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TRANSDISCIPLINARITY: FROM A REAL EDUCATIONAL ESSENCE TO A NORMAL FUTURE IN SCIENTIFIC RESEARCH

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Abstract. This paper is built with a dual purpose: to render, in natural and continuous manner, both the scientific narrative devoted to define the non-unidisciplinary science thinking and the contribution of transdisciplinarity in modern science, both in education and scientific research. After a brief introduction, based on redefining the specificity of inter-, multi-, and transdisciplinarity, trying to define the real difference between all of these concepts and, at the same time, to reveal the modern, intense and innovative expanding process of education and research in science, the second section describes the new contents of transdisciplinarity in the context of applying it as a real solution against the complex problems of reality in modern scientific education, and scientific research in general. The usual final remarks conclude in a balanced way this article 's diversity of transdisciplinarity's significances revealed through its lines in modern education and scientific research, underlining the evolution of transdisciplinarity from a real essence of education to a normal future in scientific research.

Keywords: science, discipline, inter-, multi-, transdisciplinarity, scientific thinking, education, scientific research.

1. INTRODUCTION

The emergence, development and disappearance of sciences and scientific disciplines during milenia are closely related to scientific research, which invalidates them, restructures them, or contributes to either their gradual obsolescence, up to their disappearance as real impact in the topicality of the scientific universe, or their re-grouping, interrelating and intersecting them continuously, validating or invalidating their methods and characteristic models.

The option to define modern science as a simultaneously distinctive and integrative, coherent and comprehensive way to address a specific and complex phenomenon of modern reality emerged from a combination of *theoretical* investigation with a practical simulating or prediction impact, into a segment of reality, defining *as an object of study*, through its methods, but especially with the help of *specific patterns of knowledge and interpretation*, having recourse to a new expression using the language of a multiplied inter-, multi-, and transdisciplinary type of thinking

This is briefly the essence of the mechanism of inter-, multi-, and transdisciplinarity, which has generated, and is still generating, ever new sciences. The methods and models of modern science, which have thus become essences of contemporary science, combine at least two or three types of thinking. A first example, excerpted from my own modest experience to avoid isolated research and unidisciplinary paper, bearing on methods, is the very method for analysing the concentration or diversification of contemporary processes, from specific markets to the linguistic expressions, from stocks to flows, from demographic phenomena to biological processes. Instrumentally, inter-, multi-, and transdisciplinarity type of research simultaneously exploit the statistical thinking of concentration and diversification

indices, which constitute a large family of indicators, the manner of mathematical thinking, mainly geometric, of concentration curves, the specific thinking of the biological cycle and the curve ABC, etc. [1] *Whether bridging disciplinary divides between different ways of knowing within academia* [inter-, and multidisciplinarity], *or extending the 'right to do research' to marginalized communities and groups* [transdisciplinarity], *a key feature of these processes is that of reflection – both of the world and of one's role in that world.*" [3]

1.1. Inter-, multi-, and transdisciplinarity in modern education and scientific research

The terms inter-, multi-, and transdisciplinary have a common origin, as noted in the conceptualization of the discipline and science, defining forms of antinomy of a multiverse of disciplines and sciences (*"the former category already exceeding 8000 disciplines as distinct entities according to bibliometric classifications, and the latter approaching, in keeping with relatively recent surveys, 1200 well delimited sciences"*) in relation to unidisciplinarity, addressed in a limited, closed and slightly derogatory sense, as a unique, isolating discipline. [2] For academic teaching or researching domain, unidisciplinarity, as modern significance, and not mandatory, means only to know everything related to a vast unique disciplinary field, but also to offer permanently an original education instrument and a clear research attitude in any logic scientific investigation. This general aspect is subject to a natural law of studying diversity in a homogeneous manner, or to the fact that the heterogeneity in the reality investigated in a scientific or disciplinary manner must be theoretically explained by homogeneity. [2]

The premises of the more and more intense development of this process are related to both the ontological nature of the sciences and disciplines separated from various areas of reality or specific universes composing their multiverse as a coherent set of a logical nature, and also of a general gnoseological essence, or, more specifically, strongly epistemological.

Interdisciplinarity designates establishing relationships between several disciplines and, beyond its aim, nuanced and diversified compared to unidisciplinarity, be it open, it involves phenomena, concepts and general laws that are common to several disciplines, investigated with common methods and models, it analyses and highlights, in a varied context, multifaceted issues and diverse opportunities for knowledge of reality [2] As the major induced hypothesis, interdisciplinarity favours horizontal transfer of knowledge from one discipline to another, level by level, which reshapes, permanently and by extension, the limits of a map tending towards completeness of the relief of knowledge, and requires cooperation with other disciplines. *"All the above aspects*

engender a process of specialization that constantly gives rise to new subdisciplines, and another one, of fusion, which anticipates the potential rebuilding of new disciplines. In statistical thinking, interdisciplinary is simultaneously disaggregative and aggregative, within completely different areas of scientific knowledge."[2] Basarab Nicolescu reconceptualises interdisciplinarity as a three-grade transfer of methods from one discipline to another, ontologically, logically and epistemologically [4], finally allowing to determine not only the epistemological isomorphisms but also the homomorphisms of a discipline into another, with a major impact on their development, and thus describes an extended typology of interdisciplinarity, from interdisciplinary fields to interdisciplinary levels, grades, and areas of reality and to interdisciplinary methods, models and even concepts

Among the transfers of methods and models specific to interdisciplinarity from one science to another, apart from the *applicative* and *epistemological* (cognitive) transfer, the transfer *generating new disciplines* is becoming increasingly significant and important (dominated by the transfer of methods and models), also caused by the high complexity of the problems investigated [2].

An illustration of the fact that this type of transfer is practical and continuous, can start with a first interdisciplinary transfer, that of statistical thinking in biology, defining biostatistics, and can continue with a transfer of the methods of the statistical-mathematical type in economics, configuring econometrics, the first science born at the intersection of three scientific ways of thinking, and can finally conclude with a third transfer, this time fluent and complex, that of the econometric model, within the space of financial economy, saturated with uncertainty, which generated, by the probability theory, the science of financial econometrics and the econometric financial model [5], bringing together a large family of models, and selecting only those of the ARCH and GARCH type, which represents an important proof of the specific approach of modelling interdisciplinarity.

The diversification, aiming at interdisciplinarity, of the ARCH and GARCH models began over three decades ago, and continues to date (Bollerslev in 2008). Financial econometric ARCH type models, where the variance depends on the previous series of square errors (the acronym is derived from AR – *autoregressive*, C – *conditional*, and H – *heteroskedasticity*), were introduced by Engle in 1982 and four years later, in 1986, were generalized by Bollerslev, together with Taylor, becoming GARCH (G, standing for *generalized*, was added to the old acronym. The GARCH model was established as financial econometric model increasingly powerful, simplifying assumptions, incorporating the asymmetry of the impact of the assets rate performance, separating volatility based on the trend in the short term. In 1987, Engle, Lilien and Robins proposed extending the classical GARCH model so that conditional volatility can generate a risk premium which should be incorporated in the expected return, and thus the GARCH variant in Mean appeared (GARCH -M).

The EGARCH (Exponential GARCH) model was devised by Nelson in 1991; in this model, specification of the conditional variant is done logarithmically, which means there is no constraint on estimates to avoid the negative variant (EGARCH is considered to be the best financial

econometric model to determine the volatility of stock market indices and exchange rate). The typology of such models became more diversified every year: integrated GARCH (IGARCH-Integrated), followed by NAGARCH-Nonlinear Asymmetric GARCH, whose authors are Higgins & Bera (1992); GJR-GARCH, considered the most suitable GARCH model to explain and anticipate the indices of shares on financial markets, with the authors Glosten, Jagannathan and Runkle (1993); Treshold ARCH (TARCH), whose author was Zakoian (1994); QGARCH – Quadratic GARCH, devised by Sentana (1995); GARCH-X, proposed by Brenner, Harjes and Kroner (1996); fGARCH, or Family GARCH, devised by Hentschel (1997); Tobit-GARCH, devised almost simultaneously by Lee, Morgan and Trevor (1999), and improved by Wei (2002); Matrix EGARCH, authored by Kawakatsu (2006); FCGARCH (Flexible Coefficient GARCH), construed by Medeiros and Veiga (2008), etc.[6]

Interdisciplinarity is simultaneously a process of focusing or concentration on issues that are not only complex and global, but also placed at intersection points, at the border or in the interstitial spaces of several sciences or disciplines, but in this case, too, the interlocking of the methods and models, as well as the coordination of the research may end in adopting a common and general body of theory, methods and models, that is delineating a new field of knowledge or a new science. Interdisciplinarity proves relatively more innovative, heterogeneous, auxiliary, complementary and dissipative, but also unifying, apparently linear, but frequently structured and even restrictive, preserving the originality and creativity of sui generis scientific interrelation.

Multidisciplinarity involves simultaneous application of the thinking of several sciences, and also involves the study and research of a domain of reality being achieved from several angles, descended from the multiplied thinking of several sciences simultaneously. Both the researcher, and the researched area or the area of reality under multidisciplinary scrutiny, will ultimately be richer, depending on the outcome of the research. Multidisciplinarity, as a form of intertwining disciplines, consisting in the juxtaposition and addition of certain elements of various disciplines, highlights their common issues, and entails a symmetrical communication between various specialists coming from different disciplines, who bring together their different way of thinking and turning to good account, their concepts or languages, methods or models, in their own axiometry. [2]

“Simple or exaggerated multidisciplinary does not mean mere juxtaposition or coexistence of several disciplines in the same area of reality, but rather a passage, through interdisciplinarity (permanent informational and methodological transfer from one discipline to another) to transdisciplinarity. Maximizing or to-the-extreme development of the trend of multidisciplinary aims at the complete and complex dilatation of scientific knowledge, meaning a vast dissolving of sciences into a single one, a complex fusion into a huge single science or discipline” [2].

“Transdisciplinarity appears between disciplines (sciences), along them, and sometimes even over them” [7], and is considered a superior final form of interdisciplinarity and even special kind of multidisciplinary agreed and acquired as much as possible at the level of the individual researcher, which involves concepts, principles, language and finally even theory, in parallel with methods, methodology

and models, which tend to become universal, dynamically generated by the action of the many levels of reality (systems theory, information theory, theory of scientific modelling, etc.).

In my humble opinion transdisciplinarity [8] represents maximized interdisciplinary, but finally identifies itself with the *to-the-extreme* form of complex multidisciplinary, defined as educational (academic) purposefulness, in the explosive sense of an ample dissolution of all disciplines or sciences into one, a complex fusion into a huge scientific universe (epistemological multiverse).

Transdisciplinarity as the future way of interaction of modern education and scientific research, and especially of the specific way of thinking, and finding adequate solutions to complex problems is able to induce formation trends and generate new real developments for the scientific research, with varying degrees of coverage with respect and appreciation to the methods or sciences origin [2, 9].

2. TRANSDISCIPLINARITY FROM THE FUTURE OF EDUCATION AND SCIENTIFIC RESEARCH

Both defining and understanding transdisciplinarity are the result of identifying and applying this concept in various educational and research contexts. The level of relevance of education in various fields is constantly correlated with the extent to which learning transcends the boundaries of disciplines or unidisciplinary messages as intrinsic processes of education to connect students and researchers and adapt to existing realities in the contemporary world all those who receive information [10].

A modern education and pragmatic research program will by definition be an exclusively transdisciplinary one, placed continuously in, between, but also over unidisciplinary investigative methods, shaped so as to solve pressing and complex real world problems and generate information and knowledge, even going to the point of identifying different perspectives on the world. In modern world, transdisciplinarity thus becomes the only viable solution to explore and process large amounts of data in a way that is closer to the holistic vision or approach, detailing the information layers and explaining their associations to a more and more complex reality.

A transdisciplinary research or investigation is often described as an innovative orientation, placed over a whole previous less uni-, and more and more inter- or even multidisciplinary universe. Continuity and creative approach can naturally transcend scientific research beyond the initial limits of standard unidisciplinary spaces, but also usually interdisciplinary and even those established as multidisciplinary. Transdisciplinarity is also conceptually replaced by the transcendence and comprehension of the investigation, the characteristic context and the frame of reference of these researches suddenly becoming ascendant. Intense relativization requires transdisciplinarity in research that requires a complex methodological set, as well as a major impact on the general level of scientific knowledge previous and especially of isolated or insufficiently intersected disciplines [11].

Transdisciplinarity is increasingly identified with the natural solution to the need for permanent change in the way of thinking of modern research and academic education, by

trying to ensure scientific exhaustivity or academic comprehensibility, especially in an era of disciplinary big bang and excessive specialization and even manages to it confers "the long-sought harmonization of perceptible mentalities and intelligible knowledge" [12].

The term transdisciplinarity appeared relatively recently, being introduced, as such in scientific language, only in 1970, by the Swiss psychologist Jean Piaget [7; 13-17]. In 1972, in his essay entitled *Interdisciplinarity: Problems of teaching and research in universities*, Jean Piaget was the first to use the word transdisciplinarity in writing, defining "a higher stage succeeding interdisciplinary relationships [...] which would not only cover interactions or reciprocities between specialised research projects, but would place these relationships within a total system without any firm boundaries between disciplines" [18].

After more than half a century, transdisciplinarity has remained a major educational goal, especially an academic one, but also an essential criterion of scientific research, outlining a synthesis of disciplines that ensure the highest level of complexity and abstraction, implicitly investigation, integrating and overcoming inter-, cross- and even multidisciplinary [19]. In 1985, in the volume of Basarab Nicolescu, "*Nous, la particule et le monde*," awarded by the French Academy, the author proposes from the perspective of quantum physics the unification of meanings between, inside and beyond by the prefix "trans" [20].

Everything starts from the double and at the same time sad finding that sometimes the sum of all the competencies turns into an unwanted incompetence by a teacher or researcher, but also from the apparent impossibility of in-depth communication between the more and more numerous scientists of the Earth, so called experts of some disciplines, more heterogeneous. The generous intention to form academic and research teams can give rise to some of the most unexpected combinations, especially in complex situations, related to solving large-scale projects, for example bringing together physicists and neurophysiologists, mathematicians and poets, politicians and computer scientists etc. Basarab Nicolescu remains the one who stressed for the first time the major importance of transdisciplinarity in overcoming these obstacles, seemingly insurmountable for any of the neophytes of academic disciplinary language or terminology specific to excess research, in a world, where as he also noted ironically "we have all become neophytes of others" [21].

Epistemologically applied interdisciplinarity, but also the birth of new disciplines in various academic and research interstices, intensifies any type of knowledge, while crossdisciplinarity multiplies the area of disciplinary application of techniques and methods through creative methodological borrowing, and multidisciplinary dilates the image or microscopic dilated image of the overall evolution, as well as of the understanding of the depth of the changes. Transdisciplinarity remains obsessed with its specific transposition: "at the same time placing itself between disciplines and within various disciplines and beyond any discipline." The finality of the transdisciplinary approach naturally becomes the understanding of the present world, and one of its major justifications is the complex unity of knowledge modern reality [22]. According to the classical educational approach, transdisciplinarity can be appreciated as being an absurdity, from a narrow unidisciplinary point of

view, not subject to a first practical investigation, and its form of scientific research becomes unreal, the cause being precisely the focus on "concomitant action of several levels of reality, of the logic *tertium non datur* and of the complexity" [12].

In its essence, modern transdisciplinarity has no choice but to abdicate from the conventionalism of classical scientific investigation, proving clear intentions of non-discipline, through an inclusive and unconventional approach to modern education and scientific research. This is more like a disordered and chaotic symphony of methodological approaches specific to generalized or universal knowledge, able to describe an enigmatic, abyss-like investigative process, armed with a little more creative anticipation than usual, along with a more well positioned approach of the adaptive and receptive nature of the researcher in a constantly evolving scientific universe [23]. There are some relative similarities between transdisciplinarity and multidisciplinary according to the overlapping characteristic approaches, caused by their declared intentions to wide more and more to cover the reality and the tendency towards the extended or with a higher degree of validity. One can find also significant differences, starting from the ontological structure and the definitive way to generate scientific information.

The correct positioning of the researcher in a specific trans- and multidisciplinary space gives him support and utility as long as he adopts inclusion as a research method and can naturally overcome unidisciplinary barriers, through complex adaptive efforts, focused on flexibility, creativity and interaction. Both the methodological incorporation process and the process of accepting the knowledge generated by other academic and scientific communities can show different characteristics in the usual case of transdisciplinarity from that of multidisciplinary.

The persistence of validation processes, along with the longevity of scientific truths, clearly differentiates them, transdisciplinarity being relatively less exposed to methodological precariousness and relativization of technological evolution, compared to multidisciplinary.

Similar to creative and complex approach of the profound poetry and higher mathematics, the uniqueness of transdisciplinary approach is conferred by the dominant creativity and the structured deepening of reality's problems and never by a simple improvisation or randomly validating circumstances. Thus any teacher or researcher that aspires to solve complex problems of reality can use the entire process of knowledge based on transdisciplinarity, the complex interaction incorporating unique changes on several levels, structures, themes, modeling, being guided by the transdisciplinary process, rather than by a complex research question as in the case of multidisciplinary. Both types of multi- and transdisciplinary research are inclusive, but while multidisciplinary research is relatively stable as an investigative ensemble and methodological potential, the transdisciplinary research remains always complementary and evolving, constantly offering innovation, free thinking, aspiring to authenticity ...

Modern science foreshadows a growing appreciation of transdisciplinary education and research, both in the immediate future, both on medium and long term, beginning from the mere finding that these human activities succeed in the transdisciplinary context to identify a common group of

axioms. in a continuous multiplication, for an ever-expanding set of disciplines, intensely capitalizing on a systemic logic but also a higher order synthesis of interdisciplinary relations. Thus the future can emphasize the accentuated superiority of transdisciplinary contributions, compared to inter- and even multidisciplinary. As Eric Jantsch, an Austrian astrophysicist, has pointed out transdisciplinarity has demonstrated its superiority since his terminological birth, in objective relationships that are found in reality and do not reside in deeds [24].

This has been and continues to be the major asset of transdisciplinary education and research, where scientific issues are meant to be more clearly defined, objective, static and neutral, to which the future will certainly amplify the unity of knowledge and research, focusing on the "imperative of disciplinary integration" is becoming more and more intense. Despite its growing popularity and prospects, transdisciplinarity is still far from being fully established academically and in line with current funding practices, which support it less effectively in universities and research institutions [25]

3. SOME FINAL REMARKS

This article's essence is based on a specific approach, with the help the original vision of Basarab Nicolescu, a romanian physicist, who seems to have grown and thought in the beneficent shadow of the Anton Dumitriu, being strongly marked by the history of logic, and by Dan Barbilian's transcendence from poetry to mathematics with the help of the hermeticism of the same Ion Barbu, with his justified and inimitable poetics [26-29]

Inter-, multi-, and transdisciplinarity have become, in the current multiverse of modern education and scientific research, important processes with respect to their impact in the vast area of scientific thought, but also in their taxonomy, if we only mention the famous problem of circularity of formal systems, a problem that finds that the wish to express knowledge in a formal way is illusory and that there are, relatively simple assertions or theorems in the major formal logical systems or in the related systems, which cannot be solved in that system, as the respective assertions and theorems in the model analyzed are neither provable nor indemonstrable, such as Gödel's famous question [30].

