration of particulate matter. This year the average air quality index (AQI) was reported to be 212, which is the highest value compared to the last three consecutive years. Central Pollution Control Board reported a twenty-one days of poor air quality in May 2022, which is definitely alarming. This study aims to provide a statistical data of the cause and consequences of Delhi air pollution for the past few years.

Keywords: Anthropogenic sources, meteorological factors, PM10, Smog.

Introduction

Pure air and drinking water are the basic rights of a citizen in anywhere or everywhere in the world. Pure air is a mix of different gases such as oxygen, nitrogen, carbon dioxide, argon, and very small quantities of other gases in a fixed proportion. Any change in this constitution leads

to air pollution that affects the environment and consequently humans [1]. Now air pollution has become major concern worldwide. Five most polluted countries are Bangladesh, Chad, Pakistan, Tajikistan and India as per the latest report of World Health Organization [2]. Major sources of air pollution include natural as well as anthropogenic sources. Natural sources of air pollution include volcanic activity, dust, sea-salt, forest fires, lightening, soil outgassing etc. Anthropogenic sources include stationary point sources like emission from industries, mobile sources like vehicular emission, marine vessels, and airplanes, waste disposal landfills, open burning and so on.

On the basis of origin, air pollutants are classified into primary and secondary air pollutants. Primary air pollutants are those emitted directly from a source. Pollutants like sulphur dioxide, carbon monoxide, lead, ammonia etc. come under this category. Secondary pollutants are formed by the result of reactions between primary air pollutants and other atmospheric constituents. Ozone, peroxyacetyl nitrate (PAN), smog are some the secondary air pollutants formed in the presence of solar energy. On the basis of chemical composition, air pollutants are again classified into organic and inorganic air pollutants. Hydrocarbons, ketones, aldehydes, alcohols and amines are some of the examples of organic air pollutants. Some of the sulphur, carbon and nitrogen containing compounds are categorized as potent inorganic pollutants [3]. On the basis of state of the material, air pollutants are classified into gaseous air pollutants and particulate air pollutants. Particulate air pollutants or particulate matter (PM) are microscopic solid or liquid matter suspended in the earth's atmosphere. This is an important class of air pollutant with severe impact on atmosphere.

Particulate matter is sub divided into total suspended particulate matter (TSPM) obtained by high-volume bulk sampling using a filter substrate. This include PM10 with particles size less than 10 μm in diameter. PM 2.5 with particle size less than 2.5 μm in diameter. PM1.0 with particles less than 1 μm in diameter [4]. The air pollutants responsible for serious health hazards and environmental hazards are categorized as criteria pollutants by the US Environmental Protection Agency (EPA). This includes, photochemical oxidants, particulate air pollutants, ozone, sulphur oxides, carbon monoxide and lead causing acid rain, smog, property damage and so on [5]. Major health effects pollutants like sulphur dioxide, nitrogen dioxide, PM10 and PM2.5 are shown in Figure 1.

**Figure 1**. Health effects of major air pollutants in Delhi

Delhi the capital of air pollution

The real-time air quality index in Delhi on 7th July 2022 was 156 and reported to be a highly unhealthy situation. The twenty-four-hour

average air quality index was 322 on 6th July 2022 at 4 pm. The energy policy institute at the university of Chicago warned that an average Indian resident may set to lose five years of life expectancy, if the WHO norms about air pollution are not followed [6]. At this critical scenario, the Commission for Air Quality Management (CAQM) has decided to ban the use of coal in all applications in the entire Delhi-NCR region from January 1, 2023.

Local climatic and seasonal factors highly affect the air quality of Delhi apart from the vehicular and industrial emissions [7]. The land-locked territory, surrounded by desert, hot planes and cool hill regions restricts the dilution of emissions. Delhi is in the subtropical belt with all extreme weather conditions. Winter is the most critical season for Delhi which dominated by dry and cold air and low wind conditions. A layer of warm air covers the bottom layer containing pollutants that leads to severe air pollution. Smog formation during the winter season is another problem in Delhi. Climatic as well as vehicular pollution are the major reason for smog formation. Tons of crop residues are burned during the harvest season in Indo Gangetic plains. This smoke with fog and other pollutant materials turned into smog. Increased amount of PM10 is the reason for the deterioration of air quality during summer. But the pollution is found to be minimum during rainy season [8]. There are lot of air quality monitoring stations in and around Delhi for continuous updates and analysis (Figure 2).
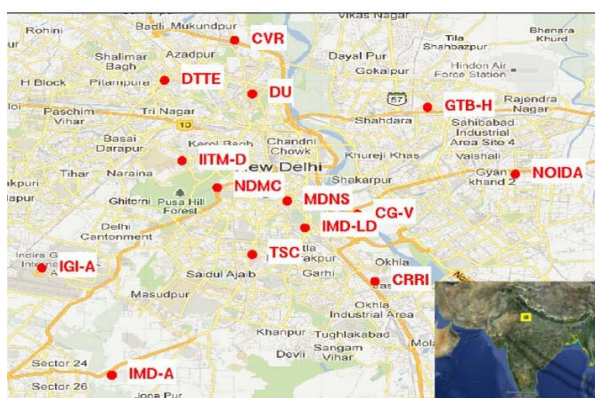
Figure 2. Air quality monitoring stations in Delhi [9]

Deepavali a major festival in north India, celebrates during the mid of autumn and winter, may be another reason for the degradation of air quality.

