ON ISOLATE ECCENTRIC DOMINATION IN GRAPHS

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ABSTRACT

A subset D of the vertex set V(G) of a graph G is said to be a dominating set if every vertex not in D is adjacent to at least one vertex in D. A dominating set D is said to be an eccentric dominating set if for every $v \in V - D$, there exists at least one eccentric vertex of v in D. An eccentric dominating set S of G is an isolate eccentric dominating set if the induced subgraph $\langle S \rangle$ has atleast one isolated vertex. The minimum of the cardinality of the isolate eccentric dominating set of G is called the isolate eccentric domination number $\gamma_{oed}(G)$. In this paper, we study the existence of isolate eccentric dominating set in a graph G and obtained some bounds for isolate eccentric domination number $\gamma_{oed}(G)$. Also, we characterize graphs for which $\gamma_{oed}(G) = 1, 2, p-2$ and $p-1$.

Keywords: *Domination, Eccentric Domination, Isolate Domination, Isolate Eccentric Domination.*

Mathematics Subject Classification: 05C12, 05C69.

Introduction

Let G be a finite, simple, connected and undirected (p, q) graph with vertex set V(G) and edge set E(G). For graph theoretic terminology refer to Harary [12], Buckley and Harary [10]. The concept of domination in graphs was introduced by Ore in [15].

The concept of domination in graphs is originated from the chess games theory and that paved the way to the development of the study of various domination parameters and its relation to various other graph parameters. For details on domination theory, refer to Haynes, Hedetniemi, and Slater [13].

Definition 1.1: Let G be a graph, and let V be a sub graph of G. For any vertex v in G, the distance d(u, v) from u to v is the shortest distance from u to a vertex v in V.

Definition 1.4 [16]: A subset $S \subseteq V(G)$ is called an isolate set if the subgraph induced by S has an isolated vertex. This set S is an isolate dominating set if it is both isolate and dominating. The minimum cardinality of an isolate dominating set is called the isolate domination number and is denoted by $\gamma_o(G)$.

Janakiraman, Bhanumathi and Muthammai [14] introduced Eccentric domination in Graphs. Bhanumathi and Muthammai [1, 3] studied Eccentric domination in trees, and some results in eccentric domination. Bhanumathi, John Flavia and Kavitha [4] studied the concept of Restrained Eccentric domination in graphs.

Definition 1.2: Let G be a connected graph and v be a vertex of G. The eccentricity e(v) of v is the distance to a vertex farthest from v. Thus, $e(v) = \max\{d(u, v) : u \in V\}$. The radius r(G) is the minimum eccentricity of the vertices, whereas the diameter diam(G) = d(G) is the maximum eccentricity. For any connected graph G, $r(G) \leq diam(G) \leq 2r(G)$. The vertex v is a central vertex if e(v) = r(G). The center C(G) is the set of all central vertices. For a vertex v, each vertex at a distance e(v) from v is an eccentric vertex of v. Eccentric set of a vertex v is defined as $E(v) = \{u \in V(G) / d(u, v) = e(v)\}$. The set E_k denotes the set of vertices of G with eccentricity k.

Definition 1.3 [11, 13]: A set $D \subseteq V$ is said to be a dominating set in G if every vertex in V – D is adjacent to some vertex in D. The minimum cardinality of a dominating set is called the domination number and is denoted by $\gamma(G)$.

Bhanumathi and John Flavia studied the concept of Total Eccentric domination in graphs and Eccentric domination in graphs [5, 6]. Bhanumathi and Sudhasenthil [7] studied the concept of the split and Nonsplit Eccentric domination in graphs. Sahul Hamid and Balamurugan [16] studied the concept of Isolate domination in graphs. Bhanumathi and Niroja [8] studied Isolate Eccentric Domination in Graphs. Bhanumathi and Meenal Abirami [9] studied the concept of Upper Eccentric Domination in Graphs.