Of all these currents that clearly challenge unidisciplinarity, transdisciplinarity dominates and even continually transcends all boundaries of academic disciplines to connect researchers, who have already accessed its advantages, to the complexity of modern reality and amplifies the importance of how concepts are integrated. theories and knowledge derived from different fields of investigation, pragmatic methods and highly appropriate tools. All this can provide answers to the expectations of different groups of economic and social actors, identifying synthetic solutions according to their own standards, in increasingly diverse problem areas such as migration, emerging technologies, public health, changes with global impact, etc.

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FRAGILITY OF HAPPINESS AS A PREDICTOR OF INSECURE ATTACHMENT AND SUBJECTIVE WELL-BEING: A STUDY ON EMERGING ADULTS

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Abstract: *The belief that happiness is fragile and transient and may soon turn into less favourable states is often experienced by a lot of us. Fragility of happiness is an aversion to the experience and/or expression of happiness due to the belief that happiness may cause bad things to happen. The present study aims to examine the impact of fragility of happiness on insecure attachment orientation and subjective well-being of emerging adults. A sample of 100 emerging adults falling into the age group 18-25 years, was taken to conduct the study. The sample included 50 males and 50 females. fragility of happiness scale (Joshi et al., 2015), Adult Attachment Scale (Collins & Read 1990) and The Satisfaction with Life Scale (Diener et al., 1985) were used to collect the relevant data. Findings indicated that subjective well being is negatively predicted by fragility of happiness. There is a positive significant association between insecure attachment styles and fragility of happiness while subjective wellbeing is related negatively to attachment orientation and fragility of happiness.*

Key Words: *Fragility of Happiness, Subjective Well-Being, Attachment Avoidance, Insecure Attachment, Fear of Happiness, Life Satisfaction*

1. INTRODUCTION

“Fragility of happiness is an aversion to the experience and/or expression of happiness due to the belief that happiness may cause bad things to happen.” [7]. Fragility of happiness goes in conjunction with the notion that happiness is a fugitive construct, that can transmute to rare favourable state or a state of unhappiness. This belief is theoretically accompanied by the fear of happiness. Also known as chrophobia, aversion to happiness or fear of happiness is an attitude where individuals may consciously refrain from events or experiences that solicit more joyful states. Some experts have classified chrophobia as a form of anxiety disorder. Individuals who experience chrophobia usually believe that being happy is a waste of time. They also assume that there is only a limit to one being happy. According to their belief, excess joy brings bad consequences. They usually hold a belief that being happy makes you an awful being and causes harm to your friends and family. Despite the plethora of research work published on happiness, there is a very sparse comprehension of happiness as a construct and happiness is substantially elucidated as an emotionally charged state marked by the feelings of rejoice, complacency, pleasure and gratification. [9]. An individual who is fearing happiness, isn't necessarily a depressed individual, but is someone who steers clear of the events that may bring or lead to happiness. Some of the examples that could define fragility of happiness are : Experiencing anxiety at the thought of attending a joyful gathering like a party;

Refusing positive life changes as this could make a negative event follow and; Avoiding events that others would find fun. While culture has credited an extensive influence on chrophobia, personality factors could also be attributed to this concept. Recent researches have identified personality to be moderating the association between fear of happiness and the experience of happiness along with their relationship with other significant factors such as personality [2]; wherein higher levels of agreeableness and neuroticism reinforced the influence of aversion to happiness.

2. LITERATURE REVIEW

The Attachment Theory was initially proposed and commenced by John Bowlby and Mary Ainsworth. They worked together on the attachment style between children and their caregivers. It was in the 1980s when Johnson introduced attachment theory to adult therapy and Hazan and Shaver (1987) further extended it. The emotive bonding that develops between an adult intimate couple is extended through a similar motivation system, i.e. the attachment behavioural system. This further increases the psychological association between infants and their caregivers.

Attachment Styles: Attachment is a profound and persisting sentimental association that binds individuals over time and space. Attachment can also be expressed as an impassioned relationship that involves reciprocity of solace, care and contentment. An individual's initial attachment orientations are established in childhood. A healthy and secure attachment style is characterized by individuals who confide in long term relationships. They report greater levels of high self-esteem, appreciate intimate relationships, look out for social assistance and the ability to develop fondness. Several studies have reported that anxious or insecure attachment patterns capitalize on chrophobia. It makes it arduous for people to believe that the feeling of contentment is effortless to attain and will persist. Attachment insecurity is usually constituted by attachment anxiety and attachment avoidance. There are four major types of attachment styles as outlined below:

1.Secure: Individuals with secure attachment orientation score less on avoidance and apprehension/anxiety. They are comfortable with affection and seldom agonize about abandonment. These individuals regard themselves and their partners in a positive light. They cater to higher levels of satisfaction and adjustment in their relationship.

2.Dismissive-Avoidant: These people show greater levels of avoidance and grow less anxious. They are not congenial with closeness and regard their independence and freedom more.

Availability of their partner is none of their concern. These individuals boast their positive self and view others in a negative light. Perceiving themselves as self-sufficient and less vulnerable, they often refuse to establish close relationships.

3. Anxious-Preoccupied: People with this attachment style show low level of avoidance but higher extents of anxiety. They yearn for closeness and intimacy and reflect higher levels of insecurity in a relationship. These individuals frequently display impulsivity, emotional dysregulation and agony. They treasure intimacy to such an extent that they develop unduly dependent attachment style.

4. Anxious and Avoidant: These people are high on both constructs, anxiety and avoidance. They are uncomfortable with intimacy and are worried about their partner's commitment and love. Individuals who go through severe trauma during childhood, may develop this attachment orientation. They seldom view themselves as worthy of the responsiveness of their attachment and suspect the credibility of their bonds.

Subjective well-being is regarded as one of the definitions of happiness. It is a self-reported assessment of well-being which is commonly procured using a questionnaire. It embraces moods and emotions along with a judgement of individuals' satisfaction with extensive and specific arenas of life.

Subjective well-being is 'people's cognitive and affective evaluations of their lives.' [4]

It has two comprehensive components:

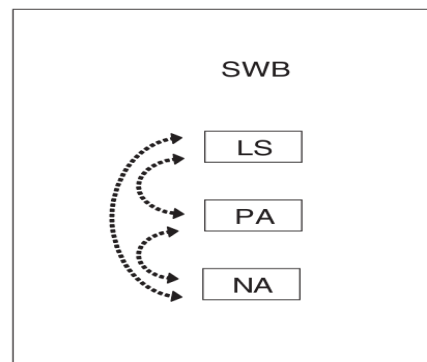
1. Cognitive Appraisal: It elucidates how we evaluate our satisfaction within our respective global and specific domains. (eg. family, life, career, etc)
2. Affective Appraisal: It discusses our experience of fierce and persistent positive state of being, along with the general absence of the negative states of being.

Subjective Well-being also encompasses 3 discrete components:

1. Positive Affect: It is the degree to which an individual experiences positive emotions.
2. Negative Affect: It deals with the extent to which an individual experiences negative emotions and poor self-concept.
3. Life Satisfaction: Life satisfaction focuses on how individuals exhibit their emotions and feelings about their career and other directions of life.

It is important to note that subjective well-being embraces the affectivity balance which is inclusive of the balance between frequent positive affect and infrequent negative affect. Levels of happiness, subjective well-being and attachment style are found to be altering social anxiety levels among university students. The study pointed out how social anxiety correlates with insecure attachment orientations. Individuals with secure attachment orientations reflect self-sufficiency in dealing with their own emotions and needs. They try to embrace intimate

relationships, fidelity and commitment, thus resulting in



happiness. [1]

Source: Bussari & Sarava, 2010

Fig. 1. Tripartite Model of SWB

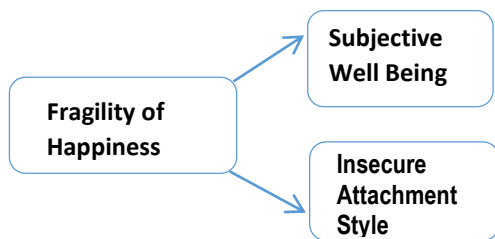
Alexithymia and depression correspond highly fear of happiness and compassion. The research explored the links of this process with adult attachment styles, cultural security and pleasure. The target population was a depressed group. Aversion to happiness reflected the variance in depression, anxiety, and stress, while fear of compassion best predicted adult attachment orientations. [5]. Another research lent evidence to how fear of happiness influences individuals' responses to items in a life satisfaction scale. Since happiness encompasses both life satisfaction and subjective well being, empirical evidence from this research highlights that aversion to happiness (a belief that happiness may bring negative consequences) brings variance in the ways individuals comprehend their life satisfaction. [1] Insecure attachment orientations are related with a spectrum of mental disorders, varying from mild negative affectivity to severe. Several studies have shown how attachment insecurities correlate with vulnerability to disorders. These studies have suggested attachment insecurities to be reasonable pathogenic states. It is worth noting that there could be miscellaneous clinical interventions helping the clients to establish a sense of secure attachment orientation. [10] Fear of happiness has also been studied in context with optimism and subjective happiness levels. Individuals who were high on the optimism quotient, reflected positive significant relationship between fragility beliefs and well-being, while people scoring less on optimism displayed aversion to happiness beliefs to be inversely related to well-being. It was predicted that fear of happiness related significantly to lowered happiness in people who displayed low levels of optimism. [6].

3. METHODOLOGY

Participants:

The sample included a total of 100 emerging adults (18-25 years), consisting of 50 males and 50 females. Purposive sampling technique was used for the same.

Research Design : A causal research design was employed.



Measurement Tools:

- **Fragility of happiness** - The 4-item fragility of happiness scale (Joshani et al., 2015)
- **Attachment styles** – Adult Attachment Scale (Collins & Read 1990)
- **Subjective well-being**- Satisfaction With Life Scale (Diener, Emmons, Larsen, & Griffin, 1985)

4. RESULTS

Table 1: Correlation between Fragility of Happiness, Attachment Style and Subjective Well-Being

	Fragility Of Happiness	Subjective Well-Being	Attachment Avoidance	Attachment Anxiety
Fragility Of Happiness	1	-0.276**	.462*	.027
Subjective Well-Being	-	1	-.201*	-.432**
Attachment Avoidance	-	-	1	.444**
Attachment Anxiety	-	-	-	1

Source: Realized by authors

Table 2: Regression (fragility of happiness as the predictor of attachment avoidance)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	72.95	5.94		12.27	.00
Fragility of Happiness	-.73	0.14	.46	-5.14	.00

Note: Fit for model R²= 0.21 Adjusted R²= 0.20, F (1,99) = 26.47, p<.001

Source: Realized by authors

Table 3: Regression (fragility of happiness as the predictor of SWB)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	6.73	3.06		2.20	.000
Fragility of happiness	.39	0.07	-.27	5.32	.000

Note: Fit for model R²= 0.22 Adjusted R²= 0.21, F (1,99) = 28.32, p<.001

Source: Realized by authors

It can be seen through the result that fragility of happiness is significantly predicting 21% variance in attachment avoidance (see table 2). It can also be noted that fragility of happiness is predicting 22% variance in subjective well-being (see table 3).

The result also indicates that there is a significant positive relation between fragility of happiness and attachment avoidance r= .462, and an inverse relation between fragility of happiness and subjective well-being r= -0.276. There is also a negative relation between subjective wellbeing and attachment avoidance, r = -.201.

5. DISCUSSION

The present study intended to assess the relationship between fragility of happiness and attachment styles, the relationship between fragility of happiness and subjective well-being, and the relationship between insecure attachment styles and subjective well-being. The sample of the study comprises 100 emerging adults(18-25 years of age) including 50 males and 50 females.

5.1. Fragility of Happiness and Insecure Attachment Style

It was hypothesized that Fragility of Happiness and Insecure Attachment Style would show a significant positive relationship. The results indicate a significant positive correlation of .462 (p<.05) between the two. It was also determined that fragility of happiness is accountable for 21% variance in the insecure attachment styles of the participants thus proving to be a significant predictor of insecure attachment styles. Individuals who find happiness as a transient concept cannot form significant attachments with others. Fragility of happiness interferes and disrupts a secure attachment style, thereby creating a more anxious and avoidant attachment orientation. Happiness is a fleeting construct is often reflected in individuals with insecure relationship inclination. In the same vein, it has also been observed that the people who usually harbour insecure attachments usually display an aversion to the experience and the expression of happiness [8].

5.2. Fragility of Happiness and Subjective Well-Being

The present study hypothesized that Fragility of Happiness and Subjective well-Being will show a significant inverse relationship. The results did display a negative correlation of -0.276, significant at 0.01 level and was also accountable for 22% variance in the subjective well-being scores of the participants confirming the belief that fragility of happiness negatively affects the subjective well-being of individuals. Subjective well being as a state of mind is characterized by satisfaction with one’s life and having a ‘happy’ outlook towards life while fragility of happiness is definitely an antagonistic component in this wake. The belief in the fleeting nature of happiness can diminish the states of well-being and can instead lead to pessimism and scepticism [11].

5.3. Insecure Attachment Style and Subjective Well-Being

From the results obtained, a significant negative relationship between insecure attachment styles and subjective well-being was found (-.201, p<.05). Attachment insecurity, both in terms of avoidance and anxiety, is associated with weariness, reduced perceived social support, and, as a result, lower well-being. A history of caregiving rejection and a view of others as unavailable or untrustworthy are associated with attachment avoidance. Individuals with an avoidant attachment orientation may not regard aid from others as readily available since they feel they are capable and self-sufficient, and hence may dismiss any social support as unavailable or unnecessary. Anxious

attachment, on the other hand, is associated with a history of inconsistency in caregiving and, as a result, anxiety about desertion [3]. People with an anxious attachment orientation utilise excessive, and often insatiable, support seeking strategies when threatened because they think they are unlovable and unworthy. Insecure attachment orientations lead to emotional incompetence, which further contribute to a degraded sense of well-being [12]. It can thus be concluded that Fragility of happiness can be consider as a significant factor affecting the attachment orientations and subjective wellbeing of individuals, particularly the emerging adults who are yet in the phase of conceptualizing their interpersonal relations, strengths and limitations. The future studies can further highlight the mechanisms behind fragility of happiness and the processes or mechanisms to tone down its impact on people.

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TRANSDISCIPLINARITY OF LOGIC'S HISTORY

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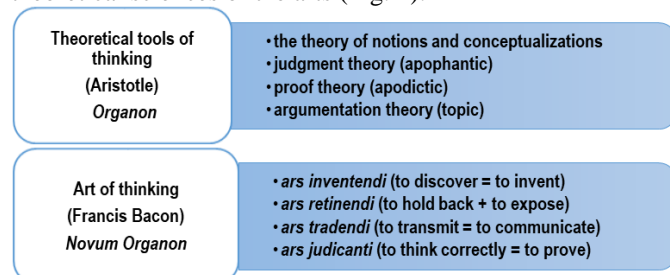
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Abstract. This article develops an associative approach between transdisciplinarity and the history of logic or the history of the first science and probably of the most adaptive scientific way of thinking from the ancient world to modern investigation. The article is also a succinct discourse in favor of the transdisciplinarity of logic, in an ever-expanding multiverse of modern science, capitalizing on the arguments of syllogistics (as the first essence of deduction or scientifically correct reasoning), but also based on the historical transition from bivalent logic as the existence of only the truth and false solutions (error) to polyvalent logic. At the end of a synthetic investigation, a few final remarks redefine the need for modern transdisciplinarity as a way of thinking more appropriate to the increasingly complex reality.

Keywords: transdisciplinarity, logic, multipurpose logic, fuzzy logic, neutrosophic logic, history of logic

1. INTRODUCTION

Logic is unanimously considered the oldest of the world's sciences, because it has never abandoned its instrumental ability to think about thinking and reason specifically to the “beginning of all science” (Aristotle), being recognized as the “discipline of disciplines” (Augustine), but also as “art of the arts” (Thomas d'Aquino), without omitting the qualities of “theory of theories” (Edmund Husserl) or “research of researches” (John Dewey) and even the whole “principles of all methods’ applied”(Albertus Magnus) in the abstract body of modern science [1] In his treatise entitled *History of Logic*, Anton Dumitriu defines the science of logic as the unique “Aristotelian intellectual act: to think about thinking”. The classical period of logic, also known as traditional logic, is already essentialized in the “*Organon*” of Aristotle, the founder of the first complex and fully defined logical theory. Aristotle's contribution is thus defining in the formation of scientific deductive reasoning and especially in the further development of all sciences. The post-Aristotelian period of the same traditional logic is balanced by the conceptualization of logic as art, outlining the end of its classical period, in Francis Bacon in “*Novum Organon*”, both works demonstrating the qualities of integration specific to the indisputable transdisciplinarity of logic, in a completely different way, emphasizing either the integration of the theoretical sciences or the arts (Fig. 1).



Source: Realised by the author from [1] (extended table, pp. 26-27).

Fig. 1. Essence of the logic's transdisciplinarity between *Organon* and *Novum Organon*

Traditional or classical logic was born and lived in the blinding light of the search for truth, as the goal of the millennial thinking of humanity and the fundamental issues of the human individual. The scientist's desperate attempt to avoid falsehood or error, often due to the inadequacy of his unidisciplinary, isolated and fragmented approach to traditional education and classical research, naturally gave birth to elements of the transdisciplinarity of logic as a necessary reaction to the complexity of reality. in a perpetual change, but especially as a possibility to understand the meaning and evolution of the world. The transdisciplinary accents of logic have multiplied in the logic of the modern age and especially in contemporary logic. If only the example of the Port-Royal logicians, Antoine Arnauld and Pierre Nicole, is capitalized, as well as their transdisciplinary emphasis on notion, judgment, reasoning and methodology, there is a further integration of gnoseological and psychological influences apparently external to classical logic. also tested by the mathematical contributions of René Descartes and Gottfried Wilhelm Leibniz. Another exemplary paradigm of modern logic and of its specific transdisciplinarity outlines the first axiomatic system of propositional calculus and precise definition or conceptualization of symbolic logic (Gottlob Frege), but also a mathematization of reasoning, giving birth to the new mathematical logic, consecrated by *Principia Mathematica* of Bertrand Russell and Alfred North Whitehead [2, 3, 4].

2. AN ANALOGY BETWEEN LOGIC' S HISTORY AND LOGIC' S TRANSDISCIPLINARITY

A classic answer, one argued unidisciplinary or exclusively on the basis of logic, even purely mathematical logic, has gradually become impossible to offer in practice, both to education and research. The framework of a new quantum logic [5], revealed to academic education and scientific research as a result of the emergence of quantum physics, brings back the hope of a new understanding of complexity in reality and offers transdisciplinary solutions of quantification and experimental validation, made with the support of new methodological thinking, specific to statistical physics. Logic, either Aristotelian or modern (symbolic or mathematical) uses essential methods:

- i. *standardization* (transformation of natural language utterances into expressions with a detachable logical structure without altering the content);
- ii. *symbolization* (the use of special symbols logically fixed in specific formulas);
- iii. *formalization* (generalization of symbols in logical calculation) but also to some universal methods.

