

**SELF RELIANT INDIA–A PATHWAY  
TO DEVELOPED INDIA MISSION  
2030 (RETURN OF GOLDEN ERA)  
(Book Chapter)**



**Editor**

**Dr. Sourabh Jain**



First Edition, 2021

Price: 470 Rs.

Size: A5

**MHRD ISBN: 978-93-90975-46-4**



**Copyrights © 2021**

All rights reserved.

### **Bibliographic Information**

**Title:**

Self Reliant India-A Pathway to Developed India Mission 2030 (Return of Golden Era) (Book Chapter)

**Editor:**

Dr. Sourabh Jain

**Year:** 2021



**Printing & Publisher Address:**

Black Pearl Publication,

Jaiprakash Ward, Singod Road Barjhai, Panagar, JBP, MP 483220

**Regional Office:** Flat No: A-1403 Prateek Fedora, Sector 61 Noida,

Delhi NCR Pin – 201301

**E-mail id:** [publicationhelpboard@gmail.com](mailto:publicationhelpboard@gmail.com)

## *Acknowledgement*



*I would like to express my sincere gratitude to all the authors, researchers and reviewers, who provided their detail research and views for "**Self Reliant India-A Pathway to Developed India Mission 2030 (Return of Golden Era) (Book Chapter)**". I would like to thank my Teacher family, who supported and encouraged me in spite of all the time it took me away from them. This book could see the light of day due to generous support from the Black Pearl Publication. This volume is wholly a collective venture. This cause would not have been possible without the great efforts paid by all the authors and we are sure their valuable contributions increased the significance of the book. The readers and beneficiaries vary from academicians, professional engineers and scientists, to undergraduate and graduate students from all over the country.*





## **TABLE OF CONTENTS**

<b>S. N.</b>	<b>NAME OF TITLE</b>	<b>P. NO.</b>
<b>1</b>	<b>DESIGN AND IMPLEMENTATION OF AN ALGORITHM TO ENHANCE CLOUD RESOURCE ALLOCATION</b> Neelema Rai	<b>01-14</b>
<b>2</b>	<b>RESULT ASSESSMENT OF TBGCA</b> Ms. Anju Dave	<b>15-17</b>
<b>3</b>	<b>ROLE OF ARTIFICIAL INTELLIGENCE TO MAKE INDIA A SELF RELIANT NATION</b> Dr. Shamsudeen E	<b>19-25</b>
<b>4</b>	<b>ECO- FEMINIST CRITIQUE TO INDIAN GOVERNMENT SYSTEM DURING COVID19 PANDEMIC</b> Dr. Umakanta Hazarika	<b>27-30</b>
<b>5</b>	<b>CONSUMER INNOVATIVENESS: A STUDY OF OPENNESS OF CONSUMER TOWARDS NEW PRODUCTS WITH SPECIAL REFERENCE TO BODY CARE PRODUCTS SEGMENT OF FMCG SECTOR AND ANNUAL FAMILY INCOME IN INDORE CITY</b> Sonam Kulkarni Jaiswal	<b>31-39</b>
<b>6</b>	<b>AWARENESS LEVEL OF CONSUMERS TOWARDS ECO-FRIENDLY FMCG PRODUCTS</b> Dr. Pooja Chouksey	<b>41-46</b>
<b>7</b>	<b>EVIDENCE BASED MANAGEMENT PROTOCOL IN TEMPOROMANDIBULAR JOINT DISORDERS: A CURRENT AND COMPENDIOUS UPDATE</b> Dr. Abhay Chavan, Dr. NG Toshniwal, Dr. Ravindra Manerikar, Dr. Shubhangi Mani, Dr. Nilesh Mote, Dr. Sumeet Mishra	<b>47-58</b>



# DESIGN AND IMPLEMENTATION OF AN ALGORITHM TO ENHANCE CLOUD RESOURCE ALLOCATION

**Neelema Rai**

(Research Scholar), Department of Computer Science,  
Dr. A.P.J .Abdul Kalam University, Indore

---

**Abstract-** This paper describes the a concepts of ECGCA algorithm implementation. Initially proposed cloud resource allocation algorithm is illustrated through an example. All the mathematical and procedural steps are defined through example.

**Keywords:** Cloud computing, Resource Allocation, Resource optimization, Graph Colouring

## 1 INTRODUCTION

Graph coloring is a well known NP-Hard problem used to solve many real world optimization problems. CPU register allocation [1], Flight scheduling management [2], Radio station frequency assignment problem [3], and time table scheduling [4] are some real world optimization problems, which can be solved using graph coloring approach. This research work is also focused on solving cloud resource allocation problem using graph coloring approach.

This paper covers the entire concepts of ECGCA algorithm implementation. Initially proposed cloud resource allocation algorithm is illustrated through an example. All the mathematical and procedural steps are defined in this example. Algorithm implementation is done through Java programming.

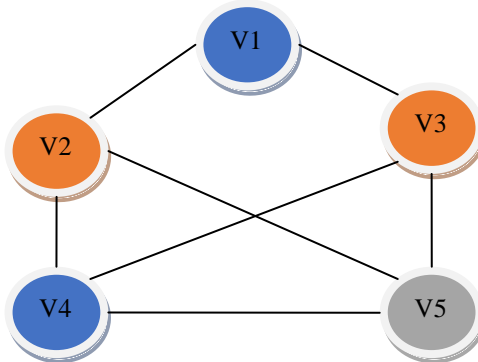
### 1.1 Types of Graph Coloring

This section covers the some popular types of graph coloring approaches used to solve real and virtual work optimization problems.

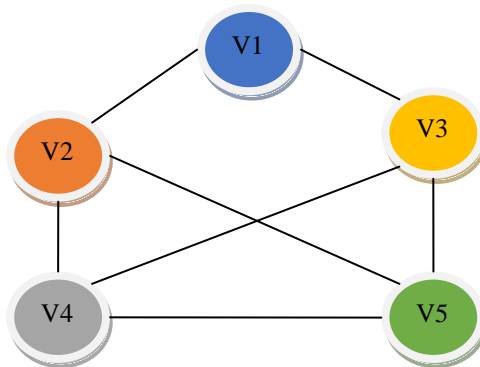
#### 1.1.1 Vertex Coloring:-

This is the most useful and preferred type of graph coloring. Even if someone talks about graph coloring it means he/she is representing vertex coloring. The very basic idea behind vertex coloring is assigning colors to each vertex of given undirected graph in such a way that no tow connected vertices share the same color. Using vertex coloring many optimization problem can be solved. Most of the vertex coloring problem focuses on optimizing the colors required. Graph vertices should be coloring using minimal number of colors. Because when we apply vertex coloring to solve any real word resource optimization problem, than color represents the resources. If graph coloring algorithm can optimize colors than it means this algorithm is able to optimize resources. In vertex coloring this optimum number is known as chromatic number. All researchers of vertex coloring field try to get minimal chromatic number.

Figure 1 and 2 shows two same graphs having five vertices and seven edges but with different coloring approach figure 1 is colored with three colors and figure2 is colored with five colors. In these both graph coloring figure 1 is optimal and effective solution of optimization.



**Figure 1 Vertex Coloring with three Colors**

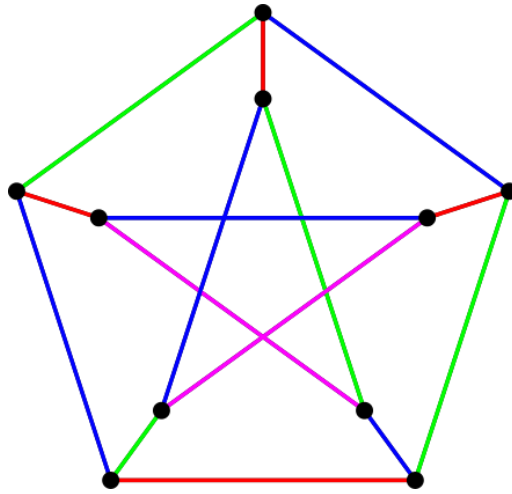


**Figure 2 Vertex Coloring with five Colors**

### 1.1.2 Edge Coloring:-

The basic idea behind edge coloring is that, in any undirected graph all edges must be colored in such a way that no two or more edges share the same color connected with same vertex. Figure 3 shows a very popular Peterson graph with edge coloring. This graph has 10 vertices and 15 edges. Four colors are required to color edges of Peterson graph using edge coloring. In edge coloring minimal number of colors required to color the edges of graph is known as chromatic number. Edge coloring has some special cases like circular edge coloring, Acyclic Edge Coloring, Berge-Furkerson and Fan-Raspoud coloring [5].





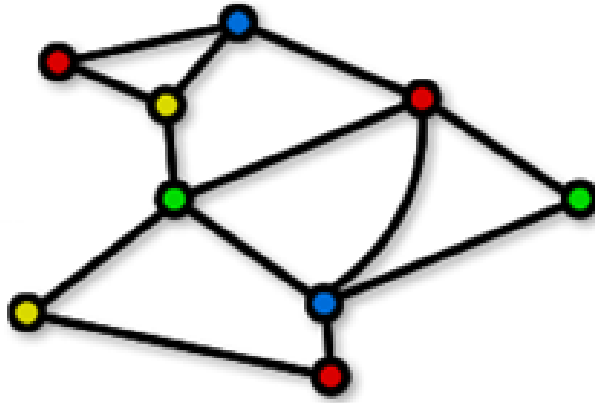
**Figure 3 Peterson Graph with Edge Coloring**

**1.1.3 Face Coloring:-**

It is also known as map coloring. Face coloring is the very first graph coloring method used to color the maps of countries in past time. Even in the present time map coloring is vastly used to color the maps. Approach of map coloring says that coloring of any map in such a way that no two areas are colored with same color if they share the same border. Face coloring problem is an NP-Complete problem [6]. The easiest way to solve the face coloring is, transfer the face coloring into vertex coloring and solve. Figure 4 and 5 a map is converted into graph by representing each area as a vertex and connecting edge represents border shared by two areas. If two areas share any border than vertices which represents the area must be connected with an edge.



**Figure 4 Face Coloring**



**Figure 5 Equivalent vertex coloring**

## **2 EDGE COVER BASED GRAPH COLORING ALGORITHM ILLUSTRATION THROUGH EXAMPLE**

ECGCA is used as a base algorithm to implement this proposed cloud resource allocation algorithm. [6]. This section illustrated the different steps involved in edge cover based graph coloring algorithm through an example.

Figure 4.3 shows the six vertices and nine edges graph. Represented as set of vertices  $V=\{1,2,3,4,5,6\}$ , set of edges  $E=\{\{1,2\}, \{1,3\}, \{1,4\}, \{1,5\}, \{2,3\}, \{3,6\}, \{4,6\}, \{5,6\}, \{4,5\}\}$  and set of Edge cover  $EC=\{\phi\}$  is an empty set (initial state).

Step 1 Calculate Degree of all Vertices -

This step calculated the degree of all vertices and arranged them in the descending order of degree as shown in Table 1.

Step 2 Find Maximum Degree Vertex -

In this step maximum value degree is selected to identify initial vertex for further process. Figure 6 shows the vertex 1 with degree of 4 in this example.

Step 3: Add Maximum Degree Vertex in Edge Cover Set and remove from Vertex Set-

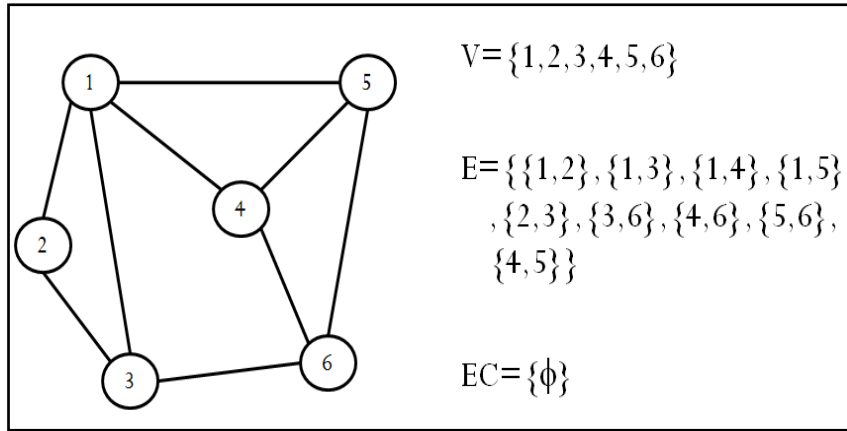
Now maximum degree vertex is added into edge cover set to identify and same vertex is removed from available vertex set. Figure 7 shows this operation for first iteration.

Step 4: Update Edge Set by removing all Edges from Edge Set of Vertex 1

This step removes all the edges connected to vertex 1 (for first iteration) and generate a new graph for further process.

Now step 1 to step 4 is repeated till all the edges graph all vertex get selected in any one of the independent set. This example required total four iterations to complete the entire process. Figure 10, 11, 12, and 13 shows the iteration 2 steps. Figure 14, 15, 16, and 17 shows the iteration 3 steps. Figure 18, 19, 20 and 21 shows the iteration 4 steps.

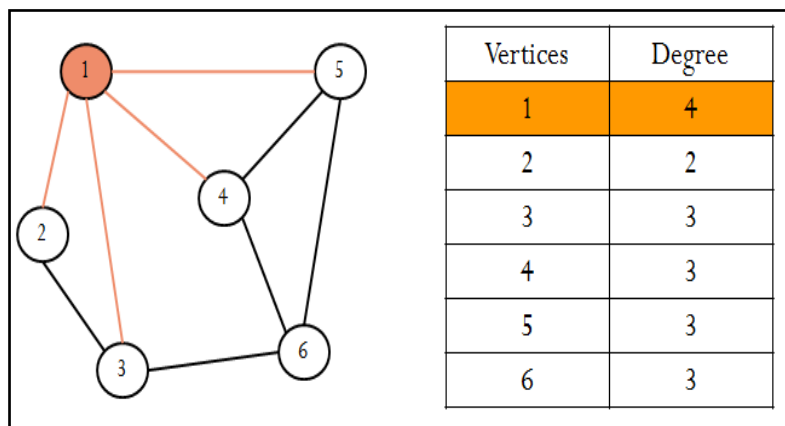
After completion of 4 iteration we found our first independent set {3, 5} in Figure 22.