Definition 1.5 [14]: A set $D \subseteq V(G)$ is an eccentric dominating set if D is a dominating set of G and for every $v \in V - D$, there exists

at least one eccentric vertex of v in D. The minimum cardinality of an eccentric dominating set is called the eccentric domination number and is denoted by $\gamma_{ed}(G)$.

Definition 1.6 [8]: A set $S \subseteq V(G)$ is a isolate eccentric dominating set if S is an eccentric dominating set and also the induced sub graph $\langle S \rangle$ has atleast one isolated vertex. The minimum of the cardinality of the isolate eccentric dominating set of G is called the isolate eccentric domination number $\gamma_{oed}(G)$.

Definition 1.7: The helm graph H_p is obtained from a wheel by attaching pendant edge at each vertex of p cycle.

Definition 1.8: The triangular snake graph is obtained from a path $v_1, v_2, \ldots, v_p$ by joining v_i and v_{i+1} to a new vertex w_i for i = 1, 2, 3, …, p – 1 and is denoted by mC_3 snake.

Theorem 1.1 [11]: For any graph G, $\lceil p/(1 + \Delta(G)) \rceil \leq \gamma(G) \leq p - \Delta(G)$.

Theorem 1.2 [17]: Let G be a connected graph with r(G) = rad(G) = 1, diam(G) = 2 with t central vertices. Then $\gamma_{ed}(G) = 2$ if and only if any one of the following is true.

(i) G has atleast one vertex of degree t.

(ii) There exists u, v ∈ V(G) such that D = {u, v} is a maximal independent set and $d_{<E2>}(u, v) \geq 3$.

Theorem 1.3 [14]: Let G be a two self-centered graph. Then $\gamma_{ed}(G) = 2$ if and only if G has a dominating edge which is not in a triangle.

Theorem 1.4 [14]: Let G be a graph with radius two and diameter three. Then $\gamma_{ed}(G) = 2$ if and only if G has a γ-set D = {u, v} of cardinality two with d{u, v} = 3 and for any u-v path uxyv in G, e(u) = e(v) = 3 and e(x) = e(y) = 2.

Theorem 1.4 [16]: (i) $\gamma_o(P_p) = \lceil p/3 \rceil$.

(ii) $\gamma_o(C_p) = \lceil p/3 \rceil$.

In [8], we defined and studied isolate eccentric domination in graphs. We need the following results for further study.

Theorem 1.5 [8]: (i) $\gamma_{oed}(G) = 1$ if and only if $G = K_p$.

(ii) If G is self-centered graph of diameter two, then $\gamma_{oed}(G) \leq (p - \deg_G w + 1)/2$, if there exists $w \in V(G)$ with $S \subseteq N_2(w)$ such that vertices in $N_1(w)$ and $N_2(w) - S$ has eccentric vertices in S.

(iii) If G is of radius two and diameter three and if G has a pendant vertex u of eccentricity three then $\gamma_{oed}(G) \leq \Delta(G)$.

(iv) If G is of radius two with a unique central vertex w then $\gamma_{oed}(G) \leq p - \deg(w)$.

(v) If G is a connected graph of radius greater than two, then $\gamma_{oed}(G) \leq p - \Delta(G)$.

Isolate Eccentric Domination in Graphs

Definition 2.1 [8]: A set $S \subseteq V(G)$ is a isolate eccentric dominating set if S is an eccentric dominating set and also the induced sub graph $\langle S \rangle$ has atleast one isolated vertex. The minimum of the cardinality of the isolate eccentric dominating set of G is called the isolate eccentric domination number $\gamma_{oed}(G)$. Obviously, $\gamma(G) \leq \gamma_o(G) \leq \gamma_{oed}(G)$ and $\gamma_{ed}(G) \leq \gamma_{oed}(G)$.

In the following theorems, we study the existence of isolate eccentric domination in graphs.

Theorem 2.1: Let G be a graph with radius one and diameter two. Then $S \subseteq V(G)$ is an isolate eccentric dominating set if and only if $S \subseteq E_2$ and is an isolate eccentric dominating set of $\langle E_2 \rangle$.