A lot of mathematical methods (arithmetic, set theory, mathematical structures, Cantor diagonals, mathematical induction, recursive methods, etc.) are included together to understand symbolic languages, from algorithmic methods to

axiomatic methods, from precise methods of definition or conceptualization to classification or grouping methods, from division methods to graphical methods, etc. Many of the methods of mathematical statistics brought by logic in their most abstract and synthetic form are easily recognized here, too. The role of logic is mainly practical, even active, capitalizing on rules of definition, classification and argumentation, emphasizing the validation or invalidation of theories and thought processes, pursuing clarity and ambiguity, precision and inaccuracy, hierarchy and structural chaos, order and disorder, consistency and inconsistency, coherence and incoherence, argued and unargued, etc. Modern logic emphasizes the importance of replacing variation with a system of constants in its reasoning as well as a proper interpretation of formalisms in parallel with modeling its own processes or logical phenomena:

- [1] *the principle of identity*, according to which each thing is identical with it only with itself (the act of thinking maintaining the meaningful identity of words in the science of logic);
- [2] *the principle of non-contradiction*, in relation to which one thing cannot be and will not be at the same time (two logical judgments one affirming and another denying the same thing cannot both be true);
- [3] *the principle of "no third [possibility] is given" (tertium non datur)* which necessarily selects one of the two previous judgments (other possibility not existing or being excluded);
- [4] *the principle of sufficient reason*, according to which everything will have a basis (there is nothing without a basis (cause), consisting of evidence or arguments).

Axiomatic logic systems must also benefit from consistency, completeness and independence, and logical operations must use the definition of notions to simplify, classify and divide, both for judgments of immediate (direct) inference and for reasoning in mediated inference. All this together gives an obvious transdisciplinarity to the logic and history of this science. The logic's history has an essential advantage over the vast majority of other sciences, because it integrates in an exemplary way everything that has been done since antiquity and until now in its specific field or, more simply, in the specific way of thinking in all the other sciences. The history of logic is something more than a seemingly trivial "summation of all the moments in the history of this science itself" [6].

All the logic disciplines types can be added to investigation in any heterogeneous transdisciplinarity approach. Neither *dialectical logic* (the theory of the composition, structure and functioning of logical operations), *nor pure/formal logic* (research of thought forms), *nor applied logic* (the approach of pure logic, undertaken by determining the forms of sentences, terms, operations and relations with or without the restriction of the number of formulas that are logically-true), *nor the logic of science* (the study of the way in which logical processes and schemes manifest in one field or another of scientific knowledge), *nor mathematical logic* (rational exposition using formalized languages anywhere by applying mathematics to the study of formal logic) *nor the many detailed logics of other mathematical disciplines*. The detailed logic applied in mathematical sciences includes *inductive logic* (whose reasoning evolves from individual to general judgments), *transductive logic* (the logic of inferences of

some generality judgments), *deductive logic* (where conclusions are obtained from judgments, from the universal to the most general ones, then to the particular ones or finally to the very individual ones).

The history of logic means much more, however, beyond a simple yet difficult historical aggregation, a credible explanation that must be permanent to the function of thinking in all fields, which makes it a limit of human knowledge, just as difficult to be attained as the truth itself. Thus the supreme Hegelian argument remains "*the history of logic can never be written definitively, this being the history of all knowledge in all its magnitude*" [7].

Any historical research of logic comes to a natural conclusion, according to which thought will not be able to omit anything of what it has previously done in the specific field of the way of thinking itself, thus being obliged to constantly reveal one or another facet of past logics. In any ancient logics either Socratic, peripatetic, Stoic, Epicurean, or ven scholastic, logicians are rediscovered or reinterpreted, either from the methodological point of view or even from the purely mathematical one, etc.

"*The unity of logic with history is more and more obvious*", being directly and non-contradictory delimited by certain "*ever-changing variables*". This unique science of thought is neither eternal nor circumstantial, but has evolved historically, more complex and more intense than all the other sciences, through a continuous redefinition focused on the multidimensional expansion of human knowledge or as a "*science of the historical development of human thought*" [8-11]. The transdisciplinarity of logic is proved even by the history of this science, placed simultaneously "*both within and within the disciplines it appeals to*", creatively, taking original aspects from the specificity of their thinking and focusing on "*concomitant actions of several levels*" of reality "*with the intention of knowing the thought's complexity*" [12].

The diversity of attempts to write a history of logic makes it increasingly difficult to identify in practice the first major treatise in this field. There are still differing opinions even today, ranging from choosing the correctness of information from Johannes Georgius Walchius's *History Logicae* (Leipzig, 1721) and the overly detailed, but also subjective *Geschichte der Logik im Abendlande [History of Logic in West]* by Cari Prantl (Leipzig, 1870), as well as supporters of the scholastic treatise of Paul Janet and Gabriel Seailles, entitled *Histoire de la Philosophie [History of Philosophy]*, which also contains a relative exposition of the history of logic (Paris 1887) to Friedrich Harms's *Geschichte der Logik [History of Logic]* (Berlin, 1881), in fact the second volume of a larger work *Die Philosophie in ihrer Geschichte [Philosophy in its History]* (Berlin, 1881). Admirers of international synthetic works still oscillate between Robert Adamson's *A Short History of Logic* (Edinburgh, 1911) and *Lehrbuch der Logik auf positivistischer Grundlage mit Berücksichtigung der Geschichte der Logik [Treatise on logic based on positivism considering the history of logic]*, Theodor Ziehen's treatise (Bonn, 1920) [6].

The first major international treatise on the history of logic was *Formal Logik*, a treatise by Józef Maria Bocheński (Freiburg - Munich, 1956), followed by *The Development of Logic* by William and Martha. Kneale (Oxford, 1962), as well as Tadeusz Kotarbinski's *De Lecons sur l'Histoire de la Logique (Lessons on the History of Logic)* (Paris, 1964), in a

summary list of the great treatises on the history of logic compiled on pure criteria chronological [6, 13-14].

The first comprehensive treatise on the History of Logic appeared in Romania, in 1966, under the signature of Professor Anton Dumitriu, who gave the second course in logic, in the academic year 1947-1948, in the first department of logic in our country, also at the University of Bucharest, updating and finally managing to recover a significant time interval from the time lag of the perception of the history of "thinking about the way of thinking", in the Romanian academic space. The history of logic of Anton Dumitriu was added and revised later in several editions, but even today it is placed internationally in the small family of the most complete and profound treatises on the history of logic, attesting to the transdisciplinarity of this science. Initially, the young and enthusiastic researcher Anton Dumitriu deepened mathematics in an original way, emphasizing the importance of conceptualizations and definitions, but also capitalizing creatively on the language, which he borrowed from reasoning with a naturalness hard to match, and finally offering specific contours in mathematical logic. In the fascinating journey of the history of logic, Anton Dumitriu's lucid thinking becomes essence and implicit landmark, as an extract from the ephemerality of the evolution of thought, similar to light importance in Spinoza way of thinking, both for his thought and for understanding human error [12]. The logic's history, written by Anton Dumitriu, simultaneously reveals not only the typology of the reasoning of all specific schools and, especially, the reunion of all of them to rationally and promptly reflect an increasingly diverse reality, but also the inherent tendencies of *transdisciplinarity* of logic able to facilitate and solve complex and pressing problems. This creative treatise and its inside attitude together with the influence of Stephane Lupasco original ideas were probably considered one of the best inspirations for Basarab Nicolescu in redefining the modern transdisciplinarity [15-19].

A preliminary conceptualization of the logic's history is a difficult attempt to make, because there is no other science that has as many meanings as logic. Logic has often been assimilated into philosophy or knowledge in general, bringing together "from metaphysics in Hegelian philosophy to aesthetics or the logic of beauty, from psychology to epistemology, from transcendental logic to ontology" [12], and capitalizing on the most abstract notions from the general mathematical language, to that of mathematical logic [6], statistics, quantum physics, etc. with the most specific and diverse meanings or signs.

3.FROM CLASSIC SYLLOGISTICS TO MODERN POLI-VALENT LOGICS

Simplifying and transforming logic into commonplace synthesis of sentences or into minimal set of essential or central principles or concepts is equally useless and perhaps even impossible process. A good example of such unadequate approach can start with the seemingly simple example of the syllogism, as it is defined by successive sentences or classic premises in which something is said initially, being followed with rational necessity or necessarily by something else to the end.

By logical formalization, various logos were treated as formulas to describe variables placed beyond the appearance of the actual use of words, etc. Hence, Joseph Bochenski,

both in his famous work *A History of Formal Logic* and in *Logic and Ontology*, finds it questionable that both the central concepts and the derived sentences that contain or explain them become multiple or multi-meaningful subjects in the science of logic. explained to the uninitiated: "What prescribed formulas, when their variables are replaced by constants, allow conditional statements, so that when the previous wording is accepted, the consequence must be admitted?" [12, 13].

The history and transdisciplinarity of logic reveals models reflecting the multifaceted nature of reality and identifying structured trends of the systems that compose it, holistically providing increasing amounts of information, explaining the layers and substrates of statistical similarities or connections, and even more statistical correlations. The transdisciplinary approach transforms the way decisions are made in almost any field, seemingly disparate contexts sharing a lot of common transdisciplinary ideas, which are unsuspectedly useful in practical activities. Logic's education and research differ from the evolution of psychology, which studies psychic phenomena that include what is right and wrong and not truth or false in the way of thinking. Psychology describes the way of thinking, including the logical one as a complex psychic process of normal investigation, totally different from the pathological, correlated with factors and conditions of thought itself (neurophysiological states, memory or imagination). Similarly, there are significant differences between logic and epistemology, as science dimensioned as a set of ways of understanding or as the philosophical study of the nature, origin, and limits of human knowledge, and between logic and ontology as a philosophical theory of its existence, essences and ultimate principles.

Sequential or particular truths, including those deduced from the stratification of the differentiated levels of unidisciplinary reality or resulting from the slicing of isolated reality, are reunited or reassembled on the trajectory of the continuity of transdisciplinarity. This finding does not exclude but obviously includes logic and the history of logic. Therefore, the transdisciplinarity of logic has become a "realistic, value-based, context-sensitive, open, interesting, and patient approach to the logic's history, and the ontology of the transdisciplinary context of logic, as science that can be seen as an ontology of connectivity" [20].

Any selection of the main moments in logic's history describes and simultaneously synthesizes the main ways of education and scientific research during the logic's evolution as one of the major transdisciplinary sciences. This long phenomenon of delimiting major processes, in which the historical research of logical thinking materializes in a profound description of the succession of correct ways of thinking, constantly searching for the truth or *aletheia*, using the famous Greek term [21]. Any selection of the main moments in logic's history describes and simultaneously synthesizes the main ways of education and scientific research during the logic's evolution as one of the major transdisciplinary sciences. The extensive investigation simultaneously reveals the transdisciplinarity of any similar approach, and for the natural understanding of the investigation's magnitude is always necessary to re-establish a family of concepts and methods including elements like "conception of the human condition, human cycle theory,

mythos as method and idea, specific etymology (i.e. orthótes tōn onomáton), philosophy's purpose, idea of logos." [21]

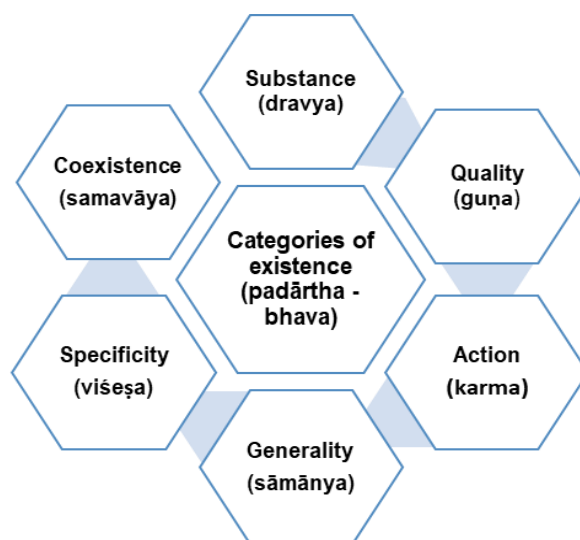
Logic originated and developed in antiquity, in various geographical and cultural areas, from China and India to Greece. Ancient Chinese logic was not a logic of extension, but a logic of order and effectiveness, starting from the Chinese philosophy, in which it was born and which remained a philosophy of existence, focused on a synthetic spirit revealed in a spiritual whole, according with some important texts such as the philosophy of Confucius. The discovery of this whole, as a concept, consisted in the knowledge of its parts, and any causality which might have implied a whole abstract has been practically ignored in ancient China. The effect concept was not an implied as analytical part of the question, but together with the cause formed a real couple, made up of the two complementary forces that describe the phenomena of life or existence, through a generalized whole of Yin-Yang type (feminine - masculine, even - odd, passive - active) [22]. Through the play of this couple of complex concepts, ancient Chinese logic tried to explain the whole order and rhythmic development of nature and society. The supreme and most difficult principle to reproduce, through its complexity, was and remained Tao, which seems to be the principle of all principles in its most general sense, from order, to totality, from responsibility, to effectiveness [5]. Also, Tao acquired the meaning of reason, close in meaning to the Platonic logos [22].

Regarding the beginnings of logic in ancient India, Surendranath Dasgupta notes that even there everything was under the cloak of philosophy, this time of traditional Hindu philosophy, in transcendent dominant context, where "philosophical systems did not simply start from speculative questions on which puts the human mind to them due to a natural inclination towards abstract ideas, but they tended to achieve a transcendent state" [23]. Indian philosophy has its sources in the Indian "scriptures" whose generic name was that of "veda" or *science*, in translation, and their texts were considered revealed. A *Vedic Samhita* also contained three annexes:

- i. *brahmana* (texts intended to instruct the brahmins on the origin and meaning of rituals);
- ii. *aranyaka* (the symbolism of ceremonial rituals known as the forest texts, from the aranya = forest);
- iii. *upanishad* (the esoteric doctrinal texts).

The Hindu philosophical systems were divided on the basis of the existential criterion (*asti* = is or *na asti* = is not) into the categories of *nastica* (including Buddhism, Jainism, and Carvaka) and *astica* (including the six *darshana* or points of view that complement each other: *Mimansa* and *Vedanta*, *Samkya* and *Yoga*, *Nyaya* and *Vaisesika*).

As forerunners of logicians, Indian philosophers did not generate or did not develop a formal logic, but a logical theory of knowledge and the beginnings of the deductive thinking based on a first form of syllogism, which would be constructed much simpler in Aristotelian form as a valid deductive argument based on two premises and a conclusion. The original purpose of Indian philosophy and, implicitly, of Indian logic, was rather that of complete relief from pain, together with salvation by general knowledge, accomplished with the support of 16 categories (pramana) or only six categories of corrective knowledge in the particular case of existence (padārtha-bhava) according to figure no. 2



Source: Graphic synthesis realized by author after [5] pp. 56-58.

Fig. no. 2. Restricted knowledge's categories of existence with major impact on epistemology of ancient Indian logic

With the appearance of the category *abhava* (non-existence), as an antinomy to existence, the conceptualization of false (error) is also certified, along with a first nuanced typology of it through the next subcategories [5]:

- a. previous non-existence or error (*prag-abhava*);
- b. non-existence or posterior error (*pradhavamsa-abhava*);
- c. absolute non-existence or error (*atyanta-abhava*);
- d. non-existence or error (*anyonya-abhava*).

The valorization of logical notion of false (error) through the category of non-existence gave birth to pure knowledge through negativity. In this context the *advaita vedanta* theory is considered the first attempt at modal logic, also belonging to Indian philosophers, more precisely to Jain logicians who described the coexistence of three distinct states: real, unreal and indescribable, defining a *tritya bhanga* where the indescribable represents the third possibility, without to accept the excluded third of ancient logic. Some traditionalist Indian logicians have not constructed their logical system with the exclusive use of affirmation (*truth*) and negation (*false*) as values of sentences, but have accepted a contrary relationship and not a strictly contradictory one [24], and thus have promoted other states and implicitly the *uniqueness through multiplicity*.

Indian logic has developed more intensely in perspective or *Nyaya darshana*, facilitating the art of debate, valid means of knowledge, beginnings of syllogism and analysis of opposing views or divergent opinions. The temptation of the Indian logicians called *naiyayika*, who capitalized on the certain *anumana* or inference, considered to be of Indian origin, also raised some questions about the unique Greek origin of the syllogism in logic (*avayava*). The existence of evidence for theorizing syllogisms focused on exemplifying Indian logicians, their specific attempts to construct the syllogism with the help of several sentences (5 or 10) could justify an original Indian debut, but not a deductive supremacy if one try to compare in fact with the clarity of the Aristotelian syllogism [25], as shown in figure no. 3:

Indian syllogism (Parathanumana)	Aristotelian syllogism (with minor premise and affirmative or negative conclusion)
Socrates is mortal. Because he's human. All people have been mortal in the past, like Thales, Zeno, etc. Socrates is a man of the same type. Therefore he is mortal.	Major premise: All men are mortal. Minor premise: Socrates is a man. Conclusion: So Socrates is mortal. Major premise: All Greeks are human. Minor premise: Human beings are not immortal. Conclusion: Therefore, the Greeks are not immortal.

Source: Realised by author after [25] p. 83

Fig. no 3: Specificity and non-similarity in syllogism's constructions (Indian versus Aristotelian syllogisms)

The traditional Indian syllogism, although considered relatively valid from a deductive point of view, remained a redundant construction from the classical logic point of view, becoming in fact a seemingly natural form of rhetoric and less a completely logical form, especially one benefiting from the maximal purity of logical deduction, from which had not yet disappeared all unnecessary elements. Any traditional syllogism demonstrated the utility both of some main notions of classical (Aristotelian) logic, and of the pillars of traditional scientific thought, intensely capitalized on in classical and modern education and research. Nearly two and a half millennia after its appearance, Aristotle's *Organon*, according to the sections *Analitica prima* and *Analitica secunda*, in the second and the third volumes, is still the best introduction to traditional logic and to the laws that govern correct reasoning.

Aristotelian syllogism, benefiting from an almost perfect simplicity of argument, started from two premises recognized as truths and essentially offered a deductive reasoning by which the conclusion became the immediate consequence of its premises, thus essentializing the whole ancient Greek theory of proof. A rigorously developed syllogism is an incipient study of scientific proof, and a proof of deductive completeness, in parallel with a demonstration of constructive simplicity, being focused on firm structural laws, beyond the mandatory three-dimensional content of reasoning, developed by the two premises, one major and one minor, as well as an absolutely necessary conclusion.

Inside classical syllogism of the Greek, Aristotelian and post-Aristotelian philosophers, an affirmative premise was necessarily present, two negative premises not being able to lead to a necessary conclusion. A *major premise*, so named from the major term included in its body, contained the logical predicate of the conclusion, while the logical subject was found in a *minor premise*, which included the minor term. In any traditional syllogism, a *conclusion* included both a subject and a predicate. The so called *structural triad* of the syllogism permanently generated two opposite final states, in relation to the fact that the syllogism illustrated a valid or an invalid argument, starting from the two true premises and reaching either a true or a false conclusion.

A valid Aristotelian argument possessed a form that made it impossible to pass from true premises to a false conclusion. Aristotle's syllogism was and remains the most important systematic formulation of classical logic, and this in the

conditions of a double conditioning in which at least one premise had to be universal and another premise had to be affirmative. A single negative premise also gave rise to an automatically negative conclusion. The apparent simplicity and constructive perfection of Aristotelian syllogism forcibly identified itself with demonstration and, to the limit, even assimilated itself with classical logic as a whole. This type of approach clearly omitted the fact that the syllogism was and remains in the history of logic a mere fragment of a debut, even if it has long been admired by any public during over the next two milenia and even more. Such an opinion of biased assimilation of classical logic in a manner restricted exclusively to Aristotelian syllogism dominated scholastic and even pre-Renaissance culture, going much further in time to the beginning of the nineteenth century.