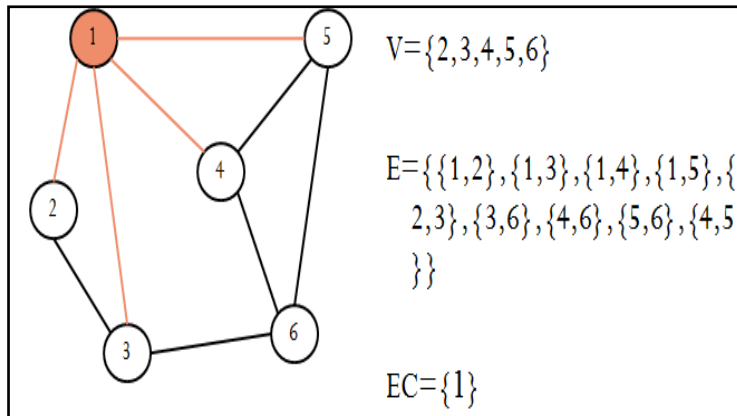
**Figure 6 Six Vertices Nine Edges Graph**

Vertices	Degree
1	4
2	2
3	3
4	3
5	3
6	3

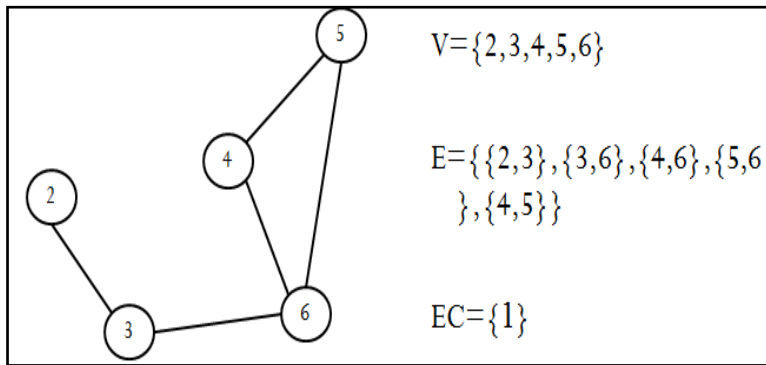
**Table1 Degree of All Vertices**



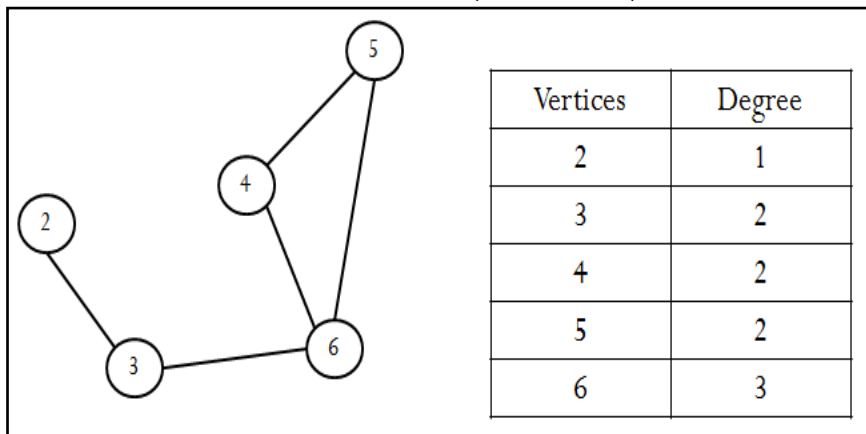
**Figure 7 Step 2 Finding Maximum Degree Vertex (Iteration 1)**



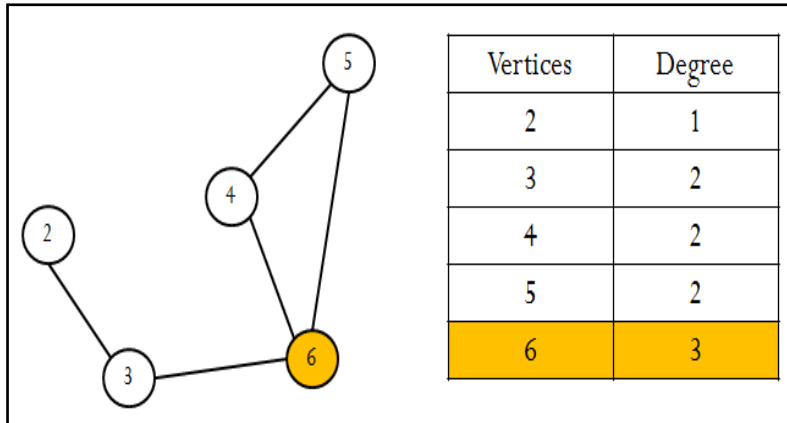
**Figure 8 Step 3 Add Maximum Degree Vertex in Edge Cover Set and remove form Vertex Set (Iteration 1)**



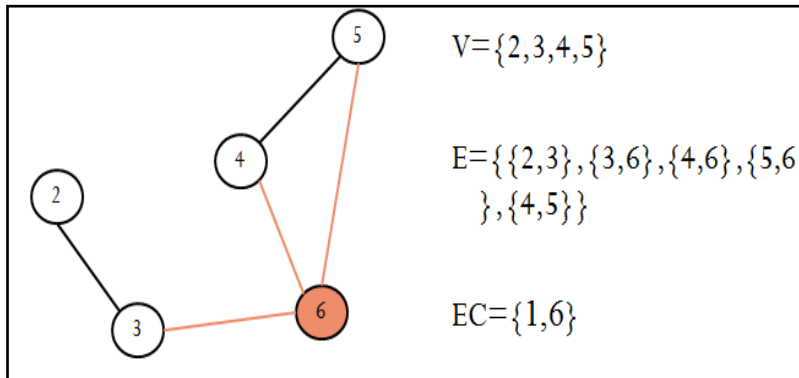
**Figure 9 Step 4 Update Edge Set by removing all Edges from Edge Set of Vertex 1 (Iteration 1)**



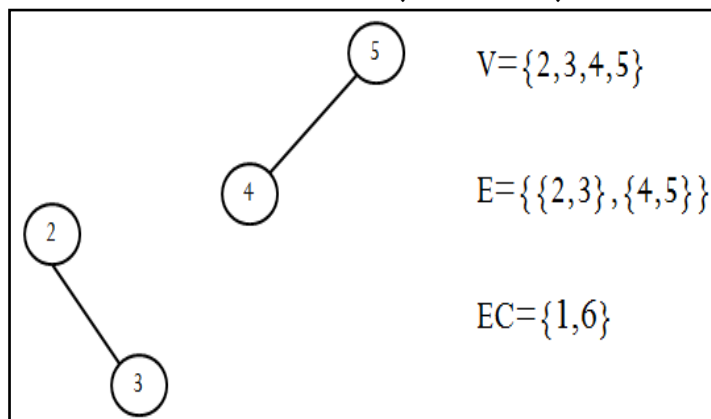
**Figure 10 Step 1 Calculate Degree of All Vertices in Vertex Set (Iteration 2)**



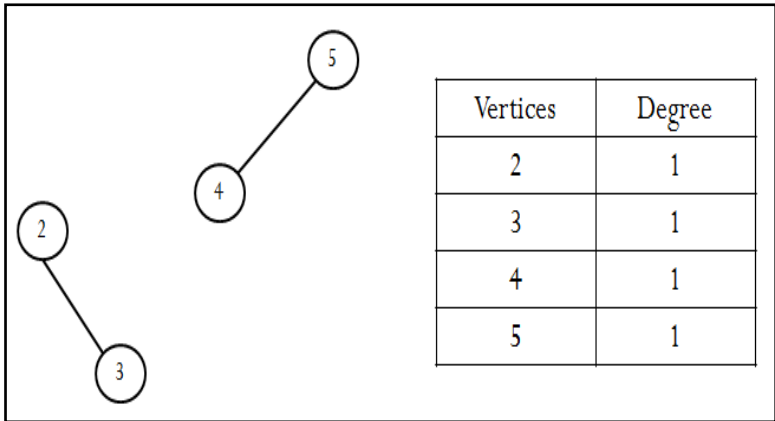
**Figure 11 Find Maximum Degree Vertex (Iteration 2)**



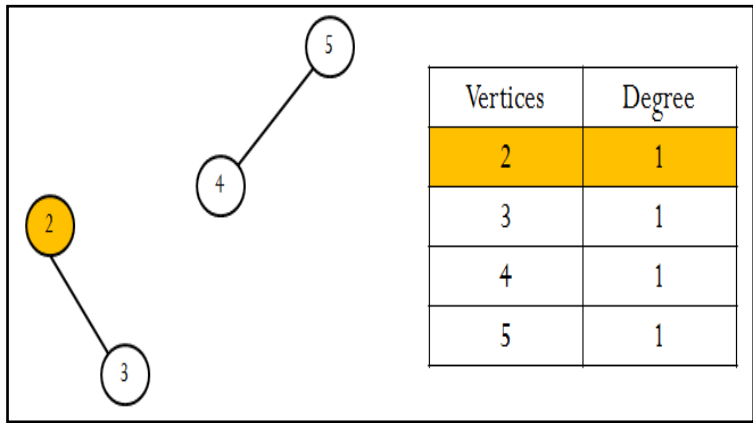
**Figure 12 Add Maximum Degree Vertex in Edge Cover Set and remove from Vertex Set (Iteration 2)**



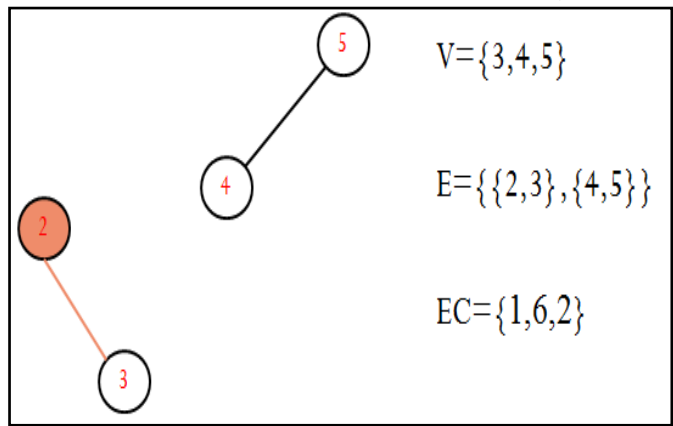
**Figure 13 Update Edge Set by removing all Edges from Edge Set of Vertex 6 (Iteration 2)**



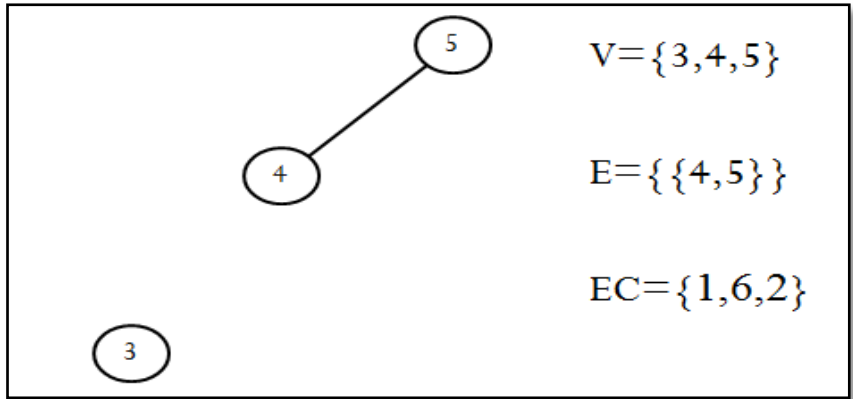
**Figure 14 Calculate Degree of All Vertices in Vertex Set (Iteration 3)**



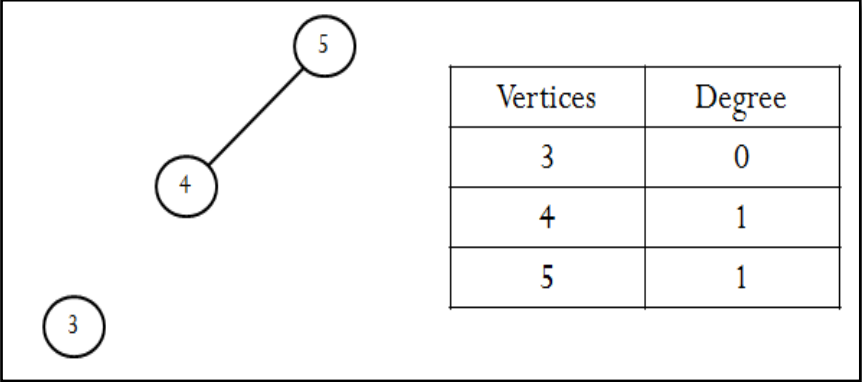
**Figure 15 : Find Maximum Degree Vertex (Iteration 3)**



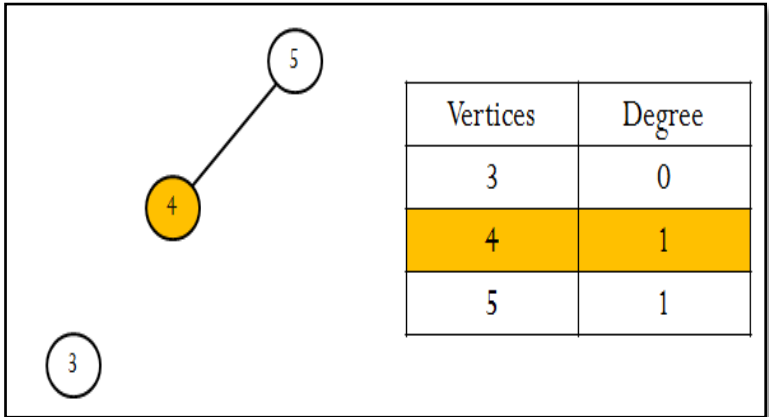
**Figure 16 Add Maximum Degree Vertex in Edge Cover Set and remove form Vertex Set (Iteration 3)**



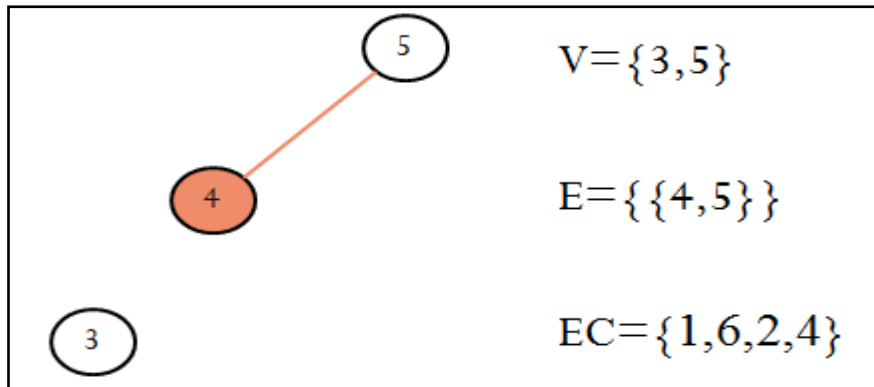
**Figure 17 Update Edge Set by removing all Edges from Edge Set of Vertex 2 (Iteration 3)**



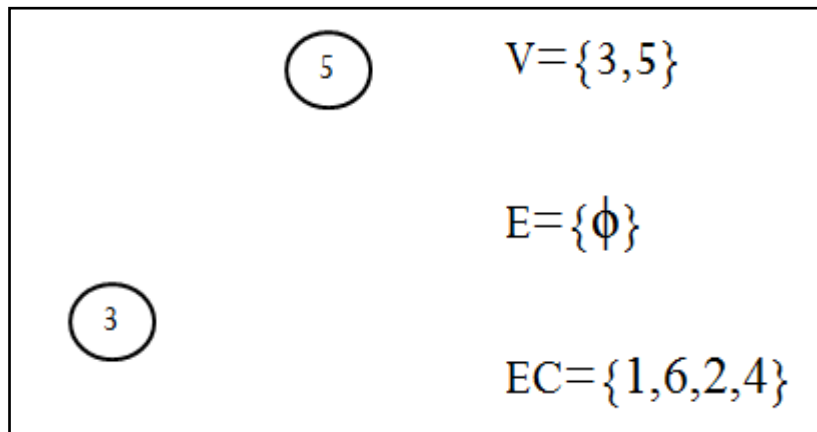
**Figure 18 Calculate Degree of All Vertices in Vertex Set (Iteration 4)**



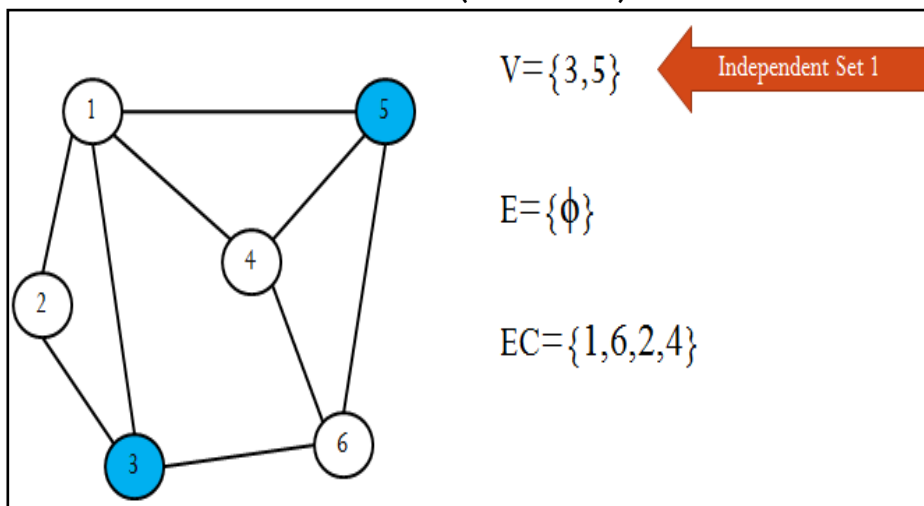
**Figure 19 Find Maximum Degree Vertex (Iteration 4)**