Proof: G is a graph with radius one and diameter two. Hence, $\gamma_{ed}(G) \geq 2$. Assume that S is an isolate eccentric dominating set of G. This implies that S does not contain any central vertices. Therefore, $S \subseteq E_2$. Thus, $S \subseteq E_2$ and S is an isolate eccentric dominating set of $\langle E_2 \rangle$.

Converse is obvious.

Example 2.1:

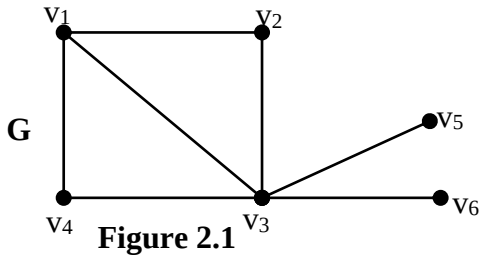


Figure 2.1

In Figure 2.1, $S = \{v_1, v_5, v_6\}$ is a minimum isolate eccentric dominating set of G. $\gamma_{oed}(G) = 3$.

Theorem 2.2: Let G be a two self-centered graph. G has an isolate eccentric dominating set if and only if there exists v∈ V(G) such that every neighbour of v has a non-adjacent vertex in $N_2(v)$.

Proof: Let D be an isolate eccentric dominating set of G. Then D has a vertex v such that v is not adjacent to any other vertex of D. Thus, $N(v) \subseteq V - D$. So every vertex in N(v) has eccentric vertex in D. Therefore, if x ∈ N(v) then x is not adjacent to atleast one vertex of $N_2(v)$.

On the other hand, suppose there exists v ∈ V(G) such that every neighbour of v has a non-adjacent vertex in $N_2(v)$. Then S = V – N(v) is an isolate eccentric dominating set of G.

Hence, G has an isolate eccentric dominating set if and only if there exists v ∈ V(G) such that every neighbour of v has a non-adjacent vertex in $N_2(v)$.

Corollary 2.1: $K_{m, n}$ has no isolate eccentric dominating set.

Corollary 2.2: $K_{2n} - M$ has no isolate eccentric dominating set, where M is a matching of G.

Example 2.2:

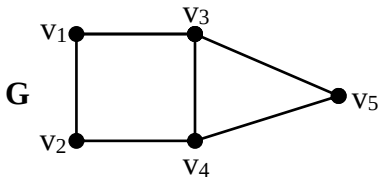


Figure 2.2

In Figure 2.2, S = {v_1, v_2, v_5} is a minimum isolate eccentric dominating set of G. $\gamma_{oed}(G) = 3$.

In the following theorems, we find some bounds for $\gamma_{oed}(G)$.

Theorem 2.3: Let G be a graph of radius one and diameter two, let $|E_1| = t$ and $|E_2| = s$. If G has a vertex of degree t, then $\gamma_{oed}(G) \leq s$.

Proof: Let u ∈ E_2 such that deg u = t. Then u is an isolated vertex of $\langle E_2 \rangle$ and E_2 is an eccentric dominating set of G. Hence, the theorem follows.

Theorem 2.4: Let G be a graph of radius two and diameter three. Then there exists an isolate eccentric dominating set for G and $\gamma_{oed}(G) \leq p - \delta(G)$.

Proof: Since diam(G) = 3, G has atleast two vertices of eccentricity three. Let v ∈ V(G) with e(v) = 3. Take D = V – N(v). Hence, every vertex adjacent to v is of eccentricity two or three. Let w ∈ V(G) be an eccentric vertex of v. Then e(w) = 3. Suppose x ∈ N(v) and e(x) = 2, then w is eccentric to x. Suppose y ∈ N(v) and e(y) = 3. Then eccentric vertex of y is in V – N(v). The vertex v dominates vertices of N(v) and every vertex in N(v) has atleast one eccentric vertex in $N_2(v) \cup N_3(v)$. Therefore, D is an isolate eccentric dominating set of G.

