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SPHERICAL SYMMETRIC DISTRIBUTION OF WET DARK FLUID ADMITTING CONFORMAL MOTIONS

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Abstract

In this article, we have studied the role of wet dark fluid (WDF) in static spherical symmetric space-time admitting one parameter group of conformal motions in the presence of cosmological constant Λ. The various properties of the solutions are also discussed.

1. Introduction

In modern astrophysics and cosmology, understanding the nature of dark energy is one of the most challenging problems. Observational data like la Supernovae suggest that the universe is dominated by two dark components containing dark energy (DE) and dark matter (DM). Dark energy with negative pressure is used to explain the present cosmic accelerating expansion while dark matter is used to explain galactic curves and large-scale structure formation [Chirde and Rahate [5]].

Recent cosmological observations, such as type I supernovae (SNeIa) [Riess et al. [21]], Sloan Digital Sky Survey (SDSS) [Tegmark et al. [27]], Wilkinson Microwave Anisotropy Probe (WMAP) [Nolta et al. [20]; Hinshaw et al. [14]], contradict the matter dominated universe with decelerating

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expansion indicating that our universe experiences accelerated expansion. Cosmologists have proposed many candidates for dark energy to fit the current observations such as cosmological constant, tachyon, quintessence, phantom and so on [Mishra and Sahoo [18]].

There is a new matter for dark energy called Wet Dark Fluid (WDF). This model is in the spirit of generalized Chaplygin gas (GCG), where a physically motivated equation of state is offered with properties relevant for the dark energy problem [Mishra and Sahoo [18], Chaubey [4]]. The cosmological models with wet dark fluid have been discussed by many researchers [Mishra and Sahoo [19], Samanta et al. [22-23], Mete et al. [17], Shobhane and Deo [18], Katore et al. [16], Deo and Singh [9], Chirde and Kadam [6], Deo et al. [10], Mahanta and Sheikh (2017), Dagwal [8]].

General relativity provides a rich arena to use symmetries in order to understand the natural relation between geometry and matter furnished by Einstein's equations. Symmetries of geometrical/Physical relevant quantities of this theory are known as collineations and the most useful collineation is conformal killing vector defined by

$$\mathcal{L}_{\xi} g_{ij} = \xi_{i;j} + \xi_{j;i} = \psi g_{ij}, \psi = \psi(x^i),$$

where $\mathcal{L}_{\xi}$ signifies the Lie derivative along ξ^i and $\psi = \psi(x^i)$ is the conformal factor. In particular, ξ is a special conformal killing vector, if $\psi_{;ij} = 0$ and $\psi_{,i} \neq 0$. Here (;) and (,) denote covariant and ordinary derivatives, respectively.

Conformal killing vectors provide a deeper insight into the space-time geometry and facilitate generation of exact solutions to the field equations and hence many of the authors [Herreraetal. [12], Herrera and Leon [13], Coley and Tupper [7], Sharif [24], Yavuz et al. [29], Yilmaz et al. [28], Aktas and Yilmaz [1], Kandalkar et al. [15], Shobhane and Deo [26]] have been studied conformal collineations.

Motivated with the work of these authors, we have examined the wet dark fluid matter in the static spherical symmetric space-time admitting one parameter group of conformal motions.

The paper is outlined as follows:

In section 2, we have obtained Einstein field equations for static spherical symmetric distribution of wet dark fluid admitting one-parameter group of conformal motions.

In Section 3, the solutions of the Einstein field equations are obtained for wet dark fluid. At the end, the properties of the solutions obtained are discussed in concluding section 4.

2. Field Equations

The most general static spherically symmetric line element in isotropic form [Banerjee and Santos [2] and Hajj-Boutros [11]] is given by

$$ds^2 = e^{\nu(r)}dt^2 - e^{\omega(r)}(dr^2 + r^2 d\Omega^2), \tag{1}$$

where

$$d\Omega^2 = d\theta^2 + \sin^2\theta d\phi^2,\ x^{1,2,3,4} = r,\ \theta,\ \phi,\ t.$$

The energy momentum tensor for wet dark fluid (WDF) is given by

$$T_{ij} = (\rho_{WDF} + p_{WDF})u_i u_j - p_{WDF} g_{ij} \tag{2}$$

together with

$$g_{ij}u^i u^j = 1, \tag{3}$$

where u^i is the four-velocity vector of the fluid, p_{WDF} and ρ_{WDF} are the pressure and the energy density of wet dark fluid respectively.

Einstein field equations can be expressed as

$$R_{ij} - \frac{1}{2}Rg_{ij} + \wedge g_{ij} = -8\pi G T_{ij}, \tag{4}$$

where Λ is the cosmological constant.

Here, we shall use geometrized units so that $8\pi G = c = 1$.

Then using equations (1), (2) and (4), we get

$$e^{-\omega}\left[\frac{\omega'+\nu'}{r}+\frac{\omega'}{2}\left(\upsilon'+\frac{\omega'}{2}\right)\right]+\Lambda=p_{WDF} \tag{5}$$

$$\frac{1}{2}e^{-\omega}\left[(\omega''+\nu'')+\left(\frac{\omega'+\nu'}{r}\right)+\frac{\nu'^2}{4}\right]+\Lambda=p_{WDF} \tag{6}$$

and

$$-e^{-\omega}\left[\omega''+\frac{2\omega'}{r}+\frac{\omega'^2}{4}\right]-\Lambda=\rho_{WDF}, \tag{7}$$

where primes denote differentiation w.r.t. r.

3. Solutions of Field Equations

Now we shall assume that space-time admits one-parameter group of conformal motions [Aktas and Yilmaz [1]], that is

$$\mathcal{L}_\xi g_{ij}=\xi_{i;j}+\xi_{j;i}=\psi g_{ij}, \tag{8}$$

where $\mathcal{L}_\xi$ signifies the Lie derivative along ξ^i and Ψ is an arbitrary function of r. Using equations (1) and (8) by virtue of spherical symmetry, we get the following expressions:

$$\xi^1\nu'=\psi, \tag{9}$$

$$\xi^1=\frac{\psi r}{r\omega'+2}, \tag{10}$$

$$\omega'\xi^1+2\xi^1_{,1}=\psi, \tag{11}$$

and

$$\xi^2=\xi^3=0,\ \xi^4=\alpha=\text{constant}, \tag{12}$$

where comma denotes partial derivative.

Using equations (9), (10) and (11), we obtain

$$\omega'=\nu'-\frac{2}{r} \tag{13}$$

and

$$\xi^1 = kr, \tag{14}$$

where $k(>0)$ is an arbitrary constant.

Using equations (9), (13) and (14), we get

$$\nu' = \frac{\psi}{kr} \tag{15}$$

and

$$\omega' = \frac{\psi}{kr} - \frac{2}{r}. \tag{16}$$

Further, on integration equation (13) gives

$$e^{\omega} = \frac{e^{\nu}}{a^2 r^2}, \tag{17}$$

Where $a(>0)$ is an arbitrary constant and $r>0$.

Using the equations (5) and (6), we get

$$\frac{2\psi'}{kr} - \frac{\psi^2}{k^2 r^2} + \frac{2}{r^2} = 0 \tag{18}$$

The general solution of differential equation (18) is given by

$$\psi = \sqrt{2}k\left[\frac{1+(br)^{\sqrt{2}}}{1-(br)^{\sqrt{2}}}\right], \tag{19}$$

Where $b(>0)$ is an arbitrary constant and $r \neq \frac{1}{b}$.

Then using equation (15)-(17) and (19), we get

$$e^{\nu} = \frac{(cr)^{\sqrt{2}}}{[1-(br)^{\sqrt{2}}]^2} \tag{20}$$

and

$$e^{\omega} = \frac{(cr)^{\sqrt{2}}}{a^2 r^2 [1-(br)^{\sqrt{2}}]^2}, \tag{21}$$

where $c(>0)$ is an arbitrary constant.

For simplicity, we denote

$$B = (br)^{\sqrt{2}} \text{ and } C = (cr)^{\sqrt{2}}. \tag{22}$$

Then (19), (20) and (21) take the form:

$$\psi = \sqrt{2}k\left(\frac{1+B}{1-B}\right), \tag{23}$$

$$e^{\nu} = \frac{C}{(1-B)^2} \tag{24}$$

and

$$e^{\omega} = \frac{C}{a^2 r^2 (1-B)^2}. \tag{25}$$

Using equations (5) and (7), we obtain

$$\rho_{WDF} = \frac{e^{-\omega}}{4k^2 r^2}(8k^2 - 3\psi^2) - \Lambda \tag{26}$$

and

$$p_{WDF} = \frac{e^{-\omega}}{4k^2 r^2}(3k^2 - 4k^2) + \Lambda. \tag{27}$$

We have

$$p_{WDF} + \rho_{WDF} = \frac{e^{-\omega}}{r^2} \geq 0. \tag{28}$$

This implies that wet dark fluid will not violate the strong energy condition. Further,

$$\rho_{WDF} - p_{WDF} = \frac{3e^{-\omega}}{2k^2 r^2}(2k^2 - \psi^2) - 2\Lambda \geq 0. \tag{29}$$

The equation of state for wet dark fluid is given by

$$p_{WDF} = \gamma(\rho_{WDF} - \rho^*), \tag{30}$$

Where the parameters γ and ρ^* are taken to be positive and $0 < \gamma < 1$, and it

is good approximation for many fluids including water, where the internal attraction of the molecules make negative pressure possibly.

Using equations (23)-(27) and (30), we get

$$\Lambda = -\frac{a^2[(4-n)(1+B^2)+12(4+n)B]}{2(4+n)C} \leq 0 \tag{31}$$

and

$$\rho^* = \frac{a^2(4-n)}{n} \geq 0, \tag{32}$$

Where $\gamma = \frac{n}{4}$, $0 < n < 4$ and B, C are given by (22).

Using (1), the space-time geometry, that is, the line element is given by

$$ds^2 = \frac{(cr)^{\sqrt{2}}}{[1-(br)^{\sqrt{2}}]^2}\left[dt^2 - \frac{1}{a^2 r^2}(dr^2 + r^2 d\Omega^2)\right]. \tag{33}$$

4. Conclusion

From space-time (33), it is clear that there are two singularities; one at $r = 0$ and another at $r = \frac{1}{b}$. Since $B - 1 < B^2$, both $p_{WDF} > 0$ and $\rho_{WDF} > 0$. At $r = \frac{(4+n) \pm \sqrt{(4+3n)(4-n)}}{2nb^{\sqrt{2}}}$, $p_{WDF} = 0$, but for real positive value of r, $\rho_{WDF} \neq 0$. Further, wet dark fluid does not violate the strong energy condition as $p_{WDF} + \rho_{WDF} \geq 0$. As $r \to 0$, $p_{WDF} \to \infty$ and $\rho_{WDF} \to \infty$ and $r \to \infty$, $p_{WDF} \to \infty$ and $\rho_{WDF} \to \infty$.

References

[1] C. Aktas, I. Yilmaz, Gen. Rel. Grav. 39 (2007), 849-862.

[2] A. Banerjee and N. O. Santos, J. Math. Phys. 22(4) (1981), 824.

[3] Chandra Rekha Mahanta and Azizur Rahman Sheikh, Astrophysics and Space Science 362(9) (2017), arXiv: 1706. 06412.

[4] R. Chaubey, Astrophys Space Sci. 321 (2009), 241.

[5] V. R. Chirde and P. N. Rahate, Global Journal of Science Frontier Research Physics and

Space Science 13(5) (2013), 25, ISSN: 0975-5896.

[6] V. R. Chirde and V. P. Kadam, International Journal for Innovative Research in Science and Technology 3(5) (2016), 63-68.

[7] A. A. Coley, O. J. Tupper, J. Math. Phys. 30 (1989), 2616.

[8] V. J. Dagwal, Canadian Journal of Physics, https://doi.org/10.1139/cjp-2019- 0226(2019)

[9] S. D. Deo and S. P. Singh, Mathematical Theory and Modelling 3(9) (2013), 30.