**Figure 20: Add Maximum Degree Vertex in Edge Cover Set and remove form Vertex Set (Iteration 4)**



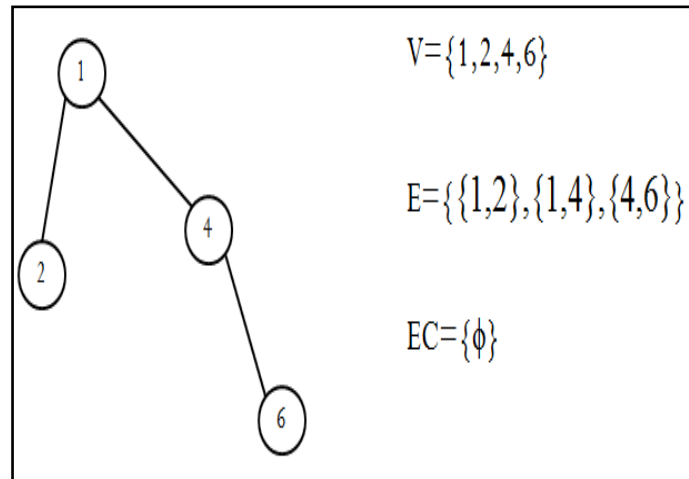
**Figure 21 Update Edge Set by removing all Edges from Edge Set of Vertex 6 (Iteration 4)**



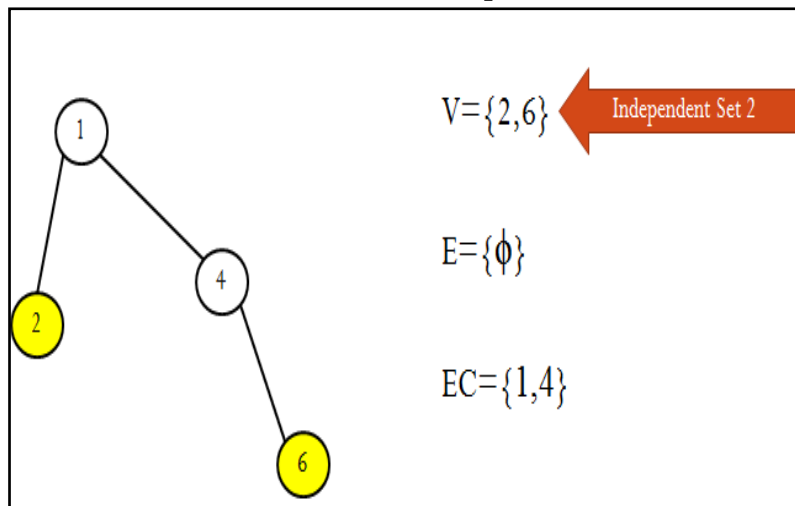
**Figure 22 Independent Set 1**



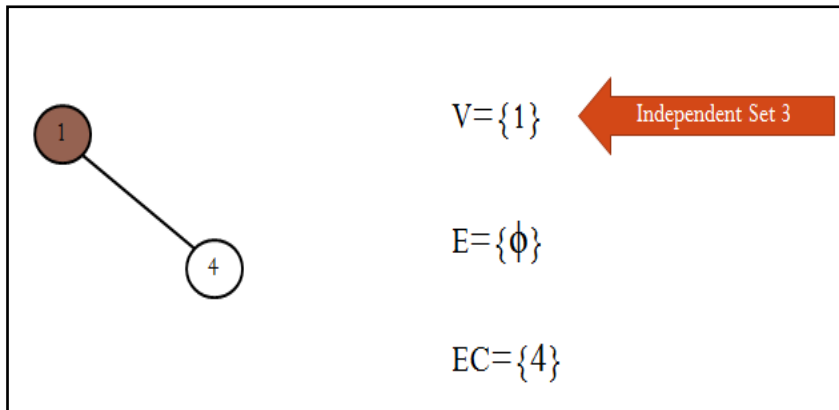
After getting first independent set  $V=\{3,5\}$ . All the vertices along with connecting edges have to remove from initial graph as shown in figure 23. Same process is repeated until all the vertices removed from graph and selected in anyone of the independent set. Figure 24, 25 and 26 shows the Independent set 2, 3 and 4 respectively. Figure 27 shows the final graph with all the vertices colored with some optimized color combination.



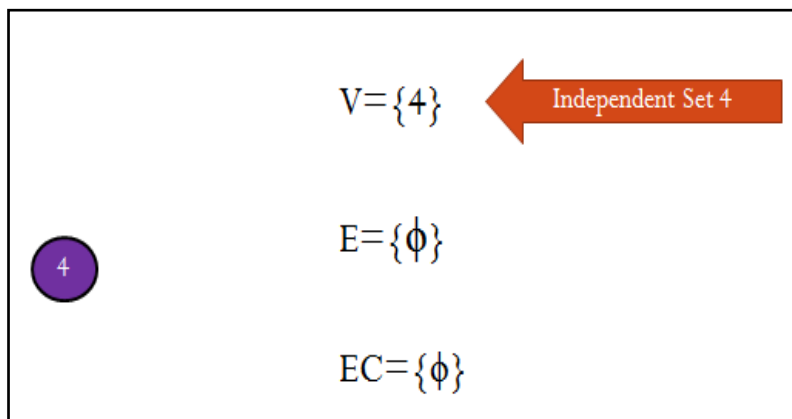
**Figure 23: Remove Independent set vertices and edges connected to them to find next independent set.**



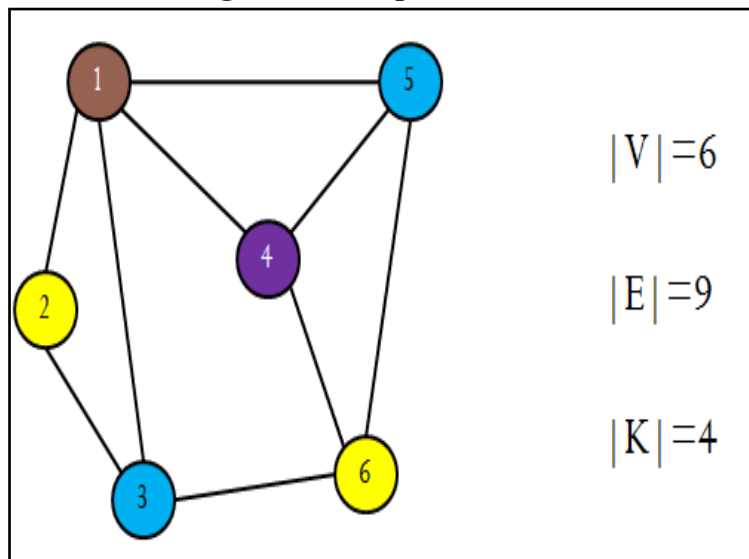
**Figure 24 Independent Set 2**



**Figure 25 Independent Set 3**



**Figure 26 Independent Set 4**



**Figure 27 Colored Graph using Edge Cover Based Graph Coloring**

### **3 MODULE IMPLEMENTATION**

Java programming language is used to implement entire algorithm and its supporting modules. Core Java fundamental concepts are used to implement the algorithm. Collection framework, file handling, exception handling, ADT classes and some basic concepts are used in implementation.

#### **3.1 Data Structure used in Implementation**

Java provides many inbuilt collection framework classes to work on data. There are many inbuilt methods are defined in these classes to create perform many data operation. In this proposed algorithm implementation some of the collection framework classes are used like List, ArrayList etc. Apart from collection framework classes, some of user define classes are implemented for smooth functioning of proposed algorithm. Figure 4.25 shows the source code of Degree class, which stores the information of vertex and connected edges count (degree of vertex). Figure 4.26 shows source code of Edge class, which is used to manage any Edge information of graph.

### **4 CONCLUSION**

This research paper we have tried to find out suitable graph coloring algorithm for implementation and we found Edge cover based graph coloring algorithm as a best graph coloring algorithm for finite resources. So this algorithm is used in proposed implementation. But if we want to increase resource utilization, in that case we can use another graph coloring algorithm.

It may be possible that for real environment some more algorithms well suited. So one can also search or implement other graph coloring algorithm as a graph colouring algorithm for cloud resource allocation.

### **REFERENCES**

1. Briggs P., "Register allocation via graph coloring", PhD thesis, Rice University, (1992).
2. Barnier N. and Brisset P., "Graph Coloring for Air Traffic Flow Management", Research, 130 (1-4), 163–178, August (2004).
3. Ahmed S., "Applications of Graph Coloring in Modern Computer Science", International Journal of Computer and Information Technology, 3(2), 1-7, (2012).
4. Hussin B., Basari A. S. H., Shibghatullah A. S. and Asmai S. A., Exam Timetabling Using Graph Colouring Approach, In Proc. IEEE Conference on Open Systems, Langkawi, 25-28 September (2011), p.139-144.
5. Appel K. and Haken W., "Every Planar Map is four colorable. Part I: Discharging", Illinois Journal of Mathematics, **21**(3), 429-490, (1977).
6. Harish Patidar and Prasun Chakrabarti, "Design Parallel Graph Coloring Algorithm – A Research Prospective", LAP LAMBERT Academic Publishing, First Edition, 2020, ISBN: 978-620-2-51991-5.

7. Garey M.R. and Johnson D.S., "Some simplified NP-complete graph problems", *Theoretical Computer Science*, 1(3), 237-267, February (1976) doi:10.1016/0304-3975(76)90059-1.
8. Hussin B., Basari A. S. H., Shibghatullah A. S. and Asmai S. A., Exam Timetabling Using Graph Colouring Approach, In Proc. IEEE Conference on Open Systems, Langkawi, 25-28 September (2011), p.139-144.
9. Ahmed S., "Applications of Graph Coloring in Modern Computer Science", *International Journal of Computer and Information Technology*, **3**(2), 1-7, (2012)
10. Barnier N. and Brisset P., "Graph Coloring for Air Traffic Flow Management", *Annals of Operations Research*, **130** (1-4), 163-178, August (2004)

#####

## RESULT ASSESSMENT OF TBGCA

**Ms. Anju Dave**

Asst. Prof., M.K.H.S. Gujarati Girls College,  
Maharani Road, Indore (M.P.)452001, India

---

**Abstract** - Register accesses are much faster than memory accesses. Register allocation [1] is one of them. Registers are fast and limited memory of any computing device. They are used to store the variables of a program[3]. If these limited registers are allocated appropriately to the variables, than the time complexity get decreases. In this paper a Tree Based Register Allocation Technique [6] is proposed. This proposed algorithm is inspired by graph coloring algorithm. Proposed algorithm gives a good performance in high quantity variables program.

### 1 INTRODUCTION

A graph coloring [2] is a projection of mark, called colors, to the vertices of a graph. Distribution of colors in that manner such no two adjacent vertices contribute to the same color.

#### 1.1 Register Allocation through Graph Coloring:

The basic idea at the back of register allocation using graph coloring is to reduce register overflow by assigning variables globally to different registers throughout the complete program by the use of following five essential Phases [4]:-

1. Assignment of each object i.e. variable, constant etc to a register.
2. Perform live range examination using the intermediate code.
3. By means of the live range analysis, construction of an interference graph occurs.
4. In this step the interference graph's nodes are colors with n colors, here n is the number of accessible registers in the end machine in order that no two adjacent nodes have the same color.
5. Allocate each object to the register that has the same color that it does.

Tree based register allocation technique is based on integrated graph coloring approach.

Broadly whole process is separated into six steps as following [4]:

Step 1: Identification of variables:

Step 2: Evaluation of live interval of variables:

Step 3: Register Interference Graph generation:

Step 4: Applying tree based graph coloring algorithm on interference graph:

Step 5: Sort independent set:

Step 6: Register assignment:

Here total 15 graph instances and their execution time are compared for both algorithms.

The proposed algorithm is tested on 15 DIMACS graph instances, comprises myciel graphs, queen graphs, DSJC series graphs, miles graphs, random series graphs, insertion and full insertion graphs[6]. In this Table V all tentative results are revealed.

Table has the following fields:-

1. Graph instance name,
2. Number of vertices of graph (V),
3. Number of edges in graph (E),
4. Average degree of vertices in graph (Average Degree) and
5. Number of colors required to color the graph, which are generated by the proposed algorithm (K).

**Table 1 Experimental Results of TBGCA Algorithm[6]**

S. No.	Instance	V	E	Average Degree	K (Result)
1.	myciel3	11	20	3.63	4
2.	Myciel4	23	72	6.17	5
3.	Myciel5	47	236	10.04	6
4.	queen5_5	25	320	25.60	5
5.	Queen6_6	36	580	32.22	10
6.	Queen7_7	49	952	38.86	7
7.	Queen8_8	64	1456	45.50	10
8.	2-Insertions_3	37	72	3.89	4
9.	miles1000	128	6432	100.50	45
10.	miles1500	128	10,396	162.44	74
11.	DSJC250.5	250	15,668	125.34	35
12.	DSJC500.9	500	224,874	899.50	150
13.	DSJC1000.9	1000	449,449	898.90	259
14.	R100_9 g	100	4438	88.76	42
15.	R50_9g	50	1092	43.68	25

## 2 CONCLUSION

As a result we conclude that the A Tree Based Register Allocation Algorithm using Graph Coloring Approach is capable, optimum time complex, large dataset sustained and extensive area of application supported algorithm.

This approach also have their importance when un sufficient registers are available. It offers maximum utilization of CPU registers and improves the execution time to allot registers to the variables which has long live interval time. Due to vibrant nature of algorithm this approach may be employ to build up any type of register allocation stage of compiler.

## REFERENCES

1. J.A. Bondy, U.S.R. Murty, "Graph Theory with its Applications", Elsevier Science Publishing Co., 1976.

2. Chaitin, G. J., Auslander, M. A., Chandra, A. K., Cocke, J., Hopkins, M. E., and Markstein, P. W. "Register Allocation via Coloring". *Computer Languages*, Vol. 6, Issue 1, 47-57, 1981.
3. David Koes and Seth Copen Goldstein, "An Analysis of Graph Coloring Register Allocation", Carnegie Mellon University Technical Report No. CMU-CS-06-111, March 1990.
4. H. Patidar, P. Chakrabarti, "A Tree-Based Graph Coloring Algorithm Using Independent Set". In: Panigrahi C., Pujari A., Misra S., Pati B., Li KC. (eds) *Progress in Advanced Computing and Intelligent Engineering. Advances in Intelligent Systems and Computing*, vol. 714. Springer, Singapore, 2019.
5. P. C. Sharma and N. S. Chaudhari, "A Tree Based Novel Approach for Graph Coloring Problem Using Maximal Independent Set", *Wireless Personal Communications*, <https://doi.org/10.1007/s11277-019-06778-0>, September 2019.
6. A. Dave, D. Pathak "Comparison Of Graph Coloring Approaches Used In Development Of Register Allocation Algorithms", *Journal of The Gujarat Research Society*, vol 21, issue 14, December 2019.

#####





## **ROLE OF ARTIFICIAL INTELLIGENCE TO MAKE INDIA A SELF RELIANT NATION**

**Dr. Shamsudeen E**

Assistant Professor of Computer Applications,  
EMEA College of Arts and Science, Kondotty, Kerala, India

---

**Abstract** - For a self-reliant India by 2030, the local manufacturing sector can act as a leading sector for economic growth. To make a sustainable local manufacturing base a huge investment to be made in technologies like artificial intelligence (AI) enabled machine learning. These technologies can play a vital role to bringing down labour costs, reduce product defects, improve transition times and increase throughput. Artificial Intelligence can be used to effectively collect huge amount of data and insights across manufacturing operations from design to delivery, including predictive problemsolving by identifying issues that may not be easy to spot by normal cause of work. AI can be used to enable finding ways to combine operational knowledge and expertise with huge amount of gathered data to create actionable insights for the business.

For years the manufacturing industry are using automation, robotics, and complex analytics. The AI that makes manufacturing more flexible is widely deployed, it can enable more cost-effective customization, and that could create a real shift in competitiveness. The integration of AI in the manufacturing sector is seen as more like an evolution than a revolution. In this chapter it is discussed in detail the sectors where the AI technology has to be focused and how the dream of being a self-reliant nation by the year 2030 can be achieved.