Delhi air pollution for the last few years

The air quality in Delhi during the Deepavali celebration for the year 2010 was monitored and studied by the Central Pollution Control Board (CPCB), Delhi. It was carried out seven locations considering all the factors. Average temperature was 21.2^{o}C, humidity profile of 75.5% and a wind speed of 0.9 m/sec. There was variation in the concentration of sulphur dioxide and nitrogen dioxide in the locations. But the concentration of the respirable suspended particulate matter (RSPM) increased in all the monitored regions in comparison to the previous years.

Similar air monitoring was done in seven locations on 26th October 2011 under an average temperature of 26.4°C with a humidity profile of 39% and a wind speed of 1.1 m/sec. The air pollutant level was found to be less compared to 2010. Sulphur dioxide and nitrogen

dioxide concentration show the similar trend but RSPM concentration decreased in all the locations. This was due to the favorable meteorological conditions like increase in mixing height, increase in temperature, increase in wind speed in combination with decreased relative humidity.

In contrast to the previous years, air monitoring taken on 13th November 2012 exhibited a decrease in air quality in all the locations. Sampling was done at a temperature of $20.2^{o}C$, relative humidity 68% and a wind speed of 0.43 m/sec. These adverse meteorological conditions ultimately lead to the increase of sulphur dioxide, nitrogen dioxide and RSPM values in all the locations.

Similar in-depth ambient air quality monitoring was carried out on 3rd November 2013 by CPCB and analysed the impact of bursting of crackers on environment. Sampling was done under a temperature of $21^{o}C$, humidity of 69% and a wind speed of 0.19 m/sec. sulphur dioxide and nitrogen dioxide concentrations exhibited variation in the locations but RSPM values increased in all the locations compared to the previous years. The increased PM10 value was attributed to the adverse meteorological conditions like low wind speed and lower night time temperature.

In relation to the increasing trend in air pollution, a close and comprehensive monitoring was carried out from 15th October 2014 to 23rd October 2014. Sampling was done at a temperature range of $19^{o}C$ to $32^{o}C$, relative humidity 41 to 90 m/s and a wind speed of 0.2 to 0.6 m/s. Levels of sulphur oxide, nitrogen oxide and RSPM were very high on the festival day compared to other normal days.

Similar sampling and analysis were carried out on 11th November 2015, the Deepavali day exhibited a decreasing trend in the concentrations of sulphur dioxide and nitrogen dioxide in some of the locations. But the PM10 and PM2.5 levels increased in comparison with the previous years. It was attributed to the adverse meteorological situations like low wind speed and lower night time temperature.

Table 1. Year wise minimum and maximum pollutant level in Delhi

(*All values are provided in microgram per cubic meter*)

Year	SO$_2$	NO$_2$	PM10
2010	8-51	34-72	704-1350
2011	4-13	34-78	416-635
2012	13-63	44-85	748-951
2013	11-56	31-52	952-1097
2014	8-32	53-82	442-756
2015	18-80	27-80	100-593
2016	16-110	43-141	100-1297
2017	11-80	47-80	100-706
2018	5-80	44-82	100-1168
2019	5-80	51-80	100-617
2020	4-80	79-101	100-953

(*National air quality standard in microgram per cubic meter: SO$_2$-80, NO$_2$-80, PM10-100*)

On 30th October 2016, concentrations of sulphur dioxide and nitrogen dioxide were found to be within the prescribed limit but higher compared to the previous year. Concentration of both PM10 and PM2.5 exceeded the prescribed limit irrespective of the sampling locations.

The analysis carried out at 19th October 2017 show that the levels of both sulphur dioxide and nitrogen dioxide were within the limit and lesser in some of the regions compared to the year 2016. Values of PM10 and PM2.5 exceeded the normal limit but was less compared to the Deepavali day of 2016.

The CPCB analysis of 7th November 2018 shows high concentrations of both PM10 and PM2.5 irrespective of all the locations. These concentrations were above the prescribed limit as obtained in the previous years. But there was not much variation in the level of sulphur dioxide and nitrogen dioxide even on the Deepavali day. The increased PM10 value was attributed to the adverse climatic conditions like low night time temperature and low wind speed.