[10] S. D. Deo, G. S. Punwatkar and U. M. Patil, International Journal of Recent Scientific Research 9(10) (2018), 29267-29269.

[11] J. Hajj-Boutros and J. Sfeila, Gen. Rel. Grav. 18(4) (1986), 395.

[12] L. Herrera, J. Jimenez, L. Leal, J. Poncede Leon, M. Esculpi and V. Galino, J. Math. Phys. 25 (1984), 3274.

[13] L. Herrera and J. Ponce de Leon, J. Math. Phys. 26 (1985), 778.

[14] Hinshaw et al. Astrophys, J. Suppl. Ser. 180 (2009), 225.

[15] S. P. Kandalkar, A. P. Wasnik, M. N. Gaikwad and S. P. Gawande, Prespacetime Journal 4(1) (2013), 48.

[16] S. D. Katore, A. Y. Shaikh, S. A. Bhaskar and G. B. Tayade, The African Review of Physics 7 (2012), 0035.

[17] V. G. Mete, V. D. Elkar, K. R. Mule, Advanced Studies in Theoretical Physics 9(12) (2015), 575.

[18] B. Mishra, P. Sahoo, Astrophys Space Sci., DOI10.1007/s10509-013-1652-6 (2013)

[19] B. Mishra and P. Sahoo, Journal of Theoretical and Applied Physics 7 (2013), 36.

[20] Noltaet al., ar Xiv: 0803. 0593[astro-ph] (2008).

[21] Riess et al., Astron. J., 116(1998), 1009.

[22] G. C. Samanta, S. Jaiswal and S. K. Biswal, Eur. Phys. J. Plus 129 (2014), 48.

[23] G. C. Samanta, B. K. Bishi, Iran J. Sci. Technol. Trans. Sci. DOI10.1007/s40995- 017-0215-z (2017).

[24] M. Sharif, Journal of Mathematical Physics 45 (2004), 15-18, arXiv: grqc/0310019v1.

[25] P. D. Shobhane and S. D. Deo, International Journal of Research in Engineering and Applied Sciences 6(11) (2016), 158.

[26] P. D. Shobhane, S. D. Deo, Prespacetime Journal 8(1) (2017), 61.

[27] Tegmark et al., Phys. Rev., D69 (2004), 103510.

[28] I. Yilmaz, M. Aygun and S. Aygun, Gen. Relativ. Gravit. 37(12) (2005), 2093.

[29] I. Yavuz, I. Yilmaz and H. Baysal, Int. J. Mod. Phys. D, 14 (2005), 1365.

EXPLORING NEW POSSIBILITIES OF MARKET EXPANSION IN RURAL INDIA

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Research Article

EXPLORING NEW POSSIBILITIES OF MARKET EXPANSION IN RURAL INDIA

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ABSTRACT

India is the country of villages as two-third of the population survives in the rural areas. Marketers and the various big brands have major opportunities to enhance their brand value by expanding their market in a rural village. The rural population can generate a lot of profit for the companies therefore companies are showing their interest in the rural market. Large quantities of industrial and manufactured products are consumed by the rural people due to the green revolution. Rural markets provide a lot of opportunities in the form of untapped markets to increase income as well as increase the literacy level. Rural marketing strategy has been implemented by the marketers and Fast Moving Consumer Goods companies to take advantage of the opportunities. This article will help to explore the various possibilities along with the current scenario of the rural market.

Keywords: rural areas, rural population, multinational companies, rural market, market expansion.

INTRODUCTION

In a few years, the growth of the rural market will get better than the urban market. The total rural population in India is about 833 million.(**Census, 2011**) Marketers are focusing on the expansion of the rural market and "Go rural" has become the new slogan of the marketers. Multinationals as well as Indian marketers such as Godrej, Palmolive, and Hindustan Liver are showing their interest in the rural market and looking for opportunities to expand their business in the rural market. Rural markets are the future of upcoming business and big brands are trying to understand the dynamics of the rural market to get more competitive advantages (Tenhunen 2018). In the earlier time, Haats were most popular among the villages that contained the local products where local buyers and local sellers were present. It was a kind of weekly event and considered as the most important source of economy. The demand base of the rural market is quite high and provides opportunities to the marketers.

India is a country of villages two-thirds of the population lives in rural areas. Market expansion approaches help different organisations to grow along with their existing channels. In this aspect, the main consideration will be given to exploring new possibilities of market expansion in rural India. The rural markets are extremely different from the urban markets and it also offers a great aspect of opportunities. In this scenario, it can be seen that the rural market of India has a huge undiscovered and untapped market which has great opportunities as well. Through this review study, the possibilities of market expansion will be analysed as

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well as different types of strategies for exploring the market opportunities and their challenges will be discussed.

LITERATURE REVIEW

In recent decades, it can be seen that the rural markets of India are gaining much importance and they are also attracting marketers due to the substantial increase in the purchasing power of the people living in the region (AnhTu et al. 2020). Rural markets offer great opportunities because promoting and estimating certain specific products and services for the rural region can give the customers fulfilment of their necessary needs as well as the organisation goals of different companies can be accomplished (Tenhunen, 2018). Since the 1980s in the consumer market of India, the marketers or around the world especially in India are accumulating strategies for rural market because the opportunity is seen by evaluating 70% of the population who are looking forward to new products and services. The present scenario of the rural market can be understood to be extremely diverse especially in India. About 60 to 70% of the people are looking for the change and there are also looking forward to consuming demanded products in a different price range (Ren et al., 2019). It is also important to see that the rural village has increased to consume and rapid change in the last ten years by advocating the growing sales around 40%.

Rural marketing in India gives the gigantic capability to different types of businesses acknowledged with colossal undiscovered needs as well as the development of rural economy (AnhTu et al., 2020). With this particular aspect of development, the improvement in literacy rate will be seen as well as the ministration of different sectors will be understood. Different types of strategies have to be incorporated for understanding and also accomplishing several needs in the ruler market area of India. One of the greatest strategies will be the product development and market penetration strategy (Tenhunen, 2018). The products and services should be developed by organisations in such a manner that the people in rural India find them attractive and also can be satisfied.

The market penetration strategy is also important because various types of price ranges have to be changed according to their consumption as well as affordable range (Daftary,2019). This particular study mainly focuses on new possibilities of market expansion in the rural regions of India. The rural regions of India have an audience that can be targeted adequately as well as it also contributes to the growth factors of all types of organisations throughout the world. This development has considered different types of possibilities in market expansion and their importance. Different aspects of strategies have also been used for which the factors related to the exploration has been evaluated. The ways through which the possibilities can be enhanced have also been discussed with the changing scenario in the industry overview.

FACTORS THAT PROVIDE NEW POSSIBILITIES OF MARKET EXPANSION IN RURAL INDIA

1) LARGE POPULATION:

Two-third of the Indian population survive in villages as India has approximately 6,40,000 villages (Census 2011). As compared to the urban population the rate of growth of the rural population is much higher than the urban population (Lele and Goswami 2017). Over 6 lakh villages, the rural population is scattered, which holds a great promise for the marketers. The large and scattered population of the villages is one of the prominent reasons for attracting marketers to explore possibilities in the village.

TABLE NO. 1: RURAL URBAN DISTRIBUTION OF POPULATION FROM 1901 TO 2011

Year	Total	Rural Population %	Urban Population %
1901	238,396,327	89	11
1911	252,093,390	90	10
1921	251,321,213	89	11
1931	278,977,238	88	12
1941	318,660,580	86	14
1951	361,088,090	83	17
1961	439,234,771	82	18
1971	548,159,652	80	20
1981	683,329,097	77	23
1991	846,427,039	74	26
2001	1,028,737,436	72	28
2011	1,210,000,000	69	31

Sources:1)https://censusindia.gov.in/census_data_2001/india_at_glance/variation.aspx
2)https://censusindia.gov.in/2011-prov-results/paper2/data_files/india/Rural_urban_2011.pdf

2) HIGHER PURCHASING CAPACITY:

Increment in the population in rural areas affects the purchasing power of the people. The potential of the rural markets is increasing as the purchasing power of rural people is on the rise. As per Kovid et al. (2021), high purchasing capacity attracts marketers to expand their operations in rural India. In developing countries like India and China, the rural market has acquired significance in the last few years. Enhancement in the capacity of purchasing power has a significant impact on the growth of the economy of the country.

3) MARKET EXPANSION:

In the last few years, lots of improvement has been found in the rural market. The growth of the market has increased due to globalization (Kovid et al. 2021). Increments in the use of social networking sites have a direct impact on product usability in the villages. Brands like Colgate, toothpaste, team soaps have become more famous in rural places. Demand for these products has increased and that acts as an opportunity for the marketers to expand the market in the rural areas.

4) LOW STANDARD OF LIVING:

In the rural areas there is diverse socio-economic backwardness that impacts the living standard of the people. In the rural areas, people are less educated and have low awareness regarding the products. Marketers find opportunities to expand their markets in rural areas by taking advantage of the illiteracy of the rural people (Sinha and Bagarukayo 2019).

5) TRADITIONAL OUTLOOKS:

Traditional outlooks of the rural people are changing and the demand pattern of the rural community is changing to provide business opportunities to big brands in the rural market.

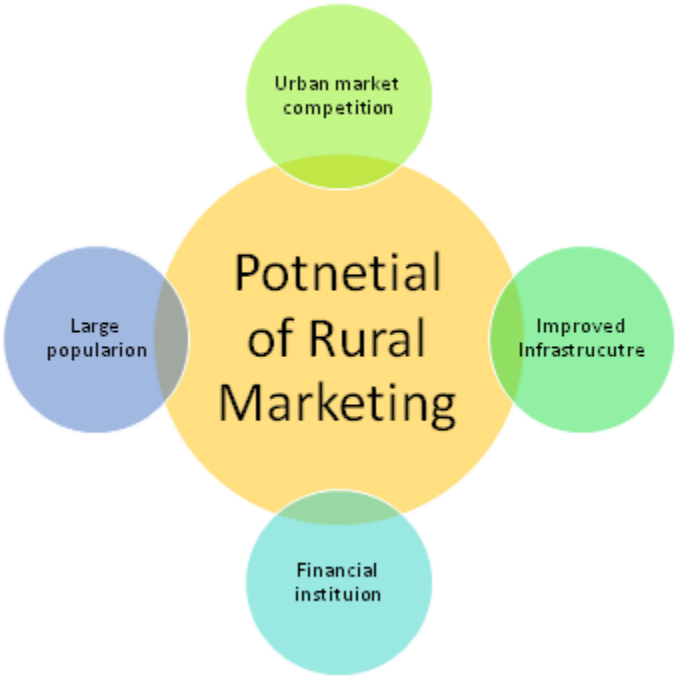
6) INFRASTRUCTURE'S DEVELOPMENT:

The scope of rural marketing has been increased through the development of infrastructure facilities such as transportation, construction of roads, and communication networks (Agarwal 2020).

7) MARKETING MIX:

Urban products and rural products are different and cannot be used on both populations. For the rural consumers, separate products are designed that need a marketing mix. According to the requirements of the rural consumers, marketing mix elements are used.

FIGURE 1: POTENTIAL OF RURAL MARKETING



(Source: Vicol 2017, p.456)

8) RURAL STRATEGY

Re-engineering of products, packaging, and practicing to customize features by some companies creates value for these markets. Chotukool refrigerator has been introduced by Godrej, low-cost ATMs have been developed by Vortex and a mobile application has been developed by Nokia that gives access to educational, agricultural, and entertainment content. Lifestyles of the rural people have improved with these innovative features and products. New communication and distribution channels have been developed by some players and created new products in the rural market including Gaon Chalo, Tata Teas, and Project Shakti. Rural India provides various opportunities to marketers to drive current business and breed news entrepreneurs (Wallenstein and Shelat 2017). Two third of the middle-class people live in rural areas and buying power of Rs 10,000 crore increased through the increment in one percent of India's rural income. A huge untapped market is required in the rural market for maximizing profitability. Still, the rural market of India is untapped and needed to implement the strategy of 3A's. 3A's include Availability, Affordability, and Acceptability.