### **1. INTRODUCTION**

In May last year, as the unprecedented pandemic break out, the Prime Minister issued a clarion call for creating an atmanirbhar (self-reliant) Indian state in the near future. The proposal for self-reliance is neither novel, nor contentious – The term, Swadesi, first used by the Father of Nation, Mahatma Gandhi, in order to use India made garments and goods to make our farmers and industrialists self-reliant and hence the nation. However, to truly make a nation self-reliant one, it is critical to recognise and acknowledge its strengths and weaknesses, which in turn must dictate decision or policymaking and governance. The Government of India realises that the Artificial Intelligence has a unique role for improving the efficiency, diversity, and productivity of our public and private sectors. As a result, in October 2020, Government of India organised a large-scale virtual conclave, RAISE 2020, wherein international and domestic intelligentsia, and technologists presented for India's prospective AI projects. Government of India has identified some

sectors where AI can play significant role which finally leads our nation to a Atmanirbhar by 2030

## **2 SECTORS WHERE AI CAN PLAY IMPORTANT ROLE**

So, let's take a look at how AI inclusive strategies can play a key role in the recently announced strategic sectors:

### **2.1 Mining**

AI technology has transformed many mining industries across the world and changed the way companies act. The mining industry's contribution- excluding petroleum and natural gas- to India's GDP is around 2-3% in 2018-19. Since being a geologically rich country its a sharp contrast to India's true potential. A significantly more contribution to GDP will go a long way in achieving India's dream of becoming a self reliant country by 2030.

People, process, and AI technology are the key levers of change and the key to the transformation and future success of the mining industry. The important task of miners is to provide enough quantities of coal of the required quality with using minimum costs of excavation. Therefore, the prediction of energy values is the main task aimed to secure the optimal usage of coal energy value.

To minimize the initial investment and get maximum result, the mining industry is implementing AI technologies to learn more about the terrain that they are working with; using computers to precisely map out and predict terrain. An error in mining at the wrong location can cost millions of dollars and its is huge loss. AI technology enabled machinery can help cut these costs.

AI is also widely used for predicting coal quality and increasing coal productivity. with the use of AI-powered autonomous systems, mining and energy industry are making greater use of self-controlling machines in harsh and tough environments.

Hence, by automating machinery operation, planning and scheduling, facilitating predictive maintenance, improving man, material and asset traceability, harnessing the power of real-time data and analytics, and providing visibility across the mine-to-market value chain can yield a higher throughput in the mining industry. The combination of Augmented Reality, AI, and big data technology are used to enhance technological capabilities of coal mining machinery's staff and it improves product design, optimises the supply chain through timed quantitative data analysis by using the gathered data and providing references for decision-making.

However, one of the main obstacles while building an automated mining industry is community resistance. It is quite natural that the mining laborers and the community who lives with the industry to resist automation in mining. The main fear continues to be that AI and robotics

are associated with loss of jobs and thus their livelihood. The mining industry needs to take the community into confidence and assure them that automation of the industry ensures their safety and improves the standard of living of all stakeholders and is not as an attempt towards reducing manpower or job opportunities. The Industry would also need to work with the community to generate employment opportunities, for example, along the supply chain related to the mine or in alternate fields, as a confidence building measure.

## **2.2 Defence**

In February 2019, the defence ministry had set up a task force for strategic implementation of Artificial Intelligence and Defence that submitted its report in June 2019. In this report it is stated that by providing a specific budgetary allocation, the Ministry of Defense is envisaging a strategic and realistic integration of AI into the country, thereby revolutionising our defence workforce and technical systems.

AI research in military sciences can aid humans in combat tasks. DRDO's AI-based systems for Geo-computation help the armed forces in taking decisions during critical defence missions. As AI assistance becomes more interactive and less intrusive, there is a wide range of applications that will be emerging in the future and not just for combat purposes.

The ministry of defence realizes the importance of the AI to be incorporated in the defence sector and it ordered to focus on the capacity building within defence machinery. The tasks range from the knowledge production in the form of real data collection, patents etc to acclimatizing the personnel on-duty through internships, training programmes and sabbaticals. Each Service Headquarter (SHQ) is provided with a window of Rs 100 crores for Artificial Intelligence specific application developments from the ministerial budgetary allocation. The task force recognized AI as a 'force multiplier' and emphasized that all the defence institutions lay down their strategies of AI appropriation.

Robotics is also one of the ways to achieve AI implementation and the Centre of Artificial Intelligence and Robotics (CAIR) in the Defence Research and Development Organisation has also developed autonomous technology-based products. It has focused on the internet-centric communication mechanisms for tactical command control. For surveillance and reconnaissance purposes, CAIR has developed intriguing probes like snake robots, hexa-bots, and sentries. It has a comprehensive library for AI-based algorithms and data mining toolboxes that can potentially be used for image/video recognition, NLP, swarming. However, in a data-based approach to artificial intelligence, efficient learner algorithms can only serve a limited purpose without the hardware that can collect and process a large amount of real-data.

In addition to this, there are many challenges that AI brings up in the defence sector.

Firstly, decision makers must have a sound understanding of the objectives that AI seeks to implement in the strategic context of India to disseminate artificial intelligence in defence sector. We should decide what kind of AI do actually we need. Whether we require fully autonomous drones to engage with the adversary aircraft in a dogfight or deploy autonomous patrolling vehicles at the borders for getting the job done? The type of autonomy should be given to the machines on the battlefield. Since being middle-income country like India, we should have clear vision of the AI programme is necessary for a that can be affordable in this sector.

Secondly, the lack of critical infrastructure is one of the biggest hurdle in the prospects of AI in our country for both civilian and defence uses. As AI runs complex algorithms on loads of real data, it is essential to have sophisticated hardware and enabling data banks within the country. If a critical AI based defence technology uses the data on a remote server located beyond the borders, it can potentially hinder the goal of Indian international policy from protecting its strategic autonomy in a way that it might be compromised.

Thirdly, the role of the private sector will be vital in making the AI technology accessible and efficient. As AI demands high-skills and capital, innovations needs to be an ecosystem supporting the free flow of both money and skill.

However, despite all the hurdles the defence ministry of our country shows very much importance to the AI based arm race.

### **2.3 Space**

In India's second mission to the moon, Chandrayaan-2, the artificial intelligence (AI)-powered rover of the Indian Space Research Organization (ISRO), has been used. The AI-powered Pragyan rover, supposed to communicate only with the Lander, includes a piece of motion technology developed by IIT-Kanpur researchers that would have to help the rover manoeuvre on the surface of the moon and aid in landing. The AI algorithm used in the rover supposed to trace water and other minerals on the lunar surface, and also send pictures for research and examination.

After the unsuccessful deployment of the AI-powered vehicle named Pragyan on the moon, ISRO is now planning to fly a Vyommitra, a half humanoid, as a trial to space before Gaganyaan goes with astronauts.

This AI powered humanoid is equipped with sensing and perception of surroundings with 3D vision. Design & Realization of FULL Vyomnoid with features that include full autonomy with 3D vision, dynamically controlled movement in zero 'g', artificial intelligence, machine learning and AR will play a crucial role in enabling real-time decision making with vision optimisation and path planning algorithms.

ISRO announced that in preparation for the 10,000 crores Gaganyaan mission and for that four astronauts had already been short-listed, and would be gone rigorous training in Russia.

ISRO's commitments towards AI is also propelled by its Sponsored Research Programme (RESPOND) under the aegis of Capacity Building Programme Office (CBPO) of ISRO, a unique initiative of the Indian Space Research Organisation to promote Research and Development activities in collaboration with well known academia. Under this RESPOND scheme, financial support is provided to academic institutions within the country to carry out research projects in a wide range of topics in space technology, space science and space applications.

## **2.4 Aviation**

AI technology has been playing a vital role in transforming the operations of the travel industry. The AI has been used to automate the travellers' checking processes with minimum contact during this pandemic and to collect flight data for optimising rout and weather forecasting. Artificial intelligence powered mechanisms has also been used to create virtual assistants for customer queries, enhanced logistics operations, facial recognition system replacing biometrics for security checks and self-service kiosks equipped with augmented reality. Airline companies are also using artificial intelligence systems to improve their air safety.

According to a recent survey, in India 97.2% of the aviation companies are working towards deploying big data, and artificial intelligence, with 76.5% of the firms are leveraging the value of collected data and empowering AI for policy making. These figures show that airline companies and airports are using technology to keep up their relevance in this amid crisis.

The aviation industry in India are majorly utilising AI, Machine Learning and robotics to keep their finances stable. One of the main areas where airline service providers are implementing AI technology in the customer service aspect, which provides huge potential for leveraging new technologies. Along with AI based chatbots, firms are also providing airport security and aircraft monitoring with AI.

Besides all these, aircraft manufacturers like Airbus are using cloud-based systems for data collection and keeping, and analyse the same to enhance the reliability of aircraft maintenance. Moreover, the airlines and airports have deployed AI powered robotics technology to onboard passengers.

Many airlines and airport authorities are also partnering with the government to provide seamless travel for their passengers. In a recent development, the Ministry of Civil Aviation launched a connected application called DigiYatra, which will process information through facial recognition at checkpoints, provide digital guidance systems, offer interactive kiosks and augmented reality apps for travellers.

## **2.5. Atomic Energy**

AI technology powered mechanisms are highly being used in atomic energy sector of India in recent years. A key feature of deep learning is characteristics of being high-dimensional. So, in the recent year, researchers demonstrated the use of deep learning for setting up nuclear reactors that hold hot plasma using a powerful and wide magnetic field. In India, Bhabha Atomic Research Centre controls all the nation's nuclear endeavours. For becoming a self reliance in this field our country moves towards renewable energy sources such as nuclear energy, more reactors may be built, and AI technology can help in both construction and in giving efficient throughput.

## **3 CONCLUSION**

Although the penetration of artificial intelligence in the mining, defence, space aviation industry, and atomic power are not a novel discovery, however, the pandemic outbreak and India's self-reliant policy has forced both the industry and government to rethink the strategies. Therefore, to stand out in this continuously evolving technology market, all major five sectors discussed above need to rely on automating their processes with the help of artificial intelligence to make our dream a true one that is becoming a self reliant nation by 2030.

## **REFERENCES**

1. <https://www.iaea.org/newscenter/news/the-future-of-atoms-artificial-intelligence-for-nuclear-applications>
2. [https://www.sipri.org/sites/default/files/2020-06/artificial\\_intelligence\\_strategic\\_stability\\_and\\_nuclear\\_risk.pdf](https://www.sipri.org/sites/default/files/2020-06/artificial_intelligence_strategic_stability_and_nuclear_risk.pdf)
3. <https://world-nuclear.org/information-library/country-profiles/countries-g-n/india.aspx>
4. <https://vikaspedia.in/education/resource-links/scientific-and-educational-institutions/department-of-atomic-energy-dae>
5. <https://analyticsindiamag.com/how-artificial-intelligence-can-help-aviation-industry-with-contactless-flying-amid-the-crisis/>
6. <https://analyticsindiamag.com/how-the-aviation-industry-joining-hand-with-ai-to-improve-air-safety/>
7. <https://www.airport-technology.com/features/artificial-intelligence-aviation/>
8. <https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Energy-and-Resources/deloitte-norcat-future-mining-with-ai-web.pdf>
9. <https://www.ltu.se/research/subjects/Drift-och-underhall/Nyheter/AI-och-underhall-for-Indiens-gruvindustri-1.192875?l=en>
10. <https://orissadiary.com/adoption-of-iot-ai-essential-to-transform-indian-mining-sector/>
11. <https://defproac.com/?p=7231>

12. <https://analyticsindiamag.com/what-are-the-scope-and-challenges-of-using-ai-in-military-operations/>
13. <https://www.quora.com/How-can-AI-help-in-the-defence-sector-in-India>
14. <https://www.isro.gov.in/empowering-indias-startups-to-transform-space-sector-with-isro-and-aim>
15. <https://www.orfonline.org/expert-speak/space-missions-amidst-pandemic-automation-private-sector-role-65078/>

#####





## **ECO- FEMINIST CRITIQUE TO INDIAN GOVERNMENT SYSTEM DURING COVID19 PANDEMIC**

**Dr. Umakanta Hazarika**

Assistant Professor in Political Science SPP College Namti

---

### **1 INTRODUCTION**

Eco-feminism is a significant branch or school of feminism. Being an integral part of feminist school it advocates and examines the connections between women and nature. Eco- feminism is a movement and school of critical thought that claims a connection between the exploitation degradation of the natural world and oppression of women. It was developed in the mid-1970s alongside second-wave feminism. Since the earliest inception of emergence eco feminist movement is raising voices against degradation of environment and oppression upon women. The proposed article is an attempt to make a theoretical estimate on eco feminism as movement for women and environment. It is a historical and analytical study. Logic used here both deductive and inductive.

Eco- feminism is one of the prominent schools of feminist movement. It links feminism with ecology and environment. Its advocates opine that in the age of modern technology and industrialisation paternalistic/capitalistic society has led to a harmful split between nature and culture and the split can only be healed by the feminine instinct for nurture and holistic knowledge of nature's processes. Eco feminism was established by French feminist Francois d'Eaubonne in the 1970. Being a new form of feminist theory it has crossed the limited structure of feminism as a philosophy by linking it with ecology and the discourse of environment. Eco-feminism addresses phenomena that effect contemporary society, particularly gender equality and environmental preservation, to understand oppression as a structural process in order to eliminate domination. The theory argues that society has been constructed to priorities' the dominance of patriarchal values and acknowledges that the union of groups who are oppressed can deconstruct the current social hierarchy to create a more inclusive society. Eco-feminism draws on environmental studies, critiques of modernity and science, and feminist critical analyses and activism to explicate connections between women and nature, and the implications of these relationships for environmental politics. The pioneers of eco-feminist movement embrace a wide range of views concerning the causal role of Western dualistic thinking, patriarchal structures of power, and capitalism in ecological degradation and the oppression of women and other subjugated peoples. Collectively, they find value in extending feminist analyses to the simultaneous interrogation of the domination of both nature and women. For most eco-feminists, ecological sustainability ultimately depends on elevating the economic and political roles that

women play in society at all levels of organization. Eco-feminism recognises similarities between the oppression of the environment and the domination of women. It concludes that humans' need to control the environment is identical to men's need to control women, elites' need to control the poor, and 'whites' need to control 'blacks'. There are struggles for power and dominance occurring cross the spectrum of marginalised groups. Eco-feminism utilises grassroots initiatives, such as collective action through rallies and bottom-up decision making, to assess and re-evaluate the overarching power and control of dominant groups while attempting to simultaneously create unity and inclusion among the oppressed. Although Eco-feminism may appear to be a movement of feminists who also care about the planet, it is much more than that. Feminism, or Liberal Feminism as it is known in International Relations theory, strives for gender equality and environmental preservation within the framework of a pre-existing patriarchal system. Eco-feminism, on the other hand, aims to dismantle this system and completely rebuild it with the foundation that all living things have value, worth, and different qualities that make them vulnerable. Instead of striving to make women equal in a man's world or to prioritize the environment in a society that values consistent and extreme development, Eco-feminism highlights what a new world order would look like with man and woman, human and planet, all respected and contributing on an even playing field.

#### Eco-feminist Critique to Indian Government System

The eco-cognizant wellbeing reactions to the COVID-19 flare-up in India have uncovered the heterosexist, racial, ageist, casteist and authoritarian biases of an obvious Hindu-Brahminical society. The possibility of environmentalism driven by free enterprise, patriotism and social government misuses minimized people, creatures and nature the same. Subsequently, the conversations around pestilences, creature government assistance, and environmental change should be only eco-feminist. The COVID-19 episode has prompted a sweeping closure of monetary exercises like flight, the travel industry, and unnecessary mechanical creation. The resultant environment results, with progress in air quality and decrease in discharges, have set off a large group of ecological talks. In any case, in India, given the seriousness of the pestilence and devastating wellbeing framework, biological pressure has been (mis)attributed to overpopulation.