Thus, always there exists an isolate eccentric dominating set for G, and $\gamma_{oed}(G) \leq p - \delta(G)$.

Example 2.3:

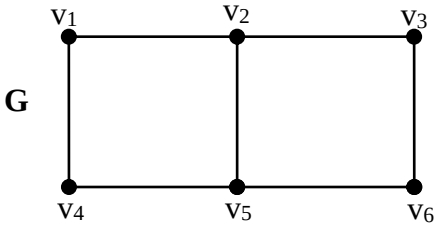


Figure 2.3

In Figure 2.3, D = {v_1, v_3, v_5, v_6}, V – N(v_1) is an isolate eccentric dominating set. S = {v_1, v_4, v_6} is also a minimum isolate eccentric dominating set of G. $\gamma_{oed}(G) = 3$.

Theorem 2.5: If G is a graph of radius two and diameter four, then $\gamma_{oed}(G) \leq p - \delta(G)$.

Proof: Since diam(G) = 4, G has atleast two vertices of eccentricity four. Let u ∈ V(G) with e(u) = 4. Take D = V – N(u). Hence, every vertex adjacent to u is of eccentricity three or four. Let w ∈ V(G) be an eccentric vertex of u. Then e(w) = 4. Suppose x ∈ N(u) and e(x) = 3, then w is eccentric to x. Suppose y ∈ N(u) and e(y) = 4. Then eccentric vertex of y is in V – N(u). Also, D = V – N(u) is an isolate eccentric dominating set of G.

Therefore, $\gamma_{oed}(G) \leq p - \delta(G)$.

Remark 2.1: For a graph G with radius greater than two, there always exists an isolate eccentric dominating set. In [8], we have proved that $\gamma_{oed}(G) \leq p - \Delta(G)$, when G is a graph of radius greater than two.

For the following results, consider the graphs G for which $\gamma_{oed}(G)$ exists.

Theorem 2.6: Let G be a graph with radius one and diameter two. Then $\gamma_{oed}(G) = 2$ if and only if there exists u, v $\in E_2$ such that each vertex of eccentricity two is adjacent to either u or v and $d_{<E2>}(u, v) \geq 3$.

Proof: Assume $\gamma_{oed}(G) = 2$. This implies that $\gamma_{ed}(G) = 2$. We know by Theorem 1.2, $\gamma_{ed}(G) = 2$ if and only if G is any one of the following.

(i) G has a vertex of degree m, where m is the number of central vertices.

(ii) G has vertices u, v with e(u) = e(v) = 2 such that each vertex of eccentricity two is adjacent to either u or v and $d_{<E2>}(u, v) \geq 3$.

If G has a vertex of degree m then D = {u, v}, e(v) = 1, e(u) = 2 and deg u = m is a γ_{ed}-set, but in this case $\langle D \rangle$ has no isolated vertices, since d(u, v) = 1. So, this case is not possible.

Let D = {u, v} be a γ_{oed}-set with e(u) = e(v) = 2. If E_2 has more than two vertices, by (ii) any vertex of E_2 is not adjacent to both u and v and $d_{<E2>}(u, v) \geq 3$ in G. This implies that u and v are both isolated in $\langle D \rangle$.

Hence, G has an isolate eccentric dominating set of cardinality two if and only if there exists u, v $\in E_2$ such that each vertex of eccentricity two is adjacent to either u or v and $d_{<E2>}(u, v) \geq 3$.

Theorem 2.7: Let G be a graph with radius one and diameter two. Then $\gamma_{oed}(G) = p - 1$ if and only if $G = K_{1, n}$.

Proof: $\gamma_{oed}(G) = p - 1$ implies there exists a γ_{ed} - set D $\subseteq E_2$ such that $\langle D \rangle$ has isolated vertices with $|D| = p - 1$.This implies that D has no central vertex. Hence, G is unicentral with radius one. If there exists an edge in $\langle E_2 \rangle$, then $\gamma_{oed}(G) < p - 1$. Hence, the result follows.