In the few years, marketers have shown their interest in the rural market and relook for several reasons. The most important reason found is the immense market competition that leads to flat as well as declining sales. The saturation of the urban market is another big reason for the attraction of marketers.

Tapping the latent demand in the rural market as well as reaching out to 150 million rural markets is the easiest way of market expansion. As per Yadav et al. (2019), sachet marketing and microfinance are the kinds of markets that are exploring themselves in the rural market. Sachet marketing is the kind of marketing where the rural people can buy the products in an affordable range. Over a year various companies and advertising products led to the realization of the potential of rural India. The rural market expanded as various brands such as Coca-Cola started their campaign that provided a huge success to the company. Chic Shampoo as well as Cavinkare expanded their market in the rural areas. Cadbury came with one rupee of chocolate to attract the people and provided a slogan to attract the rural people such as Pappu pass ho Jaega as well as a cow campaign.

E-choupal was launched at Sagar district in Madhya Pradesh that introduced a new perspective to the branding of rural India. According to Patidar et al. (2018), the media explosion, enhancement in literacy rate brought a major change in the lifestyle of the people. Rural people are becoming more conscious as well as aware regarding their lifestyle. They understand the importance of brand values as brand consciousness is on the top. This allows the increment in the rural household's income that has made the rural consumer more demanding and choosier that can be seen in the purchasing behavior of the customers. Remarkable improvement in the form of products used can be seen in the behavior of the consumer. From indigenous teeth cleaning to tooth powder and toothpaste households of the people are improving. People have shifted to coils as well as mats from traditional mosquito repellent to get protection from the mosquito that shows the up-gradation of the rural people (Gupta 2019).

TABLE NO. 2 :MARKET SIZE OF FAST MOVING CONSUMER GOODS IN INDIA FROM FINANCIAL YEAR 2011 TO 2020, WITH ESTIMATES UNTIL 2025

Years	FMCG market size in billion US $
2011	31.6
2012	33.3
2013	35.7
2014	38.8
2015	43.1
2016	49
2017	52.8
2018	68.8
2019	83.3
2020	110
2025	220

Source: https://www.statista.com/statistics/742463/india-fmcg-market-size/

From the above table no. 2 the Fast Moving Consumer Goods has been showing consistent increase in market size since 2011 to 2020. It is expected that the FMCG market will be 220 billion dollars by 2025. Though the FMCG has a low share in the Indian economy although a large volume of traded goods is growing. When India announced its first nation-wide lockdown in the face of the coronavirus pandemic in March 2020, online shopping turned into a more relevant alternative for offline FMCG purchases.
Rural people are shifting from unbranded products to branded products as well as low price brands to premium brands. At present Indian rural markets are shifting towards consumerism that outer space the urban market in increasing demand for durable products such as fans, wrist watchers, television as well as non-durable products such as ice cream, nail polish, mosquito repellents, and shampoo. As per Kumar et al. (2019), utilisations of these products have provided an opportunity to the organization to continue their markets as well as develop them in the untrapped market. They need to invest more in these markets and they need to fulfil the gap of the rural markets by following three waves. Godrej, Agrovet, ITC, and DCM Shriram are some famous brands that are expanding themselves in the rural areas and eclipse the growth in the urban counterparts that include future group-owned food Bajar chain as well as reliance fresh.

Fast-moving consumer goods (FMCG) in rural areas have been growing in the rural areas. Compared to urban income, the growth in the income of the rural market is better and they get the least support price for the crops such as paddy and wheat that have been hiked (Chatterjee et al. 2020). Over the last year, the price of rice, pulse, oilseeds, and milk have been dramatically enhanced. Hariyali Kisaan Bazaar has been promoted by DCM Shriram Consolidated that runs 180 stores in the various states of India including Uttar Pradesh, Haryana, Punjab, Rajasthan, and Maharashtra. 30 to 40 percent growth in the FMCG sales has been seen in these stores (Ma et al. 2020).

MATERIALS AND METHODS

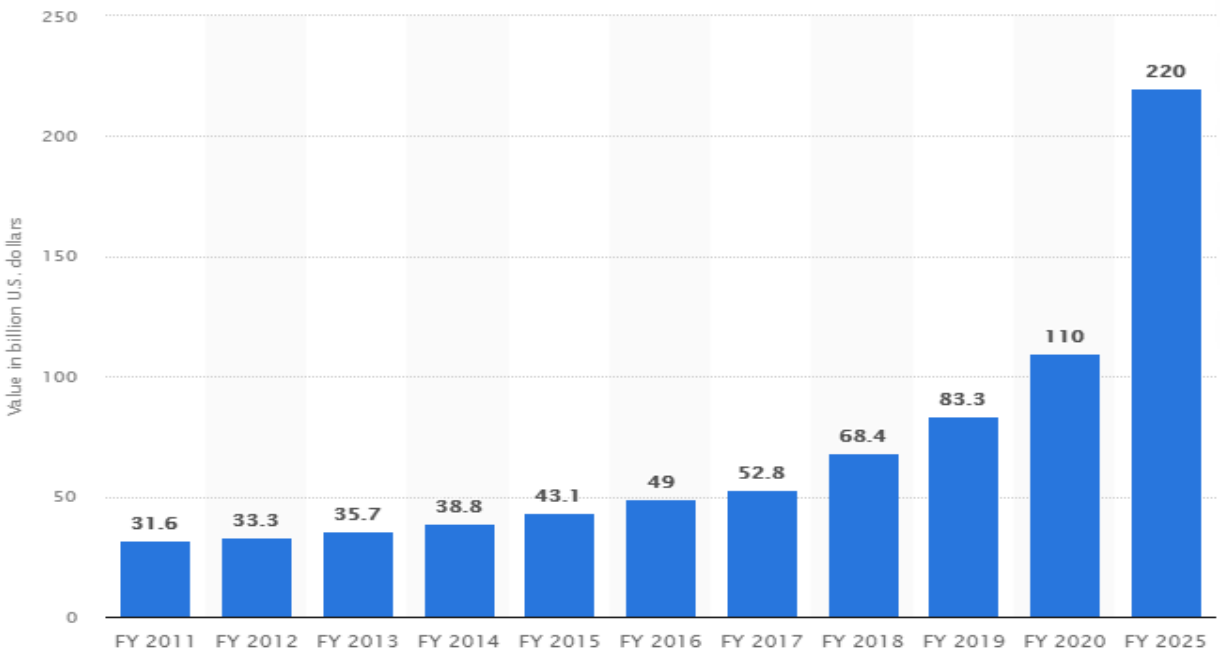
THE 4A APPROACH

Marketers are attracting more towards the rural market due to several reasons, however; it is not an easy task. The major problem in the rural market is low per capita income as compared to urban markets income, acute dependence on the monsoon, a large number of daily wages workers as well as polar roads, power problems, and inaccessibility to get media for advertising. These are the major challenges faced by marketers while expanding their business in the rural market. As per Clinton and Whisnanat (2019), urban consumers, as well as rural consumers, are different from each other in various ways therefore multinational companies, as well as marketers, face the challenges of 4As such as Availability, affordability, acceptability, and awareness.

i) **Availability**: Ensuring the availability of the products and services is the biggest challenge. More than 627,000 villages are present in India that spread over 3.2 million sq km. Two-third of the population including 700 million people survive in the rural areas and finding them is a difficult task. At least 13,113 villages should be strived by any serious marketer who wants to expand his market in the rural market (Sinha and Sheth 2018). Unilever is one of the famous brands that have a strong distribution system that helps to reach the interior of the rural market. Coca-cola is considered as the future growth driver of the rural market as it has evolved a spoke distribution model to reach the villages. Understanding the buyer's behavior helps increase 35%

of the purchase occasions. Decisions of brand choice are affected by sheer product availability. HLL is an FMCG giant that enhances the control of the rural supply chain through streamlining. HLL started a project named Shakthi with the collaboration of a self-help group of rural women.

FIGURE NO. 2: MARKET SIZE OF FAST-MOVING CONSUMER GOODS IN INDIA FROM 2011 TO 2025



(Source: Dhaliwala 2020, p.345), Graph have prepared from the Table no. 2

ii) **Affordability**: To ensure affordability to the products and services is the second major issue faced by marketers. It is difficult for rural people to afford the products and services with low disposable income. Most of the rural people are daily wage workers and they cannot afford the products and services of multinational companies. To overcome the problem of affordability, companies have started introducing small units packs to increase the customer bases in the rural areas. Cinthol, Fair Glow, and Godrej in 50 gm packs have been introduced by Godrej at an affordable price to expand its market in the rural villages of India. Hindustan Lever is one of the most famous companies and it has released the potential of India's rural market and launched Lifebuoy at Rs 2 for 50 gm (Agarwal et al. 2018). The company has launched a variant of its biggest selling soap to attract the targeted customer of the rural areas. Coca-cola has also introduced 200 ml glass at Rs 5 for increasing the customer base. At present approx 80% of the drinker's consumers are from the rural markets. Sunfilled has also been introduced by Coca-cola which is a powdered soft drink concentrate.

iii) **Acceptability:** To gain acceptability for the product and service in rural areas is not an easy task. In the rural areas, people are not willing to change the products that they are using for a long period. It is a big challenge for the market to bring a product that suits the rural market. LG is one of the most famous brands that reaped rich dividends and it developed a customized television for the rural market. Coca-cola started providing low-cost ice boxes due to electricity problems in rural areas as well as most people have not aware of refrigerators. For the rural

market insurance companies started tailor-made products to enhance performance in the rural market. HDFC tries with the nongovernmental organization to offer affordable price policies to get group insurance covers (Bisht et al. 2020).

TABLE 3: ATTRACTING ATTRIBUTES OF RURAL MARKETS ESTIMATED ANNUAL SIZE: RURAL MARKET

FMCG	INR 650000 million
Durables	INR 500000 million
Agri-inputs (including tractors)	INR 4500000 million
Two/four Wheelers	INR 800000 million
Total	INR 12300000 million

Source: Chakravarty, Anjan. (2015). The Evolving Scope of Rural India. Advances in Economics and Business. 3. 261-271. 10.13189/aeb.2015.030702.

Awareness: In digital time, where mass media has its value, however, it is unable to cover whole rural areas. Only 57% of the rural population are aware of the mass media. People have a lack of awareness regarding the various products and services due to having unconventional media that include ambient media. To increase the brand and pack visibility shop fonts, Cinema vans, wells, and other media vehicles are utilized. Lux and Lifebuoy use innovative media to create awareness among the people about the products. These companies have followed this idea not for the advertising purpose, however, for at the time of consumption. Most of the rural areas have no access to conventional advertising media. In rural areas, only 41 percent of people have access to television.

Building awareness among the rural people is a challenging task. The Experiences of rural consumers are different from the urban people. In rural areas, the consumption of branded products is treated as a special treat. The Hindustan lever has started its own company organized media to reach in the interior of the villages where theory can promote their products. Stockists have been given the responsibility to organize their promotional events. Godrej consumer products use radio to promote their products in the various regional languages. TV, cinema, and radio are used by coca-cola to make people aware of their products. Coca-cola promotes its products at a magical price point of Rs 5 per bottle that attracts a lot of rural customers. LG has started vans and road shows to promote its products. The company uses regional language to get connected with the customers (Adomako et al. 2019).

RESULT AND DISCUSSION

CHALLENGES IN RURAL MARKETING

1) UNDERDEVELOPED CUSTOMERS AS WELL AS UNDERDEVELOPED MARKETS:

Most of the people of rural communities are underdeveloped and they have not much information regarding the various products as well as they are not able to adapt to the changes. Most of the customers are

underdeveloped due to which the market in the rural areas is underdeveloped. People are less awareness regarding the technology as a result products based on technology can not see growth in the rural areas.

2) INADEQUATE MEDIA COVERAGE FOR RURAL COMMUNICATION:

Rural people are less aware of the products due to not having the proper media coverage for rural communication. Coverage related to marketing is inadequate due to having less technology in the rural areas.