Populace administration in India has had a disagreeable record of forced cleansings and conspicuous sabotaging of the sexual and conceptive soundness of womxn. Meddlesome family arranging estimates that place the onus of "preparation" on womxn just propagate male centric and heteronormative thoughts of a family. Ecocentric talks around the COVID-19 flare-up immediately named it's anything but a catastrophic event and exercise to mankind. In any case, an ecofeminist examination of the political manner of speaking that encompassed the pandemic uncovers how patriotism abused the normal. Country pioneers

all throughout the planet offered away the chance to study and gain from the COVID-19 episode circumstance in focal point China to additional their xenophobic plans.

Eco-feminism is an activist and academic movement that see critical connections between the domination of nature and the exploitation of women. Eco-feminist activism grew during the 1980s and 1990s among women from the anti-nuclear, environmental, and lesbian-feminist movements. The “Women and Life on Earth: Eco-feminism in the Eighties” conference held at Amherst (1980) was the first in a series of eco-feminist conferences, inspiring the growth of eco-feminist organizations and actions...“Eco-feminism is a movement that sees a connection between the exploitation and degradation of the natural world and the subordination and oppression of women. It emerged in the mid-1970s alongside second-wave feminism and the green movement It brings together elements of the feminist and green movements, while at the same time offering a challenge to both. It takes from the green movement a concern about the impact of human activities on the non-human world and from feminism the view of humanity as gendered in ways that subordinate, exploit and oppress women.”-- Eco- feminism sees parallels between the exploitation of nature and the exploitation of women, parallels that are understood in the context of patriarchy. The COVID-19 flare-up has uncovered the abuse of the nonhuman. Be that as it may, a broad prosecution of mankind for natural pressure and weakening disguises biases propagated by power constructions of free enterprise, government, and man centric society. Ecofeminist thought, in this way, alerts against automatic ecocentric responses to emergencies that hurt the underestimated.

Pioneers of eco feminism are in view that the modern capitalist patriarchy knows no technological restrictions and, as the instrument of capital, modern science and technology sets out to ‘substitute’ (ie extinguish) life and death, the creation of life, humanity, women and mothers, the earth, plants and animals, and matter itself. This is a profound expression of the patriarchal urge to dominate and control. Since the Left does not advocate forsaking technological progress, its analysis is deeply compromised. Thus the Left is unable to present a real alternative to the ecologically and socially destructive system we are living in. So – what is the eco feminist alternative to capitalism that von Werlhof and her colleagues propose? Maria Mies presents a vision for an alternative ecological society developed from the eco feminist critique outlined above. She describes this vision as the ‘subsistence perspective.’ This is not to be confused with the usual understanding of a subsistence economy – it is not an economic model; rather, it is a new way of looking at the economy. It is called a subsistence perspective because it focuses on the creation, recreation and support of life and the living, and it has no other purpose than this. It is life that stands at the centre of this vision, rather than money, economic growth or profit, and as such it

requires the rejection of capitalist industrial society. Even in the 1960s, Mies says, the working class in the cities of the western world engaged in many subsistence activities: growing vegetables, preserving fruit, sewing clothes, repairing household items. In the rural economy, small farms produced the majority of foodstuffs and supplied the urban population. Overall, there was considerable reciprocity, communality and mutual assistance, collective work and collective enjoyment. While city life and the rural economy is much changed, many of the elements of a subsistence perspective are not beyond living memory.

## **2 CONCLUSION**

The above discussion reveals the diversity and significance of eco-feminism. Since the earliest inception eco-feminism either as a philosophy or a movement has been able to attract the attention of intellectuals, activist associated with women and environmental issues. Feminist movement has achieved both dynamism and relevance by women issues with a global and common discourse like environment and ecology .It is not concerned with women only but deals with the major issues of the contemporary period. The trend of eco feminism in India is found to be reflected through the Chipko movement, anti arrack movement etc. Since these movement basically carried out by women for protection of environment and nature creates a momentum impact upon contemporary social domain.

## **REFERENCES**

1. Tandon ,Niru (2008) Feminism: A Paradigm Shift Pp.23-24.
2. Melloh,Mary(1997) From the introduction to Feminism & Ecology, p.87
3. Millet, Kate(1970), Sexual Politics, P.110.

#####

**CONSUMER INNOVATIVENESS: A STUDY OF OPENNESS OF  
CONSUMER TOWARDS NEW PRODUCTS WITH SPECIAL REFERENCE  
TO BODY CARE PRODUCTS SEGMENT OF FMCG SECTOR AND  
ANNUAL FAMILY INCOME IN INDORE CITY**

**Sonam Kulkarni Jaiswal**

Assistant Professor at M.K.H.S. Gujarati Girls College, Indore

---

**Abstract-** “Consumer innovativeness: A study of openness of consumer towards new products with special reference to FMCG sector” is a construct that deals with finding how open consumers are in trying new FMCG products based on demographic factor Annual Family Income. It has been found that Annual Family Income does not have a significant effect on consumer innovativeness with reference to Body Care Products Segment of FMCG sector.

**Keywords:** Consumer Innovativeness, FMCG

### **1 INTRODUCTION**

“FMCG stands for Fast Moving Consumer Goods also known as Consumer Packed Goods (CPG). FMCG products are that products which are sold quickly and at relatively lower costs. Non- durable goods such as packaged food, beverages, body care products, toiletries, over-the-counter drugs and other household consumables come under the category of FMCG.” (Fast Moving Consumer Goods, 2019) For the purpose of this research body care products section of FMCG sector has been taken into consideration. “Consumer behavior is the study of individuals, groups, or organizations and all the activities associated with the purchase, use and disposal of goods and services, including the consumer's emotional, mental and behavioral responses that precede or follow these activities. Characteristics of individual consumers such as demographics, personality lifestyles and behavioral variables such as usage rates, usage occasion, loyalty, brand advocacy, willingness to provide referrals, in an attempt to understand people's wants and consumption are all investigated in formal studies of consumer behavior. The study of consumer behavior also investigates the influences, on the consumer, from groups such as family, friends, sports, reference groups, and society in general.” (Consumer Behavior, 2020) “Consumer Innovativeness is a construct that deals with how receptive consumers are to new products. Consumer innovativeness has been defined as a predisposition or propensity to buy or adopt new products or a preference for new and different experience.” (Consumer Innovativeness, 2019)

“Innovativeness is also defined as the degree to which individuals adopt new ideas faster than other members in a society. The term consumer innovativeness is very diverse, depending on the research contexts.” (Kusmawati & Irmawati, 2018)

“Annual family income is the total compensation received by all family members age 15 or older living in the same household. Compensation may include wages, social security, child support, pension’s capital gains, and dividends.” (Family Income, 2020)<sup>1</sup>

## **2 REVIEW OF THE LITERATURE**

Hassan has investigated the relationship between customer’s innovativeness and their intentions to adopt new mobile phones in Egyptian university students. The research elaborates the direct effects of the five dimensions of customers’ innovativeness on their intentions of new products adoption, which are measured through the mediating effect of two factors: the risks to mobile phones perceived by the customers and customer involvement. The research also aims to identify the so-called “initiators” segment; customers who have the highest probability for purchase the product early. The research results will help marketing managers for better market fragmentation and identify customer segments with high innovativeness; which helps organizations prepare appropriate marketing campaigns and thus leads to the success of new products deployment.

Gopiseti et al. have attempted to study the factors affecting the Consumer Buying Behavior towards selected Personal Care Products. For this study the primary data was collected from 200 respondents of Nizamabad District with structured questionnaires. The secondary data has been collected from various Books, Journals, Articles and Websites. In this regards Television, Quality and Brand loyalty are the powerful factors to influence the consumer buying behavior. Television is the powerful tool for spreading the information of brands to the final consumers. Regarding the brands, Sunsilk and Head & Shoulder in shampoo Parachute in hair oil, Colgate in tooth paste, Santoor in bathing soap and Ponds in cosmetics are more powerful brands in personal care products. The consumers were high satisfied with their used brands of Hair oil and followed by bathing soap. Low satisfied with their used brands of Cosmetics.

Bucatariu et al. have targeted to find a structure of consumer behavior, especially regarding the preference for the newly-released products in the market as compared to the traditional ones from McDonald’s in Romania and Austria. The analysis was done with the support of an econometric model of simple regression. This research confirms the validation of the structure and the attitude of the consumers towards the new products, launched by that company. The results of this research show if there really is transformation in behavior towards traditional products and in what degree consumers are influenced by innovation.

### 3 OBJECTIVES OF THE STUDY AND HYPOTHESIS

The purpose of the research is • to determine the openness of a consumer for trying out new products with special reference to FMCG in Indore region of Madhya Pradesh state. • to determine whether annual family income has any effect on consumer innovativeness in Indore region of Madhya Pradesh state o with reference to body care products The null hypothesis and alternate hypothesis for the above research problems are as follows: With educational qualification as independent variable: Body care products H0(3B) : Annual Family Income has no significant effect on consumer innovativeness with reference to body care products in Indore region of Madhya Pradesh state. H1(3B) : Annual Family Income has an effect on consumer innovativeness with reference to body care products in Indore region of Madhya Pradesh state.

### 4 METHODOLOGY

**The Study:** This study is descriptive, quantitative and single cross sectional in nature.

#### The Tools:

**A) For Data Collection:** A specifically designed and structured Questionnaire has been used for collecting data related to the research topic. For the purpose of this research FMCG sector has been broadly classified into three categories, which formed the basis of diving the questionnaire into three sections.

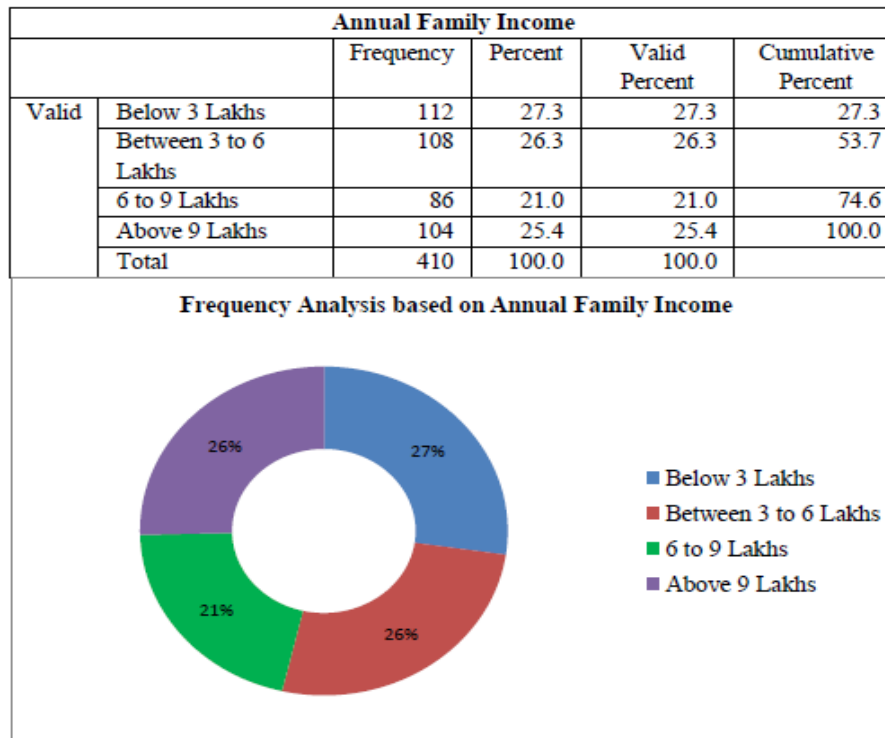
**B) For Data Analysis:** For analyzing the data and to generate results Independent Sample t-test and One way ANOVA have been used.

**The Sample:** Data has been collected from 410 respondents belonging of Indore city of central India, who were approached on random basis. Primary data has been used for analysis. The data has been collected by respondents of different genders

### 5 ANALYSIS OF DATA AND INTERPRETATIONS:

#### 5.1 Frequency Analysis Using SPSS:

Statistics		
Annual Family Income		
N	Valid	410
	Missing	0



**Test Results:** With annual family income as independent variable: Body care products HO: Annual Family Income has no significant effect on consumer innovativeness with reference to body care products in Indore region of Madhya Pradesh state. H1: Annual Family Income has an effect on consumer innovativeness with reference to body care products in Indore region of Madhya Pradesh state.

Descriptives								
BQTotal								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Below 3 Lakhs	112	28.6696	5.59824	.52898	27.6214	29.7179	10.00	42.00
Between 3 to 6 Lakhs	108	28.4352	6.25811	.60219	27.2414	29.6290	10.00	48.00
6 to 9 Lakhs	86	27.8488	5.43954	.58656	26.6826	29.0151	16.00	42.00
Above 9 Lakhs	104	28.2596	5.84093	.57275	27.1237	29.3955	12.00	40.00
Total	410	28.3317	5.79454	.28617	27.7692	28.8943	10.00	48.00

Table 5. 1 Annual Family Income Descriptives for body care products

By observing the mean of each group in Descriptives table, it can be concluded that there is homogeneity of variances.



Test of Homogeneity of Variances			
BQTotal			
Levene Statistic	df1	df2	Sig.
.326	3	406	.807

**Table 5.2 Test of Homogeneity of Variances for body care products with respect to Annual Family Income**

According to Levene's Test for homogeneity of Variances, if significance value of Levene's Test for Homogeneity of Variances test is greater than 0.05 then the data meets the requirement of assumption 6 i.e. there is homogeneity of variances.

Here, significance value of Levene's Test for Homogeneity of Variances test is 0.807 which is greater than 0.05 hence the data meets the requirement of assumption 6 i.e. there is homogeneity of variances

ANOVA					
BQTotal					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	34.539	3	11.513	.341	.796
Within Groups	13698.348	406	33.740		
Total	13732.888	409			

**Table 5.3 ANOVA for body care products with respect to Annual Family Income**

Sig. value ANOVA table is 0.796 which is greater than 0.05 therefore null hypotheses (H0) is accepted. So it can be concluded that Annual Family Income has no significant effect on consumer innovativeness with reference to body care products in Indore region of Madhya Pradesh state.

## 5.2 Post Hoc Tests

Multiple Comparisons						
Dependent Variable: BQTotal						
Tukey HSD						
(I) Annual Family Income	(J) Annual Family Income	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound

Below 3 Lakhs	Between 3 to 6 Lakhs	.23446	.78336	.991	-	2.2553
	6 to 9 Lakhs	.82081	.83281	.758	-	2.9692
	Above 9 Lakhs	.41003	.79099	.955	-	2.4506
Between 3 to 6 Lakhs	Below 3 Lakhs	-.23446	.78336	.991	-	1.7864
	6 to 9 Lakhs	.58635	.83948	.898	-	2.7520
	Above 9 Lakhs	.17557	.79801	.996	-	2.2342
6 to 9 Lakhs	Below 3 Lakhs	-.82081	.83281	.758	-	1.3276
	Between 3 to 6 Lakhs	-.58635	.83948	.898	-	1.5793
	Above 9 Lakhs	-.41078	.84661	.962	-	1.7732
Above 9 Lakhs	Below 3 Lakhs	-.41003	.79099	.955	-	1.6305
	Between 3 to 6 Lakhs	-.17557	.79801	.996	-	1.8831
	6 to 9 Lakhs	.41078	.84661	.962	-	2.5948

Table 5. 4 Multiple Comparisons for body care products with respect to Annual Family Income

### 5.3 Homogeneous Subsets

BQTotal		
Tukey HSD <sup>a,b</sup>		
AnnualFamilyIncome	N	Subset for alpha = 0.05
		1
6 to 9 Lakhs	86	27.8488
Above 9 Lakhs	104	28.2596
Between 3 to 6 Lakhs	108	28.4352
Below 3 Lakhs	112	28.6696
Sig.		.746

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 101.443.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

With the help of ‘Multiple Comparison table’ it can be determined if there is a significant difference between any two groups:

- The Sig. value corresponding to ‘Below 3 Lakhs (in first column)’ and ‘Between 3 to 6 Lakhs (in second column)’ is 0.991 which is greater than 0.05 therefore it can be concluded that there is no significant difference in consumer innovativeness of both the income groups with reference to body care products.
- The Sig. value corresponding to ‘Below 3 Lakhs (in first column)’ and ‘Between 6 to 9 Lakhs (in second column)’ is 0.758 which is greater than 0.05 therefore it can be concluded that there is no significant difference in consumer innovativeness of both the income groups with reference to body care products.
- The Sig. value corresponding to ‘Below 3 Lakhs (in first column)’ and ‘Above 9 Lakhs (in second column)’ is 0.955 which is greater than 0.05 therefore it can be concluded that there is no significant difference in consumer innovativeness of both the income groups with reference to body care products.
- The Sig. value corresponding to ‘Between 3 to 6 Lakhs (in first column)’ and ‘Between 6 to 9 Lakhs (in second column)’ is 0.898 which is greater than 0.05 therefore it can be concluded that there is no significant difference in consumer innovativeness of both the income groups with reference to body care products.
- The Sig. value corresponding to ‘Between 3 to 6 Lakhs (in first column)’ and ‘Above 9 Lakhs (in second column)’ is 0.996 which is greater than 0.05 therefore it can be concluded that there is no significant difference in consumer innovativeness of both the income groups with reference to body care products.
- The Sig. value corresponding to ‘Between 6 to 9 Lakhs (in first column)’ and ‘Above 9 Lakhs (in second column)’ is 0.962 which is greater than 0.05 therefore it can be concluded that there is no significant difference in consumer innovativeness of both the income groups with reference to body care products.