The structure of the syllogism seemed to be extracted from the balance or constructive perfection of the triangle in geometry, the sides becoming terms of major, medium and minor type, in relation to the size of their sphere of logical significance. Like the geometric continuity of the area or perimeter of the triangle, the middle term was distributed at least in one premise to ensure the connection with the major and minor term, considered the extreme terms, which appeared both distinctly in a premise and together in conclusion. The modal value (mode) is conferred by the three judgments (*n*) that make it up, the two premises and the conclusion, but also by the four combinations of quality and quantity (*M*). As a simple example, a categorical syllogism has the ability to generate or differentiate, in the end, no less than 64 distinct modes (M^n where $M = 4$ and $n = 3$). Aristotle recognized in a reductionist way two modes considered perfect in syllogism or which required nothing else to be valid, namely the universal affirmative mode and the universal negative mode, while all other syllogisms had to be converted into these two types. The existence of the three terms or acronyms [major (*meizon akron*), minor (*elaton akron*) and middle (*meson akron*)] in the perfectly constructed Aristotelian syllogism depended decisively not on the extremes that formed the predicate and the subject of the conclusion, but on of the *meson* term, which united the two syllogistic premises. The laws or rules of the syllogism were fully applied to the categorical syllogism, because it had all the standard components, they gave classical logic stronger and more precise arguments.

In fig no. 4, their statement is summarized in a structured manner, based on the three different colors and each group of three lines coincides with the laws of terms, laws of premises' quality and laws of premises' quantity:

I. A syllogism contains 3 terms: major & minor premise, and conclusion
II. The average term will be distributed in at least one premise.
III. A term distributed in conclusion will appear in a relevant premise, too.
IV. Both premises can never be negative, at least one will be affirmative.
V. If a premise is negative, the conclusion will still be negative.
VI. If two premises are affirmative, the conclusion will still be affirmative
VII. At least one of the premises will be universal
VIII. If a premise is particular, the conclusion will still be particular
IX. Necessary and sufficient general laws give rise to necessary particular conditions

Source: Realized by author after [5, 26]

Fig. no 4: Syllogism's laws of terms, laws of premises' quality and laws of premises' quantity

In this narrow approach to the history of logic, the syllogism was first selected as an example of the natural existence and persistence of cultural differences, which have left a clear mark on traditional logic, but also as a gradation of clarity of reasoning and the complexity of the concept of deduction, with a major impact on the transdisciplinary validity of its logic and history. From syllogism's example one can more easily deduce the huge leap made by Greek logic and philosophy, the power of crystallization and symbolization of logic and implicitly the history of logic in Greek antiquity as well as its first signs of transdisciplinarity and pragmatism. The syllogism defined both a main notion of classical (Aristotelian) logic and one of the pillars of scientific thought, in classical and modern education and research with the first clear accents of transdisciplinarity. The Aristotelian syllogism clearly emphasizes the major role of deduction in the logic of the ancient Greek philosophers, delimiting it more and more clearly from the dominant role of experience (intuition) in Chinese and Indian logic and made possible the emergence of a deductive system at the same time. Aristotelian syllogism offered also a maximum level of completeness, able to rigorously establish the axioms and the logical apparatus necessary for any scientific approaches that had claims of accuracy.

An incredible constructive premeditation of truth (alétheia) is identified in Aristotelian syllogism [27-30], even if the work of the Greek philosopher is reduced to only two explanatory findings (apophantikos):

- i. *truth and false (error) imply union and separation;*
- ii. *every truth has as much truth as its existence,* emphasizing the deeper roots of Greek logic arising from the particularly deep philosophical layers of Chinese and Indian culture) [21].

The syllogism's diversification became obsessive in the medieval history of logic, and many scholastic logicians have been intensely and unusually preoccupied with enumerating, exemplifying, and hypologizing syllogisms as logical expressions, without creatively generating other forms. Henrik Lagerlund summarized the main evolutionary moments of medieval syllogistics, selecting several personalities who had defining contributions in the rebirth and development of the syllogism "from Boethius to Abelard and beyond him, to the new logic of at the end of the 12th century or even until the Renaissance" [31]. The early medieval logicians, starting from the example of Boethius, did not add many new aspects to the syllogism, but tried to convey the legacy of Aristotelian logic in a clear or unambiguous manner. Between 750 and 1258, the syllogistic contributions of Arab logicians justified the consideration of the entire Abbasid caliphate as a "golden age". The restitution through remarkable interpretations of Aristotelian logic in the space of Arab culture made Al-Farabi to stand out, nicknamed the second master (mentor) after Aristotle, and the syllogistic creativity of Ibn-Sina, whose Latinized name was Avicenna. Avicenna divided syllogisms into *conjunctive* and *repetitive*, in a similar way to the distinction of classical logic between categorical and hypothetical syllogisms. No minimalist synthesis of Arab logicians can be concluded without mentioning Ibn-Ruschd or Averroes, nicknamed the third Aristotle, to whom the extensive teaching of the duality of truth was connected [32]. Peter Abelard creatively condensed the syllogism, including the hypothetical one, without mixing

the logic of the terms with the propositional logic, but sophisticatedly developing the latter [31]. Other personalities in the history of medieval syllogistic logic were Richard Rufus of Campsall, William of Ockham, and John Buridan. Richard Rufus of Campsall identified and creatively developed the asymmetry between affirmative and negative modal sentences. Although he made original contributions to the theory of assertive syllogism, Jean Buridan regarded syllogistics as a formal consequence and thus modified its image by practically subsuming it into the theory of formal consequence or the logic of extended and complex consequences. Known as a professor of Martin Luther and a staunch supporter of Ockham and Buridan, Jodocus Trutfetter and his treatise on logic (*Summulae totius logicae*) theoretically ended the medieval period of syllogistics.

With *Novum Organon*, Francis Bacon originally developed inductive logic based on scientific induction, as opposed to the scholastic distortions of medieval scholasticism. This extensive approach was followed by Rene Descartes who practically changed the approach in education and research, according to *Discours de la methode*, reconsidering as true only verified and proven works and ideas, breaking down complex processes into simpler subprocesses. Rene Descartes investigated from the obvious in the direction of the less obvious and studied the ensembles in more and more detailed way. As a result, although important schools of logic appeared in the post-medieval period whose intentions were to purify Aristotelian logic from scholastic distortions, listing here *Port Royal school*, run by Cartesianists Antoine Arnauld and Pierre Nicole, or the *Hamburg school* of Joachim Jungius, they proved to be poorer or less significant by their syllogistic contributions, in fact only deeper interpretations of classic ideas. The case of Joachim Jungius and his paternity on *oblique syllogism*, in which the argument was not made directly but indirectly (obliquely), is a proof of an excess, not creative but interpretive, because examples of such syllogisms were present in medieval logic even Wilhelm de Occam [5]. The *Port-Royal school* took the initiative to analyze the sentences more as a combination of ideas and less as terms. During the Renaissance, syllogism retained conventionalism for some time, but gradually gave way to the logic of terms and then to the development of mathematics. The essence of the classical syllogism, which was also dependent on words (implicitly letters), but also on the meanings of words (implicitly letters), was increasingly clearly seeking a valid general support

A critical support of the classical syllogism has been received from the mathematician Gottfried Wilhelm von Leibniz, who has constructed new deductive theories structured in the form of mathematical calculus, or from an idealistic philosopher like Immanuel Kant, who has reconsidered the truth-false concordances or inconsistencies as excerpted from both ideas and reality. Even a dialectician like Georg Wilhelm Friedrich Hegel, who has been interested rather in the impact of the laws of logic and less in syllogistics and who have shaped to syllogism an image relatively incompatible with scientific evolution, generated a support for the classic syllogism, renamed by John Stuart Mill only a verbal inferential vision, and therefore apparent or at best a "disguise" of a real inference [33].

A System of Logic as John Stuart Mill's new interpretation of syllogistics has subordinated the syllogism to other aspects of

logic, his previously eminent status turning into an auxiliary one, and has connected any syllogism at the same time to simple processes of inference.

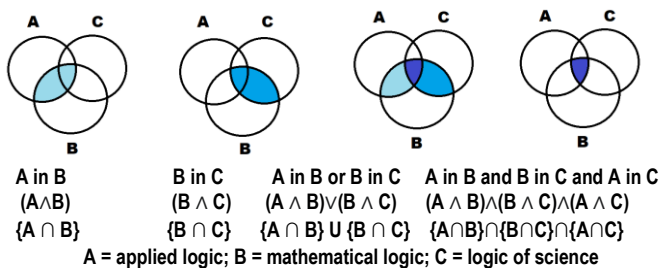
Since the nineteenth century, classical logic has changed completely under the creative impact of mathematics, benefiting in a very short time not only from many congruent names given to it, from formal logic, to the algebra of logic or to symbolic logic. but also by new logical theories constructed with the help of specific notations and more rigorous deductive methods. All of these intense changes translated not only transdisciplinary tendency, but a pragmatic attitude and a dominant wish for adequacy. In *Formal Logic* Augustus De Morgan, with the support of set theory provides the solution to the mathematical generalization of syllogism validation, and in *The Laws of Thought*, George Boole constructed a new computational logic, based on binary values of truth {1} and false {0}, and John Venn in *Symbolic Logic*, radically simplified the validation of syllogisms with the help of his diagrams (fig. no. 5).

Classic syllogism with negative minor premise and conclusion	
Major premise: A=All Greeks are human.	
Minor premise: B=Human beings are not immortal.	
Conclusion: C=Therefore, the Greeks are not immortal	

Source: A syllogism exemplified, visualized, validated by author.

Fig. no. 5: Venn diagram for a better visualization and validation of classic syllogism

Venn diagrams could be used extensively in syllogisms with more than two premises, intersected or logically reunited, also benefiting from the implicit logic of set theory or Boolean logic (fig. no. 6).



Source: Realized by the author as a simple example of visualization and prompt validation

Fig. no. 6: Syllogisms validation based on Venn diagram and on Boolean support of set theory language

Through his entire work, Charles Sanders Peirce developed a logical system for relations and quantifiers and contributed to the almost total change of logic, which would occur from 1879, with the book *Conceptography*, written by Friedrich Ludwig Gottlob Frege, an Aristotelian personality. Gottlob Frege's logical system and, in particular, his contributions to propositional calculus and formal language were ignored for a period, due to the relatively complicated notation created by him, but succed in forming later the theoretical basis for the

emergence and development of computer science and computers. The first logician to unify all the previous names of mathematical developments in logic into one, namely *mathematical logic*, was Giuseppe Peano, who recognized himself also as an Aristotelian descent. His evolution in logic was based on a system, with new algebraic notations, much more abstract, a truly unique system of mathematical signs. In the twentieth century, the evolution of mathematical logic became exponential, especially after 1910, the year of the publication of *Principia mathematica* by Bertrand Russell and Alfred North Whitehead, a book that intuitively and avoids paradoxes, and capitalizes on specific notation from Frege's logic and Peano's logic, which is still valid today. Clarence Irving Lewis creates among the latest syllogistic echoes in the much more advanced subject of mathematical logic and brings back the classic conditional "if/then" in the analysis of *A Survey of Symbolic Logic*, published in 1918, to solve definitively the syllogistic problems, as a strict implication, which to be true, requires a stronger relationship between the antecedent and its aftermath, compared to the classical conditional. Remarkable logicians outline new directions in mathematical logic:

- i) metamathematics, proposed in 1920 by David Hilbert;
- ii) fuzzy logic, the 1920s nuance of the space between truth and falsehood (untruth), through an endless number of intermediate degrees by Jan Łukasiewicz;
- iii) modeling abstract calculus, a vast process from 1930, undertaken by an almost endless suite of great logicians: Kurt Gödel, Alan Turing, Stephen Kleene, Emil Leon Post, Haskell Curry, Alonzo Church, etc;
- iv) natural deduction, in 1935, according to the works of Gerhard Gentzen;
- v) relational algebra, outlined in 1940, by Alfred Tarski and his disciples;
- vi) the hierarchical classification of the different grammars that generate formal languages, in 1956, by Noam Chomsky;
- vii) the logic's history, from 1956, when the first great treatises of Józef Maria Bocheński, William and Martha Kneale, Tadeusz Kotarbinski and Anton Dumitriu began to appear successively.

The second important aspect in the narrow structure of this chapter is the relationship between the logical concepts of truth and falsehood (error). The logic initially synthesized as a reasoning of ideas in a rigorous order structured by words, from the meanings of the Greek logos, generated not only the desire to know the truth as accurately as possible, but also as an increasingly accurate identification of false or error. From the Hellenic times, logic as a science of human thought about different way of thinking has tried to multiply the specific ways to delineate an error or untruth, beginning with *doubt* or *uncertainty*, continuing with *confusion* or *ambiguity*, to complete the process with *aberration* or *absurdity*.

In dual Aristotelian analysis, which loses nothing of its purely existential naturalness, truth has been defined as the statement that *it is not what it is not*, and that *it is what it is*, while the false has been described as the statement in which it is found that *it is not what it is* and that *it is what it is not* [30]. The dogmatic approach to the truth-false duality, however, appeared in Chrysippus, later renamed Chrysippian, even against his Stoic school, which recognized the neutral, in addition to truth and false, redefining logic itself as "the science of true, false, or *neither true, nor false*" (none of

those) [34]. Classical logic was born and developed as pure or formal logic, comprising laws strictly dependent on the values of truth and false, and the study of its operations and relations was done exclusively through the formal properties of relations and through the true and false values. After more than two millennia, Jan Łukasiewicz, returning to Chrysippos' name and ideas of truth-false duality or of bivalent logic, gave rise to a poly- or multi-valent mathematical logic, which he named *non-Chrysippian logic*. Jan Łukasiewicz used this because the Chrysippos' formulation about *tertium non datur*, the memorable Stoic being considered the most rigid and dogmatic philosopher in the entire logic's history. Jan Łukasiewicz's new approach, which introduced a third state called "*possible*", transformed truth-false duality into an initial three-dimensionality, that would later evolve in the direction of advanced poly- or multi-valent attitude, starting from the mere fact of admitting the existence between the true and false states of an endless number of intermediate degrees.

Since 1920, when Jan Łukasiewicz's created a poly- or multi-valent mathematical logic from the classic bivalent one, many researcher, but especially mathematicians and logicians have tried to give it important practical use. Lotfi Zadeh fully succeeded in this desire, being considered the father of a new applied mathematical logic, which he called fuzzy or nuanced logic. [35]. As a responsible father of fuzzy theoretical and applied logic, Lotfi Zadeh noted since 1965 that as an analysis (including logic or statistics) "*increases complexity, precise formulations lose meaning and meaningful formulations I lose my precision.*" Lotfi Zadeh applied his fuzzy logic in terms of approximate reasoning, characterized by the use of inaccurate inputs or approximate values to give rise to significantly improved outputs as understood, through a completely new interpolation reasoning, focused on the fuzzy paradigm. Since 1972, after the detailed theorizing of the linguistic variable (a qualitative variable, expressed in linguistic terms), the applicability of fuzzy logic have expanded unexpectedly in all complex processes and systems, generating a process of fuzzyfication in almost all applied mathematical disciplines and in early research focused on artificial intelligence (AI).

Classical bivalent logic, described by the set of values $\{0;1\}$, where the alternative variable admits the duality false (0) - true (1), is naturally nuanced in a trivalent logic $\{0; \frac{1}{2}; 1\}$, where ($\frac{1}{2}$) represents the "possible" state of doubt between true and false, then in tetravalent logic $\{0; \frac{1}{3}; \frac{2}{3}; 1\}$, where ($\frac{1}{3}$) and ($\frac{2}{3}$) translate into false, but not necessarily false and true, but not necessarily true, then into pentavalent logic $\{0; 1/4; 2/4; 3/4; 1\}$, between (0) and (1) appearing the three intermediate degrees already described etc. Thus, in a natural generalization of the n - valence logic the set of values is of the form [36]:

$$\{0; 1 / (n-1); \dots; (n-2) / (n-1); 1\} \quad (1)$$

As originally described by Jan Łukasiewicz, the new concept of "possible" changed the truth-false duality of classical logic and allowed a sentence to be interpreted in three ways as true, gradually true, or false, infinitely multiplying not only theoretical and applied possibilities of modern mathematical logic.

This logical nuance is easily assimilated to the statistical distribution of the quantile's family, detailed by modal segmentation (trivalent logic), quartiles (tetravalent logic), quintiles (pentavalent logic), etc. Finally, Jan Łukasiewicz

was named as the author of polyvalent logic, and Lotfi Zadeh the father of fuzzy logic, more appropriately translated as nuanced logic in Romanian in the books and papers of Grigore Moisil, in a culture where the negative impact of complexity and excess of precision are perfectly outlined in the well-known wisdom of a proverb: the forest is not visible because of the trees. A first attempt to generalize nuanced or fuzzy logic did not take long to appear, and in 1995, the logic paradigm was to be practically enriched with the contribution of neutrosophy focusing on neutralities and their interactions, Florentin Smarandache introducing and delimiting a new scientific theory. Neutrosophy reconsidered any notion or idea "A" only together with their distinctive opposition or negation, represented by "Anti-A", as well as their specific spectrum of neutralities "Neut-A". All of these notions became the real support of neutrosophic logic, neutrosophic sets, neutrosophic probability and even neutrosophic statistics which were subsequently increasingly used together in software-based applications or computer fusion.

Neutrosophical logic as a first generalization of nuanced or fuzzy intuitionistic logic characterized each sentence with the help of a three-dimensional neutrosophical space, valuing its specificity and quality through truth (A), false (F) and indeterminacy (I) [37-39]. In this way A, F and I are considered incomplete information when their sum is less than 1 or complete when they reach the value of aggregates 1. From a static point of view A, I and F are subsets of the neutrosophic set $\{A + I + F\}$, and dynamically A, I and F become functions or operators that depend on known or unknown parameters. In both situations A, I and F are transformed into real standard or non-standard neutrosophic subsets outside the standard range $[0,1]$, but belonging to the non-standard range $]0, 1[$.

The dogmatism of the truth-false duality that characterizes classical logic was indeed gradually replaced by the versatility of these final logical forms, the realism and flexibility brought by such mathematical logics can be considered thus permanently detached from the Aristotelian tradition and syllogistics.

4. SOME FINAL REMARKS

This paper mainly focused on transdisciplinarity impact of logics's history underlying some major moments in the history of the scientific way of thinking, from Aristotelian syllogistics to modern nuanced logics.

Organon and *Novum Organon* underlines an eternal scientific truth. Logics and not concepts are the tool (*organon*) with which teachers and researchers manage to creatively identify solutions to complex phenomena. Logics, especially mathematical and polyvalent ones, are practically a starting point for the future defined as something else, they enter the transdisciplinary processes, ie all modern logics have their own assimilated and assimilable history which is a lesson of pure, unique or sui generis transdisciplinarity.