Similar air monitoring was carried out on 27th October 2019 in different locations with low night time temperature and low wind speed. Sulphur dioxide concentration was within the range and comparatively less than in the previous year. But the nitrogen dioxide concentration was higher than the prescribed limit in one of the locations. PM10 and PM2.5 values exceeded the limit in all the locations but comparatively less than in the previous year.

The air monitoring carried out at different locations on 9th November 2020 shows higher levels of all the pollutants in some of the locations

compared to the previous year analysis. There were high concentrations of both PM10 and sulphur dioxide in one of the location due to the impact of firecracker bursting. The meteorological conditions were highly favorable for the deterioration of air quality during the analysis.
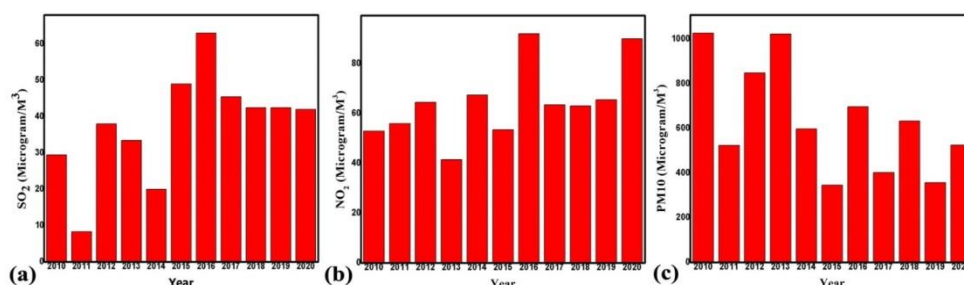
Figure 3. Delhi air pollutant concentration (a) SO_2 (b) NO_2 and
(c) PM10 from 2010-2020

Conclusion

Air monitoring data analysis for the last few years in Delhi shows that the situation is still alarming. Even though the authorities are well aware of the alarming situation, the inhabitants of Delhi suffer the shortage of fresh air. The deterioration of air quality is not only of the impact of seasonal celebrations but also the impact of vehicular emissions, stubble burning by farmers of adjacent states along with meteorological conditions. Sulphur dioxide, nitrogen dioxide and respirable particulate matter are the major pollutants of concern in Delhi region. There was a slight decrease in the concentration of sulphur dioxide and PM10 compared to the 2010 situation. But the level of nitrogen dioxide shows continuous increase from 2010 to 2020 and still higher. There was expectation for an improvement in air quality due to covid-19 lock down but on contrary it was still lower.

But reduction in the amount of some of the pollutants may be considered as a relief for the inhabitants. The high concentration of PM10 and PM2.5 is a challenge and should be controlled by proper measures. Source and sector-specific measures should be planned and implement immediately. Other measures like controlling the burning of stubble and other bio-mass, reduction in vehicular emission, implementing new pollution standards, controlling dust and industry and demolition waste reduction should be strictly followed.

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Synthesis of Visible-Light Active Bismuth Oxide Nanoparticles

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Abstract

Metal oxide semiconductors with a bandgap between 2-4 eV are an important class of compounds in the electronics industry and for photocatalysis. With the demand for these materials expanding rapidly, especially in the field of photocatalysis, the fabrication of nanoscale metal oxide particles, which increases the surface-to-volume ratio and thereby reduces the materials costs, is an emphasis of current research. For the purpose of photocatalysis, another important quality is the ability to absorb light efficiently. The reliable synthesis of nanosized particles of metal to oxides remains an ongoing challenge for materials researchers. This manuscript is intended provide a brief overview of different existing methods of Bismuth oxide nanoparticles synthesis.

Key words: Bismuth Oxide, Photocatalyst, Hydrothermal, Green synthesis.

Introduction

Traditional semiconductors (with a bandgap < 2 eV), have revolutionized the electronics industry in the last few decades. Wide band-gap semiconductors with a bandgap between 2-4 eV and typically > 3 eV offer possible solutions since the wider bandgap allows them to withstand rapid switching frequencies and high-power loads while maintaining insulating properties[1]. However, such wide band-gap semiconducting materials are chemically sensitive, especially toward oxidation, which creates complications with respect to their fabrication, modification, and utilization [2]. In addition to possessing a wide bandgap, metal oxides, in lieu of already being in the oxidized state, resist oxidation at high temperatures and are robust under a wide variety of chemical environments. These characteristics are especially important for photocatalysis, a contact process, where the chemical stability of wide band-gap metal oxides is massively important, as is the need for compatibility with a wide variety of reaction media and reacting species. The wide bandgap of most metal oxides is also comparable to electrode potentials of many important reactions, such as the splitting of water to produce both hydrogen and oxygen, reduction of CO2, oxidation of organic molecules, and the degradation of dyes and other pollutants [3]. Upon irradiation by light having an appropriate wavelength, electrons are excited from the valence band (VB) to the conduction band (CB), while at the same time creating holes in the VB [4]. The photogenerated electrons can participate in reduction reactions, while the holes in the VB can catalyse oxidation reactions, making metal oxides powerful photocatalytic materials. In addition to the aforementioned benefits, metal oxides are also the most