## **6 CONCLUSION**

After conducting a thorough research on “Consumer Innovativeness: A study of openness of consumer towards new products with special reference to FMCG sector”, by collecting primary data with the help of well structured questionnaire from Indore region of Madhya Pradesh state and analyzing the data with the help of SPSS, it can be concluded that:

Annual Family Income has no significant effect on consumer innovativeness with reference to body care products in Indore region of Madhya Pradesh state. This states that people of different income group are equally innovative in trying new types of body care products.

## REFERENCES

1. [https://en.wikipedia.org/wiki/Fast-moving\\_consumer\\_goods](https://en.wikipedia.org/wiki/Fast-moving_consumer_goods).
2. <https://www.investopedia.com/terms/f/fastmoving-consumer-goods-fmcg.asp>  
<https://www.ibef.org/industry/fmcg.aspx>.
3. S. Ramaswamy and S. Namakumari, "Marketing Management," Macmillan, 4 ed., pp. 738-742, 2009.
4. T. N. Chhabra and S. K. Grover, "Marketing Management," Dhanpat Rai & Co., 4 ed., pp. 1.141-1.157, 2007
5. [https://en.wikipedia.org/wiki/Consumer\\_behaviour](https://en.wikipedia.org/wiki/Consumer_behaviour).
6. [https://en.wikipedia.org/wiki/Consumer\\_innovativeness](https://en.wikipedia.org/wiki/Consumer_innovativeness).
7. <https://knepublishing.com/index.php/Kne-Social/article/view/3162/6705>.
8. P. Kotler, K. L. Keller, A. Koshy and M. Jha, "Marketing Management," Pearson Education, 2 ed., pp. 47-49, 2009
9. N. K. Malhotra, "Marketing Research," Pearson Education, 1 ed., pp. 166-167, 2004.
10. Available: <https://en.wikipedia.org/wiki/Gender>
11. <http://www.businessdictionary.com/definition/family-income.html>
12. <https://stats.oecd.org/glossary/detail.asp?ID=744>.
13. D. R. Williams and L. B, "Analyzing Urban & Rural Consumer Behaviour Towards FMCG Brands In Mysuru District.(Karnataka State, India)," International Journal of Exclusive Management Research, vol. 8, no. 7, pp. 85-105, July 2018.
14. D. Chhabra and A. Farooque, "Factors Affecting Consumer Buying Behaviour and Decision Making Process towards FMCG Products," Journal of Advances and Scholarly Researches in Allied Education, vol. 15, no. 6, pp. 131-139, 2018.
15. A. A. Santoki and M. H. Parekh, "Brand awareness & consumer buying behaviour of Selected FMCG products among rural consumer in dang area of Gujarat," International Journal of Applied Research, vol. 3, no. 6, pp. 433-437, 2017.
16. H. S. Hassan, "The Role of Customer Innovativeness in the New Products Adoption Intentions: An Empirical Study on Mobile Phone Customers of the Egyptian Universities Students," International Business Research, vol. 10, no. 4, pp. 117-130, 2017.
17. D. R. Gopiseti and G. Linganna, "Consumer Buying Behaviour towards Fast Moving Consumer Goods (A Study of Selected Personal Care Products in Nizamabad District of Telangana State)," IOSR Journal of Business and Management, vol. 19, no. 11, pp. 54-59, 2017
18. M. Bucatariu, A. I. Nicolescu and A. Tasnadi, "Consumer Behaviour Towards New Products," International Journal on Business Excellence, vol. 1, no. 1, pp. 904-915, 2017
19. R. Senthilkumar, "A study on attitude and behaviour of rural consumers towards branded FMCG products in Pudukkottai district of Tamil Nadu," International Journal of Applied Research, vol. 3, no. 6, pp. 517-521, 2017.
20. K. Asha and A. M. T. Joy, "Attitudinal Analysis of Rural Consumers towards FMCG Products in Sivagangai District," Indian Journal of Science and Technology, vol. 9, no. 33, pp. 465-470, 2016.
21. S. S. Chauhan and V. B. Singh, "A study of Indian consumer buying behavior of FMCG products (with special reference of bathing soap)," International Journal of Scientific and Innovative Research, vol. 4, no. 1, pp. 176-182, 2016.
22. I. Firmansyah, "Consumer innovativeness and new product adoption: The case of payment card," Journal of Marketing & Consumer Behaviour, vol. 2, no. 1, pp. 40-58, 2016.
23. S. M. Qasim and A. Swati, "Consumer Behaviour towards selected FMCG (Fast Moving Consumer Goods) in Delhi NCR," International Journal of Informative & Futuristic Research, vol. 2, no. 7, pp. 2041-2048, 2015.
24. F. R. A.K, "A Study of Consumer Buying Behaviour of FMCG Products in Calicut City (With Special Reference of Tooth Paste)," International Journal of Scientific Research and Management (IJSRM), vol. 5, no. 7, pp. 6455-6460, 2017.

25. S. Batool, M. A. Ahmed, M. Umer and Z. Zahid, "Impact of Consumer innovativeness on shopping styles; A Case of Pakistan," *International Journal of Business and Management Invention*, vol. 4, no. 2, pp. 19-28, 2015.
26. A. Katiyar and N. Katiyar, "An empirical study of Indian consumer buying behavior of FMCG products (with special reference of bathing soap)," *International Journal of Management and Commerce Innovations*, vol. 2, no. 1, pp. 211-217, 2014.
27. N. Kumar and J. Joseph, "A Study on Consumer Behavior towards FMCG Products among the Rural-Suburban HHS of Ernakulam," *Journal of Global Economics*, vol. 2, no. 4, pp. 127-136, 2014.
28. R. Kumar, "Impact of Demographic Factors on Consumer Behaviour - A Consumer Behaviour Survey in Himachal Pradesh," *Global Journal of Enterprise Information System*, vol. 6, no. 2, pp. 35-47, 2014.
29. M. M. Khan and S. Khan, "An Analysis of Consumer Innovativeness and Cognitive Buying Behavior of Young Adults: An Empirical Study on University Students," *The Journal of Commerce*, vol. 5, no. 4, pp. 11-26, 2013.
30. A. Ali, V. R. R. Thumiki and N. Khan, "Factors Influencing Purchase of FMCG by Rural Consumers in South India: An Empirical Study," *International Journal of Business Research and Development*, vol. 1, no. 1, pp. 48-57, 2012.
31. M. D. Barcellos, L. K. Aguiar, G. C. Ferreira and L. M. Vieira, "Willingness to try innovative food products: A comparison between British and Brazilian Consumers," *Brazilian Administration Review*, vol. 6, no. 1, pp. 64-80, 2009.
32. S. Chakrabarti and R. K. Baisya, "The influences of consumer innovativeness and consumer," *International Journal of Consumer Studies*, vol. 33, no. 1, pp. 706-714, 2009.
33. G. Wang, W. Dou and N. Zhou, "Consumption attitudes and adoption of new consumer products: a contingency approach," *European Journal of Marketing*, vol. 42, no. 2, pp. 238-254, 2008.
34. S. Yenyurt and J. D. Townsend, "Does culture explain acceptance of new products in a country?," *International Marketing Review*, vol. 20, no. 4, pp. 377-396, 2003.

#####



## **AWARENESS LEVEL OF CONSUMERS TOWARDS ECO-FRIENDLY FMCG PRODUCTS**

**Dr. Pooja Chouksey**

(Asst. Professor at M.K.H.S. Gujarati Girls College, Indore)

---

**Abstract** - Customers' perception is changing towards the environment to encourage innovation for conservation and the benefits from this source of innovation are certain to outlive our current generation. Eco-friendly products are those products which are environmentally safe or does not create any threat to environment". Several activities are involved in eco-friendly marketing which includes product modification, packaging and advertising. This research study is based on the FMCG eco-friendly products but specifically on Consumers' Perception towards Eco-friendly FMCG Products. This paper investigates consumer perception and beliefs on environment protection and buying behavior of eco-friendly products.

A quantitative approach was adopted for the study by using a questionnaire, 440 respondents data were collected through internet by using Google.doc surveys. In present study independent samples t-test is used to test to compare the perception, awareness, satisfaction level of respondents with different demographic characteristics like gender, age and monthly family income.

The findings of this work indicate that age has no significant effect on awareness of consumers towards eco-friendly products and availability of the eco-friendly products. Different age groups of consumers are having equal awareness towards eco-friendly products.

**Keywords:** Eco-friendly products, Perception, Environmental awareness.

### **1 INTRODUCTION**

Consumer Perception Consumer perception is the study of individual customer who is involved in procuring and using goods and services. All the activities associated with the purchase, use and disposal of goods and services, including the consumer's emotional, mental and behavioural responses that precede or follow these activities. Consumer perception is about how customers look at the product, what they expect from the products and from the manufacturers. It is a big task for manufacturer to understand the perception of customers. Consumer perception involves the psychological processes that consumers, make recognizing the needs, finding ways to solve these needs collect and interpret information, make plans, and implement these plans, making purchase decisions and post purchase behaviour.

#### **1.1 Eco-Friendly Products**

"Eco-friendly products are products that do not harm the environment whether in their production, use or disposal". (all-recycling-facts.com) Eco-friendly products are usually having basic two goals –maximizing

resource efficiency and reducing waste. Eco-friendly products are manufactured by using environmentally-friendly procedures and toxic-free ingredients. It is certified by recognized organizations like Forest Stewardship Council, Energy star, etc.

### **1.2 Fast Moving Consumer Goods**

Fast-moving consumer goods (FMCG) are products that are sold quickly and at a relatively low cost. In India Fast Moving Consumer Goods (FMCG) is an important and very fast growing sector. Large populations of India are depending on FMCG in one or another way. As per India Info line News Service, Mumbai, January 6, 2016, Indian FMCG sector, which is the fourth largest in economy with market size of US\$ 3.1 billion. Consumers are mainly depending on FMCG sector for their day to day activities. The products like soaps, detergents, tooth paste, food products, beverages, cosmetics and other products comes under FMCG category. (wikipedia, 2019)

## **2 REVIEW OF LITERATURE**

**Patnaik** et al in their Study the consumer attitude towards green FMCG products are correlated with price, product, place, awareness, brand knowledge, pre-purchase and post purchase behaviour. Nowadays people are careful about their daily product like cosmetics, baby products, body care, food etc. The quality of the products is the most important factor that influences the purchase of green FMCG products.

**Pandey** et al this research study took place in Delhi NCR Region, researcher analyze the consumer's attitude towards organic food products. In India the concept of eco-friendly food is still in the primary stage. The marketer must create awareness through advertisement and publicity of organic food product, so that the market size of organic food products is increased. The researcher study showed that most of the consumers were aware about the organic food products like better in quality, better in taste, food products free from pesticides, purchased by the publicity through word of mouth. But most of the consumer said that organic foods products are not easily available in market places, more expensive and the information related to eco-friendly foods products is very limited.

**Katait** innovative study analyzed the Consumer behavior towards green products of FMCG, the authors found that consumers are becoming more concerned and aware about the environment friendly products. Many companies are doing their best by adopting Green Production Process. Consumer attitude is well affected by their product attributes, product knowledge and existing culture.

**Unnamalai** conducted a study on consumer Attitudes towards Green Fast Moving Consumer Goods with Special Reference to Tiruchirapalli Town. The usage and awareness of green FMCG products is very low among the peoples. Most of the people have no knowledge



about the eco-friendly products. But majority of people are having consciousness about the eco-friendly environment and they are trying to save earth from pollution.

**Yusuf** et al conducted a study on consumer attitude and perception towards green products. consumers has awareness about the implication of global warming, harmful impact of pollutants, non biodegradable solid waste etc, both consumer and marketer are switching to eco-friendly products and most of companies have accepted their responsibility not to waste the natural resources and not to harm the environment. Samples were selected through random sampling, near about 70 college going students participated in the research. For this sample statistical analysis Pearson correlation was used.

**Kumar** et al this study aimed to gain knowledge about consumer behaviour towards organic products Consumption and Market potential of the Organic food products. The results concluded that marketing of organic product is very poor and demand for organic product is increases, most of the consumer prefer organic food product. The major reasons are organic food producer are low, sufficient market facility is not there, lack of awareness, few number of shops and so on. But if farmer and government give interest to improve production of organic food product as well as quality, good packaging and market system, it helps to get better standard of living farmer and it helps to government and also it healthy to environment.

## **2.1 Research Objectives**

1. To study the awareness level of Consumers towards green FMCG Products.
2. To find out the Consumer Perception towards environment friendly FMCG products.

## **3 RESEARCH METHODOLOGY**

### **3.1 Data Collection**

Primary data is termed as data collected by the researcher for specific purpose. To analysis of consumer perception towards eco-friendly food products a well framed closed ended questionnaire was filled in by the respondents and the findings are presented as figures and facts found during the analysis. This study is mainly based on the information and data obtained from the primary sources.

### **3.2 Data Analysis**

Statistical techniques were used with the help of Statistical Package for Social Sciences (SPSS) for hypothesis testing. In present study independent samples t-test and One-Way ANOVA is used for hypothesis testing.

**Sample Size.** For this research, a sample of 440 respondents was selected.

### 3.3 Gender of Respondents

Gender	No. of Respondents	Percentage
Male	225	51.1
Female	215	48.9
<b>Total</b>	<b>440</b>	<b>100</b>

From the above table it is found that 51.1% representation is obtained from male consumers of Eco- friendly food products and 48.9 % female respondents which are involved in the purchase of Eco- friendly products.

### 3.4 Hypothesis Testing

#### Awareness of consumers towards Eco-friendly products

**H0 (B2):** Age has no significant effect on awareness of consumers towards eco-friendly products.

**H1 (B2):** Age has an effect on awareness of consumers towards eco-friendly products.

Applying One-Way ANOVA using IBM SPSS statistics 21.0 Software

Descriptives								
BQ TOTAL								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
30-40 years	154	10.3896	2.54197	.20484	9.9849	10.7943	5.00	17.00
41-50 years	63	9.8730	2.33136	.29372	9.2859	10.4602	5.00	15.00
51-60 years	121	10.2397	2.52331	.22939	9.7855	10.6938	5.00	17.00
60 and above years	102	9.8333	2.80764	.27800	9.2819	10.3848	5.00	16.00
<b>Total</b>	<b>440</b>	<b>10.1455</b>	<b>2.57493</b>	<b>.12276</b>	<b>9.9042</b>	<b>10.3867</b>	<b>5.00</b>	<b>17.00</b>

**Table 4.1: Age descriptives for Awareness of consumers towards Eco-friendly products**

The mean of each group in Descriptives table, it can be concluded that there is homogeneity of variances.

Test of Homogeneity of Variances			
BQ TOTAL			
Levene Statistic	df1	df2	Sig.
1.307	3	436	.272

**Table 4.2: Test of Homogeneity of Variances for Awareness of consumers towards Eco-friendly products with respect to age of the Respondents**

According to Levene's Test for homogeneity of Variances, if significance value of Levene's Test for Homogeneity of Variances test is more than 0.05 then there is homogeneity of variances.