3) LACK OF POWER, PHYSICAL COMMUNICATION FACILITIES:

Most of the villagers have no idea about roads and physical communication. During the monsoon period, most of the villages become inaccessible (Osunmuyiwa et al. 2019).

4) VARIOUS LANGUAGES AND DIALECTS:

India is the country where languages change from place to palace. It is quite difficult to manage the language while implementing any marketing strategy.

5) CHALLENGES OF NATURAL CALAMITIES:

Epidemics, examine rain or drought, lack of printer storage facilities, and inadequate market intelligence are the most common problems faced by the marketers during the implementation of any strategy.

CONCLUSION

It can be concluded that the future can be very promising for the marketers and the MNCs who understand the dynamics of the rural markets. Various challenges and opportunities are present that can attract marketers to expand their market in rural areas. Marketers need to implement strategies according to the nature and consumers of the rural place. Customer expectations and demand of the urban market and rural market are different from each other. Therefore, marketers need to develop different strategies by understanding the dynamics of the rural markets. There is a need for academics and practitioners to address the problem of communication that includes marketing and advertising. The rural people are mostly daily wages workers and have low per capita income that creates difficulties for the various companies to expand their business in the rural market such as nestle.

References:

1. Adomako, S., Amankwah-Amoah, J., Dankwah, G.O., Danso, A. and Donbesuur, F., 2019. Institutional voids, international learning effort, and internationalization of emerging market new ventures. Journal of International Management, 25(4), p.100666.
2. Agarwal, B., 2020. Does group farming empower rural women? Lessons from India's experiments. The Journal of Peasant Studies, 47(4), pp.841-872.
3. Agarwal, N., Chakrabarti, R., Brem, A. and Bocken, N., 2018. Market driving at Bottom of the Pyramid (BoP): An analysis of social enterprises from the healthcare sector. Journal of Business Research, 86, pp.234-244.
4. AnhTu, C., Sarker, T. and Rasoulinezhad, E., 2020. Factors influencing the green bond market expansion: evidence from a multi-dimensional analysis. *Journal of Risk and Financial Management*, *13*(6), p.126.
5. Bisht, I.S., Rana, J.C. and Pal Ahlawat, S., 2020. The future of smallholder farming in India: Some sustainability considerations. Sustainability, 12(9), p.3751.

6. Chatterjee, S., Majumdar, D., Misra, S. and Damaševičius, R., 2020. Adoption of mobile applications for teaching-learning process in rural girls' schools in India: an empirical study. Education and Information Technologies, pp.1-20.
7. Clinton, L. and Whisnant, R., 2019. Business model innovations for sustainability. In Managing Sustainable Business (pp. 463-503). Springer, Dordrecht.
8. Daftary, D., 2019. Elected local bodies, space, and the governance of market expansion in rural India. *Geoforum*, *103*, pp.105-113.
9. Dhaliwal, A., 2020, December. Digital Inclusion of Farmers and Rural Hinterland: The Case of Digital India. In Workshop on E-Business (pp. 91-110). Springer, Cham.
10. Ghouse, S., McElwee, G., Meaton, J. and Durrah, O., 2017. Barriers to rural women entrepreneurs in Oman. International Journal of Entrepreneurial Behavior& Research.
11. Gupta, A., 2019. Teacher-entrepreneurialism: A case of teacher identity formation in neoliberalizing education space in contemporary India. Critical Studies in Education, pp.1-17.
12. Harrington, R.A., Califf, R.M., Balamurugan, A., Brown, N., Benjamin, R.M., Braund, W.E., Hipp, J., Konig, M., Sanchez, E., and Joynt Maddox, K.E., 2020. Call to action: rural health: a presidential advisory from the American Heart Association and American Stroke Association. Circulation, 141(10), pp.e615-e644.
13. Kumar, V., Rajan, B., Venkatesan, R. and Lecinski, J., 2019. Understanding the role of artificial intelligence in personalized engagement marketing. California Management Review, 61(4), pp.135-155.
14. Lele, U. and Goswami, S., 2017. The fourth industrial revolution, agricultural and rural innovation, and implications for public policy and investments: a case of India. Agricultural Economics, 48(S1), pp.87-100.
15. Ma, W., Grafton, R.Q. and Renwick, A., 2020. Smartphone use and income growth in rural China: Empirical results and policy implications. Electronic Commerce Research, 20(4), pp.713-736.
16. Osunmuyiwa, O. and Ahlborg, H., 2019. Inclusiveness by design? Reviewing sustainable electricity access and entrepreneurship from a gender perspective. Energy Research & Social Science, 53, pp.145-158.
17. Patidar, R., Agrawal, S. and Pratap, S., 2018. Development of novel strategies for designing sustainable Indian agri-fresh food supply chain. Sādhanā, 43(10), pp.1-16.
18. Perera, E.D.J., Mahanama, P.K.S. and Gamage, P., 2019. A Novel Approach For Planning An Aerocity (Aerotropolis) In Negombo-KatunayakePeri-Urban Region. International Journal of Advanced Research and Publications (IJARP), 3(8).
19. Ren, C.R., Hu, Y. and Cui, T.H., 2019. Responses to rival exit: Product variety, market expansion, and preexisting market structure. *Strategic Management Journal*, *40*(2), pp.253-276.
20. Sinha, E. and Bagarukayo, K., 2019. Online Education in Emerging Knowledge Economies: Exploring factors of motivation, de-motivation, and potential facilitators; and studying the effects of demographic variables. International Journal of Education and Development using Information and Communication Technology, 15(2), pp.5-30.
21. Sinha, M. and Sheth, J., 2018. Growing the pie in emerging markets: Marketing strategies for increasing the ratio of non-users to users. Journal of Business Research, 86, pp.217-224.
22. Tenhunen, S., 2018. *A village goes mobile: Telephony, mediation, and social change in rural India*. Oxford University Press.
23. van der Ploeg, J.D., 2020. From biomedical to politico-economic crisis: the food system in times of Covid-19. The Journal of Peasant Studies, 47(5), pp.944-972.
24. Verger, A., Steiner-Khamsi, G. and Lubienski, C., 2017. The emerging global education industry: analyzing market-making in education through market sociology. Globalization, Societies, and Education, 15(3), pp.325-340.

25. Vicol, M., 2017. Is contract farming an inclusive alternative to land grabbing? The case of potato contract farming in Maharashtra, India. Geoforum, 85, pp.157-166.
26. Vicol, M., 2019. Potatoes, petty commodity producers and livelihoods: Contract farming and agrarian change in Maharashtra, India. Journal of Agrarian Change, 19(1), pp.135-161.
27. Wallenstein, J. and Shelat, U., 2017. Hopping aboard the sharing economy. Boston Consulting Group, 22, p.2017.
28. Yadav, P., Heynen, A.P. and Palit, D., 2019. Pay-As-You-Go financing: A model for viable and widespread deployment of solar home systems in rural India. Energy for sustainable development, 48, pp.139-153.
29. Kovid, R.K., Kumari, D. and Pandey, S., 2021. Strategic Response to the Corona Pandemic Crisis: A Case of Indian Women Entrepreneurs. In *Stakeholder Strategies for Reducing the Impact of Global Health Crises* (pp. 68-84). IGI Global.
30. Lele, U. and Goswami, S., 2017. The fourth industrial revolution, agricultural and rural innovation, and implications for public policy and investments: a case of India. *Agricultural Economics*, *48*(S1), pp.87-100.
31. Sinha, E. and Bagarukayo, K., 2019. Online Education in Emerging Knowledge Economies: Exploring factors of motivation, de-motivation and potential facilitators; and studying the effects of demographic variables. *International Journal of Education and Development using Information and Communication Technology*, *15*(2), pp.5-30.
32. Tenhunen, S., 2018. *A village goes mobile: Telephony, mediation, and social change in rural India*. Oxford University Press.

Mukti Kon Pathe?
Caste and Class in Ambedkar's Struggle

SANTOSH SURADKAR

In the 1930s, for the first time in Indian politics, Ambedkar jointly addressed caste and class, unravelling the connections between caste, class, and religion in Indian society. A focus on the anti-*khoti* struggle in the Konkan region and the working class struggle in Bombay, under Ambedkar's leadership through the Independent Labour Party during 1936–42, allows for a deeper exploration of this ideological position. Ambedkar's formulation and emphasis of the "untouchables' question" in class struggle, then and now, has continued to disrupt traditional formulations of working class solidarity.

On 20 June 1936, Ambedkar delivered a speech in Bombay titled *Mukti Kon Pathe?* (Which Way to Emancipation?), which was reproduced in his self-published news weekly *Janata*. This speech was important as it presented pathways for the emancipation of the untouchables and laid bare the interlinkages between caste, class, and religion. The speech was delivered between two important events of Ambedkar's life—his announcement of leaving the Hindu religion in 1935 and the establishment of the Independent Labour Party (ILP) in 1936, a concerted effort to march along the outlined pathways.

The formation of the ILP in the 1930s did not represent a shift or expansion in Ambedkar's anti-caste ideology; rather it had always been one of the core tenets of his philosophy since the writing of "Castes in India: Their Mechanism, Genesis and Development" (1916). The material reality of caste and class was always central to his ideological position. His first struggle, the Mahad Satyagraha in 1927, had passed a resolution along economic lines. According to Raosaheb Kasbe (1985: 57), the period of the 1930s had given a realistic approach to Ambedkar's political position.

This conjuncture presents us with several questions. Why did Ambedkar not join an existing labour organisation? What forced him to establish a separate political organisation of labourers? This could be explored through his ideological position on the underpinning of caste, class, and religion. So far, most historical accounts on Ambedkar's movement, its demands and followers have pointed out that the mobilisation was largely limited to Dalits and even amongst them, the Mahars (Zelliot 1996; Omvedt 1994; Jaffrelot 2005; Gokhale 1993). However, the period of the founding of the ILP and its immediate aftermath witnessed an expanding social base, especially in the Konkan region. This paper explores the processes underlying changes in the social constituents of the movement in the context of two important struggles, under Ambedkar's leadership, in Bombay and Konkan based on his intersectional analysis of caste, class, and religion.

The late 1930s saw a definite turn in political developments in India. Elections to the first elected provincial government in Bombay in 1937 saw the emergence of various social and political forces. The untouchables were mobilised for the first time ever as a political force under Ambedkar's leadership. At the same time, he shifted to a labour organisation in order to expand the social base of his movement. After the elections, Ambedkar's party became a major political force in the

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RIPIC BASED KEY EXCHANGE PROTOCOL

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ABSTRACT. In this article, we intend to bring out a unique system of designing key exchange protocol (KEP) based on isomathematics. The significant concept of our proposal is to use ring isopolynomials with the usage of general isointegral coefficient. This class of KEP is an interesting asset for further study because of isomathematical structure permutable permutation of ring isopolynomials with isointeger coefficient (RIPIC).

1. INTRODUCTION

A KEP is a key formation technique where a common secret key is determined by more than two users as a component of data deliberated by, or connected with each of these users, in an ideal situation in such a way that no user can foreordain the subsequent value [1, 2]. In a symmetric key cryptography based protocols, two conveying users use a commonly identified algorithm and a secret key that is shared by the users. Secret key exchange can be made possible by employing few ways like- utilizing out-of-band correspondence, (for example, by telephone, via mail, manual entry etc.), utilizing a trusted third party key distribution center, and so forth. The greater parts of these techniques require approximately from the earlier secret key creation between the protocol and single users. Secret key

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exchange without the utilization of an out-of-band channel still remains an exceptionally difficult issue [3].