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STATISTICAL TREND AND FORECAST MODELING OF AIR POLLUTANTS IN BHUBANESWAR

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Abstract. In this study, attention has been paid on the statistical analysis of trends and developing models for forecasting of the atmospheric pollutants and meteorological parameters of Bhubaneswar, Odisha. Further, using autoregressive integrated moving average model, future values of air pollutants levels are predicted. The monthly data on seven parameters SO_2 , NO_2 , O_3 , $PM_{2.5}$, PM_{10} , average temperature and relative humidity, for the period 2005 to 2019 were collected from AQI station. Mann-Kendall and Sen's slope estimator tests are used for non-seasonal data for the period 2005 – 2019, trend results and power of the slopes are estimated. Atmospheric pollutants, $PM_{2.5}$ and meteorological parameter, average temperature show non-significant increasing trend, whereas other parameters such as SO_2 , NO_2 , O_3 , PM_{10} , and relative humidity shows an increasing trend over the past few years. For this analysis, different autoregressive integrated moving average models are compared with goodness of fit statistics. ARIMA (2, 1, 2) is found as the best-suited model for forecasting of different pollutants in Bhubaneswar. PM_{10} and O_3 show a rising trend with predicted approximate annual concentration of $92.530\mu g/m^3$ and $26.46\mu g/m^3$; $PM_{2.5}$, SO_2 and NO_2 show a reducing trend with an approximate annual concentration of $40.93\mu g/m^3$, $2.21\mu g/m^3$ and $38.63\mu g/m^3$, respectively, by the year 2025. The meteorological parameters that are average temperature and relative humidity exhibit a rising trend in the annual concentration of Bhubaneswar. Hence, ARIMA (2, 1, 2) is a suitable model for forecasting the atmospheric pollutants and meteorological parameters of air pollution of Bhubaneswar, for future planning and policy-making to reduce the pollution of the city.

Keywords: Air pollutants; Forecast; Mann-Kendall; Sen's slope estimator; Autoregressive integrated moving average (ARIMA); Prediction.

1. INTRODUCTION

Air pollution has become an important factor in environmental degradation. Air pollution is a total of pollutants that freely exit in the air, and on coming in contact with human beings and plants, can cause harmful effects (Sharma *et al.*, 2018). Urban and peri-urban air pollution is one of the important environmental concerns throughout the world. Atmospheric particulates and gaseous pollutants, pose severe health effects both for humans and plant species (Gupta and Kulshrestha, 2016; Maatoug, 2010). Monitoring for urban AQI

2. MATERIALS AND METHODS

The past pollutants data for the study is retrieved from State Pollution Control Board (SPCB), Bhubaneswar, India. The air pollutants which are selected in this study are the PM particles PM_{10} and $PM_{2.5}$, O_3 , SO_2 and NO_2 . The pollutants data retrieved for the study is from January 2005 to December 2019. The meteorological parameters (average temperature and relative humidity) are collected from the India Meteorological Department (IMD). Excel-XLSTAT version 2019.1 is used as

mostly comprises tracking of pollutants like carbon monoxide (CO), particulate matters (PM), Ozone (O_3), lead (Pb) particles, Sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and ammonia (NH_3) (Azmi *et al.*, 2010; Gurjaret *et al.*, 2008). With available pollutants data under AQI, trend analysis and forecasting are possible through various statistical modeling techniques. Can (2017) used graphical and statistical approaches for time-series analysis of air pollutants, Rani *et al.* (2018) used past air pollution index data for trend analysis using XLSTAT. Trend estimation highly depends upon the characteristics of data and thus are considered as a complex approach (Kisi and Ay, 2013). In the proposed study, non-parametric tests are applied for statistical analysis. Parametric approaches are considered more precise than nonparametric tests but come with a limitation of normally distributed independent data whereas non-parametric tests have no such constraints (Wathanacheewakul, 2011). The proposed study uses the non-parametric Mann-Kendall (M-K) test in addition with Sen's-slope estimator approach for trend estimations of different pollutants and autoregressive integrated moving average (ARIMA) approach for modeling the pollutants forecast. M-K and Sen's - slope estimator tests are well-established tests for estimating the rising or reducing trends for the non-parametric data. ARIMA modeling is a generalized approach in which the models are fit on the time-series data to predict the future values (Brocklebank *et al.*, 2018; Eymen and Köylü, 2018). The proposed study first used M-K test along with Sen's slope estimator tests to assess trend existence in the pollutants time series data and afterward ARIMA modeling is done to forecast the pollutants value with precision. Different pollutants considered in the study of statistical analysis are $PM_{2.5}$, and PM_{10} , O_3 , NO_2 , and SO_2 . Mann-Kendall and Sen's slope estimator tests are used for non-seasonal data and ARIMA modeling is done for the yearly forecast of the pollutants consider. This study has been carried out for the city Bhubaneswar, India in 2020 and considers the past data of year 2005 to 2019 for statistical trend assessment of air pollution.

statistical software for M-K test, Sen's slope estimator, and ARIMA modeling.

2.1. Mann-Kendall test

The Mann-Kendall (MK) test is a non-parametric trend analysis for identifying the increasing and decreasing pattern in time series of the data. It compares the relative magnitudes of sample data rather than the data values themselves (Gilbert 1987). The MK test is first implemented using the null hypothesis (H_0) of no trend testing, that is, the observations X_i are randomly ordered in time, against the alternative

hypothesis (H_1), where there is an increasing or decreasing monotonic trend. The data values evaluated as ordered time series are compared with all subsequent data values. If a data value from a later period is higher than a data value from an earlier period, the statistic S is incremented by 1. On the other hand, if the data value from a later period is lower than a data value sampled earlier, S is decremented by 1.

The net result of all these increments and decrements yields the final value of S (Shahid 2011; Shrestha *et al.*, 1999; Yue *et al.*, 2002; Domankoset *et al.*, 2003). The MK test statistic S is computed as:

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^n \text{sgn}(x_j - x_k) \quad (1)$$

$$\text{Sgn}(x_j - x_k) = \begin{cases} -1 & \text{if } (x_j - x_k) < 0 \\ 0 & \text{if } (x_j - x_k) = 0 \\ +1 & \text{if } (x_j - x_k) > 0 \end{cases} \quad (2)$$

where x_j and x_k are the annual values in different years j and k , $j > k$, respectively. If $n < 10$ then the value of $|S|$ is compared directly with the theoretical distribution of S that is derived by the Mann-Kendall test (Gilbert 1987). The two-tailed test issued. At some probability level, H_0 is rejected in favour of H_1 if the absolute value of S equals or exceeds a specified value $S_{\alpha/2}$, where $S_{\alpha/2}$ is the smallest Shaving the probability less than $\alpha/2$. A positive (negative) value of S indicates an upward (downward) trend (Salmi *et al.*, 2002; Luo *et al.*, 2008).

For $n \geq 10$, the statistic S is approximately normally distributed with the mean and variance as follows:

$$E(S) = 0$$

$$\text{Var}(S) = \frac{1}{18} [n(n-1)(2n+5) -$$

$$\sum_{p=1}^q t_p(t_p-1)(2t_p+2)] \quad (3)$$

q is the number of tied groups and t_p is the number of data values in the p^{th} group. The standard test statistic Z is computed as:

$$Z = \begin{cases} \frac{S-1}{\sqrt{\text{Var}(S)}} & ; \text{if } S > 0 \\ 0 & ; \text{if } S = 0 \\ \frac{S+1}{\sqrt{\text{Var}(S)}} & ; \text{if } S < 0 \end{cases} \quad (4)$$

The presence of a statistically significant trend is evaluated using the Z value. A positive (negative) value of Z indicates an upward (downward) trend. To test for either an upward or downward monotonic trend (a two-tailed test) at α level of significance, H_0 is rejected if $|Z| > Z_{1-\frac{\alpha}{2}}$, where $Z_{1-\frac{\alpha}{2}}$ is obtained from the standard normal cumulative distribution tables. The Kendall's τ values are calculated as Eq. 5.

$$\tau = 2 \frac{S^*}{z(z-1)} \quad (5)$$

In which S^* denotes Kendall's sum, computed as $S^* = A-B$ where A represents the number of chances when the difference

of x_b to x_a is greater than zero and B represents the number of chances when the difference of x_b to x_a is less than zero (Chattopadhyay *et al.*, 2012; Xu *et al.*, 2004).

2.2, Sen's slope estimator test

This test also termed as Theil-Sen slope test is a widely used statistical tool for non-parametric data to estimate the power of trend, detected through the M-Ktest (Caloiero *et al.*, 2017; Eymen and Köylü, 2018). Developed by Theil, 1950, and Sen, 1968, this is a median-based tool that evaluates the slope of the trend through a linear model. If there are m number of pollutant data points in a time-series ($X_1, X_2, X_3, \dots, X_m$) and X_a and X_b are the pollutant values at time instance a and b such that $b > a$, then variance of the residual is computed as Eq. 6 and 7.

$$T_i = \frac{x_b - x_a}{b - a} \text{ for } i = 1, 2, 3, \dots, m \quad (6)$$

The median of all T_i values, denoted as T_{med} , is the Sen's slope estimator and is calculated as equation 7. The sign of T_{med} reveals the upward or down ward trend of the data and its numeral denote the trend steepness.

$$T_{\text{med}} = \begin{cases} T_{\frac{m+1}{2}} & \text{if } m = \text{odd} \\ \frac{T_{\frac{m}{2}} + T_{\frac{(m+2)}{2}}}{2} & \text{if } m = \text{even} \end{cases} \quad (7)$$

The trend prediction of the pollutants through the M-K test depends upon the significance level α , and there is a possibility of the existence of trends with other significant levels. So through Sen's slope estimator, the changing rates can be assessed for the pollutants which shows no trend in M-K Test.

2.3. Autoregressive integrated moving average (ARIMA)

The ARIMA model, developed for prediction and estimation of future values in univariate time-series data, was introduced by Box and Jenkins (1976). ARIMA includes a combination of several timeseries techniques to give a better representation and analysis of time-series data. Auto regression (AR), differencing order integration (I) and moving average (MA) collectively makes ARIMA (p, d, q) model in which p is the order of auto regression model, d is for differencing order integration, and q is the moving average model order. In the first step of multimethodology, time-series data are checked whether it is stationary or not. Dickey-Fuller (D-F) test is used in the paper to check the data (Dickey and Fuller, 1979). If the data is stationary, the model moves in the second step else the data is made stationary by difference. In the next step, p, d, q possible values are estimated using correlogram of autocorrelation and partial autocorrelation functions (ACF and PACF). In next stage, for determining the adequacy of the model, the values of Akaike information criteria (AIC), and other error estimation measures are assessed over the best-suited goodness of fit statistics to select appropriate ARIMA model order. For the idea of order determination of the ARIMA model in the provided study, various goodness of fit statistics criteria observed which, other than AIC, includes sum of squared errors (SST), root mean squared deviation (RMSD), W-N Variance, mean absolute percentage deviation (MAPD) and final prediction error (FPE). With the chosen model, the last step involves estimation of forecasted values for the provided time-series data. A generalized expression of ARIMA(p, d, q) can be given as Eq. 9.

$$\phi(\beta)\nabla^d f_t = \theta(\beta)e_t \quad (8)$$

Where, $\phi(\beta)$ and $\theta(\beta)$ represent the polynomial of degree p and q respectively, β is a backward shift operator, ∇ is difference operator, f_t is pollutants parameter at time t and e_t is the error term at time t .

3. RESULTS AND DISCUSSIONS

In this section of study, results estimation and analysis of its inferences are carried out for the Mann-Kendall test, Sen's slope estimator test and, ARIMA modeling of time-series pollutants data of AQI sampling station of Bhubaneswar. The analysis in annual scale indicated that the SO_2 has a decreasing trend, the p -value (0.014) is below the significance level, with a negative value of Kendall's tau (-0.144), so the null hypothesis is rejected confirming the alternate hypothesis of acceptance of trend in the time series data (Table 1; Fig 1). The trend of SO_2 on a monthly scale, on the other hand, shows an increasing trend from November and December (Table 2). The MK trend analysis of nitrogen dioxide (NO_2) shows an increasing trend, with a positive value of Kendall's tau (0.506), the p -value is below the significance level, so the null hypothesis is rejected then accepted the alternative hypothesis for the time series data (Table 1; Fig 2). It is interesting to note that the Nitrogen dioxide (NO_2) shows a significant increasing trend in the monthly scale as well (Table 2). The tropospheric ozone (O_3) is recognized as one of the major air pollutants affecting the climate of the earth. The result reveals that the tropospheric O_3 show an increasing trend over Bhubaneswar

with positive Kendall's value 0.236 (Table 1; Fig. 3). The trend of Tropospheric Ozone (O_3) shows an increasing pattern in September and November (Table 2).

The particulates of size 2.5- μm diameter ($\text{PM}_{2.5}$) shows no trend over provided years, as p -values are 0.194, that is more to 0.05, H_0 is accepted (Table 1; Fig. 5). In the case of a monthly scale, an increasing trend is observed in February and November. The particle of size 10- μm diameter (PM_{10}) shows an increasing trend with Kendall's tau value 0.254, the p -value is below the significance level (Table 1; Fig.5). The monthly trend of PM_{10} concentration, on the other hand, shows an increasing trend from January to June and September, November (Table 2).

Climate change and its inter-annual and intra-seasonal variability are the major global concern in recent times. The temperature plays a deciding role in understanding the climate change brought about by urbanization and industrialization. The MK trend of average surface temperature shows no trend over Bhubaneswar from 2005 to 2019 with Kendall's tau value 0.085, the p -value is above 0.05, H_0 is accepted (Table 1; Fig. 6). However, the monthly trend of average temperature shows an increasing pattern from June to August and no trend observed in the rest of the months (table 2). The MK trend of average relative humidity indicates an increasing trend over Bhubaneswar with Kendall's Tau value 0.112 (Table 1; Fig. 7). The MK trend in the monthly scale depicts a decreasing nature in January and no trend is found in the rest of the months (Table 2).

Table 1: The result of the Mann–Kendall trend test for atmospheric pollutants and meteorological parameters over Bhubaneswar from 2005 to 2019

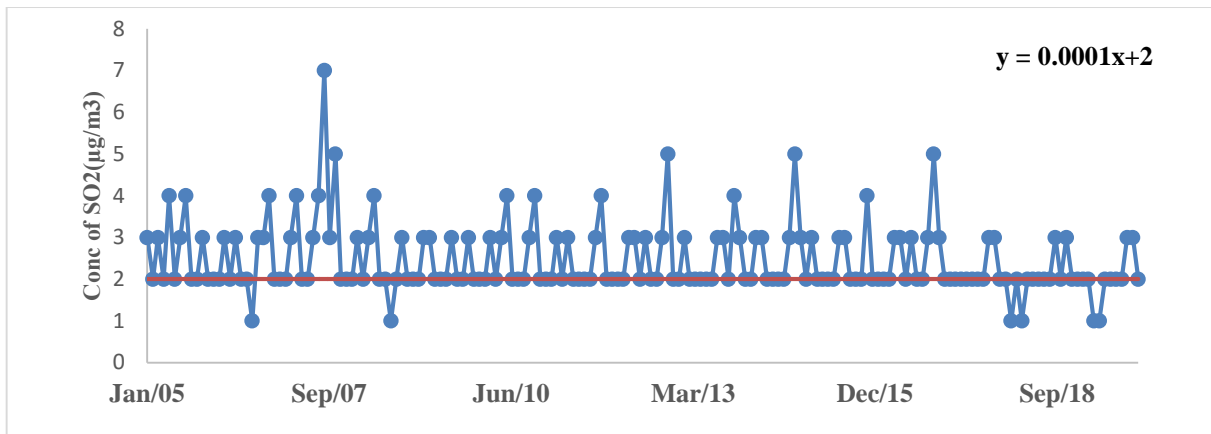
Pollutants	Kendall's tau (τ)	p-value*	S value	Result	Sen's slope T_{med}
$\text{SO}_2(\mu\text{g}/\text{m}^3)$	-0.144	0.014*	-1731.00	Trend exits	-0.011
$\text{NO}_2(\mu\text{g}/\text{m}^3)$	0.506	<0.0001*	7934.00	Trend exits	8.061
$\text{O}_3(\mu\text{g}/\text{m}^3)$	0.236	0.006*	563.00	Trend exits	0.013
$\text{PM}_{2.5}(\mu\text{g}/\text{m}^3)$	0.066	0.194	1050.00	No trend	0.004
$\text{PM}_{10}(\mu\text{g}/\text{m}^3)$	0.254	<0.0001*	4076.00	Trend exits	4.698
Relative Humidity-%	0.112	0.029*	1766.00	Trend exits	0.107
Average temperature- $^{\circ}\text{C}$	0.085	0.099	1333.00	No trend	0.002

* p value<0.05 indicates rejection of the null hypothesis of no trend and thus, revealing the existence of the trend

Source: Realised by authors

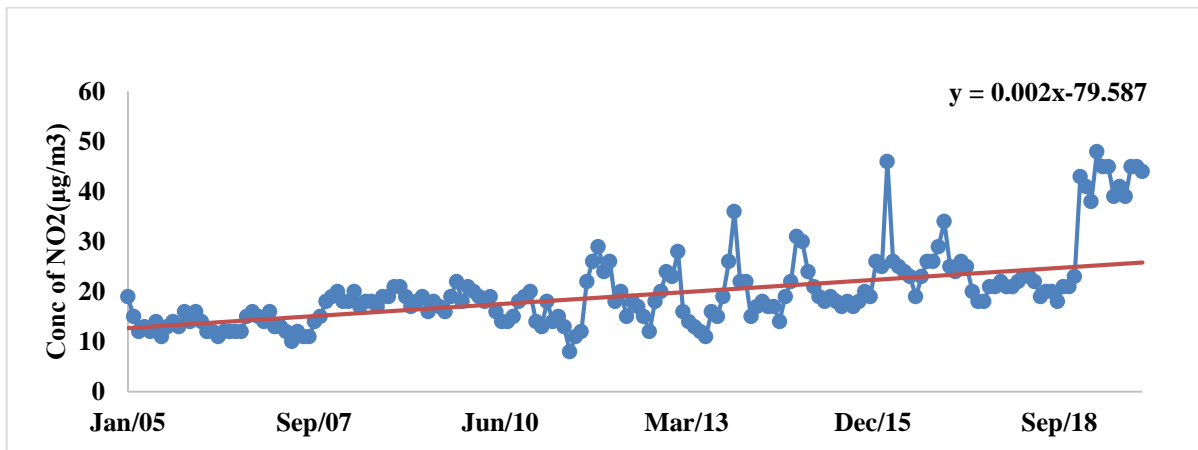
The values of Sen's slope estimator T_{med} is also provided in Table 4.2, and the outcomes of Sen's slope test validates the M-K test results. T_{med} values are also calculated for those pollutants data in which no trend exists. This is for the reason that the hypothesis in the M-K test is established over a significant level α and there is a possibility of the presence of a trend, and thus the trend slope possibility, beyond α , In the proposed study, α is kept at 5% for the results. The Sen's slope results presented in Table 4.2 confirms the results of M-K test

and shows the similar slope orientations. The T_{med} value of SO_2 shows a negative slope for the trend (-0.011). M-K test for the $\text{PM}_{2.5}$ and Average temperature shows no trend, and the Sen's slope estimator values predicted a positive slope with value 0.004 and 0.002, respectively. The T_{med} value of NO_2 , O_3 and PM_{10} shows a positive slope confirming an increasing trend in the data of the air pollutants. The T_{med} value for relative humidity shows a positive slope for the trend (0.107).