Converse is obvious.

Theorem 2.8: Let G be a graph with radius one and diameter two. Then $\gamma_{oed}(G) = p - 2$ if and only if any one of the following is true:

(i) $G = K_{1, p-1} + e$.

(ii) $G = K_2 + (p - 2)K_1$.

Proof: Let D be a γ_{oed}-set with $|D| = p - 2$. Since D is a γ_{oed}-set, D has no central vertices. Therefore, G may have one or two central vertices only.

Case (i): G has only one central vertex.

In this case $|E_2| = p - 1$. Let u $\in$ V(G) with e(u) = 1 and u $\notin$ D. Let v $\in$ V(G) such that e(v) = 2 and v$\notin$ D. D = V(G) – {u, v}, since v $\notin$ D, v is adjacent to some vertex of D. Let x $\in$ D be isolated in $\langle D \rangle$. Hence, x is eccentric to all other vertices of D and e(x) = 2, v may be adjacent to x or not (since e(v) = 2, v cannot be adjacent to all vertices of D). Vertices v and x are in E_2. Hence, if there exists more than one edge in $\langle E_2 \rangle$ then we can find a minimal isolate eccentric dominating set such that $\gamma_{oed}(G) < p - 2$. Thus,$\gamma_{oed}(G) = p - 2$ implies that G is a graph with radius one and there exists p – 2 independent vertices in E_2.

That is, $\beta_o(\langle E_2 \rangle) = p - 2$ and hence $\beta_o(G) = p - 2$. In this case, G is of the form $K_{1,n} + e$.

Case (ii): G has two central vertices.

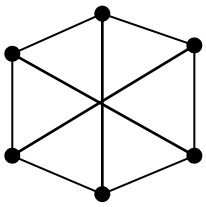
Let u, v be the central vertices. Let w $\in$ D be isolated in $\langle D \rangle$. E_2 = V(G) – {u, v} = D. The vertex w is eccentric to all vertices of E_2, since it is isolated in D. As in previous case, if there exists any edge in $\langle E_2 \rangle$ then we can find a minimal isolate eccentric dominating set such that $\gamma_{oed}(G) < p - 2$. Hence, there exists no edges in $\langle E_2 \rangle$. Thus, G = $K_2 + (p - 2) K_1$.

Theorem 2.9: Let G be a two self-centered graph having an isolate eccentric dominating set. Then $\gamma_{oed}(G) \neq 2$.

Proof: Assume $\gamma_{oed}(G) = 2$. Then $\gamma(G) = \gamma_{ed}(G) = \gamma_{oed}(G) = 2$, since $\gamma_{ed}(G) \neq 1$ and $\gamma(G) \neq 1$ for G. $\gamma_{ed}(G) = 2$ implies that there is a γ_{ed}-set D = {x, y} such that e = xy is a dominating edge of G which is not in a triangle by Theorem 1.3. But D is an isolate eccentric dominating set implies that x and y are not adjacent in G, which is a contradiction

to xy is an edge. Hence, $\gamma_{oed}(G)$ cannot be two.

Example 2.4:



G

This graph G is two self-centered but it has no isolate eccentric dominating set.

Theorem 2.10: Let G be a two self-centered graph having an isolate eccentric dominating set. Then $\gamma_{oed}(G) \neq p - 1$ and $3 \leq \gamma_{oed}(G) \leq p - 2$.

Proof: Let G be a two self-centered graph having an isolate eccentric dominating set D. Let w be an isolated vertex in D. Hence, D contains no neighbours of w.

Thus, $|D| \leq p - \deg u \leq p - \delta(G)$. Therefore, $\gamma_{oed}(G) \leq p - \delta(G)$. Since, G is two self-centered $\delta(G) \geq 2$. Hence, $\gamma_{oed}(G) \neq p - 1$. Also, by previous theorem $\gamma_{oed}(G) \neq 2$.