Diffie-Hellman [4], KEP is the first applied asymmetric cryptographic scheme that allows more than two users who have not seen each of them ahead of time to set up a typical secret key over an apprehensive network. These days, the most ordinarily utilized public KEP's are number theory based. The theoretical quality depends upon the structure of abelian groups. Their robustness depends on the difficulty of solving certain issue over finite commutative algebraic structures. The discrete logarithm problem [5, 6] is, as one with the integer factorization problem [7,8] and the elliptic curve discrete logarithm problem [9] which is one of the primary issues where public key cryptosystems are constructed. In this way, for the competently computable groups, the discrete logarithm problem is difficult to break are vital in cryptography [10,11]. Different executions of the Diffie-Hellman protocol in matrix rings, for different kind of matrices, are offered in [12, 13]. Meshram C. [14] presented some new cryptographic protocol based on double discrete logarithm problem and some other implication on cryptography protocols in [15, 17]. This work focuses basically on the design of public KEP's over ring polynomial with integral coefficient. Meshram A. [18, 20] offered certain new cryptographic protocol based on suzuki 2-group and dihedral group which are secure in CPA, IND-CPA, IND-CCA2. Recently, Meshram C. [21] suggested QERPKC based on Partial Discrete Logarithm Problem (PDLP). Security of the presented scheme is based on the hardness of PDLP.

2. Preliminaries

In this article, we offer a novel technique for designing KEP based on RIPIC. We can represent isopolynomials and take them as the underlying work structure. By doing so, it is much secure and easy to execute the KEP. The rest of the article is organized different sections. In section 3, we have discussed the related required background for article. Section 4, explains the proposed RIPIC based KEP. Finally, in section 5, we have given the conclusions.

Herein, we have explained the definition such as RIPIC, Symmetrical Decomposition Problem (SDP) over ring $\Re$ with isopolynomial, Diffie-Hellman Problem (DHP) over ring $\Re$ with isopolynomial and some implications on ring isopolynomial.

Isomathematics:
The framework of isomathematics was first proposed by Santilli [22], which is generalization of multiplication, division and multiplicative unity "1" in modern mathematics. By using isomathematics, we show that "Four multiplied by three is equal to sixty" (for inverse of isounit $\widehat{T} = 5$).

Arithmetic Operations in Modern Mathematics:
We all familiar with arithmetic operations, are addition, subtraction, multiplication, and division. In modern mathematics, "0" and "1" are additive unity and multiplicative unity respectively such that:

$$m + 0 = m,\ m - 0 = m,\ m^0 = 1,\ m \times 1 = 1 \times m = m,\ m \div 1 = m,$$
$$1 \div m = \tfrac{1}{m},\ m \times n = mn, \text{ and } m \div n = \tfrac{m}{n}, \text{ etc.}$$

Arithmetic Operations in Santilli's Iso-mathematics:
Santilli [22], define isoaddition $\widehat{+}$, isosubtraction $\widehat{-}$, isomultiplication $\widehat{\times}$ and isodivision $\widehat{\div}$ as follows:

$$m\widehat{+}n = m + \widehat{\kappa} + n,\ m\widehat{-}n = m - \widehat{\kappa} - n,\ m\widehat{\times}n = m\widehat{T}n, \text{ and } m\widehat{\div}n = \left(\tfrac{m}{n}\right)\widehat{I},$$

where, i) $\widehat{T}\widehat{I} = 1$, $\widehat{T}$ is called inverse of isounit $\widehat{I} \neq 1$; ii) $\widehat{\kappa}$ is called isozero.

RIPIC:
We define, additive abelian group $(\Re, +, \widehat{\kappa})$ and $(\Re, *, \widehat{I})$ for ring $\Re$. Let us consider RIPIC with ring application. Firstly, the concept of scale multiplication over $\Re$ is already a known fact.

As $\widehat{n} \in \mathbb{Z} > 0$ and $\widehat{x} \in \Re, (\widehat{n})\widehat{x} \triangleq \underbrace{\{\widehat{x} + \widehat{x} + \widehat{x} + ... + \widehat{x}\}}_{n\text{-times}}$. When $\widehat{n} \in \mathbb{Z} < 0$, we can define $(\widehat{n})\widehat{x} \triangleq (-\widehat{n})(-\widehat{x}) = \underbrace{(-\widehat{x}) + ... - \widehat{x}}_{-n\text{-times}}$. If $\widehat{n} = 0$, then it can be defined that $(\widehat{n})\widehat{x} = \widehat{\kappa}$.

Property 1. *For every $\widehat{x} \in \Re$, we get $(\widehat{c})\widehat{x}^{\widehat{m}} * (\widehat{d})\widehat{x}^{\widehat{k}} = (\widehat{c}\widehat{d})\widehat{x}^{\widehat{m}+\widehat{k}} = (\widehat{d})\widehat{x}^{\widehat{k}} * (\widehat{c})\widehat{x}^{\widehat{m}}, \forall \widehat{c}, \widehat{d}, \widehat{m}, \widehat{k} \in \mathbb{Z}$.*

Proof. As per the defined scale multiplication we can conclude that the distributivity of multiplication with respect to addition, and commutativity of addition.

As per observations, for distinct isonumbers $\widehat{x}$ and $\widehat{w}$, we get $(\widehat{c})\widehat{x} * (\widehat{d})\widehat{w} \neq (\widehat{d})\widehat{w} * (\widehat{c})\widehat{x}$.

Assume that $\widehat{f}(\widehat{y}) = \widehat{c_0} + \widehat{c_1}\widehat{y} + ... + \widehat{c_k}\widehat{y_k} \in \mathbb{Z}^+[\widehat{y}]$. is a given RIPIC. By allocating this isopolynomial and using an element $\widehat{x}$ in $\Re$, an outcome we get $\widehat{f}(\widehat{x}) = \sum_{i=0}^{k}(\widehat{c_i})\widehat{x^i} = (\widehat{c_0}) + (\widehat{c_1})\widehat{x} + \cdots + (\widehat{c_k})\widehat{x^k} \in \Re$. Further, when we consider $\widehat{x}$ as a variable in $\Re$, then $\widehat{f}(\widehat{x})$ can be viewed as a isopolynomial about variable $\widehat{x}$. All these isopolynomials, taking over all $\widehat{f}(\widehat{x}) \in \mathbb{Z}^+[\widehat{x}]$, can be considered the extension of $\mathbb{Z}^+$ with $\widehat{x}$ denoted by $\mathbb{Z}^+[\widehat{x}]$. Suitably, it can be called as the set of $\Re-$isopolynomials with 1-ary positive IC.

Let us consider that if $\widehat{f}(\widehat{x}) = \sum_{i=0}^{\widehat{k}}(\widehat{c_i})\widehat{x^i} \in \mathbb{Z}^+[\widehat{x}], \widehat{h}(\widehat{x}) = \sum_{j=0}^{\widehat{m}}(\widehat{d_i})\widehat{x^i} \in \mathbb{Z}^+[\widehat{x}]$ and $\widehat{k} \geq \widehat{m}$, then $(\sum_{i=0}^{\widehat{k}}(\widehat{c_i})\widehat{x^i}) + (\sum_{j=0}^{\widehat{m}}(\widehat{d_j})\widehat{x^j}) = (\sum_{i=0}^{\widehat{m}}(\widehat{c_i} + \widehat{d_i})\widehat{x^i}) + (\sum_{i=\widehat{m}+1}^{\widehat{k}}(\widehat{c_i})\widehat{x^i})$, and as per property and distributivity, it results into $(\sum_{i=0}^{\widehat{m}+1}(q_i)\widehat{x^i}) = (\sum_{i=0}^{\widehat{k}}(\widehat{c_i})\widehat{x^i}) * (\sum_{j=0}^{\widehat{m}}(\widehat{d_j})\widehat{x^j})$, where $q_i = \sum_{j=0}^{i}(\widehat{c_i})\widehat{d}_{i-j} = \sum_{j+n=i}\widehat{c_i}\widehat{d_n}$ Henceforth, coming to a conclusion following is the theorem according to property. □

Remark 2.1. $\widehat{f}(\widehat{x}) * \widehat{h}(\widehat{x}) = \widehat{h}(\widehat{x}) * \widehat{f}(\widehat{x}), \forall \widehat{f}(\widehat{x}), \widehat{h}(\widehat{x}) \in \mathbb{Z}^+[\widehat{x}]$. *As per observations, for two distinct variables* $\widehat{x}$ *and* $\widehat{w}$*, we get* $\widehat{f}(\widehat{x}) * \widehat{h}(\widehat{w}) \neq \widehat{h}(\widehat{w}) * \widehat{f}(\widehat{x})$.

Some Implication on Ring Isopolynomials:
Assume if $(\Re, +, *)$ a RIPIC. At random selected element $b \in \Re$, can be define a set $Qb \subseteq \Re$ by $Qb \triangleq \{\widehat{f}(\widehat{b}) : \widehat{f}(\widehat{x}) \in \mathbb{Z}^+[\widehat{x}]\}$. Now, let us study the different forms of SDP and DHP problems over $(\Re, *)$ with its subset Qb respectively.

SDP over Ring $\Re$ *with isopolynomial:* For given $(\widehat{z}, \widehat{y}, \widehat{x}) \in \Re^3$ and $\widehat{m}, \widehat{k} \in \mathbb{Z}$, find $\widehat{z} \in Qb$ such that $\widehat{y} = \widehat{z^m}\widehat{x}\widehat{z^k}$.

DHP over Ring $\Re$ *with isopolynomial:* Compute $\widehat{x^{z_1 z_2}}$ (or $\widehat{x^{z_2 z_1}}$) for given $\widehat{x}, \widehat{x^{z_1}}$ and $\widehat{x^{z_2}}$, where $\widehat{x} \in \mathcal{G}, \widehat{z_1}, \widehat{z_2} \in Qb$.

3. RIPIC BASED KEP

Let us take RIPIC as the basic essential set - up and design an KEP, where the secret session key can be shared between the two users i.e Shekhar and Akshay through insecure channel.

The procedure is described as stated below:

(1) For launching the protocol, one of the user's i.e Shekhar refers two arbitrary small, positive integers $\widehat{m}, \widehat{k} \in \mathbb{Z}^+$ and two arbitrary elements $\widehat{c}, \widehat{d} \in \Re$ to second user i.e Akshay.
(2) Shekhar selects an arbitrary isopolynomial $\widehat{f}(\widehat{x}) \in \mathbb{Z}^+[\widehat{x}]$ such as $\widehat{f}(\widehat{c}) \neq \widehat{\kappa}$ and then takes $\widehat{f}(\widehat{c})$ as his secret key.

(3) Akshay selects an arbitrary isopolynomial $\widehat{h}(\widehat{x}) \in \mathbb{Z}^{+}[\widehat{x}]$ such as $\widehat{h}(\widehat{c}) \neq \widehat{\kappa}$ and then opts $\widehat{h}(\widehat{a})$ as his secret key.
(4) Shekhar calculates $\widehat{\alpha} = \widehat{f}(\widehat{c})^{\widehat{m}} * \widehat{d} * \widehat{f}(\widehat{c})^{\widehat{k}}$ and sends $\widehat{\alpha}$ to Akshay.
(5) Akshay calculates $\widehat{\beta} = \widehat{h}(\widehat{c})^{\widehat{m}} * \widehat{d} * \widehat{h}(\widehat{c})^{\widehat{k}}$ and sends $\widehat{\beta}$ to Shekhar.
(6) Shekhar calculates $\widehat{K}_{Shekhar} = \widehat{f}(\widehat{c})^{\widehat{m}} * \widehat{\beta} * \widehat{f}(\widehat{c})^{\widehat{k}}$ as the shared session key.
(7) Akshay calculates $\widehat{K}_{Akshay} = \widehat{h}(\widehat{c})^{\widehat{m}} * \widehat{\alpha} * \widehat{h}(\widehat{c})^{\widehat{k}}$ as the common session key.

In regular practice, steps (1), (2) and (4) can be completed at once and require only one time communication between Shekhar and Akshay. Further, step (3) and (5) can be completed at once and require only one time communication between Akshay and Shekhar. At the end, Shekhar and Akshay can perform step (6) and (7) individually irrespective of further communication. The illustration of the protocol is shown in the following table.