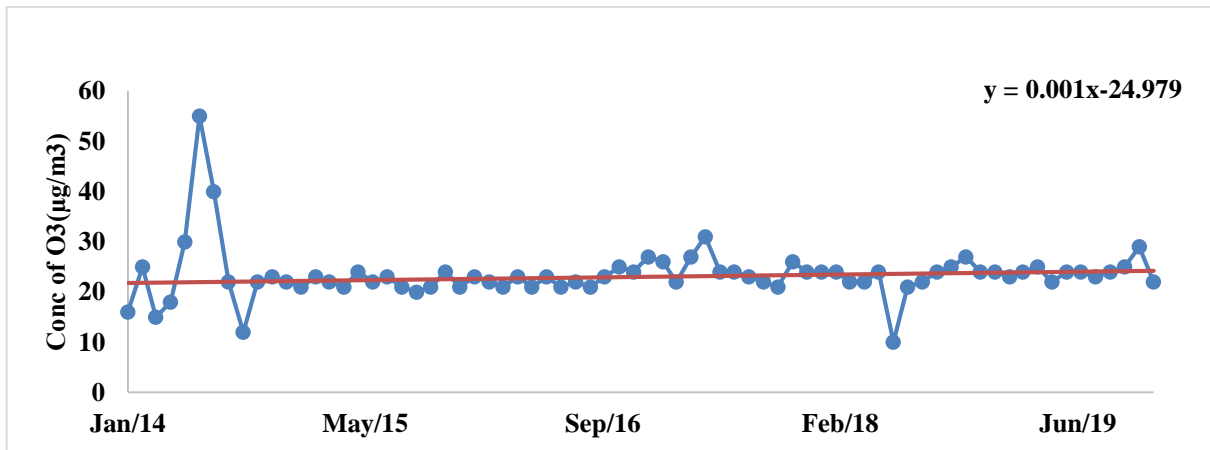
Source: Realised by authors

Fig. 1 Trends of SO₂ concentrations (µg/m³) over Bhubaneswar during the period from 2005 to 2019



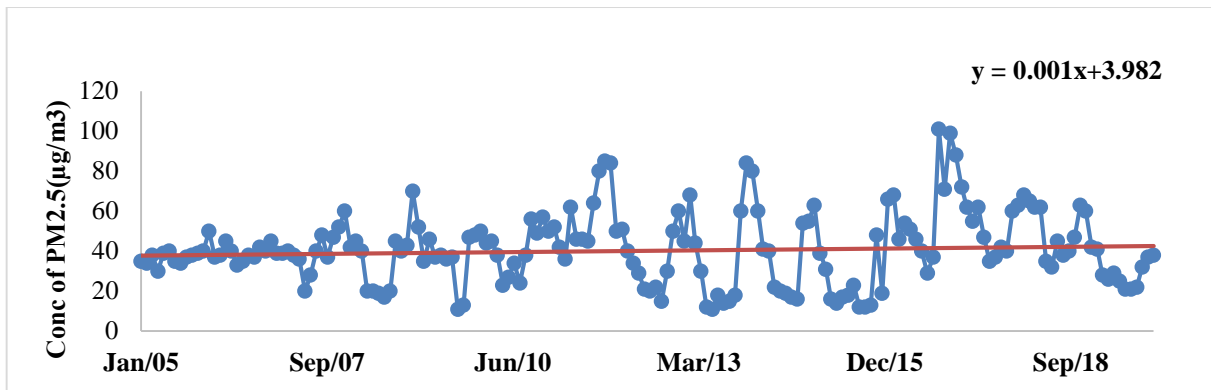
Source: Realised by authors

Fig. 2 Trends of NO₂ concentrations (µg/m³) over Bhubaneswar during the period from 2005 to 2019



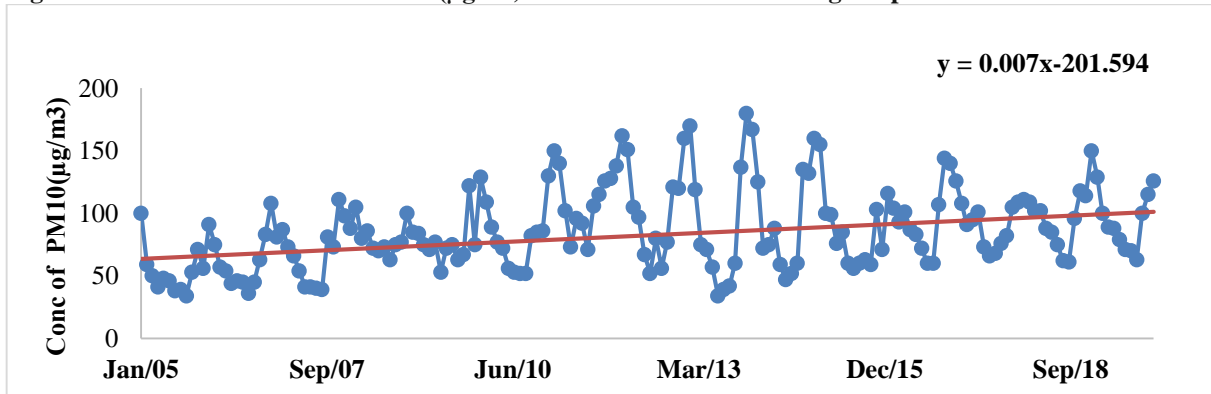
Source: Realised by authors

Fig. 3 Trends of O₃ concentrations (µg/m³) over Bhubaneswar during the period from 2005 to 2019



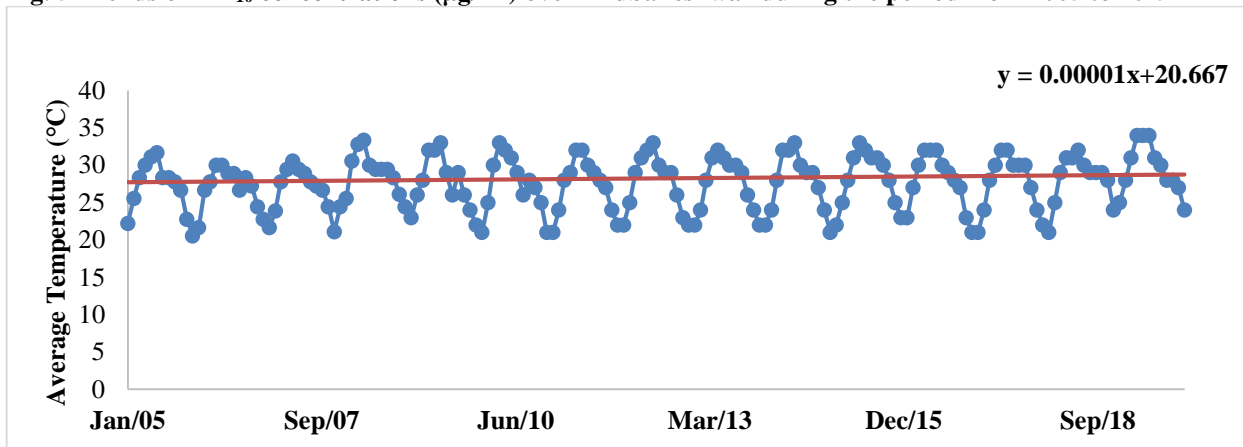
Source: Realised by authors

Fig. 4 Trends of PM_{2.5} concentrations (µg/m³) over Bhubaneswar during the period from 2005 to 2019



Source: Realised by authors

Fig. 5 Trends of PM₁₀ concentrations (µg/m³) over Bhubaneswar during the period from 2005 to 2019



Source: Realised by authors

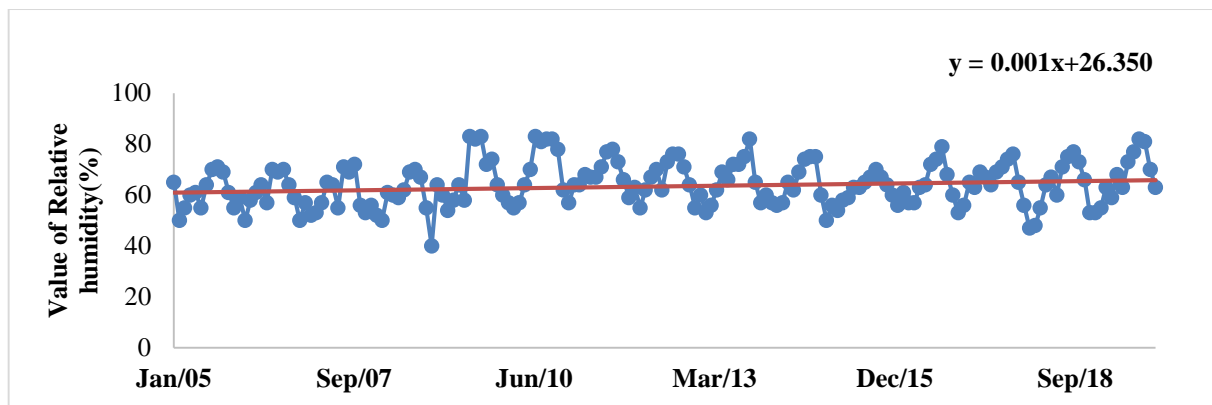
Fig. 6 Trends of average temperature (°c) over Bhubaneswar during the period from 2005 to 2019

Table 2: Result of the Mann-Kendall trend test for pollutants&meteorological parameters (monthly scale)

Dec	0.635	0.006	46.00	Trend exists	0.560	0.005	58.00	Trend exists	0.234	0.681	3.00	No trend	0.271	0.180	28.00	No trend	0.314	0.113	33.00	No trend	0.235	0.263	23.00	No trend	0.117	0.584	12.00	No trend
Nov	0.476	0.026	42.00	Trend exists	0.572	0.004	58.00	Trend exists	1.000	0.009	15.00	Trend exists	0.425	0.033	44.00	Trend exists	0.429	0.029	45.00	Trend exists	0.163	0.447	16.00	No trend	0.243	0.233	25.00	No trend
Oct	0.267	0.248	21.00	No trend	0.604	0.003	61.00	Trend exists	0.501	0.243	7.00	No trend	0.038	0.882	4.00	No trend	0.364	0.067	38.00	No trend	0.267	0.203	26.00	No trend	0.320	0.112	33.00	No trend

Pollutants	Trend tests	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep
SO ₂ (µg/m ³)	Kendall's τ value	-0.153	0.052	-0.678	0.307	-0.064	-0.127	0.339	-0.282	-0.116
	P-value*	0.552	0.908	0.003	0.179	0.817	0.616	0.148	0.211	0.632
	S value	-8.00	2.00	-52.00	25.00	-5.00	-8.00	26.00	-22.00	-9.00
	Result	No trend	No trend	Trend exits	No trend	No trend	No trend	No trend	No trend	No trend
NO ₂ (µg/m ³)	Kendall's τ value	0.638	0.580	0.625	0.657	0.579	0.612	0.525	0.586	0.566
	P-value*	0.001	0.003	0.002	0.001	0.004	0.002	0.009	0.003	0.005
	S value	65.00	60.00	64.00	66.00	59.00	63.00	53.00	60.00	58.00
	Result	Trend exits	Trend exits	Trend exits	Trend exits	Trend exits	Trend exits	Trend exits	Trend exits	Trend exits
O ₃ (µg/m ³)	Kendall's τ value	0.690	-0.138	0.745	0.600	-0.276	-0.138	-0.215	0.545	0.966
	P-value*	0.08	0.848	0.070	0.133	0.566	0.848	0.697	0.217	0.013
	S value	10.00	-2.00	10.00	9.00	-4.00	-2.00	-3.00	7.00	14.00
	Result	No trend	No trend	No trend	No trend	No trend	No trend	No trend	No trend	No trend
PM _{2.5} (µg/m ³)	Kendall's τ value	0.237	0.471	0.243	0.058	-0.087	-0.010	0.010	-0.174	-0.010
	P-value*	0.249	0.017	0.233	0.804	0.691	1.000	1.000	0.398	1.000
	S value	24.00	49.00	25.00	6.00	-9.00	-1.00	1.000	-18.00	-1.000
	Result	No trend	Trend exits	No trend	No trend	No trend	No trend	No trend	No trend	No trend
PM ₁₀ (µg/m ³)	Kendall's τ value	0.390	0.478	0.333	0.510	0.580	0.574	0.364	0.290	0.414
	P-value*	0.048	0.015	0.092	0.010	0.003	0.003	0.067	0.150	0.040
	S value	41.00	50.00	35.00	53.00	60.00	60.00	38.00	30.00	42.00
	Result	Trend exits	Trend exits	No trend	Trend exits	Trend exits	Trend exits	No trend	No trend	No trend
Average Temperature(°C)	Kendall's τ value	-0.010	0.001	0.262	0.213	0.323	0.481	0.770	0.460	0.270
	P-value*	1.00	1.00	0.216	0.313	0.131	0.019	<0.001	0.025	0.201
	S value	-1.00	0.01	25.00	21.00	29.00	47.00	71.00	45.00	26.00
	Result	No trend	No trend	No trend	No trend	No trend	Trend exits	Trend exits	Trend exits	No trend
Relative humidity (%)	Kendall's τ value	-0.531	0.301	0.363	0.089	0.347	0.234	0.176	0.126	0.215
	P-value*	0.009	0.136	0.072	0.688	0.089	0.252	0.397	0.551	0.295
	S value	-53.00	31.00	37.00	9.00	35.00	24.00	18.00	13.00	22.00
	Result	Trend exits	No trend	No trend	No trend	No trend	No trend	No trend	No trend	No trend

*p value<0.05 indicates rejection of the null hypothesis of no trend and thus, revealing the existence of the trend



Source: Realised by authors

Fig. 7 Trends of relative humidity (%) over Bhubaneswar during the period from 2005 to 2019

The statistically significant relationship between the meteorological parameters and pollutants is observed for Bhubaneswar where highlighted correlations are significant at $p < 0.05000$. PM_{10} , SO_2 , NO_2 , and O_3 are positively correlated

with each other, whereas NO_2 , SO_2 , $PM_{2.5}$, PM_{10} are negatively correlated with temperature. $PM_{2.5}$ and PM_{10} are highly correlated with each other (Table 3).

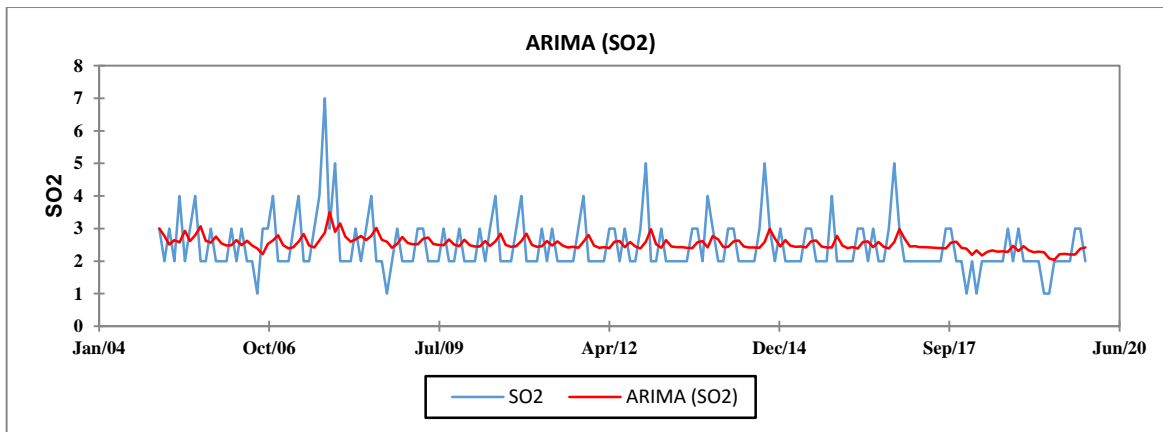
Table 3: Correlation matrix of all pollutants and meteorological parameters over Bhubaneswar (Marked correlations are significant at $p < 0.05000$)

	SO_2	NO_2	$PM_{2.5}$	PM_{10}	Temperature	Humidity	O_3
SO_2	1						
NO_2	-0.13477	1					
$PM_{2.5}$	0.125816	0.224156	1				
PM_{10}	-0.00231	0.492156	0.616585	1			
Temperature	-0.06602	-0.07757	-0.52222	-0.51422	1		
Humidity	0.076917	-0.07267	-0.30742	-0.36213	0.28607	1	
O_3	-0.16191	0.529737	0.086872	0.180262	0.124029	0.007094	1

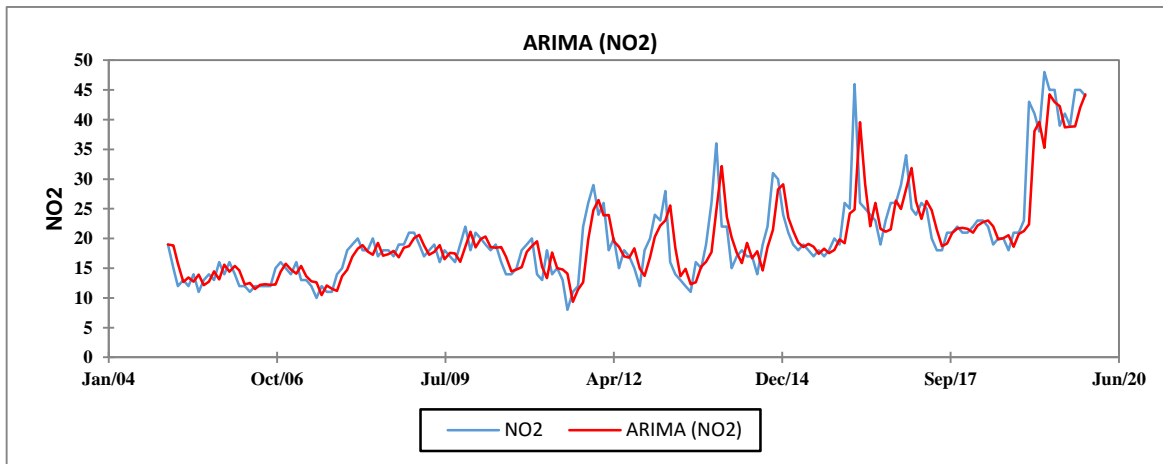
Source: Realised by authors

ARIMA time-series model is fitted on the available pollutant data. Using the D-F test, the data is checked with null hypothesis H_0 which shows the existence of unit rooting time-series data and alternative hypothesis H_1 which shows no unit root confirming a stationary time-series data. Computed p-value in D-F test for the time-series data of each of the pollutants in different season comes lower to a significance level of 0.05, due to which H_0 is rejected, and data confirms to be stationary and suitable for applying ARIMA (p, d, q) model. Three models are selected for the purpose; ARIMA (2, 1, 1), ARIMA (2, 1, 2) and ARIMA (2, 0, 2) at 95% level of confidence. All three models are selected and checked over the goodness of fit statistics for choosing the best-suited model. Table 4 gives comparisons of the goodness of fit statistics for different pollutant time-series data. From the results of Table 4 and statistical analysis of the residual plots, the ARIMA (2, 1, 2) model has the least error estimation values in the goodness of fit statistics and thus appears to be best suited for the forecasts of the pollutants value of Bhubaneswar. Figs. 8, 9, 10, 11, 12, 13, 14, shows the actual pollutant values and the forecasted pollutant values with ARIMA (2, 1, 2) model at a 95% confidence interval for the year 2005 to 2019. In Figures,

ARIMA (2, 1, 2) plot is compared with the original data points of different pollutions where the blue line represents the monthly mean concentrations of observed pollutants value and the red line represents the ARIMA (2, 1, 2) model values. ARIMA (2, 1, 2) model can be used for predicting and forecasting future pollutants values which can aid the decision-makers for planning steps to mitigate the pollutants which shows a rise in trend and are above the permissible standard limits. From the result of Table 5 shows that there is a reducing trend in the annual concentration of SO_2 , NO_2 and $PM_{2.5}$, whereas O_3 and PM_{10} shows a rising trend in the annual concentrations of Bhubaneswar. Also, Table 4.6 illustrates much higher concentrations of $PM_{2.5}$ and PM_{10} , to that of the permissible standard annual concentration limits, that is, $40 \mu g/m^3$ of $PM_{2.5}$ and $60 \mu g/m^3$ of PM_{10} . SO_2 and NO_2 are through under the permissible standard annual concentration limits $50 \mu g/m^3$ and $40 \mu g/m^3$ respectively and are showing a decreasing trend, but still are very close to the permissible limits and the results from Fig.3 shows that NO_2 have frequently crossed the acceptable limits during the year 2005 to 2019. Average Temperature and Relative Humidity shows a rising trend in the annual concentration of Bhubaneswar.