abundant materials in the Earth's crust, which translates to low costs compared to other types of wide band-gap semiconductor materials. Metal oxides are also known for their good mechanical stress tolerance and compatibility with organic materials, extending their range of applications. Nevertheless, the desired wide bandgap for metal oxides comes at a price. The corresponding absorption of these materials is limited to the UV region (5% of the solar spectrum reaching the Earth's surface), which hinders their efficient utilization of the entire solar spectrum. Therefore, for the purpose of photocatalysis and photovoltaics, a more efficient absorption of solar light is desirable one which encompasses a much wider range of wavelengths. This shortcoming is driving the search for wide band-gap metal oxide materials with optical responses in the visible to near-IR regions. One way of achieving this objective is to couple the metal oxides with visible-light-absorbing materials such as organic dyes or plasmonic noble metal nanoparticles and by doping the metal oxides with selected elements [5]. Amongst various oxide semiconductor photocatalysts, Bismuth Oxide has proven to be the most widely used due to its strong oxidizing power, non-toxicity and long-term photostability. This review focuses on previously conducted research on the synthesis of visible-light-active Bismuth oxide nanoparticles.

Bismuth Oxide

Dibismuth trioxide is one of the industrially important compounds of Bismuth. Bismuth (III) oxide is commonly used to generate Dragon' egg effect in fireworks. It can replace highly toxic red lead in Pyrotechnic. Bismuth oxide (Bi_2O_3) is an interesting material and very

important in modern solid-state technology. It is fascinating to scientists owing to its unique structures and physical properties, such as a large energy band gap, high refractive index, dielectric permittivity and high oxygen ion conductivity, as well as marked photoconductivity and photoluminescence [6]. Due to these properties is used in a variety of areas, such as sensor technology, optical coatings and electrochromic materials [7], [8]etc.

Bi_2O_3 has five main polymorphic forms, denoted by α-, β-, γ-, δ- and ω- Bi_2O_3 [9]. The room temperature phase, α- Bi_2O_3 has a monoclinic crystal structure. There are three high temperature phases, a tetragonal β-phase, a body-centred cubic γ-phase, a cubic δ- Bi_2O_3 phase and an ω- phase. Among them, the band gaps of the low-temperature α-phase and high-temperature metastable β-phase are 2.85 eV and 2.58 eV, respectively [10]. Existence domains of the four polymorphs of Bi_2O_3 as a function of temperature. (a) The α-phase transforms to the δ-phase when heated above 727 °C, which remains the structure until the melting point, 824 °C, is reached. When cooled, the δ-phase transforms into either the β-phase at 650 °C, shown in (b), or the γ-phase at 639 °C, shown in (c). The β-phase transforms to the α-phase at 303 °C. The γ-phase may persist to room temperature when the cooling rate is very slow, otherwise it transforms to the α-phase at 500 °C.

The room temperature α-phase has a complex structure with layers of oxygen atoms with layers of bismuth atoms between them. The bismuth atoms are in two different environments which can be described as distorted 6 and 5 coordinate respectively. β- Bi_2O_3 has a structure related to fluorite. γ- Bi_2O_3 has a structure related to that of

$Bi_{12}SiO_{20}$ (sillenite), where a fraction of the Bi atoms occupy the position occupied by Si(IV), and may be written as $Bi_{12}Bi_{0.8}O_{19.2}.\delta$-$Bi_2O_3$ has a defective fluorite-type crystal structure in which two of the eight oxygen sites in the unit cell are vacant. ε- Bi_2O_3 has a structure related to the α- and β- phases but as the structure is fully ordered it is an ionic insulator. It can be prepared by hydrothermal means and transforms to the α- phase at 400 °C.

The monoclinic α-phase transforms to the cubic δ- Bi_2O_3 when heated above 729 °C, which remains the structure until the melting point, 824 °C, is reached. The behaviour of Bi_2O_3 on cooling from the δ-phase is more complex, with the possible formation of two intermediate metastable phases; the tetragonal β-phase or the body-centred cubic γ-phase. The γ-phase can exist at room temperature with very slow cooling rates, but α- Bi_2O_3 always forms on cooling the β-phase. Even though when formed by heat, it reverts to α- Bi_2O_3 when the temperature drops back below 727 °C, δ- Bi_2O_3 can be formed directly through electrodeposition and remain relatively stable at room temperature, in an electrolyte of bismuth compounds that is also rich in sodium or potassium hydroxide so as to have a pH near 14.