FIGURE 1. RIPIC based KEP

Pass	Shekhar	Akshay
	Slects at arbitrary $\hat{m},\ \hat{k} \in \mathbb{Z}^{+}$ Slects at arbitrary $\hat{c}, \hat{d} \in \Re$ Slects at arbitrary $\hat{f}(\hat{x}) \in \mathbb{Z}^{+}[\hat{x}]$	
1	$\hat{m}, \hat{k}, \hat{c}, \hat{d}, \hat{f}(\hat{c})^{\hat{m}} \hat{d} \hat{f}(\hat{c})^{\hat{k}}$ →	
		Slects at arbitrary $\hat{h}(\hat{x}) \in \mathbb{Z}^{+}[\hat{x}]$
2	← $\hat{h}(\hat{c})^{\hat{m}} \hat{d} \hat{h}(\hat{c})^{\hat{k}}$	
	$\widehat{K}_{\text{Shekhar}} = \hat{f}(\hat{c})^{\hat{m}} \hat{h}(\hat{c})^{\hat{m}} \hat{d} \hat{h}(\hat{c})^{\hat{k}} \hat{f}(\hat{c})^{\hat{k}} = \hat{h}(\hat{c})^{\hat{m}} \hat{f}(\hat{c})^{\hat{m}} \hat{d} \hat{f}(\hat{c})^{\hat{k}} \hat{h}(\hat{c})^{\hat{k}} = \widehat{K}_{\text{Akshay}}$	

Example 1. *RIPIC based KEP Using Matrix Rings For simplicity, let an integer* $N = 5 * 3$*, isounit* $\widehat{I} = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ *and inverse of isounit* $\widehat{T} = \begin{bmatrix} -2 & 1 \\ 1.5 & -0.5 \end{bmatrix}$.

Assume that Shekhar selects; $m = 2, k = 3, \widehat{c} = \begin{bmatrix} 22 & 30 \\ 14 & 24 \end{bmatrix}, \widehat{d} = \begin{bmatrix} 18 & 26 \\ 14 & 20 \end{bmatrix}$ *and* $\widehat{f}(\widehat{x}) = \widehat{5}\widehat{x}^{\widehat{3}} + \widehat{3}\widehat{x}^{\widehat{2}} + \widehat{x} + \widehat{2}$*. Shekhar calculate:*

$$\widehat{f}(\widehat{c}) = \widehat{5}\begin{bmatrix}22 & 30\\ 14 & 24\end{bmatrix}^{\widehat{3}} + \widehat{3}\begin{bmatrix}22 & 30\\ 14 & 24\end{bmatrix}^{\widehat{2}} + \begin{bmatrix}22 & 30\\ 14 & 24\end{bmatrix} + \widehat{2}\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix} = \begin{bmatrix}39 & 58\\ 17 & 26\end{bmatrix} mod 15$$

$$\widehat{f}(\widehat{c}) = \begin{bmatrix}9 & 13\\ 2 & 11\end{bmatrix}$$

and

$$\widehat{\alpha} = \widehat{f}(\widehat{c})^{\widehat{m}} * \widehat{d} * \widehat{f}(\widehat{c})^{\widehat{k}}$$

$$\widehat{\alpha} = \begin{bmatrix}9 & 13\\ 2 & 11\end{bmatrix}^{\widehat{2}} * \begin{bmatrix}18 & 26\\ 14 & 20\end{bmatrix} * \begin{bmatrix}9 & 13\\ 2 & 11\end{bmatrix}^{\widehat{3}} = \begin{bmatrix}7 & 9\\ 6 & 5\end{bmatrix}$$

Then, Shekhar sends $\widehat{m}, \widehat{k}, \widehat{c}, \widehat{d}$ *and* $\widehat{\alpha}$ *to Akshay. Assume that Akshay, after receiving* $\widehat{m}, \widehat{k}, \widehat{c}, \widehat{d}$ *and* $\widehat{\alpha}$ *from Shekhar, selects a different isopolynomial* $\widehat{h}(\widehat{x}) = \widehat{2}\widehat{x}^{\widehat{5}} + \widehat{x} + \widehat{3}$ *and calculates:*

$$\widehat{h}(\widehat{c}) = \widehat{2}\begin{bmatrix}22 & 30\\ 14 & 24\end{bmatrix}^{\widehat{5}} + \begin{bmatrix}22 & 30\\ 14 & 24\end{bmatrix} + \widehat{3}\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix} = \begin{bmatrix}14 & 9\\ 10 & 12\end{bmatrix}$$

and

$$\widehat{\beta} = \widehat{h}(\widehat{c})^{\widehat{m}} * \widehat{d} * \widehat{h}(\widehat{c})^{\widehat{k}} = \begin{bmatrix}14 & 9\\ 10 & 12\end{bmatrix}^{\widehat{2}} * \begin{bmatrix}18 & 26\\ 14 & 20\end{bmatrix} * \begin{bmatrix}14 & 9\\ 10 & 12\end{bmatrix}^{\widehat{3}} = \begin{bmatrix}9 & 12\\ 12 & 0\end{bmatrix}.$$

After that, Akshay refers $\widehat{\beta}$ *to Shekhar. Lastly, Shekhar computes the session key*

$$\widehat{K}_{Shekhar} = \widehat{f}(\widehat{c})^{\widehat{m}} * \widehat{\beta} * \widehat{f}(\widehat{c})^{\widehat{k}},$$

$$\widehat{K}_{Shekhar} = \begin{bmatrix}9 & 13\\ 2 & 11\end{bmatrix}^{\widehat{2}} * \begin{bmatrix}9 & 12\\ 12 & 0\end{bmatrix} * \begin{bmatrix}9 & 13\\ 2 & 11\end{bmatrix}^{\widehat{3}} = \begin{bmatrix}6 & 3\\ 3 & 0\end{bmatrix}$$

While Akshay computes the session key

$$\widehat{K}_{Akshay} = \widehat{h}(\widehat{c})^{\widehat{m}} * \widehat{\alpha} * \widehat{h}(\widehat{c})^{\widehat{k}},\ \widehat{K}_{Akshay} = \begin{bmatrix}14 & 9\\ 10 & 12\end{bmatrix}^{\widehat{2}} * \begin{bmatrix}7 & 9\\ 6 & 5\end{bmatrix} * \begin{bmatrix}14 & 9\\ 10 & 12\end{bmatrix}^{\widehat{3}} = \begin{bmatrix}6 & 3\\ 3 & 0\end{bmatrix}$$

Hence $\widehat{K}_{Shekhar} = \widehat{K}_{Akshay}$ *holds, i.e., the key agreement is successful achieved.*

4. Conclusion

In recent times, few of the promising non-commutative groups like as braid groups, Thompson's groups, etc. have distinctively figured out various KEP's. In this article, we have deigned a unique KEP based on the ring isopolynomials with isointeger coefficient. This set of KEP is an interesting asset that will pave the way for further study like authentication, signatures and digital identities; because of isomathematical structure permutable permutation of ring isopolynomials with isointeger coefficient.

References

[1] A. Menezes, P. van Oorschot, S. Vanstone: *Handbook of Applied Cryptography*, Boca Raton, FL: CRC, 1997.

[2] D. Xiao, X. Liao, S. Deng: *A novel key agreement protocol based on chaotic maps*, Information Sciences, **177** (2007), 136–142.

[3] P. Naik, K. Ravichandran, M. Krishna, Sivalingam: *Cryptographic key exchange based on locationing information*, Pervasive and Mobile Computing, **3** (2007), 15–35.

[4] W. D. Diffie, M. E. Hellman: *New directions in cryptography*, IEEE Transactions on Information Theory, **22**(6) (1976), 644–654.

[5] K. McCurley: *The discrete logarithm problem, Cryptology and Computational Number Theory*, Proceedings of Symposia in Applied Mathematics, **42** (1990), 49–74.

[6] T. ElGamal: *A public key cryptosystem and a signature scheme based on discrete logarithms*, IEEE Transactions on Information Theory, **31** (1985), 469–472.

[7] I. Lin, C. Chang: *Security enhancement for digital signature scheme with fault tolerance in RSA*, Information Sciences, **177** (2007), 4031–4039.

[8] R. Rivest, A. Shamir, L. Aleman: *A method for obtaining digital signature and public-key cryptosystem*, Comm. ACM, **21**(2) (1978), 120–126.

[9] Blake, G. Seroussi, N. Smart: *Elliptic Curves in Cryptography*, London Mathematical Society, Lecture Notes. Series, Cambridge University, **265** (1999).

[10] D. Coppersmith, A. Odlyzko, R. Schroeppel: *Discrete logarithms in GF(p)*, Algorithmica, **265** (1986), 1–15.

[11] R. Alvarez, L. Tortosa, J.F. Vicent, A. Zamora: *Analysis and design of a secure key exchange scheme*, Information Sciences, **179** (2009), 2014–2021.

[12] J. Climent, F. Ferrandez, J. Vicent, A. Zamora: *A nonlinear elliptic curve cryptosystem based on matrices*, Applied Mathematics and Computation, **174** (2006), 150–164.

[13] R. Alvarez, L. Tortosa, J. F. Vicent, A. Zamora: *A non-abelian group basedon block upper triangular matrices with cryptographic applications*, Applied Algebra, Algebraic Algorithms, and Error-Correcting Codes, Lecture Notes in Computer Science, pages. Springer-Verlag, Berlin, **5527** (2009), 117–126.

[14] C. MESHRAM: *A Cryptosystem based on Double Generalized Discrete Logarithm Problem*, International Journal of Contemporary Mathematical Sciences, **6**(6) (2011), 285–297.

[15] C. MESHRAM, S. A. MESHRAM: *A Public Key Cryptosystem based on IFP and DLP*, International Journal of Advanced Research in Computer Science, **2**(5) (2011), 616–619.

[16] C. MESHRAM, S. S. AGRAWAL: *Enhancing the security of A Public key cryptosystem based on DLP* $\gamma \equiv \alpha a \beta b(modp)$, International Journal of Research and Reviews in Computer Science, **1**(4) (2010), 67–70.

[17] C. MESHRAM, S. A. MESHRAM: *PKC Scheme Based on DDLP*, International Journal of Information & Network Security (IJINS), **2**(2) (2013), 154–159.

[18] A. MESHRAM, C. MESHRAM, N. W. KHOBRAGADE: *An IND-CPA secure PKC technique based on dihedral group*, Indian Journal of Computer Science and Engineering (IJCSE), **8**(2) (2017), 88–94.

[19] A. MESHRAM, C. MESHRAM, N. W. KHOBRAGADE: *An IND-CCA2 secure public key cryptographic protocol using suzuki 2-group*, Indian Journal of Science and Technology, **10**(12) (2017), 01–08.

[20] A. MESHRAM, C. MESHRAM, N. W. KHOBRAGADE: *Public key cryptographic technique based on suzuki 2-group*, International Journal of Advanced Research in Computer Science, **8**(03)(2017), 300-305.

[21] C. MESHRAM, M. S. OBAIDAT, S. A. MESHRAM: *New efficient QERPKC based on partial discrete logarithm problem*, International Conference on Computer, Information and Telecommunication Systems (CITS), Hangzhou, China, (2020), 1-5,doi: 10.1109/CITS49457.2020.9232533.

[22] R. M. SANTILLI: *Isonumbers and genonumbers of dimension 1, 2, 4, 8, their isoduals and pseudoduals, and "hidden numbers" of dimension 3, 5, 6, 7*, Algebras, Groups and Geometries, **10** (1993), 273–322.

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Practitioner Paper

Participatory Communication Approach for RD: Evidence from Two Grassroots CR Stations in Rural India

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Abstract

The traditional approach of communication for rural development (RD) was greatly influenced by the dominant paradigm of development. The retort against this paradigm gave birth to the participatory approach of communication wherein the common people in rural areas were considered as the 'subjects' of development in conjunction with their active involvement. It is the era when alternative communication medium like community radio (CR) was accepted as a tool of participatory RD in developing counters like India. Based on case studies of India's pioneer CRs (Sangam Radio and Radio Bundelkhand), using media ethnography tools, a qualitative enquiry was carried out to explore its role in the process of RD by inclusion of voices of rural subalterns in their own development.