So if G is a two self-centered graph having an isolate eccentric dominating set then $3 \leq \gamma_{oed}(G) \leq p - 2$.

Theorem 2.11: Let G be a two self-centered graph having an isolate eccentric dominating set. Then $\gamma_{oed}(G) = p - 2$ if and only if G is C_5 or $C_5 + e$.

Proof: Let $D \subseteq V(G)$ be an isolate eccentric dominating set with $|D| = p - 2$. Then $|V - D| = 2$. Let $V - D = \{x, y\}$. Let D contains an isolated vertex v. Since v is isolated in D, $N(v) \subseteq V - D$ and hence, $N(v) = \{x, y\}$. So, $v \in V(G)$ is a vertex of degree two.

Case (i): $xy \notin E(G)$.

There exists atleast one $v_1 \in N_2(v)$ not adjacent to x and there exists atleast one $v_2 \in N_2(v)$ not adjacent to y. Also, every vertex of $N_2(v)$ is adjacent to any one of x or y, since G is two self-centered.

Hence, $\{v, v_1, v_2\}$ is an isolate eccentric dominating set.

Hence, $\gamma_{oed}(G) = p - 2$ implies that $N_2(v)$ must contain only two vertices v_1 and v_2.

Hence, $|V(G)| = 5$ and $G = C_5$.

Case (ii): $xy \in E(G)$.

By the same argument, we get $G = C_5 + e$.

Converse is obvious.

Theorem 2.12: Let G be a connected graph of radius two and diameter three. Then $\gamma_{oed}(G) = 2$ if and only if G has a γ-set $D = \{x, y\}$ such that $d(x, y) = 3$, $e(x) = e(y) = 3$ and for any shortest path xuvy in G, $e(u) = e(v) = 2$.

Proof: We know that $\gamma_{oed}(G) = 2$ implies that $\gamma_{ed}(G) = 2$. But by Theorem 1.4, $\gamma_{ed}(G) = 2$ if and only if G has aγ-set $D = \{x, y\}$ such that $d(x, y) = 3$, $e(x) = e(y) = 3$ and for any shortest path xuvy in G, $e(u) = e(v) = 2$. In this case, both x and y are isolated in $\langle D \rangle$. Hence, D is an isolate eccentric dominating set.

Theorem 2.13: Let G be a graph with radius two and diameter three. Then $\gamma_{oed}(G)$ cannot be $p - 1$.

Proof: Let G be a graph with radius two and diameter three. Suppose $\gamma_{oed}(G) = p - 1$, there exists $D \subseteq V(G)$ such that $D = V - \{x\}$ and D is a γ_{oed}-set. Now D is a γ_{oed}-set implies that there exists $y \in D$ such that y is isolated in $\langle D \rangle$. Hence, y has no neighbor in D. So it is adjacent to only x. This implies that deg y = 1 in G. This implies that e(y) = 3 in G, x is the support vertex of y. Hence, e(x) = 2, let w be some other vertex adjacent to x such that xwz is a path and z is an eccentric vertex of x. Hence, e(z) must be three.

Case (i): e(w) = 2.

In this case, w is adjacent to $z \in D$ and $y \in D$ is eccentric vertex of w. Hence, we can delete w from D to a minimum γ_{ed}-set.

Case (ii): e(w) = 3.

Then w has some other vertex in D which is an eccentric vertex of w and z is adjacent to w. In this case, also $D - \{w\}$ is an eccentric dominating set.

Hence, $\gamma_{oed}(G)$ cannot be $p - 1$.

Theorem 2.14: Let G be a graph with radius two and diameter four. Then $\gamma_{oed}(G)$ cannot be p – 1.

Proof: Let G be a graph with radius two and diameter four. Suppose $\gamma_{oed}(G) = p - 1$, there exists $D \subseteq V(G)$ such that $D = V - \{x\}$ and D is a γ_{oed}-set. Now D is a γ_{oed}-set implies that there exists $y \in D$ such that y is isolated in $\langle D \rangle$. Hence, y has no neighbor in D. So it is adjacent to only x. This implies that deg y = 1 in G. This implies that e(y) = 3 or 4 in G, x is the support vertex of y. Hence, e(x) = 2 or 3. Now, proceeding as in Theorem 2.13, we can prove this theorem.