Solid phases of Bi_2O_3
(melting point 824°C)
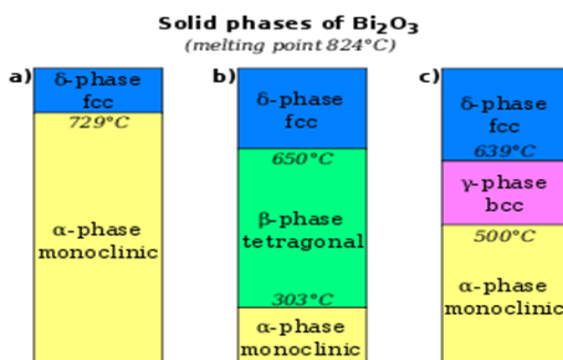
Synthesis of Bismuth oxide

Methods for the synthesis of nanoparticles vary widely and require a range of approaches and much greater control compared to bulk powders. Bismuth Oxide nanostructures can be fabricated by several methods such as solution [11], solution combustion, solvothermal [12], hydrothermal [13], laser ablation [14], microwave [15], sol–gel [16], flame spray pyrolysis [17], thermal decomposition [18], electrodeposition [19], thermal oxidation [20], chemical vapour deposition [21], precipitation [22] and green synthesis [23]. The green synthesis is a challenge for preparation of monodispersed nanoparticles with specific sizes and shapes. Biosynthesis methods have more advantages than other classical synthesis procedures due to the easy availability, rich biodiversity, and eco-friendly processes. Beside basic spherical nanoparticles which are the most popular, there are several other types of Bi_2O_3 nanostructures such as nanowires [24], nanofibers, nanoflakes, and nanospheres [25].

Strategies for the synthesis of nanoparticles can be broadly classified as top-down or bottom-up. The top-down approach begins with large particles (macro or micro scale) that are broken down to nano-sized particles, typically via mechanical processes such as milling. A major disadvantage of this approach is the lack of control over the shape, size, and uniformity of the resulting nanoparticles. In contrast, the bottom-up approach begins with atomic nuclei, which affords much greater control over the structural parameters. In the latter approach, the precursor salts of the constituent elements are treated with oxidizing/reducing agents, leading to seeding and growth of the desired

nanoparticles. Bottom-up approaches were first explored and optimized with elemental nanoparticles of noble metals such as gold, silver, and palladium [26]. Later, the approaches were adapted for the synthesis of bimetallic nanoparticles, composed of two elements, starting with dual precursors. Further advances in this field saw the nanoparticle synthesis of metal oxides, chalcogenides, polymers, carbon-based nanostructures, and recently doped and multicomponent versions of these materials.

The primary advantage of the bottom-up approach is that the nanoparticle seeding and growth processes can be controlled by additional reagents acting as ligands, surfactants, and growth inhibitors [27]. Colloidal nanoparticles experience inter-particle van der Waals attraction that pull them closer while high surface energies cause them to aggregate. To inhibit aggregation, colloidal nanoparticles are often stabilized by the use of ligands or surfactants that bind to the surface of the nanoparticles, lowering their surface energy and providing steric or electrostatic stabilization [28]. Commonly used surfactants include polyethylene glycols (PEGs), poly(vinylalcohols) (PVAs), poly (vinylpyrrolidone) (PVP), polyacrylamides, Triton X100, citrate, sodium dodecyl sulfate (SDS), and cetyltrim-ethyl ammonium chloride or bromide (CTAC, CTAB). The addition of surfactants during synthesis can also stabilize the seeded nuclei or bind to the surfaces of the growing nanoparticles, providing additional control over the growth process [29]. Nanoparticle seeding and growth processes can also be controlled by modifying a variety of parameters such as temperature, pressure, stir-speed, solvent, degassing, and reaction times.

The most common methods for the synthesis of Bismuth Oxide nanoparticles are wet chemical methods, such as solution-based, hydrothermal, sol-gel, microwave-assisted, non-aqueous (solvothermal), and polyol methods. Solution based methods are typically carried out in glass reactor vessels at temperatures below 150 °C. The advantages of this method are the ability to monitor the progress of the reaction visually, adjust stir-speed, step-wise addition of reagents, and the option to conduct the reaction under inert atmosphere or reflux conditions [30]. However, for the synthesis of Bismuth Oxides nanoparticles, hydrothermal methods are more common. Hydrothermal methods are sometimes also preceded by a low-temperature solution-based preparation step. Hydrothermal synthesis utilizes higher temperature and high-pressure water conditions to generate nanoparticles from precursors that are insoluble at moderate temperatures and pressures. Hydrothermal synthesis is usually carried out below 300 °C and can be regarded as an electrostatic reaction between metal ions and hydroxyl ions to generate the metal oxide [31]. Hydrothermal conditions are preferred over routine solution-based methods since high temperatures in a closed vessel, typically a Teflon lined autoclave inside a stainless-steel reactor, aids in the formation of crystalline nanoparticles. Furthermore, this facile and convenient method provides good control over homogeneity, size, composition, phase, and morphology [32].