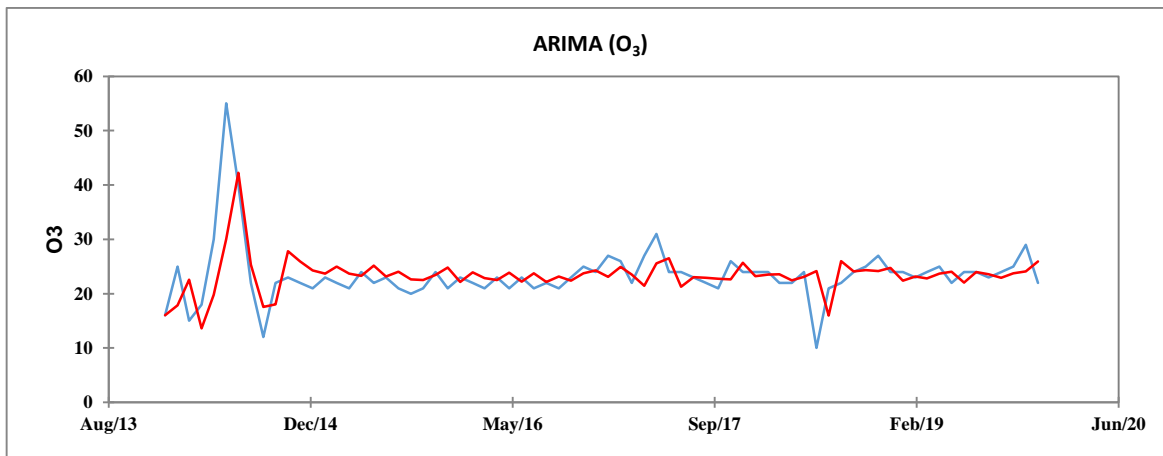


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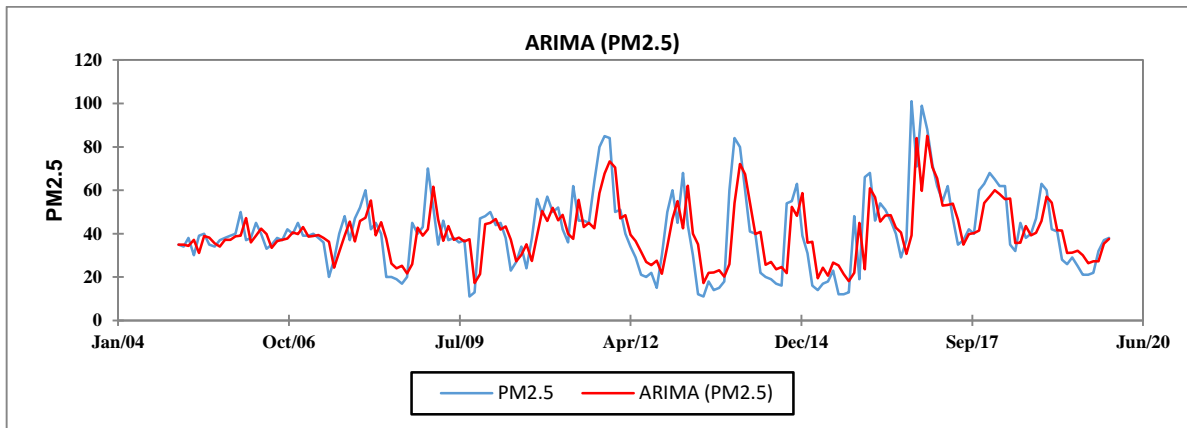
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Fig.9 The diagram shows the observed and ARIMA (2,1,2) model forecast of NO₂ concentration($\mu\text{g}/\text{m}^3$)



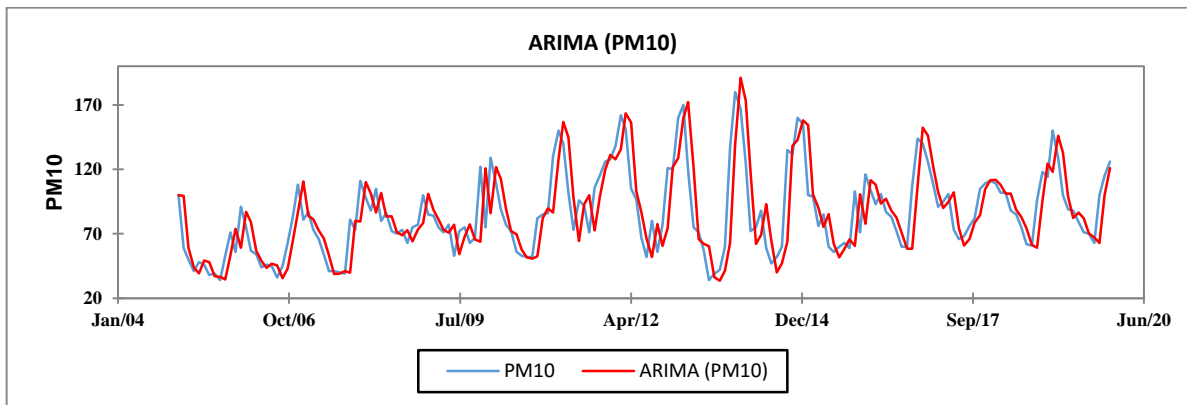
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Fig.10 The diagram shows the observed and ARIMA (2,1,2) model forecast of O₃ concentration($\mu\text{g}/\text{m}^3$)



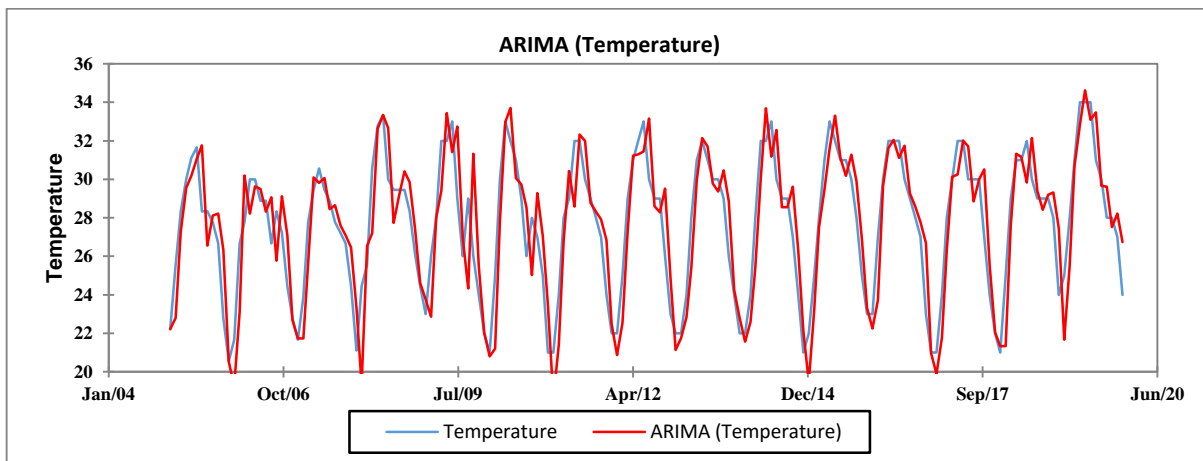
Source: Realised by authors

Fig.11 The diagram shows the observed and ARIMA (2,1,2) model forecast of PM_{2.5} concentration($\mu\text{g}/\text{m}^3$)



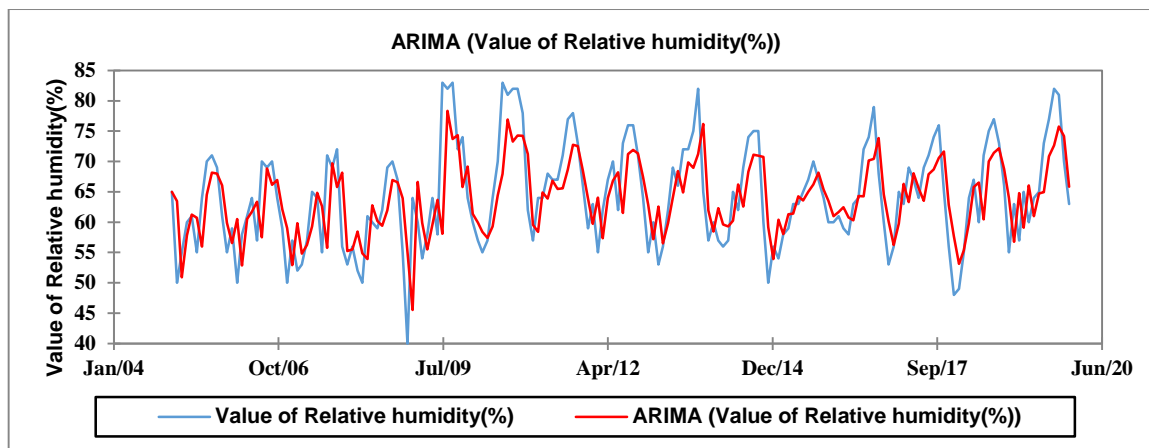
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Fig.12 The diagram shows the observed and ARIMA (2,1,2) model forecast of PM₁₀ concentration($\mu\text{g}/\text{m}^3$)



Source: Realised by authors

Fig.13 The diagram shows the observed and ARIMA (2,1,2) model forecast of average temperature($^{\circ}\text{C}$)



Source: Realised by authors

Fig.14 The diagram shows the observed and ARIMA (2,1,2) model forecast of relative humidity (%)

Table 4: The results of different models at 95 % confidence level for forecasting the spatial distribution of meteorological parameters and pollutants

Seasons	Goodness of fit statistics	ARIMA (2,1,1) 95%	ARIMA (2,1,2) 95%	ARIMA (2,0,2) 95%
SO ₂ (µg/m ³)	SSE	119.162	119.200	138.288
	MAPE	28.3131	28.452	28.936
	WN variance	0.665	0.665	0.768
	FPE	0.680	0.680	0.785
	AIC	445.855	440.916	476.803
	AICC	446.084	443.263	477.147
	BIC	458.604	453.853	492.7678
NO ₂ (µg/m ³)	SSE	2952.916	2902.736	3258.996
	MAPE	12.923	12.929	18.105
	WN variance	0.664	0.665	0.768
	FPE	16.869	16.582	18.512
	AIC	1018.148	1017.017	1046.402
	AICC	1018.377	1017.364	1046.747
	BIC	1030.897	1032.954	1062.367
O ₃ (µg/m ³)	SSE	1493.261	1465.24	2385.666
	MAPE	12.833	12.686	15.780
	WN variance	21.031	20.932	33.134
	FPE	22.251	22.163	35.027
	AIC	429.934	425.85	469.045
	AICC	430.540	426.798	469.955
	BIC	438.985	437.103	480.429
PM _{2.5} (µg/m ³)	SSE	33105.59	28280.29	32620.21
	MAPE	24.893	26.027	23.8596
	WN variance	0.665	0.665	0.768
	FPE	189.127	161.560	185.295
	AIC	1450.387	1427.747	1459.148
	AICC	1450.617	1428.094	1459.493
	BIC	1463.136	1443.684	1475.113
PM ₁₀ (µg/m ³)	SSE	77112.08	88108.4	89243.79
	MAPE	18.527	19.208	18.592
	WN variance	0.6622	0.6659	0.768
	FPE	440.529	503.3494	506.940
	AIC	1607.265	1590.669	1640.874
	AICC	1607.754	1592.016	1641.219
	BIC	1626.39	1610.606	1656.839
Average temperature (°C)	SSE	638.630	614.0329	812.4368
	MAPE	5.477	5.392	6.4636
	WN variance	0.6622	0.6659	0.7682
	FPE	3.648	3.507	4.6149
	AIC	748.136	739.199	798.922

	AICC	748.625	739.546	799.267
	BIC	767.261	755.136	814.887
Relative Humidity (%)	SSE	6804.156	6794.745	8386.719
	MAPE	7.8003	7.7243	8.5956
	WN variance	0.6622	0.6659	0.768
	FPE	38.871	38.817	47.6399
	AIC	1173.16	1171.642	1217.013
	AICC	1173.648	1171.989	1217.358
	BIC	1192.284	1187.579	1232.977

Source: Realised by authors

Table 5: Annual concentration of pollutants forecasted by ARIMA (2, 1, 2) of Bhubaneswar up to 2025

Year	SO ₂ (µg/m ³) Forecast value	NO ₂ (µg/m ³) Forecast value	O ₃ (µg/m ³) Forecast value	PM _{2.5} (µg/m ³) Forecast value	PM ₁₀ (µg/m ³) Forecast value	Average temperature(°C) Forecast value	Relative Humidity (%) Forecast value
2014	2.560	20.489	20.973	41.472	96.212	27.553	64.526
2015	2.515	20.078	22.305	29.450	89.734	27.886	62.751
2016	2.524	25.068	22.142	48.717	90.663	27.721	63.298
2017	2.470	23.688	24.596	53.168	93.136	27.542	65.090
2018	2.319	21.146	22.547	48.717	92.411	28.031	64.039
2019	2.247	39.027	24.062	34.640	95.907	28.721	65.320
2020	2.240	40.168	26.496	40.375	96.168	27.999	65.042
2021	2.240	38.716	26.457	40.925	92.617	28.048	66.231
2022	2.230	38.642	26.467	40.931	92.532	28.036	66.435
2023	2.220	38.639	26.467	40.931	92.530	28.034	66.452
2024	2.220	38.639	26.469	40.930	92.530	28.034	66.454
2025	2.215	38.639	26.469	40.930	92.530	28.030	66.455

Source: Realised by authors

The ARIMA (2, 1, 2) model prediction of NO₂ shows a better condition and the pollutants in future years are predicted satisfactorily below to the annual permissible limits of 50µg/m³ in Bhubaneswar (National Air Quality Index, 2014; Permissible level for pollutants, 2017). The result of the study helps to assess the conditions of different air pollutants in Bhubaneswar in recent past years. It is inferred from the results of M-K and Sen's slope estimator tests presented in Table 1, that more control measures are required for pollutants especially for particulate matter 10, O₃ and Nitrogen dioxide. Result reveals that PM₁₀ and O₃ are increasing in past years of Bhubaneswar and thus better policies are required such as improved road traffic conditions, limiting vehicular pollutions by better vehicle types these are the main sources of PM₁₀ and NO₂ (CAI-Asia Factsheet, 2010; Lenschowet *al.*, 2001). After the introduction of BSES IV environment standard vehicles, the Indian government has somewhat limited the growth of traffic-related NO₂ and PM₁₀ emissions (Bansal and Bandivadekar, 2013; Hilboll et al., 2017) but still, the positive trend in results indicates the need of better strategies for countering such pollutants.

SO₂ and PM_{2.5}, though show a decreasing tendency in previous years but the low magnitude of their slopes indicates that these pollutants also required specific measures for systematic controlling.

Inferences from the results of the ARIMA model gives an estimate that PM₁₀ and O₃ are a bigger concern in the coming years and will require specific measures to control its emissions. The study summarizes that PM₁₀ with an increasing trend and higher concentrations, and PM_{2.5} with the decreasing trend but a still higher concentration is the primary concern in Bhubaneswar.

4. CONCLUSION

The study presented in the paper provides a statistical analysis of trends in the atmospheric pollutants of the city Bhubaneswar, and further, a forecasting model is formulated to predict different pollutants concentrations in the forthcoming years. M-K and Sen's slope estimator tests are applied to past pollutants data retrieved from Central Laboratory and Regional Office, State Pollution Control Board, Bhubaneswar, Odisha. The meteorological parameters (average temperature and relative humidity) are collected from the India Meteorological Department (IMD) and ARIMA (p, d, q) model is applied for predictive analysis. Results of M-K test shows the existence of a trend in some of pollutants data in different seasons and the outcomes of Sen's slope estimator test defined power of the trends. ARIMA (2, 1, 2) model resulted in being best suited for predicting the future pollutant levels by comparing the goodness of fit statistics. The forecast result shows that there is a reducing trend in the annual concentration of SO₂, NO₂ and PM_{2.5}, whereas O₃ and PM₁₀ show a rising trend in the annual concentrations of Bhubaneswar. PM₁₀ has a higher concentration which is above the standard annual concentration limits. The concentration of SO₂ and NO₂ in the air are under the permissible standard annual concentration limits 50µg/m³ and 40µg/m³ respectively and are showing a decreasing trend, but still are very close to the permissible limits. PM₁₀ and O₃ exhibit a rising trend with predicted approximate annual concentration of 92.530µg/m³ and 26.46µg/m³; PM_{2.5}, SO₂ and NO₂ show a reducing trend with an approximate annual concentration of 40.93µg/m³, 2.21µg/m³ and 38.63µg/m³, respectively, by the year 2025. The meteorological parameters, average temperature and relative humidity show a rising trend in the annual concentration of Bhubaneswar.

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ABBREVIATIONS

%	-percentage
$\mu\text{g}/\text{m}^3$	-Microgram per cubic meter
ACF	-Autocorrelation function
AIC	-Akaike's information criterion
API	-Air Pollution Index
AQI	-Air Quality Index

AR	-Auto-regression
ARIMA	-Autoregressive Integrated Moving Average
d	-Degree of differencing
D-F	-Dickey-Fuller
e_t	-Error term at time t
FPE	-Final Prediction Error
MAPE	-Mean Absolute Percentage Error
NO_2	-Nitrogen dioxide
O_3	-Ozone
PM	-Particle Matter
RMSE	-Root Mean Square Error
SO_2	-Sulphur dioxide
SSE	-Sum of Squares Error
α	-Significance level
τ	-Mann-Kendall's tau value

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STUDY ON IMPACT OF EMOTIONAL ADVERTISING ON CONSUMER BUYING BEHAVIOR FOR FMCG PRODUCTS

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Abstract. Over several years, advertisements have seen a drastic change in the way they are communicated to the target audience. From using billboards to newspapers, radio, television and now social media. From direct way of delivering information to now using different creative ways; advertisements have come a long way. What has remained common is the goal of every advertisement which is to inform, influence and remind customers of products. This paper aims to identify if emotional advertisements influence the consumer buying behavior for low involvement products i.e., Fast Moving Consumer Goods products; and a product category taken for the purpose of the study is soaps. Two soaps have been taken into account- Dove and Pears, both belong to the same parent company i.e. Hindustan Unilever. Primary data has been collected using online questionnaire sent across India via different social media platforms. The data analysis tool that was used for the study was SPSS. The results show that emotional advertisements do impact customers and their purchase intentions with respect to FMCG products. The study also shows that emotional advertisements create a liking bias in the minds of customers when it comes to soaps.

Keywords: Consumer buying behavior, emotional advertisements, liking bias, low involvement products, purchase intention.