Here, significance value of Levene's Test for Homogeneity of Variances test is 0.272 which is more than 0.05. Hence there is homogeneity of variances.

ANOVA					
BQ TOTAL					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	24.867	3	8.289	1.252	.290
Within Groups	2885.824	436	6.619		
Total	2910.691	439			

**Table 4.3: ANOVA Test Statistics for Awareness of consumers towards Eco-friendly products with respect to age of the Respondents**

From the ANOVA table the Sig. value is 0.290 which is more than 0.05. Hence null hypothesis (H<sub>0</sub>) is accepted. So it can be concluded that age has no significant effect on awareness of consumers towards eco-friendly products.

## 5 FINDINGS

Age has no significant effect on awareness of consumers towards eco-friendly products. Different age groups of consumers are having equal awareness towards eco-friendly products.

## 6 CONCLUSION

The findings of the study clearly confirm that, in Indore most of the consumers have favourable perception towards eco-friendly products. Consumers are aware about environment degradation, global warming etc. Consumers are having more concerned towards the environment and have moderate awareness on Eco-friendly FMCG products. The consumers is buying Eco-friendly products as it is healthy and safe for

the environment and as well as for the human beings. The consumers are also satisfied with the eco- friendly products. The main barrier for buying Eco-friendly FMCG products are too high price as it is compared to non Eco-friendly products price.

## **REFERENCES**

1. Patnaik and S. K. Pradhan, "A Study on consumer attitude towards green FMCG Products," International Journal of Scientific Development and Research, vol. 1, no. 12, pp. 83-91, 2016.
2. Pandey and P. Misra, "Consumer's Attitude Towards Organic Food Products with Reference to Delhi NCR," International Journal of Research and Analytical Reviews, vol. 3 , no. 21, pp. 2349-5138, 2016.
3. S. K. Katait, "Consumer behaviour towards green products of FMCG," International Journal of Commerce and Management Research, vol. 2, no. 8, pp. 43-4, 2016.
4. T. Unnamalai, "A Study on Consumer Attitudes towards Green Fast Moving Consumer Goods (FMCG) With Special Reference to Tiruchirapalli Town," International Journal of Engineering and Management Research, vol. 6, no. 4, pp. 380-389, 2016.
5. S. Yusuf and Z. Fatima, "Consumer Attitude and Perception towards Green Products," The International Journal of Indian Psychology, vol. 2, no. 3, pp. 140-146, 2015.
6. S. Kumar AD and H. M. Chandrashekar, "A Study on Consumers Behavior Towards Organic Food Products In Mysore City," International Journal of Management Research, vol. 5, no. 11, pp. 1082-1091, 2015.

#####

**EVIDENCE BASED MANAGEMENT PROTOCOL IN  
TEMPOROMANDIBULAR JOINT DISORDERS: A CURRENT AND  
COMPENDIOUS UPDATE**

**Dr. Abhay Chavan**

Post graduate student, Department of Orthodontics and Dentofacial  
Orthopaedics, Rural Dental College, Pravara Institute of Medical Sciences,  
Loni

**Dr. NG Toshniwal**

Professor and Head of Department, Department of Orthodontics and  
Dentofacial Orthopaedics, Rural Dental College, Pravara Institute of  
Medical Sciences, Loni

**Dr. Ravindra Manerikar**

Principal, Rural Dental College, Pravara Institute of Medical Sciences,  
Loni

**Dr. Shubhangi Mani**

Professor, Department of Orthodontics and Dentofacial Orthopaedics,  
Rural Dental College, Pravara Institute of Medical Sciences, Loni

**Dr. Nilesh Mote**

Professor, Department of Orthodontics and Dentofacial Orthopaedics,  
Rural Dental College, Pravara Institute of Medical Sciences, Loni

**Dr. Sumeet Mishra**

Senior Lecturer, Department of Orthodontics and Dentofacial  
Orthopaedics, Rural Dental College, Pravara Institute of Medical Sciences,  
Loni

---

**Abstract-** Optimum health of Temporomandibular Joint is of prime concern for many health care professionals including dental surgeons and it's all specialities as temporomandibular disorders are seen in a lot of individuals nowadays. These disorders can be related to soft tissues or hard tissues within the temporomandibular joint. There are many signs and symptoms associated with TMJ disorders which can be analysed by the dentist. Management of temporomandibular joint disorders can be done through various ways like Topical anaesthetic agents, or even with systemic or oral analgesics, certain physiotherapy exercises to relax the muscles involved with TMJ, Dental management, usage of occlusal splints and surgical alternatives. While searching Evidence based Philosophies the most popular model used is "Biopsychosocial Model". This review provides a brief detail on etiopathogenesis, clinical features and evidence-based approach in Temporomandibular disorder management using the current evidences and studies.

## **1 INTRODUCTION**

Temporomandibular disorders (TMD) is a broad term which consists of various clinical problems such as the temporomandibular joint (TMJ), masticatory musculature, surrounding hard and soft tissue components,

and combinations of these. There are many symptoms associated with Temporomandibular disorders such as decreased mandibular range of motion, TMJ pain, pain in muscles of mastication, locking or deviation of jaw opening, associated joint noise (clicking, popping, or crepitus) with function or generalized myofascial pain<sup>1</sup>.

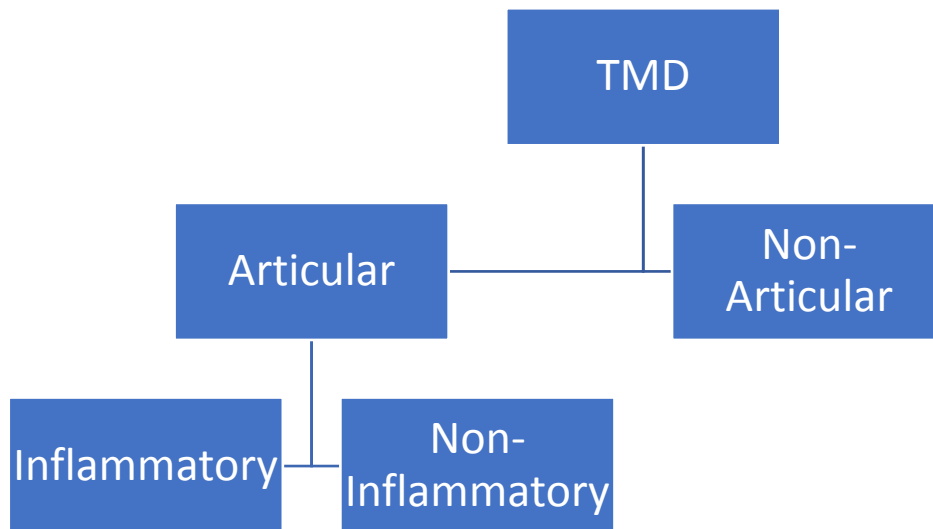
Otolaryngologist JB Costen first described TMD in 1930's when he established the TMJ as a separate source of otalgia. He stated that TMJ problems could be due to structural imbalance between the cranium and the mandible and only a dentist could take care of such TMJ problems<sup>2</sup>. In the recent years, emerging evidence has grown in support of a biopsychosocial model of TMD pain<sup>3</sup>. The importance of occlusion and equilibrating the occlusion to treat/prevent TMD has been mentioned way back in history of gnathology. TMD is also considered as Musculo-skeletal disorder. TMD is also the main cause of pain of non-dental origin in the oro-facial region including head, face and related structures<sup>4</sup>. There can be various factors responsible for Temporomandibular disorders and various other ways to prevent TMD or to treat TMD's. This article will enlighten the readers about evidence approaches to TMD management and certain factors considered during dental treatment to help in reduction of Temporomandibular disorders.

## **2 PREVALENCE AND INCIDENCE OF TEMPOROMANDIBULAR DISORDERS**

It has been seen that prevalence of TMD is in about 6%-12%<sup>5</sup> of the population with the peak occurring in age group 20-40 years of age<sup>6</sup>. According to study done in 2015 carried out in India<sup>7</sup> myofascial pain dysfunction syndrome (MPDS) was reported in 0.8% of the population, internal derangement in 38.3%, and osteoarthritis in 14.6% of the population. Temporomandibular disorders are also more prevalent in women than in men. The reason behind the gender variability is not clear but it has been suggested that it can be due to hormonal influence<sup>8-10</sup>. In patients with TMD increased levels of estrogen have been found.<sup>11</sup>

## **3 CLASSIFICATION OF TEMPOROMANDIBULAR DISORDERS**

TMD's can be classified into Articular and Non-articular disorders or Intracapsular and Extracapsular disorders respectively<sup>11</sup>.



**Figure 1 Classification of TMD's**

Articular disorders can be subdivided into Inflammatory and Non-inflammatory. Inflammatory articular disorders include Rheumatic arthritis, ankylosing spondylitis, psoriatic arthritis, gout, and infectious arthritis. Noninflammatory articular disc disorders include joint damage from prior trauma or surgery due to various reasons, osteoarthritis, or other cartilage or bone disorders.

Nonarticular disorders mostly present as myofascial pain focused to the muscles of mastication. They may also include disorders with chronic conditions such as fibromyalgia, muscle strain, and myopathies. Most myofascial pain and dysfunction (MPD) are theorized to arise from clenching, bruxism, or other parafunctional habits.

### **3.1 Why do Temporomandibular Disorders occur?**

The factors responsible for TMD's can be divided into 3 categories<sup>12</sup>

1. Predisposing factors: These include a combination of morphological, physiological, psychological, and environmental variables which will increase the susceptibility to a certain disease for an individual.
2. Precipitating factors: These include various combinations of trauma, stress, hyperfunction, and possibly failure of natural inhibiting factors, all of which lead to the onset of symptoms.
3. Perpetuating factors: These include poor healing capacity, failure to control etiologic factors, secondary gains from staying sick, and negative effects from inappropriate treatments which will result in TMD's.

So Temporomandibular disorder can occur from combination of these factors and present with various signs and symptoms.

Causes to TMD's are multifactorial, some of them are:

1. Acute trauma to the jaw
2. Trauma from hyperextension
3. Differences in maxillomandibular relationships
4. Comorbidity due to pre-existing musculoskeletal disorders
5. Parafunctional habits (Bruxism or tooth clenching)
6. Emotional distress
7. Iatrogenic causes

## **4 DIAGNOSTIC PROTOCOLS IN ASSESSMENT OF TEMPOROMANDIBULAR DISORDERS**

### **A. Essential diagnostic aids**

#### **1. Case History**

Case history involves description and recording of relevant information from the patient or parent in help in overall diagnosis of the case. A proper case history could reveal if the patient has any signs and symptoms regarding the TMD or it could help in assessing if the patient had any history of previous trauma that could have made TMD to aggravate.

A thorough case history would reveal if the patient has any relevant medical or dental history, like degenerative diseases can lead to TMD symptoms or TMD could present with any occlusal interference which can be of dental origin.

#### **2. Clinical examination**

A General clinical examination can help in assessing the facial symmetry of the face as asymmetries occur in some cases of TMD's which can be due to swelling or any previous trauma which has resulted in TMJ ankylosis in that area. Auscultation and Palpation of the TMJ is of much importance in diagnosis of Temporomandibular joint disorders. Palpation of TMJ could reveal clicking sound of TMJ or pain on palpation.

Importance of clinical examination lies in assessing the functional occlusion and path of closure of the mandible. Path of closure will reveal if any hinderance is created during path of closure which can help in proper fabrication of treatment plan for the case.

#### **3. Study models**

Study models can be fabricated from making of accurate impression of the patients' intraoral structures. With the help of bite registration these models can also be mounted on the articulator which can help in viewing the proper movement of the jaw related to patients existing occlusion.

#### **4. Certain radiographs**

##### **Orthopantogram**

OPG can help in assessing the teeth present involving third molar and can help in comparing the Temporomandibular joint on both the sides which could evaluate any bony changes in the condylar region if any.



## **5. Facial photographs**

Accurate Extraoral and Intraoral facial photographs could reveal any asymmetry present related to TMD. Left and right profile view can be compared to assess the symmetry on both the sides of the face. Intraoral photographs could reveal any possible interferences present which could lead to disruption of the occlusion.

## **B. Supplemental diagnostic aids**

### **1. Lateral cephalogram**

Lateral cephalogram can reveal relationship of maxillary and mandibular jaw with the cranium base. A proper tracing of the condylar region can be done to view the changes in TMJ region. The major drawback Lateral cephalogram hold in TMD diagnosis is that in the radiograph condyles of both the sides are overlapped over one another which would create a problem in diagnosis.

### **2. Electromyographic examination**

Electromyographic examination can record activity of the muscles which are related to the Temporomandibular joint. EMG examination of Masseter, Temporalis, Medial and Lateral pterygoid can reveal hyperactivity of these muscles which can a factor responsible for TMD's. A proper EMG examination is important to help in accurate diagnosis.

According to a study by Schiffman et al the 12 common TMD include arthralgia, myalgia, local myalgia, myofascial pain, myofascial pain with referral, disc displacement disorders, degenerative joint disease, subluxation and headache associated with TMD.

Traditionally TMD diagnosis was done by TMJ tomograms, Lateral cephalograms, Electromyograms. One drawback they had was that these diagnostic aids provided with 2D image of the TMJ and surrounding structures which was overcome by the newer diagnostic aids.

Recently newer diagnostic aids like CT (computed tomography) scans, CBCT (cone beam computed tomography) have led to a much accurate diagnosis of the disorder. They provide a 3D image of the TMJ with any signs of inflammation and can also assess the volumetric changes of the articular fluid in the Temporomandibular joint.

### **4.1 Temporomandibular joint disorders Management**

TMD's can be both Nocturnal and daytime and can be both throughout the day or in short episodes. More overly, the symptomatic treatment can be helpful in managing TMD in many cases<sup>13</sup>.

Temporomandibular disorders can be managed either by Traditional approach or combining traditional with recent treatment therapies.

## **4.2 Traditional therapies to treat TMD's**

Traditional therapies can be divided into Medications, Dental management, Physical therapies, Surgical management.

### **1. Medications**

#### **A. Oral medications and Topical medications**

Most commonly used drugs include nonsteroidal anti-inflammatory drugs (NSAIDs), corticoids, analgesics, muscle relaxants, anxiolytics, opiates, tricyclic antidepressants (TCAs), gabapentin, and lidocaine patches<sup>14,15,16,17</sup>.

NSAIDs which commonly used are

- Diclofenac (50mg twice/thrice daily)
- Naproxen sodium (500mg twice a day)
- Celecoxib
- Piroxicam (20mg once a day for 10 days)
- Palmitoylethanolamide (300–1,200 mg daily up to 120 days)

NSAIDs have many adverse effects, however, such as exacerbation of hypertension, gastrointestinal effects ranging from dyspepsia to ulceration, and worsening of renal function, which makes diagnosis of an individual case of prime importance.

Topical application of medicines has also proven to be effective. The application of four doses a day of topical diclofenac combined with dimethyl sulfoxide to improve its absorption is recommended<sup>18</sup>.

#### **B. Injectable drugs**

Some of the studies have shown that the use of injections of the corticosteroid  $\beta$ -methasone or sodium hyaluronate for TMJ pain have proved to be effective. Corticosteroid moreover has anti-inflammatory effect while hyaluronate helps in joint lubrication.

Some studies have stated the efficacy of botulinum toxin (BTX) in treatment of TMD's. Of 5 studies included in a systematic review<sup>19</sup>. 2 studies showed positive effect by significant reduction in pain, one study showed similar effects with masticatory manual therapy and the other 2 studies showed no significant differences. Hence more detailed studies are required for analysing effects of injectable drugs in treatment of temporomandibular disorders.

### **2. Dental management**

One of the most common approach for treating TMD is by dental management. Orthopaedic stabilization therapy and occlusal adjustment therapies are mostly carried out in patients with TMD's<sup>20</sup>. Orthopaedic stabilization can be done by splint therapy while Orthodontics and occlusal adjustments can be used for achieving definitive correct stable occlusion. Splint therapy can provide with conservative treatment in cases with TMD pain associated with bruxism. Occlusal adjustments can help the patient from further damage of the dentition from tooth grinding.