Another popular technique for Bismuth Oxide nanoparticle synthesis is the sol-gel technique. The sol-gel technique begins with a homogeneous solution of the precursors; after condensation of the solution to a gel, the solvent is dried to form the nanoparticles [33].

This technique is especially suitable for fabricating multicomponent nanoparticles with good control over size and shape, and can yield crystalline nanoparticles using ambient temperatures for sol and gel preparation. Most of these methods typically require an additional calcination step to improve the crystallinity of the resulting nanoparticles.

However, aqueous sol-gel and hydrothermal methods suffer from certain disadvantages due to the double role of water as ligand and solvent, complicating the synthesis of small structures. As such, non-aqueous solvothermal and sol-gel methods have seen increased use for the synthesis of binary, ternary, and doped metal oxide nanoparticles. Using organic solvents, such as benzyl alcohol, offers a better match in reactivity of metal oxide and dopant precursors, providing good control over size and shape. The polyol method, using ethylene glycol and its derivatives as solvent, is another powerful method for controlled nanoparticle synthesis. The sheer multitude of available polyols with varying molecular weights and boiling points, combined with water-like solubility for common precursors, offers additional flexibility; furthermore, synthesis temperatures of 200-320 °C can be accessed without using autoclaves [34]. Wet chemical methods using combinations of oleic acid, oleyl amine, and oleic alcohol have also shown great success for the synthesis of uniform Bismuth Oxides at temperatures near 390 °C. These high temperature processes allow for the formation of crystalline nanoparticles directly from the liquid phase. Notwithstanding the advantages of the abovementioned wet chemical methods, these processes generally need long reaction times (typically between 4 to 48 hours). Microwaves can penetrate and

supply heat throughout the volume of a material, enabling temperatures well above the boiling point of the solvent. Such heating can increase the speed of reactions by a factor of 10-1000, allowing reactions to be completed in minutes or even seconds [32]. Even at such rapid processing times, it has been observed that microwave assisted synthesis can also maintain narrow size distribution and high purity. These aforementioned methods for the synthesis of Bismuth Oxide nanoparticles can be modified and adapted to fabricate doped Bismuth Oxide nanoparticles.

Green synthesis is very easy and cost-effective method for production of nanoparticles using the extract. The plant extract can act as reducing and capping agent for the reduction of metal ions and the formation of nanoparticles because of presence of the various biomolecules such as flavonoids, enzymes, proteins, phenolic acid, alkaloids, and terpenoids.

Conclusion

As described in this review, much useful research on the synthesis of Bismuth oxide nanoparticles has been conducted. Surprisingly, hollow, porous, or mesoporous nanospheres are often easier to synthesize than solid nanoparticles. Hydrothermal/solvothermal syntheses are the most popular methods for preparing Bismuth oxide nanoparticles, owing largely to their simplicity and potential for scale up. Sol-gel methods are also commonly used, while the surfactants include polyethylene glycols (PEGs), poly vinyl alcohols (PVAs) method provides a powerful approach for large-scale synthesis of uniform nanoparticles with fine control over their shape and size. Bismuth oxide is an inexpensive catalyst and features recyclability and non-toxicity. A

comprehensive understanding of readily manufacturable Bismuth Oxide nanoparticles opens the door to all these possibilities. Undoubtedly, we will continue to see creative advances in this promising field of research.

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Silver nanoparticles incorporated Hand sanitizer- A Better tool to prevent bacterial/viral infections

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Abstract

During the current pandemic situation, the use of hand sanitizer is becoming an inevitable part of our lives. Appropriate hand hygiene using sanitizers can prevent the transmission of pathogens from one person to another. We have synthesized a herbal hand sanitizer, incorporated it with silver nanoparticles and studied their efficiency by anti-microbial study. Moreover, compared its efficiency with a commercially available hand sanitizer. The result showed that the synthesized sanitizer shows better efficiency against both gram positive and gram-negative bacteria.

1. Introduction

Coronavirus disease 2019 (COVID-19), first identified in China in late 2019, is a highly contagious viral illness caused by SARS-CoV-2. The virus quickly spread across the globe. During the corona virus outbreak, hand sanitizers have become an inevitable part of our life. It has played an important role in cleanliness and personal hygiene. Hand sanitizers are made with alcohols such as ethyl alcohol or isopropyl alcohol, the ingredients for moisturizing are aloe vera and glycerol are used. For fragrance various essential oils or other natural ingredients are used. Depending on the active ingredient used, hand sanitizers can

be classified as one of two types: alcohol-based or alcohol-free hand sanitizer. Alcohol-based products typically contain between 60 and 95 percent alcohol, usually in the form of ethanol, isopropanol, or n-propanol. Alcohol-free products are generally based on disinfectants, such as benzalkonium chloride (BAC), or on antimicrobial agents, such as triclosan. Studies revealed that efficiency of hand sanitizers can be improved by adding nanoparticles, anti-microbial agents or by maintaining temperature, pH, etc.