Keywords

Participatory communication, community-radio, media ethnography, rural development, India

Introduction and Rationale

The discourse on rural development (RD) in fact reflects upon the international agenda for the development of developing nation's right from the 1950s when Community Development Programmes (CDP) were prescribed for and launched in many of these countries like India. The role of communication perspective had been perceived as one of the key elements of RD. RD with special reference to communication perspective is defined as the practice of methodically applying the processes, strategies and philosophy of communication to bring about affirmative change in rural society (Patil, 2010). The history of communication

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for development associated with the so-called 'dominant paradigm' evolved during the post-Second World War when new sovereign countries such as Asian, African and Latin American endeavoured to grow to be an advanced, self-sufficient and mechanised nations. Initially, the forefathers of communication (Daniel Lerner and Wilbur Schramm) connected the axiom 'development' primarily as a top-down approach linking with few emerging popular material aspects, for instance: modernisation, fiscal growth, technological dissemination furthering to federal planning and policymaking, extensive mechanisation, along with the amplification of fundamental public communication infrastructure. The very objective of mass communication channels was to encourage desired change in the mindsets, values and manners of masses.

The post-independent political era of Nehru and the Western dogma among the planners in India passionately applied this so-called approach of implementing communication media channels as means for advocacy and influence, targeted especially India's largest section of rural poor to transform their attitudes and bring out desired societal change. Communication strategies and campaigns focusing primarily on health communication (family planning) and agriculture communication (green revolution) were the pioneering efforts in India's development communication history. For instance: (a) UNESCO sponsored 'radio farm forums' implemented in the villages of Pune district of Maharashtra in the mid–1950's with an objective of inculcating advanced agricultural practices among the peasants, (b) the USA (NASA) supported gigantic communication project 'Satellite Instructional Television Experiment (SITE)' in the mid–1970s in six backward states. These two were truly noteworthy initiatives of this perspective. However, the post 1970s demonstrated disillusionment within the popular hypothesis of the classical dominant theory of development that relied heavily on modernisation and economic growth which did not correlate to the structural social realities and cultural ecology of the underdeveloped and developing countries including India. Appraisal reports of communication programmes designed to cater the needs of rural audience showed extremely scanty evidences of the effects of 'dominant' theory since the rural sociocultural fabric let down these efforts absolutely. The elitist Western centric planning bureaucracy and the historic sociocultural hurdles were two fundamental reasons that made the application of mass media for RD unproductive. In India, there were critical political crises like emergency that gave birth to various social movements during the same period. Since the 1980s, movements lead by NGO's and social activists around issues such as environment, gender equity and human rights of indigenous and peasants opened up severe critique on the dominant paradigm that eventually paved way for the emergence of participatory, the democratic and alternative communication approach of development. These new approaches emphasised the need to establish decentralised media systems with a more 'receiver centric' and participatory. Community-based independent media, such as community radio (CR), participatory video and popular theatre are currently professed by media activists and NGO's as a means of enabling rural people to manage their own development needs (see, Agarwal, 2006; Patil, 2015; Patil & Ambekar, 2006; Pavarala, 2016). The central focus of such participatory communication initiatives is to provide fundamental right to the voice of the marginalised communities like

rural subalterns who have excluded from the mainstream development discourse and development, so far. This process has further created voice poverty among the voiceless rural masses. Voice poverty has been considered as a serious human development concern in an agrarian country like India and a key hurdle in the process of sustainable RD. In this study, we are primarily concerned with the 'voice poverty'—the inability of citizens to influence the decisions that affect their lives and eventually right to development. 'Voice' can be defined in relation to development as inclusion and participation in social, political and economic processes. So defined, strategies to reduce voice poverty require a bottom-up communication approach which can give underserved communities an opportunity to influence their own social vectors using communication channels (Tacchi, Watkins, & Keerthirathne, 2009). In such a context, after a decade, long movement by media activists and NGO's in 2006, the Ministry of Information and Broadcasting (MIB) approved participatory CR policy in India. After its approval, as of now nearly 180 CRs have been functioning, of which about a third are serving in the rural backward regions of India. For this present study, the case studies of two pioneering CRs located in the most backward regions of rural India were purposively selected:

1. Deccan Development Society (henceforth DDS) run Sangam Radio (SR), a CR in Medak district of Andhra Pradesh and
2. Development Alternatives (henceforth DA) run Radio Bundelkhand (RB) in Orchha district of Madhya Pradesh, India.

Thus, against this backdrop, this article attempts to explore the following research questions:

1. Whether CR in India gives voice and space to the voiceless marginalised sections to participate in their own development affairs?
2. If yes, what sort of positive developmental changes emerged out of the actions of the voiceless marginalised sections in the rural setting?

Methodological Framework

Method

Researching on alternative media like CR is not merely a head count; it goes beyond and explores micro realities at the grass roots level (Kidd, 1999). Studies of alternative media tend to employ qualitative approaches. Therefore, for the present study, case study method was used.

Tools of Data Generation

The media ethnography tool is used which is more appropriate for this kind of study that mainly includes observation, in-depth interviews, background studies, focus group discussions (FGDs) and document analysis with an ethnographic fascination in the research context.

Data Collection

Considering the vitality of this study, 27 in-depth interviews were conducted at both SR and RB. These interviews were conducted taking into consideration the preferential categories of participants such as CR reporters and CR managers of both CRs. Likewise, five FGDs were also conducted including the listener's participants during April–May 2011 and November–December 2012.

Results and Discussions

This section provides analysis based on the two critical research questions raised in the earlier section. The upcoming segment attempts to explore the answers of the first research question briefly, followed by the concluding question duly.

Inclusion of Local Voices

The representation of community in the CR (mainly reporters–managers) is one of the important indicators of the inclusion of the voiceless people. This implies providing representation to those groups (gender, ethnicity, age and minority religion) not usually represented in the mainstream media as well as providing the audience with access and an opportunity to voice their own wants and needs.

In this context, the Station Manager of RB Anuja Shukla explained the station's philosophy regarding the representativeness of local community:

> The station deems that the community radio must be staffed by the community. Natural talent, aptitude, mastery of local languages, knowledge of community and the willingness to work for its development are criteria for selecting volunteers and reporters. Radio Bundelkhand is aware of its community function as a CR. The stations programming aims at reflecting the interests, believes and traditions of its listeners. The station makes an effort to be representative of its community. RB staff covers a strong representativeness and voice of age as well as gender, religion, social groups and region origin.

Table 1. Inclusion of the Representatives of the Voiceless Rural Masses in the CRs

Sr. No.	Variables	Radio Sangam	Radio Bundelkhand
1	Age	Middle and senior age	Young, middle age
2	Gender	Female concentration	Both male and female
3	Religion/caste/class	Downtrodden backward caste (Dalit), Buddhist: lacks minority and tribal representation	Lower middle caste, Hindu: lacks minority and tribal representation
4	Class	Lower below poverty line (BPL)	Lower below poverty line (BPL)
5	Region/community	Same region, community	Same region, community

Source: Patil (2014, p. 10).

If we see the variables selected in Table 1, it clearly demonstrates how a grassroots alternative media provides equity and inclusiveness in representation of the subaltern groups who have historically been excluded from both media and other social institutions in Indian society. It is interesting to note that none of them have any kind of journalistic education or experience. This shows the strength of alternative journalism where 'ordinary people' can also participate in production and distribution process of media content. Voice is the ability of people to be heard and to influence decisions affecting them. It is not only the voice of the majority that needs to be heard but also the poor and the marginalised. The qualitative observations during the field work at both the CRs confirm that many of the CR listeners are women from the lower socio-economic status with erratic earnings or landless or seasonal labourers and people such as SC's/ST's and OBC's who have traditionally and historically excluded with diminutive voice in their communities. Plurality and diversity gives better power to democracy than law of the utmost amount. As Steve Buckley (2006, p. 18) says,

> The growth of community radio is a story of people and communities striving to speak out and to be heard. Community radio has provided a means of empowerment and of self-reliance. It has enabled people to engage in dialogue about their conditions and their livelihoods.… It is a story in which the pursuit of social and development goals has been deeply entwined with the struggle for human and political rights and particularly the right to freedom of expression.

The socio-economic characteristics of the listeners and the representation of local community members as radio staff and volunteers in both CRs confirm that community voices are well represented through the participation of community volunteers and reporters which is one of the prerequisites of participatory development communication.

Participatory Content Creation

Participatory content creation can be shown to provide a mechanism to express oneself and participate in social and public spheres. But real life is messy, and a one-size-fits-all approach is unlikely to succeed; context is all important. Especially in a country like India, where a range of factors—including gender, land ownership, religion and caste—significantly affect the rural subaltern voices for inclusion in the content creation. It is a kind of developmental process through which the voiceless people find socially acceptable space and access in the content-creation process for their personal development.

> Content created after extensive discussions, conversations and decision-making with the target community; and where community group members take on content creation responsibilities according to their capacities and interests. (Tacchi et al., 2009, p. 1)

During the fieldwork, participatory content-creation activities were monitored throughout in both CRs that allowed a range of people—including marginalised individuals and communities—to have a voice within local public spheres.

Furthermore, the field observations also indicates that in a patriarchal and traditionally caste-based dominant society, the participation of women is increasing; it is quite positive indication, however, the participation of other subaltern groups, that is, SC, ST and OBC's too is significantly improving in the content creation of various programmes of CRs. SR has discarded the traditional top-down development approach. Instead, the participatory approach has been adopted, where the community makes the decisions about what is important to their lives and accordingly they prepare and construct their programme content. At SR, the 16 *sangham* (association of rural folk) supervisors, 6 men and 10 women, are assigned the task of producing radio programmes of one hour each every month. SR is working keenly towards actualising that every woman in their village has a chance to participate in the radio programme at least once a year. On the other hand, regarding the initiatives for participatory content creation, RB has been working in the following way:

> Before the radio shows are scripted and recorded, the RB teams meet with a group of 30–50 men and women who attend a one-two day-long working session to suggest specific content and themes to be addressed, working from the RB's themes related to good governance, water, education, agriculture and so on. The presence of important community members at the initial stakeholders meeting ensures that the members of local society are apprised of the content of the radio programmes and have the opportunity to make suggestions. The stakeholders are the first set of voices to begin shaping the content for the radio programme and the act of seeking input at the earliest possible stage establishes the element of the programmes I identify as contributing most to their success—their porous and inclusive design. (Anuja Shukla, Station Manager, RB)

Likewise, explaining the importance of participatory content creation, Buddamma, a semi-literate agricultural woman, critically remarks the following facts:

> When we share our views with our people then only we know our local issues such as government subsidies for income generating programme and local livelihoods issues, for example goat raring or buffalo marketing. We will tell about where we bought the goats. How did we take care of them? What were our problems? How did we solve them? And how did we make profit out of it. The commercial media never participate with us and do not care for our voices. As we share these experiences, we also get suggestions from our community members. I am very happy that our radio can do this efficiently and provide equal freedom in our radio. (Says Buddamma, SR)

Thus, the above notions indicate that in the context of globalisation and revival of grassroots movements, conventional development strategies are giving way to more participatory and inclusive approaches that are recognising the involvement of those who have suffered systematic inequalities and deprivations as 'equal partners' in developmental process. This paradigmatic shift from dominant-hegemonic to alternative-proletariat counter approach offers prospects of giving everyone, who has a stake, a voice and a chance.

Alternative Actions for Rural Development: Evidences from SR–RB

Broadcast media can serve as an imperative agent of social development when sufficient consideration is paid to both message production and reception factors. Media programmes that are based on audience needs evaluation, participatory content creations are particularly likely to be successful. In this context, CR has been emerging as one of the 'most appealing tools' for participatory communication and development. Participatory communication (PC) approach to development involves a collective action of individuals who are closest to the social problems to develop solutions that address social issues (Patil, 2014). Before going to explore the tangible developmental actions by adopting PC approach by both the CRs at the village level, let us first have a synoptic outlook of how these two CRs operationalised the PC towards policy issues in RD and their mode of collective actions. The PC approach to RD at both the CRs has shown three-fold features: (a) effective mapping diffusion of local problems and issues (b) Monitoring and coordination with rural administrators towards local developmental goals (c) Identification of local developmental challenges and working on alternatives (see Table 2).