Occlusal splints can help in adjustment of the position of TMJ to a position of mandible in centric relation. Occlusal splints can be fabricated for the patients who have symptoms like TMJ pain or have bruxism habit which can be nocturnal or during daytime. Occlusal splints can help reduction of trauma due to bruxism

### **3. Physical Therapies**

Physical therapy helps in pain relieving, reduction of inflammation and/or restoration of motor function. Many Physical therapies are used in treatment of temporomandibular disorders like Manual therapies, Electrotherapy, Transcutaneous electrical nerve stimulation (TENS), Therapeutic ultrasound, Dry needling (DN) and acupuncture procedures. These therapies have proven to be effective in resolution of chronic TMJ pain mostly by reduction of muscle activity involved in temporomandibular joint. These therapies can also be used in combination like Manual therapies like Joint mobilization or soft tissue mobilization can be followed by acupuncture for more benefits in TMD'S.

### **4. Surgical Therapy**

There are various surgical therapies available for treatment of TMD's. Arthrocentesis based on articular lavage with or without injection of pharmaceuticals and arthroscopy are the two most frequently used approaches for internal derangements of the TMJ or degenerative pathology<sup>21,22</sup>. It has also been stated that medical management or rehabilitation is much preferred over surgery in cases with internal derangement of TMJ. Moreover, there is growing evidence regarding the benefit of platelet-rich plasma injections over hyaluronate combined with arthrocentesis for TMJ osteoarthritis and it has shown to have some positive effect<sup>23-25</sup>.

In TMD patient's surgery is rarely needed. One study stated that over 2,000 TMD patients from many practices found that only 2.5% underwent TMJ surgery (1.4% arthrocentesis, 1.0% arthroscopy, and 0.1% open joint procedures)<sup>26</sup>.

### **4.3 Biopsychosocial Model for Temporomandibular Joint Disorder Management**

Patients with chronic TMD usually are associated with some psychological factor which may aggravate the severity of TMD. Biopsychosocial approach with Cognitive therapy helps in managing the patient's thoughts or behaviours that may exacerbate the pain symptoms. The Biopsychosocial model was proposed by Engle in 1970's<sup>27</sup>. In 1970's Engle concluded that 'The proposed<sup>27</sup>biopsychosocial model provides a blueprint for research, a framework for teaching, and a design for action in the real world of health care. Whether it is useful or not, it had to be seen.' This model helps the clinician in treatment of the disease or the

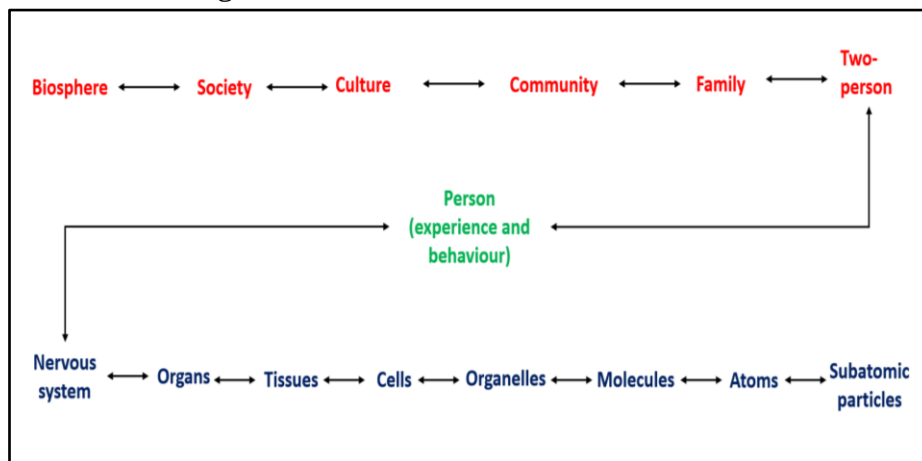
disorder with biological as well as psychological approach which can result in long term benefits to the patient.

According to Engle nothing in nature exist in isolation rather it is always a result of combination of many factors, Likewise Temporomandibular disorders does not exist in isolation but their occurrence can be multifactorial.

The biomedical model is characterized by a different approach that attributes the disease to a single cause located within the body and that considers disturbances of mental processes as a separate and unrelated set of problems. The biopsychosocial model enables the physician to extend application of the scientific method to aspects of everyday practice and patient care heretofore not deemed accessible to a scientific approach.

Weiss<sup>28</sup> pointed out that the systems theory is the best approach in explaining the observation in the nature which can be explained by a hierarchical arrangement with larger units (complex) super ordinating to smaller units (less complex). According to this the Single individual (Person) is the highest unit of organismic hierarchy and at the same time the lowest unit of the social hierarchy.

Each level in hierarchy represents an organised dynamic as a whole. Each of them holds their unique qualities and relationship. According to Engel<sup>28</sup>. Nothing in nature exist in isolation, whether it is a cell or a person, it will always be in the configuration of the system in which it is existing.



**Figure 2 Levels of Hierarchy**

It is also stated that the model does not add anything to what is involved in ideal treatment plan of the patient rather it helps the clinician to think rationally and motivates him to be skilful and informed around the psychosocial areas.

Healthcare of patients could improve if all healthcare units were more aware of and used the biopsychosocial model of illness. It underlies

person-centred care which provides an evidence based service to the patient with informed and skilful services by the doctor<sup>29,30</sup>.

A biopsychosocial model requires collective sharing and working across existing boundaries, which requires trust and sharing among the doctor and the patient and also an agreed understanding of the situation.

Hence patients when treated with combination of biopsychosocial approach and biological approach stand a better chance in long term better treatment results of TMD than those treated only with biological approach.

#### **4.4 Recent Evidences Supporting the Treatment of TMD**

In a systematic review and metaanalysis by Moraissi et al<sup>31</sup>in 2017 it was stated that Orthognathic surgery caused a decrease in TMD symptoms for many patients who had symptoms before surgery, but it also created symptoms in a smaller group of patients who were asymptomatic before hence they also stated that more research was needed in surgical field to assess the effect of surgery in TMD.

In a study done by Moldez et al<sup>32</sup>in 2018 they stated the effect of injection of sodium hyaluronate or corticosteroids for intracapsular temporomandibular joint disorders where they concluded that sodium hyaluronate had better effect in treating TMD.

In another systematic review by Melis et al<sup>33</sup>in 2019, it was concluded that Oral myofunctional therapy was proved to be effective in reducing the pain intensity due to TMD

In a systematic review done by de Melo et al<sup>34</sup>in 2020, they stated that Manual therapy proved to be better in treatment of Temporomandibular disorder than no treatment and even manual therapy combined with home therapies was better than home therapy alone.

Another systematic review which was done by Peixoto et al<sup>35</sup> in 2021 stated that traditional acupuncture showed better results and seemed to relieve the signs and symptoms of temporomandibular disorders. Laser acupuncture with occlusal splint also reduced the pain from TMD.

#### **5 CONCLUSION**

Occurrence of temporomandibular disorders has increased in recent era and are common due to adverse eating habits, stress, hormonal changes etc. Also, the causes can always be multifactorial. The main aim of the dentist should be providing symptomatic treatment to the patient initially, and then assessing the proper cause through correct diagnostic aids to provide relief to the patient. Dental treatment if needed should be carried out to stabilize the malocclusion which will in turn help in relaxation of muscles in the orofacial area providing relief from TMD's.

The newer Biopsychosocial approach combined with medical treatment guarantees the patient with long term relief from TMJ pain symptoms.

## REFERENCES

1. Wadhwa S, Kapila S. TMJ Disorders: Future Innovations in Diagnostics and Therapeutics [Internet]. Vol. 72, Journal of Dental Education. 2008. p. 930–47.
2. Scrivani SJ, Keith DA, Kaban LB. Temporomandibular disorders. *N Engl J Med*. 2008 Dec 18;359(25):2693–705.
3. Suvinen TI, Reade PC, Kemppainen P, Könönen M, Dworkin SF. Review of aetiological concepts of temporomandibular pain disorders: towards a biopsychosocial model for integration of physical disorder factors with psychological and psychosocial illness impact factors. *Eur J Pain*. 2005 Dec;9(6):613–33.
4. de Leeuw R, Klasser GD. *Orofacial Pain: Guidelines for Assessment, Diagnosis, and Management*. Quintessence Publishing Company Incorporated; 2018. 327 p.
5. Lipton JA, Ship JA, Larach-Robinson D. Estimated prevalence and distribution of reported orofacial pain in the United States. *J Am Dent Assoc*. 1993 Oct;124(10):115–21.
6. Manfredini D, Guarda-Nardini L, Winocur E, Piccotti F, Ahlberg J, Lobbezoo F. Research diagnostic criteria for temporomandibular disorders: a systematic review of axis I epidemiologic findings. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2011 Oct;112(4):453–62.
7. Muthukrishnan A, Sekar G. Prevalence of temporomandibular disorders in Chennai population [Internet]. Vol. 27, Journal of Indian Academy of Oral Medicine and Radiology. 2015. p. 508.
8. Abubaker AO, Omar Abubaker A, Raslan WF, Sotereanos GC. Estrogen and progesterone receptors in temporomandibular joint discs of symptomatic and asymptomatic persons: A preliminary study [Internet]. Vol. 51, Journal of Oral and Maxillofacial Surgery. 1993. p. 1096–100.
9. Milam SB, Aufdemorte TB, Sheridan PJ, Triplett RG, Van Sickels JE, Holt GR. Sexual dimorphism in the distribution of estrogen receptors in the temporomandibular joint complex of the baboon. *Oral Surg Oral Med Oral Pathol*. 1987 Nov;64(5):527–32.
10. Aufdemorte TB, Van Sickels JE, Dolwick MF, Sheridan PJ, Holt GR, Aragon SB, et al. Estrogen receptors in the temporomandibular joint of the baboon (*Papio cynocephalus*): an autoradiographic study. *Oral Surg Oral Med Oral Pathol*. 1986 Apr;61(4):307–14.
11. De Rossi SS, Greenberg MS, Liu F, Steinkeler A. Temporomandibular disorders: evaluation and management. *Med Clin North Am*. 2014 Nov;98(6):1353–84.
12. Greene CS. Etiology of temporomandibular disorders [Internet]. Vol. 1, Seminars in Orthodontics. 1995. p. 222–8.
13. Wright EF, North SL. Management and treatment of temporomandibular disorders: a clinical perspective. *J Man Manip Ther*. 2009;17(4):247–54.
14. Agius AM, Jones NS, Muscat R. A Randomized Controlled Trial comparing the efficacy of low-dose amitriptyline, amitriptyline with pindolol and surrogate placebo in the treatment of chronic tension-type facial pain [Internet]. Vol. 51, Rhinology journal. 2013. p. 143–53.
15. White AP, Arnold PM, Norvell DC, Ecker E, Fehlings MG. Pharmacologic Management of Chronic Low Back Pain [Internet]. Vol. 36, Spine. 2011. p. S131–43.
16. Gewandter JS, McDermott MP, McKeown A, Hoang K, Iwan K, Kralovic S, et al. Reporting of cross-over clinical trials of analgesic treatments for chronic pain: Analgesic, Anesthetic, and Addiction Clinical Trial Translations, Innovations, Opportunities, and Networks systematic review and recommendations. *Pain*. 2016 Nov;157(11):2544–51.

17. Firmani M, Miralles R, Casassus R. Effect of lidocaine patches on upper trapezius EMG activity and pain intensity in patients with myofascial trigger points: A randomized clinical study. *Acta Odontol Scand*. 2015 Apr;73(3):210–8.
18. Di RienzoBusinco L, Di RienzoBusinco A, D'Emilia M, Lauriello M, Coen Tirelli G. Topical versus systemic diclofenac in the treatment of temporomandibular joint dysfunction symptoms. *Acta Otorhinolaryngol Ital*. 2004 Oct;24(5):279–83.
19. Chen Y-W, Chiu Y-W, Chen C-Y, Chuang S-K. Botulinum toxin therapy for temporomandibular joint disorders: a systematic review of randomized controlled trials. *Int J Oral Maxillofac Surg*. 2015 Aug;44(8):1018–26.
20. Gil-Martínez A, Paris-Aleman A, López-de-Uralde-Villanueva I, La Touche R. Management of pain in patients with temporomandibular disorder (TMD): challenges and solutions. *J Pain Res*. 2018 Mar 16;11:571–87.
21. Al-Moraissi EA. Open versus arthroscopic surgery for the management of internal derangement of the temporomandibular joint: a meta-analysis of the literature [Internet]. Vol. 44, *International Journal of Oral and Maxillofacial Surgery*. 2015. p. 763–70.
22. Rigon M, Pereira LM, Bortoluzzi MC, Loguercio AD, Ramos AL, Cardoso JR. Arthroscopy for temporomandibular disorders. *Cochrane Database Syst Rev*. 2011 May 11;(5):CD006385.
23. Kiliç SC, Güngörmüş M, Sümbüllü MA. Is Arthrocentesis Plus Platelet-Rich Plasma Superior to Arthrocentesis Alone in the Treatment of Temporomandibular Joint Osteoarthritis? A Randomized Clinical Trial [Internet]. Vol. 73, *Journal of Oral and Maxillofacial Surgery*. 2015. p. 1473–83.
24. Hancı M, Karamese M, Tosun Z, Aktan TM, Duman S, Savaci N. Intra-articular platelet-rich plasma injection for the treatment of temporomandibular disorders and a comparison with arthrocentesis [Internet]. Vol. 43, *Journal of Cranio-Maxillofacial Surgery*. 2015. p. 162–6.
25. Hegab AF, Ali HE, Elmasry M, Khallaf MG. Platelet-Rich Plasma Injection as an Effective Treatment for Temporomandibular Joint Osteoarthritis [Internet]. Vol. 73, *Journal of Oral and Maxillofacial Surgery*. 2015. p. 1706–13.
26. Brown DT, Gaudet EL. Temporomandibular Disorder Treatment Outcomes: Second Report of a Large-Scale Prospective Clinical Study [Internet]. Vol. 20, *CRANIO®*. 2002. p. 244–53.
27. The Pelican Freud Library. Edited by A. Richards. Harmondsworth. 1979 and 1980
28. Engel GL. The Clinical Application of the Biopsychosocial Model [Internet]. Vol. 6, *Journal of Medicine and Philosophy*. 1981. p. 101–24.
29. Smith RC, Fortin AH, Dwamena F, Frankel RM. An evidence-based patient-centered method makes the biopsychosocial model scientific [Internet]. Vol. 91, *Patient Education and Counseling*. 2013. p. 265–70.
30. Kitson A, Marshall A, Bassett K, Zeitz K. What are the core elements of patient-centred care? A narrative review and synthesis of the literature from health policy, medicine and nursing [Internet]. Vol. 69, *Journal of Advanced Nursing*. 2013. p. 4–15.
31. Al-Moraissi EA, Wolford LM, Perez D, Laskin DM, Ellis E. Does Orthognathic Surgery Cause or Cure Temporomandibular Disorders? A Systematic Review and Meta-Analysis [Internet]. Vol. 75, *Journal of Oral and Maxillofacial Surgery*. 2017. p. 1835–47.
32. Moldez MA, Camones VR, Ramos GE, Padilla M, Enciso R. Effectiveness of Intra-Articular Injections of Sodium Hyaluronate or Corticosteroids for Intracapsular Temporomandibular Disorders: A Systematic Review and Meta-Analysis. *J Oral Facial Pain Headache*. 2018;32(1):53–66.
33. Melis M, Di Giosia M, Zawawi KH. Oral myofunctional therapy for the treatment of temporomandibular disorders: A systematic review. *Cranio*. 2019 Sep 17;1–7.
34. de Melo LA, Bezerra de Medeiros AK, Campos MDFTP, Bastos Machado de Resende CM, Barbosa GAS, de Almeida EO. Manual Therapy in the Treatment of Myofascial Pain Related to Temporomandibular Disorders: A Systematic Review. *J Oral Facial Pain Headache*. 2020;34(2):141–8.

35. Peixoto KO, Abrantes PS, De Carvalho IHG, De Almeida EO, Barbosa GAS. Temporomandibular disorders and the use of traditional and laser acupuncture: a systematic review [Internet]. CRANIO®. 2021. p. 1-7.

#####