A nanoparticle is a small particle that ranges between 1 to 100 nanometres in size and nanotechnology is the study of manipulating matter on an atomic scale. Green synthesis of nanoparticles has gained significant importance in recent years as it has several merits such as it is simple, cost-effective, nanoparticles formed have good stability, less time consumption, non-toxic by-products, environment-friendly and can be easily scaled up for large-scale synthesis.Green synthesis of nanomaterials refers to the synthesis of different metal nanoparticles using bioactive agents such as plant materials, microorganisms, and various biowastes including vegetable waste, fruit peel waste, eggshell, agricultural waste, and so on. The growing need to develop "green" and economical synthesis systems for metal nanoparticles has prompted researchers to explore the use of microorganisms, plant extracts, and other biomaterials. In our study we have synthesized silver nanoparticle incorporated hand sanitizer and compared its anti-microbial activity with reference to a commercially available hand sanitizer. Green synthesis method was used for producing silver nanoparticles from silver nitrate.

2. Experimental

2.1 Materials

Silver nitrate was purchased from Nice chemicals, surgical spirit, glycerine and Dettol were purchased from nearby medical shop. Neem, Aloe Vera and guava leaves were collected from nearby garden. Distilled water was used throughout the experiments.

2.2. Green Synthesis of silver nanoparticles

In order to prepare the silver nanoparticles by biological method, the neem leaves were washed and cut into small pieces. 25 g of the neem leaves in distilled water is boiled and filtered, this is the neem extract. The neem extract is filled in the burette and it is used as the reducing and capping agent for the green synthesis of silver nanoparticles.

10 mg of silver nitrate in 50 ml of distilled water was taken in a beaker.The magnetic stirrer was set upwith temperature to 80-90 degree Celsius. The leaf extract was added drop wise and very slowly in to the silver nitrate solution until yellow color forms. The synthesis route is outlined in figure below

2.3. Synthesis of Hand sanitizer

For preparing the hand sanitizer first, 10 pieces Aloe vera leaves and Guava leaves were collected and washed thoroughly to remove the unwanted particle and dust. The aloe veraleaveswere cut into half and inner pulps are separated from the leaves by knife. The pulps were grinded in grinder machine and then put the gel into separate bowl. Washed guava leaves were added in water and boiled with guava leaves until it is syrupy. Then the syrup was strained to remove dust. Then 70 ml of surgical spirit was mixed with 7 ml of glycerin. Into the mixture

a20 ml aloe vera gel and 2 ml guava extract syrup were added. At last 1 ml of dettol was added and mixed to get homogeneous liquid sanitizer.

To 50 ml of synthesized sanitizer, 5 ml of Ag nanoparticles were added and mixed thoroughly to get silver nanoparticle incorporated hand sanitizer.

3. Results and Discussion

3.1. UV–visible spectroscopy

The UV visible spectrum of synthesized silver nanoparticles (Fig. 1)was taken and analyzed. The UV visible spectrum of the aqueous medium containing silver nanoparticles showed absorption peak at 433 nm which indicated the formation of silver nanoparticles.
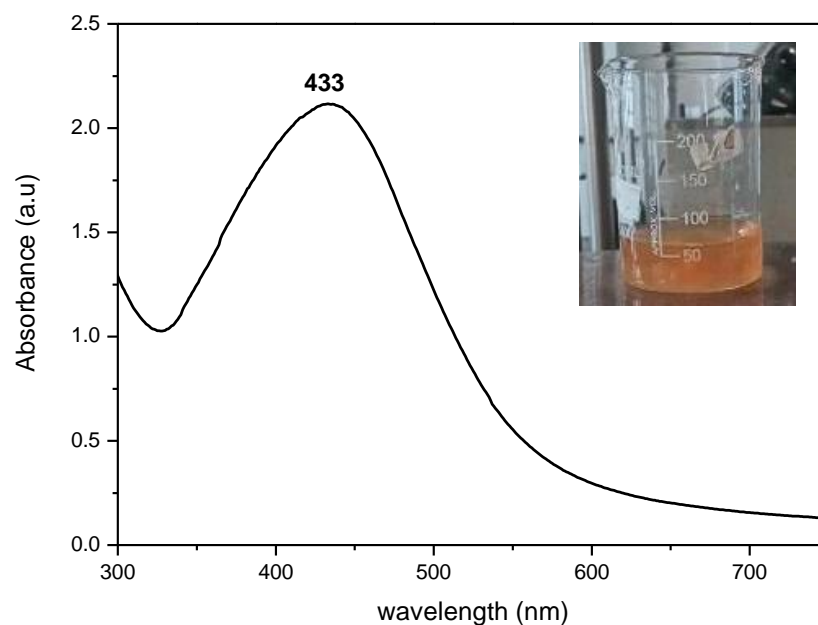