1. INTRODUCTION

Advertisement is the way how companies first introduce their products to customers. The basic purpose of an advertisement is to inform, influence and remind customers of the products. In olden days, companies only focused on traditional mainstream advertisement techniques, wherein only the basic information, features and purpose of the product was communicated. But with increase in competition, modern companies are finding new and new ways to stand out from their competitors. Today, marketers are using different promotional gimmicks to attract customer's attention and to maintain long term customer-relationship with them. There are different types of strategies how a company can formulate their ad structure. Apart from these, emphasizing on emotional dimension has always been considered a plus point, since emotions are something that is inevitable in human life. Different types of emotional appeal have different impact on different people. From using love to humor, happiness or sadness, excitement or just savvy; all these emotions have potential to grab the customer's attention. Studies have proved that FMCG companies like Hindustan Unilever, ITC etc. all adopt this trick.

FMCG products; and a product category taken for the purpose of the study is soaps. Two soaps have been taken into account- Dove and Pears, both belong to the same parent company i.e. Hindustan Unilever.

2. RESEARCH PROBLEM, OBJECTIVE AND HYPOTHESES

Today, customers are exposed to abundance of advertisements that makes their decision process slightly more challenging, especially when it comes to low involvement products i.e., FMCG products. Hence FMCG companies must take strategic decisions to formulate their advertisements in such a way that they stand out; and adopting emotional appeal in their advertisements would be a great way to do so. It could be an effective way of product differentiation and building strong customer relationships and eventually influencing their purchase decision.

Some major objectives of the research are:

- To identify the effect of emotional advertisements on consumer buying behavior for FMCG products.
- To determine the effectiveness of emotional advertisement in creating strong customer relationship.
- To determine if advertisements influence customers' preferences towards soaps.

Here the most three important research hypotheses are detailed together with alternative:

1. Emotional advertisements & brand attitude

H10: There is no impact of emotional advertisements on brand attitude.

H11: There is a significant impact of emotional advertisements on brand attitude.

2. Emotional advertisements & gw.r.t.ender

H20: There is no impact of emotional advertisements on consumer buying behavior for FMCG products w.r.t gender.

H21: There is a significant impact of emotional advertisements on consumer buying behavior for FMCG products w.r.t gender.

3. Emotional advertisements & consumers' preference

H30: There is no relationship between emotional advertisements and consumers' preference for Dove over Pears.

H31: There is a relationship between emotional advertisements and consumers' preference for Dove over Pears.

3. LITERATURE REVIEW

Several studies have been done in the past on how different types of advertisements can help marketers present their product more effectively to their audience. A good product with a bad advertisement won't work. The primary use of an advertisement is to inform and persuade customers about the product. Advertisements can assist customers in deciding which product or service to purchase. Advertisements are a

powerful form of communication that can effectively communicate a message to a specific target of customers. Moreover, advertisements have the ability to easily convince the customers for the product. Furthermore, ads must also be appealing for customers to engage in it. [1]

Modern marketers today use different strategies to increase their product engagement among their customers. One such strategy is celebrity appeal. Research [2] found out that celebrities are more effective at promoting highly socialized goods than the field experts themselves. While customers can identify the professionalism shown by the expert, celebrities add a little more attractiveness in making recommendations when it comes to advertisements.

With so much exposure to internet and mass media, it is obvious that several psychological impressions are bound to happen in customer's mind. When a customer is exposed to an advertisement, he is not just looking at the product but is also imprinting the brand associated with it in his mind subconsciously. This is called the brand image. It is not necessary to form a brand image; rather, it is shaped naturally. People generally have a positive outlook toward the brand image. A study also found out that teenagers in Gujranwala, Pakistan are much conscious about their social status, so they prefer branded products and advertisements affects their consumer buying behavior positively. [3]

3.1. Why Emotional Advertising?

The primary goal of an advertiser is to reach out to potential customers and influence their perceptions, and purchasing behavior. They spend a lot of money to keep people interested in their products (markets). To succeed, they must first understand what are the reasons their potential customers act the way they do. Advertisements including emotional appeals motivate customers emotionally rather than the rational part. It is established through research by [4] that Emotional response have a strong association with the consumer buying behavior. Consumers buy products which they are emotionally attached to. And these attachments are generated through advertising in the form of audio, video, and text, which he or she finds appealing.

But nonetheless, it is an accepted truth that consumer behavior can sometimes be unpredictable. Different people react differently to the same things. Or advertisements in this case. And hence consumer responses towards advertisements or various marketing program cannot be the same. So, a lot of marketers try to aim for different emotional chords of their target customers to achieve maximum advertising effectiveness. The growing importance of customer emotions in purchasing decisions has prompted researchers to emphasize emotions as a purchase engine.

3.2. Does it really work?

Since many centuries scientists have been trying to prove that everything happens for a scientific reason. At the end of the day, everything around us is science. Including our own body. Our psychological feelings happen for a reason. In advertising, brand recall is crucial. The success or failure of a brand is determined by brand recall at the point of purchase. When a customer views an advertisement, his brain immediately processes the information. The brain tends to have two functionally distinct ways of recognizing intelligence. This is done in two ways: a) by acquaintance;

and b) by explanation. The holistic and synthetic blend of sensory data from both the internal and external world is known as information through acquaintance based on emotional platform. The sequential and logical processing of information based on how the receiver assesses the world is known as knowledge by definition (reason). Consumers are motivated by rational appeals in ads because of facts and logical arguments, whereas emotional appeals use images and emotions to shape consumers' perceptions of the brand. It is observed that regardless of the type of emotional platform used to execute the promotional campaign, affective or emotional appeals seem to elicit a more optimistic and affective response than non-emotional appeals. [5]

Researchers [6] describes emotional advertising as a powerful promotional tool that draws in customers' attention and trigger their feelings, attitudes, and perceptions about a product or service. They also add that emotional advertising is simple to comprehend, engages people's interest, and cultivates strong brand memories. These memories remain in the back of a customer's mind, and when they are faced with a purchasing decision, these memories motivate them to make a final decision. Even emotional ads have the power to persuade customers to purchase a costly or unnecessary item.

Different types of commercials hit one's mind when customer thinks of emotions in advertising; advertisements that display moving and heart-touching images, cooing babies, or romping puppies come to mind. Typically, emotional responses to ads are thought to have the ability to bring tears or a smile to one's face. However, any advertisement elicits a sentimental response because almost anything we encounter in life elicits an automatic emotional response. As a result, it is possible to infer that emotion is more important than most advertisers know. Consumers who have a favorable impression of the advertisement are more likely to be interested in purchasing the item. [7]

3.3. Different Emotional Appeals

Customer brand preferences, brand awareness, brand recall, and ultimately purchasing decision are all influenced by the type of emotion used in advertising. Advertisements are used by marketers to sell their products, and emotions in advertisements can build a positive or negative brand picture in the minds of customers. [8]

Even though rational appeals are important, it is also inferred that emotional and rational; both play a significant role for different product categories. As concluded by researchers, that both rational and emotional advertising appeals have a positive impact on advertising attitude and purchasing intent. Whereas emotional appeals have a greater impact on advertising attitude for low-involvement goods, objective or rational appeals have a greater impact on high-involvement products. [9]

3.4 Research gap

FMCG as a sector, is full of competition and its market is huge. Thus, FMCG companies must take significant steps to position themselves in a way that they stand out by adopting emotional appeals in their advertisements. Most of the research above on emotional advertisement domain focused on general antecedents- i.e., previously existed things and its consequences. This study aims at directing research efforts in examining emotional advertisements effects and assessing

how effective they are in creating preference in the minds of the customers with respect to two soaps, i.e., Dove and Pears.

4. BRIEF RESEARCH METHODOLOGY

A quantitative method was used to study the impact of emotional advertising on consumer buying behavior for FMCG Products [10], [11]. The responses were collected using questionnaire which was circulated online via different social media platforms. The sample size of respondents for the study was 173, but 160 responses were taken into account after removing the outliers. The objective was to collect as much genuine responses as possible and the identity of all the respondents has been kept confidential.

The responses were gathered using a questionnaire that was distributed over several social media channels online, and the data was analyzed using SPSS software. The tests conducted are linear regression analysis, cross tabs, and chi-square test.

5. DATA ANALYSIS

Table 1 presents general favourable images of the research:

Category	Sub-category	Percentage
Gender	Females	51.4%
	Males	48.6%
Age Distribution	Below 18	12.1%
	18-30	54.9%
	31-40	12.1%
	41-50	6.9%
	Above 50	13.9%
Qualification	Diploma	10.9%
	Graduate	48.9%
	Post Graduate	32.8%
	PhD	2.3%
	Others	5.1%
Occupation	Student	44.3%
	Corporate Employee	32.2%
	Homemaker	9.2%
	Business Person	6.3%
	Others	8%

Source: Realised by authors

Table no. 1 A synthesis of sample's demographic data

Reliability Test-

Cronbach's Alpha provides with a simple way to measure the reliability of estimates [12]. Its use assumes that it has multiple elements measuring the same underlying structure. As a rule of thumb, a Cronbach's alpha of 0.70 or higher is better.

Cronbach's Alpha	N of Items
.744	2

Source: Realised by authors

Table no. 2 reveals a higher Cronbach's Alpha value (0.744) which is above the limit equal to the prescribed value of 0.7. The conclusion offers validity status to research and thus the sample's data are reliable indeed, according to the above-mentioned standard thumb rule for checking the reliability of the information set collected by this online survey forms.

Hypothesis Tests-

A. Hypothesis 1:

There is a significant impact of emotional advertisements on brand attitude.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.594 ^a	.353	.348	.495

a. Predictors: (Constant), FMCG companies that focus on connecting and engaging people in their advertisements, give me a positive feeling about the brand.

Source: Realised by authors

The R value of 0.594, shown in **Table no. 3**, identifies simple and moderate correlation, indicating that the dependent and independent variables are positively correlated. The R square value (0.353) indicates how much of the total variation in the dependent variable (watching new and creative emotional advertisements to make a better brand) can be explained by the independent variable (FMCG companies that focus on connecting and engaging people in their advertisements offer positive feeling about the brand). In this case, more than 1/3 of general variation can be explained to a moderate extent.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	21.072	1	21.072	86.021	.000 ^b
	Residual	38.703	158	.245		
	Total	59.775	159			

a. Dependent Variable: Watching new and creative emotional advertisements makes me like the brand better.

b. Predictors: (Constant), FMCG companies that focus on connecting and engaging people in their advertisements, give me a positive feeling about the brand.

Source: Realised by authors

The ANOVA **Table no. 4** shows how well the regression equation fits the data, or how well it predicts the dependent variable. This table indicates that the regression model predicts the dependent variable moderately well. The regression model is statistically significant since the significance value = 0.000 satisfies $p < 0.05$.

Thus, from above analysis, the null hypothesis is rejected, i.e., There is no impact of emotional advertisements on brand attitude. Therefore, this research can confirm that *there is a significant impact of emotional advertisements on brand attitude i.e., and accept the alternate hypothesis.*

B. Hypothesis 2:

There is a significant impact of emotional advertisements on consumer buying behavior for FMCG products w.r.t gender.

Gender * Would you buy any FMCG product, if its emotional ad intrigues you?					
Count					
		Would you buy any FMCG product, if its emotional ad intrigues you?			Total
		1 (Yes)	2 (Maybe)	3 (No)	
Gender	Female	39	44	1	84
	Male	18	52	6	76
Total		57	96	7	160

Source: Realised by authors

A number of 39 females from above **Table no. 5**, would definitely buy an FMCG product, if its emotional ad intrigues them, whereas 44 women maybe do the same. Whereas, 18 men would definitely buy an FMCG product, if its emotional ad intrigues them and 52 men maybe do the same.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.604 ^a	2	.003
Likelihood Ratio	12.152	2	.002
Linear-by-Linear Association	11.373	1	.001
N of Valid Cases	160		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 3.33.

Source: Realised by authors

Chi-Square statistic is 11.604, inside the **Table no. 6** and appears in the similar entitled column. The p-value appears in the same row in the “Asymptotic Significance (2-sided)” column which is 0.003, and thus the result becomes significant (the value is equal to or less than the designated alpha level which is taken to be 0.05). In this case, the p-value is smaller than the standard alpha value, so the research reject the null hypothesis which states that there is no impact of emotional advertisements on consumer buying behavior for FMCG products w.r.t gender. Therefore, this research can accept the alternate hypothesis which states *there is a significant impact of emotional advertisements on consumer buying behavior for FMCG products w.r.t gender.*

C. Hypothesis 3:

There is a relationship between emotional advertisements and consumers’ preference for Dove over Pears.

Do you remember any emotional advertisement related to Dove? * Do you think you have a liking bias towards Dove/Pears because of its emotional advertisement? Crosstabulation					
Count					
		Do you think you have a liking bias towards Dove/Pears because of its emotional advertisement?			Total
		1 (Yes)	2 (Maybe)	3 (No)	
Do you remember any emotional advertisement related to Dove?	1 (Yes)	41	68	40	149
	3 (No)	1	0	10	11
Total		42	68	50	160

Source: Realised by authors

Inside **Table no. 7**, 41 respondents remember emotional advertisement related to Dove and think they have a liking bias towards it because of its emotional advertisement. Whereas 68 respondents remember emotional advertisement related to Dove and think they might have a liking bias towards it because of its emotional advertisement and 40 respondents do not have a liking bias.

Do you remember any emotional advertisement related to Pears? * Do you think you have a liking bias towards Dove/Pears because of its emotional advertisement? Crosstabulation					
Count					
		Do you think you have a liking bias towards Dove/Pears because of its emotional advertisement?			Total
		1 (Yes)	2 (Maybe)	3 (No)	
Do you remember any emotional advertisement related to Pears?	1 (Yes)	23	39	35	97
	3 (No)	19	29	15	63
Total		42	68	50	160

Source: Realised by authors

Inside **Table no. 8**, 23 respondents remember emotional advertisements related to Pears and think they have a liking bias towards that soap because of its emotional advertisement, whereas 39 respondents who remember the ad, may not have a liking bias with 35 respondents not having bias at all. There are 19 respondents who do not remember any emotional advertisement related to Pears but have a liking bias towards a soap because of its emotional advertisement, 29 respondents may not have a liking bias and 15 do not remember any ad nor have a preference or bias towards the soap.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	19.798 ^a	2	.000
Likelihood Ratio	20.634	2	.000
Linear-by-Linear Association	12.099	1	.001
N of Valid Cases	160		
a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is 2.89.			

Source: Realised by authors

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.751 ^a	2	.253
Likelihood Ratio	2.805	2	.246
Linear-by-Linear Association	2.323	1	.127
N of Valid Cases	160		
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 16.54.			

Source: Realised by authors

The p value, asymptotic significance is 0.000 for **Table no. 9- Chi-Square Tests (Dove)**; whereas the p-value for **Table no. 10- Chi-Square Tests (Pears)** is 0.253. If p-value is less than 0.05, only then there's a relationship or association between two variables. From above, the p value being less than 0.05 (for Dove), the research can reject the null hypothesis which states there is no relationship between emotional advertisements and consumers' preference for Dove over Pears, and accept the alternate hypothesis that *there is a relationship between emotional advertisements and consumers' preference for Dove over Pears*.

6. KEY FINDINGS

The study was aimed to find out if emotional advertisements influence the purchase decisions for FMCG products; and a product category taken for the purpose of the study was soaps. Two soaps had been taken into account-Dove and Pears, both belong to the same parent company i.e. Hindustan Unilever. An illustrative literature review from various research papers and articles published by national and global organizations to collect preliminary information about the topic was done [13]. A questionnaire was circulated online among various groups of people of different age groups and professions to answer different questions related to the topic.

After the data analysis, it was found that:

- i) 95.4% of the respondents believe that advertisements are important and more than half of the total respondents believe that advertisements influence their purchase decisions;
- ii) 83.2% of the respondents think emotional advertisements help them remember the product and the brand associated with it better while 35.8% of the total respondents are into buying any FMCG product, if its emotional ad intrigues them and almost 60% of the remaining may consider buying

products based on how much the emotional advertisements have intrigued them;

iii) 90.7% of the respondents agree that FMCG companies that focus on connecting and engaging people in their advertisements, give them a positive feeling about the brand and almost 87% of the total respondents agree that watching new and creative emotional advertisements make them like the brand better; making way for strong customer relationships and enhancing favorable brand attitude in the minds of customers towards the brands;

iv) 96% of the respondents have voted for television advertisements as their source of awareness of different soaps, among other sources and 84.4% of the total respondents' main factor for selecting a soap is the brand among other factors like fragrance, lather, packaging, discounts & offers and others;

v) 93.1% of the respondents remember emotional advertisements related to Dove Soap while 62.4% of the total respondents remember emotional advertisements related to Pears Soap. 49.1% of the total respondents prefer Dove Soap over any other soap and 9.8% prefer Pears Soap;

vi) 76.9% of the respondents could recall advertisements related to Dove/Pears because of their unique emotional advertisements among other factors like social media posts appreciating them, hoardings, billboards, newspaper ads and others;

vii) 25.4% of the total respondents think they do have a liking bias towards their preferred soap because of its emotional advertisement while 42.8% may have a liking bias towards their preferred soap because of its emotional advertisement;

7. DISCUSSIONS

The findings help us show that although there are a lot of other ways to advertise or market your product, emotional advertisements do create an impact in consumers' minds; especially when it comes to FMCG products. Advertisements are becoming more and more popular with advancement of technology and social media. Everyone wants to be in the top of their games and customer engagement is a great way to do so. Hence from above we can assert that companies that create quality emotional advertisements are more likely to be remembered and liked by people and that can in turn convert them into their potential buyers. It was also found that respondents preferred Dove over Pears as their preferred soap and that was most likely because they could remember the emotional advertisement of Dove better than that of Pears and hence that created a liking bias in their minds towards that soap

8. SUGGESTIONS

Emotional advertisements usually focus on the psychological part, and it is important for companies to focus on other aspects as well. Future studies can maybe focus on other different aspects and appeals of advertising and can take into account a large number of sample sizes and from different geographical areas. It can also include some new parameters to give much in-depth knowledge and a broad perspective about the topic which can add a new dimension to the study. Behavioral studies can also be conducted related to changing information consumption of products due to advancement of social media and technology. Moreover,

there is always a scope to explore other advertising strategies used by companies to compete in market.

9. CONCLUSION

This study mainly focused on impact of emotional advertising on consumer buying behavior for FMCG products and their preference towards a soap because of it. The study was confined to Indian consumers of different age groups and professions. Almost 55% of the respondents belonged to the age group of 18-30 years. A majority of the total respondents were students and corporate employees. From the above findings, this research concludes emotional advertisements do impact consumer buying behavior for FMCG products. Companies that create quality emotional advertisements are more likely to be remembered and liked by people and that can in turn convert them into their potential buyers. Today, marketers are trying a lot of different strategies to create a difference, to engage more and more customers, and emotional advertisements indeed is a great way to do that.

Since FMCG is a huge sector, a product category taken for the study was soaps. The purpose was to identify if emotional advertisements create a liking bias towards soaps and two most popular soaps of a popular FMCG company was taken into consideration, i.e., comparison between preference for Dove or Pears based on their emotional advertisements; both belonging to the same parent company, HUL. It was found that people preferred Dove soap over Pears soap and they remembered the product well because of its emotional advertisement. This paper also concludes that people do have a liking bias towards Dove soap more because of their unique emotional advertisements.

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