Theorem 2.15: Let G be a graph with radius greater than two. Then $\gamma_{oed}(G)$ cannot be p – 1.

Proof: As in Theorem 2.13, we can prove the theorem.

Theorem 2.16: Let G be a connected graph. Then $\gamma_{oed}(G) = p - 1$ if and only if $G = K_{1, n}$.

Proof: Proof follows from Theorems 2.7, 2.10, 2.13 and 2.14.

Theorem 2.17: Let G be a connected graph. Then $\gamma_{oed}(G) = 2$ if and only if any one of the following is true:

(i) G is a graph with radius one and diameter two such that there exists $u, v \in E_2$ such that each vertex of eccentricity two is adjacent to either u or v and $d_{<E2>}(u, v) \geq 3$.

(ii) G is a graph of radius two and diameter three such that G has a γ-set $D = \{x, y\}$ such that $d(x, y) = 3$, $e(x) = e(y) = 3$ and for any shortest path xuvy in G, $e(u) = e(v) = 2$.

Proof: If G is a graph with radius greater than two or radius 2 and diameter 4 then $\gamma_{ed}(G) > 2$. Hence the proof follows from Theorem 2.6, 2.9 and 2.10.

Conclusion

We have studied exact values of isolate eccentric domination number for some graphs. Also, we have characterized graphs for which $\gamma_{oed}(G) = 1, 2, p - 2$ and $p - 1$.

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DOMINATION PARAMETERS OF $BG_5(G)$

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ABSTRACT

Let G(V, E) be a simple, finite and undirected connected graph. $BG_1(G)$ is a graph with vertex set $V(G) \cup E(G)$ and two vertices are adjacent if and only if they correspond to two adjacent vertices of G or to a vertex and an edge not incident to it in G and BG(G) is a graph with vertex set $V(G) \cup E(G)$ and two vertices are adjacent if and only if they correspond to two non adjacent vertices of G, a vertex and an edge not incident to it in G.

$$BG_5(G) = BG(G) \cup BG_1(G).$$

In this paper, we study some domination parameters of $BG_5(G)$.

Keywords: Boolean graph $BG_5(G)$, Domination parameters.

Introduction

Let G = (V, E) be a (p, q) simple undirected graph. For v∈ V(G), the set of all vertices adjacent to v in G is called the neighborhood $N_G(v)$. A point and a line are said to cover each other if they are incident. A set of points which covers all the lines of a graph G is called a point cover for G, while a set of lines which covers all the points is a line cover. The smallest number of points in any point cover for G is called its point covering number and is denoted by $\alpha_0(G)$ or α_0. $\alpha_1(G)$ or α_1 is the smallest number of lines in any line cover of G and is called its line covering number.

T.N. Janakiraman, M. Bhanumathi and S. Muthammai introduced "Boolean graphs in [3, 11, 12, 13, 14]. M. Bhanumathi and M. Kavitha studied Boolean Graph operator of a graph in [5].

The concept of domination in graphs was introduced by Ore[17]. A set D □□V is said to be a dominating set in G, if every vertex in V□D is adjacent to some vertex in D. The minimum cardinality of a dominating set is called the domination number and is denoted by □(G). A dominating set with cardinality γ(G) is referred as a γ-set. A dominating set D is called a minimal dominating set, if no proper subset of D is a dominating set. A dominating set D of a graph G = (V, E) is a total dominating set, if the induced sub graph < D > has no isolated vertices. The total domination number γt(G) of a graph G is the minimum cardinality of a total dominating set. A dominating set D is a connected dominating set, if < D > is a connected sub graph of G.

A dominating set D is an independent dominating set, if no two vertices in D are adjacent that is D is an independent set. A dominating set D is a perfect dominating set, if for every vertex u ∈ V – D, |N(u) ∩ D| = 1.