Fig 1   UV visible spectrum of the silver nanoparticles (inset-image of synthesized silver nanoparticles)

3.2 Anti-microbial Test

The sanitizer prepared in the laboratory without silver nanoparticles (denoted as A), sanitizer incorporated with silver nanoparticles (denoted as B), a commercially available hand sanitizer(Dettol, designated as C), were evaluated for antimicrobial activity against both gram positive and gram negative bacterial strains. The four plates contained Ecoli (plate 1), Staphylococcus (Plate 2), Pseudomonas (Plate 3) and Kelbsiellapneumonia (plate 4) respectively. By analyzing the plates, it was confirmed that the sample B, the Ag nanoparticle incorporated hand sanitizer showed maximum efficiency against all strains of bacteria. Sample C which is the commercially available hand sanitizer shows minimum efficiency against all strains of bacteria. Sample D which is the control shows is the least efficient against all the strains of bacteria among the samples which were analyzed. Analyzing the samples, antimicrobial efficiency order was found to be B>A>C>D in plate 1, plate 2 and plate 4, whereas in plate 3 no activity can be seen. It shows that the samples don't show any activity to Pseudomonas. The values of diameter are shown in Table and the plates were shown in Fig 2.

Table 1 Diameter zone of inhibition of the plates

SAMPLE	PLATE 1	PLATE 2	PLATE 3	PLATE 4
A	2.8	1.8	0.6	2.4
B	3.0	2.0	0.7	2.8
C	2.5	1.7	0.5	2.1
D	1.1	1.5	0.6	1.0
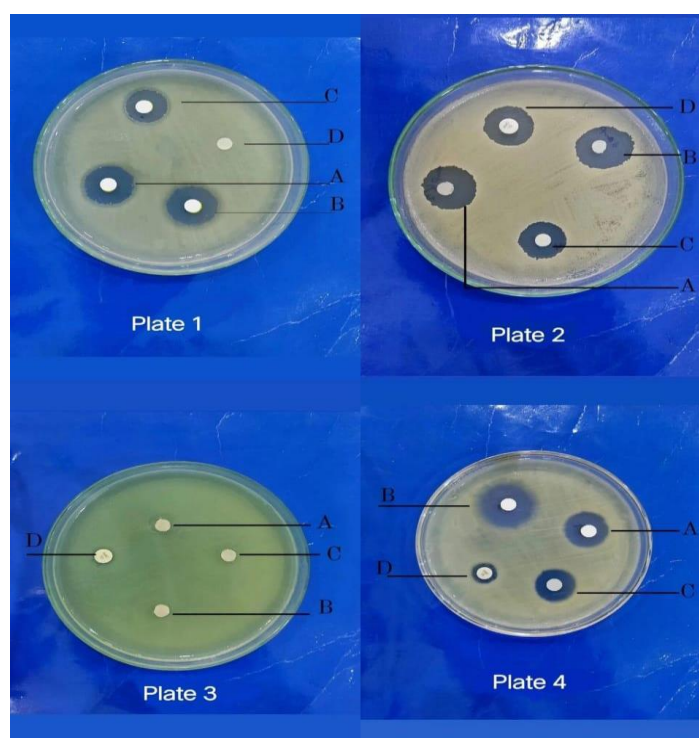
Fig 2 Antimicrobial activity of the samples A, B, C and D against Ecoli (plate1), Staphylococcus (plate 2), Pseudomonas (plate3) and Kelbsiella pneumonia (plate 4).

4. Conclusions

Proper hand hygiene can prevent the transmission of pathogens from one person to another. Herbal hand sanitizers are effective and environmental friendly. Hand sanitizer synthesized from guava leaves can be made with easily available ingredients and they are shown to be effective. Various researches had already determined the antimicrobial potential of the guava leaves. The antimicrobial activity of the hand sanitizer is enhanced by adding silver nanoparticles synthesized from silver nitrate using neem leaves extract as reducing agent. The formation of silver nanoparticles was confirmed by UV-Visible

absorption studies. Silver nanoparticle incorporated hand sanitizers possessed maximum antimicrobial effect against all the bacteria followed synthesized herbal hand sanitizer and commercially available hand sanitizer, respectively. The commercially available hand sanitizer showed least efficiency which suggests that despite the claims of efficiency and 99.9% bacterial reduction by hand sanitizer manufacturers, there still exsists a need for verification of these claims by regulatory bodies and higher authorities for the enforcement of good-quality measures.

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