Table 2. CR: Policy Issues in Rural Development and Mode of Participatory Actions by SR–RB

Sr. No.	Policy Issues in Rural Development	Mode of Participatory Actions by SR and RB
1	Effective mapping—diffusion of local problems and issues	**SR** has strong SHG members and participatory methods for feedback. Highly dedicated cadre of volunteers to collect micro data and an ability to disseminate the same while maintaining local sociocultural features. **RB** uses narrowcasting method to collect and disseminate local needs/problems even in the remote villages, recordings of listener's feedback and comment box in every village through effective localised appropriate and truly participatory methods.
2	Monitoring and coordination with rural administrators towards local developmental goals	**SR** evolved a participatory monitoring and coordination mechanism through primary contacts and action groups that concurrently works with rural administrators through weakly meetings and invited talk show and discussion forums. **RB** synchronised feedback mechanism with government officials, follow-up news, involvement in programme production as guest editor and online interface programmes on selected issues.

(Table 2 Continued)

(Table 2 Continued)

Sr. No.	Policy Issues in Rural Development	Mode of Participatory Actions by SR and RB
3	Identification of local developmental challenges and working on alternatives	**SR** has a traditional concept of *sangham* group meetings through which they identify local development challenges and prepare a very clear plan for the proposed action at local level in a participatory way. Furthermore, SR also provides support and appropriate publicity as the action is being implemented like in the case of awareness about indigenous seeds of cotton and the ill effects of 'BT cotton'. **RB** has quite modernised and multipronged strategies such as organising special episodes on identification of local problems, use of mobile calling and SMS, and preparing case studies on special problems such as water scarcity, out migration and climate change. Likewise, RB also keeps their CR listeners informed about the actions on specific problems and its concurrent progress and also collects their reactions on specific problems and most importantly reporting the impact of the action on rural masses and the administrators.

Source: Patil (2015).

The taxonomy of PC approach narrated in Table 2 demonstrates the essence of CR even though in a relatively limited rural setting. Further section explores some of the concrete developmental evidences at grassroots level occurred in the jurisdictions of both the CRs.

Stories of Developmental Actions: Sangam Radio

Agricultural sustainability is an important feature of RD adopted by SR. For few years, farmers of this region were facing severe problem regarding the use of BT cottonseeds and genetically modified crop. To create awareness, reporters made extensive reporting and grass roots level research to record the dismal experiences and opinions of farmers and made an excellent programme, *Why are Warangal Farmers Angry with BT Cotton?* which has generated a favourable environment among the farmers to go with alternative measures such as organic seeds and practices that further create a sense of belongingness irrespective of CR listeners or non-listeners, or agriculturalist or non-agriculturalist. Since majority of the people are illiterate and poor, they are not able to learn these issues through written material, but the programmes made by SR in their own language with supporting local level evidences and experts creates mammoth impact.

An illiterate farmer says,

> We cannot follow written material, but we can listen to the programmes and learn more about things that affect our lives.

SR's efforts endurably help the poor people for making sustainable agriculture. A preliminary content analysis reveals that near about 99 per cent of the programmes have been made by local people on local concerns importantly in which more than 80 per cent of the participants are women and Dalits (in the traditional Indian caste system, a member of the lowest caste). Substantial contributions come from the elderly who are seen by the station as repositories of very valuable knowledge otherwise are exclusively treated as most uncreative and neglected by mainstream media.

Narsamma (Manager, SR) says, not without some pride:

> We have programmes on agriculture, gender, children not attending school, bonded labour, health, tips in cropping, weeding, organic manure and other subjects. We interview people with traditional knowledge and skills, record discussions on current issues and have over 300 hours of recordings.

For the first time, it seems that many of these community members feel an ownership of the radio and its content and also an understanding of the power of expression and access to the public sphere to create social change and action. SR has created various tangible changes among the rural communities, for example, it has provided right to voice to the common people through which they are now able to ask questions to even the public servants much more efficiently than the earlier.

> Now we discuss matters in our *sanghams*, make radio programmes and even talk to any superior public official, including the *patwari* [village accountant] to whom earlier we even can't speak. (Member, *sangham*)
>
> When we go to conduct interviews with government officials, because they see recorders in our hands, they take us a bit seriously. You can see that they have 'prepared' themselves for this interaction as they have all their relevant documents and files in place to show you. That is the first step towards transparency and accountability for us. (General Manager, SR)

Furthermore, it has the potential to be extremely powerful—symbolically and in everyday practice. It allows for everyday issues of ordinary people to be voiced in ways that is extraordinary in the opportunity it provides.

General Narsima, who was one of the pioneers of SR since 1997, says,

> After working in this field for more than 10 years, I've really come to appreciate a kind of magic ability to empower and mobilise that comes from sharing the ability to have your voice heard in the media with communities that for too long might have been excluded from decision-making in their societies. It seems so simple, but I've seen over and over again, in so many contexts, that this is the key to positive social change in many rural communities.

SR's Initiatives on Climate Change

P. V. Satheesh, Director, DDS, Hyderabad, says,

> In order to create a Community Charter on Climate Crisis, SR was used for a series of participatory exercises to consult local communities. The consultation revealed living and dynamic capacities of the local communities to combat the climate crisis through their traditional farming, fishing, pastoral and other such life affirming practices and their resounding confidence in their ability to find solutions to the climate crisis. If this awareness does not follow this route and depends upon those very scientists and scientific institutions which through their agricultural and energy policies brought about the climate crisis in the first place, it would be a travesty of justice and an incompetent use of the media.

Rural Women: Inclusion of Most Excluded Voices

One of the most excluded groups in rural communication structure is women. However, it has been observed that through the various initiatives of both the CRs, the traditional power structure of information is liberating and the marginalised sections mainly rural women are getting a new space. SR is the only CR in India owned, run and managed completely by women and Dalits.

So far although the above cases are merely an indicative but offers absolutely tangible message to the development community towards the essence of PC approach. The impending section will also focus on the stories of participatory developmental actions taken up at RB with quite different contexts and alternatives.

Stories of Developmental Actions: Radio Bundelkhand

At the very first instance during the FGD at RB, we have received encouraging feedbacks from the direct listeners. Some of which are mentioned as follows:

> We expect CR should be different than the AIR (All India Radio) or private FM radio channels, because they never come to us and ask about our needs and problems. It is the RB where we have hopes and really observed that it reflects our day-to-day common needs and problems. It is only possible with frequent community interaction and involvement. (Puspesh, a college student, RB)

> When we hear on the radio that the problems of neighbouring villages have been solved, we will also put together an effort to take actions to do something about our own situation. (Keshv Panth, RB)

> [Radio Bundelkhand] is a medium to express and make known my concerns and views … freely; there is also a feedback (phone-in programme, drop-box in villages and letters) that opens a space people who had not have the chance to be participants in this medium. (Local tourist guide, RB)

The real strength of RB is their truly participatory way of programme production and selection based on participatory content-creation process. The channel's popular chunk *Apne Aas-paas* (our surrounding) is an open forum programme. In

this programme, many of local problems highlighted and some of those have been solved. The participatory communication initiatives of RB resulted in the following outcomes:

1. Sitapur village (8 km away from RB station) had piling waste near school premises inviting many diseases on the health of students. Due to collaborative efforts of reporter and village youth, public attention to get rid of this danger was drawn.
2. Community members raised issues of Pratappura water hoarding problem, Jijora village water scarcity problem and Ajadpura's unavailability of wheel in well. This resulted in action by authorities. In fact, National Rural Employment Guarantee Scheme (NREGS) is a big success story of impact of radio in the area; some listeners also purchased radio to get aware of the information. In Maharajpura, workers got back their job cards after learning about (NREGS) through radio programmes.
3. *Khet khalihan* (Farming threshing) is another successful programme. The channel has collected a number of case studies and success stories where the community applied suggestions and solutions, broadcast from radio. Letters of impact of its programmes and folk songs were sent in by listeners, where issue-based folk songs and programmes were composed, inspiring and motivating the community to take action.
4. At the time of village level election campaign of '*Hamara sarpanch kaisa ho*' (How should be our village chief), channel received remarkable reaction from listeners that include not only youth who just turn 18 years old but women in veil were also willing to share their opinion on the ideal face of *Sarpanch* (village chief) via phone calls. To engage women and identify the issues of women in the area, radio started a biography based programmes *stri ... ek kahani meri bhi* (Women: A story of self).
5. Spreading awareness on climate change as part of the *Shubh Kal* (Tomorrow Morning) radio campaign in Bundelkhand is also encouraging which works on the principle that the local and global effects of climate change can, in some measures, be dealt with in rural communities by adopting the means to derive enhanced economic benefits with lower carbon emissions and work to regenerate the environment.

Bundeli Idol: A Way Towards Sustaining Local Culture

The oral traditions are very strong in this region. RB, one of the early CR stations in India, started live musical programme which is meant for preserving the local music and promoting local talent through the participation of local, amateur artists in a show called *Bundeli Idol*, a version of the popular reality television show American/Indian Idol.

Prakash Narayan, one of the community reporters of RB, says it is our natural responsibility to give a voice to the marginalised. The programme (*Bundeli Idol*), he adds, is also aimed at giving opportunities for oppressed/suppressed artistic talent (*Kuchle/dabe hue kalakar*) in the villages.

Kamalnath, a local artisan and upcoming singer from village Orchha, says,

> The programme Bundeli idol gave us tremendous confidence and encouragement to express our unexplored talent, the most important factor is it has given us a different identity as a singer among the community members.

Till date, RB has collected 1,025 songs and around 400 artists from the communities who have performed for the radio and won the prestigious Commonwealth Educational Media Centre Asia Award in 2011. It has enabled the people to broadcast in their own *Bundeli* (a local dialect of Hindi) language, tell their own story and sing their own songs.

Conclusion

This study concludes that there is a paradigm shift in the earlier dominant approach of communication. It has moved from merely using media to inform and aware rural masses to engaging the beneficiaries in the communication process not as receiver but producer of the content itself. A participatory paradigm has been instrumented in successfully reaching out to the marginalised communities and assisting in their development at the village level. The participatory bottom-up approach of community media has proved significant marks, as corroborated by the evidences aforementioned. The PC approach has also justified that there is a need to change the development process upside down. The study also necessitate that an interactive, participatory tool like CR to engage the rural masses which encourages them to participate in their own socio-economic developmental subjects more conveniently where the government system has to function as a facilitators. However, it is finally suggested that while interplaying with state, funding agencies and NGOs, the core values of CRs should not be negotiated.

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References

Agarwal, B. C. (2006). Communication technology and rural development in India. *Indian Media Journal*, *1*(1), 1–9.

Buckley, S. (2006). *Community radio and empowerment*. Background Paper Presented at 2006 World Press Freedom Day. Retrieved from http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/CI/WPFD2009/pdf/wpfd2006_Steve+Buckley.doc

Kidd, D. (1999). The value of alternative media. *Peace Review*, *11*(1), 113–119.

Patil, D. A. (2010). *Communication for rural development in India: From green revolution to 'E' revolution*. New Delhi: Serials Publications.

———. (2014). Exploring the subaltern voices: A study of community radio reporters (CRR's) in rural India. *The Qualitative Report*, *19*(65), 1–26.

———. (2015). *Liberating marginal voices: Rise of community radio from conscientisation to participatory development in India*. Germany: Scholars' Press.

Patil, D. A., & Ambekar, J. B. (2006). Information and communication technology (ICT) and rural development: Lessons from rural India. *IASSI Quarterly*, *25*(2), 105–122.

Pavarala, V. (2016). Blurred vision: Development communication and community radio in India. *Journal of Anveshi*, *2*(10), 11.

Tacchi, J., Watkins, J., & Keerthirathne, K. (2009). Participatory content creation: Voice, communication, and development. *Development in Practice*, *19*(4–5), 573–584.