A set S of vertices is said to be irredundant, if for every vertex v ∈ S, $P_n[v, S] = N[v] – N[S –(v)] \neq \phi$, that is, every vertex v ∈ S has a private neighbour. The irredundance number ir(G) equals the minimum cardinality of a maximal irredundant set in G. A set of points in G is independent if no two of them are adjacent. The largest number of points in such a set is called the point independence number of G and is denoted by $\beta_0(G)$ or β_0. An independent set of lines of G has no two of its lines adjacent and the maximum cardinality of such a set is the line independence number $\beta_1(G)$ or β_1.

A set S of vertices is called a neighbourhood set provided G is the union of the subgraphs induced by the closed neighbourhoods of the vertices in S, that is, $G = \bigcup_{u \in S} < N[v] >$.

In 1993, Sampathkumar and Pushpalatha [19] introduced the concept of point set dominating set. A set S ⊆ V is a point set dominating set, if for every T ⊆ V – S, there exists a vertex v ∈ S such that the

subgraphs $< T \cup \{v\} >$ induced by $T \cup \{v\}$ is connected.

Theorem 1.1[19]: D is a point set dominating set if and only if for every independent set W in V – D there exist $x \in D$ such that $W \subseteq N(x) \cap V - D$.

Locating dominating set was defined by D.F Rall and P. J. Slater[18]. A dominating set S in a graph G is called a locating dominating set in G, if for any two vertices v, $w \in V(G) - S$, $N_G(v) \cap S$, $N_G(w) \cap S$ are non- empty and distinct. The locating domination number of G is defined as the minimum number of vertices in a locating dominating set in G and denoted by $\gamma_L(G)$.

In [4], Bhanumathi and Muthammai introduced the concept of eccentric domination. A set $D \subseteq V(G)$ is an eccentric dominating set if D is a dominating set of *G* and for every $v \in V - D$, there exists at least one eccentric vertex of *v* in D. An eccentric dominating set D is a minimal eccentric dominating set if no proper subset $S \subseteq D$ is an eccentric dominating set. The minimum cardinality of an eccentric dominating set is called the eccentric domination number and is denoted by $\gamma_{ed}(G)$.

Theorem 1.2[4]: If G is a two self centered graph then $\gamma_{ed}(G) \leq 1 + \delta(G)$.

Arumugam and Velammal introduced the concept of edge domination in graphs [1]. A subset X of E is called an edge dominating set of G if every edge not in X is adjacent to some edge in X. The edge domination number $\gamma'(G)$ is the minimum cardinality taken over all edge dominating sets of G.

Theorem 1.3[1]:

$$\gamma'(K_p) = \begin{cases} \frac{p}{2} & \text{if p is even} \\ \left\lceil \frac{p}{2} \right\rceil & \text{if p is odd} \end{cases}$$

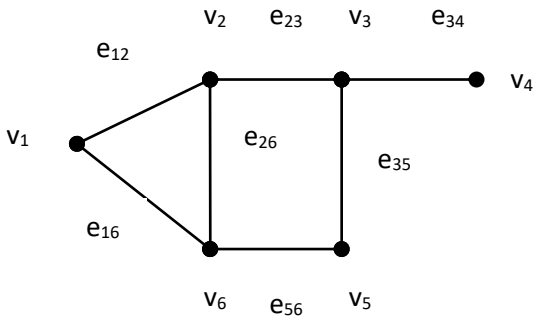
Definition of $BG_5(G)$

Let G(V, E) be a simple, finite and undirected connected graph. $BG_1(G)$ is a graph with vertex set $V(G) \cup E(G)$ and two vertices are adjacent if and only if they correspond to two adjacent vertices of G or to a vertex and an edge not incident to it in G and BG(G) is a graph with vertex set $V(G) \cup E(G)$ and two vertices are adjacent if and only if they correspond to two non adjacent vertices of G, a vertex and an edge not incident to it in G.

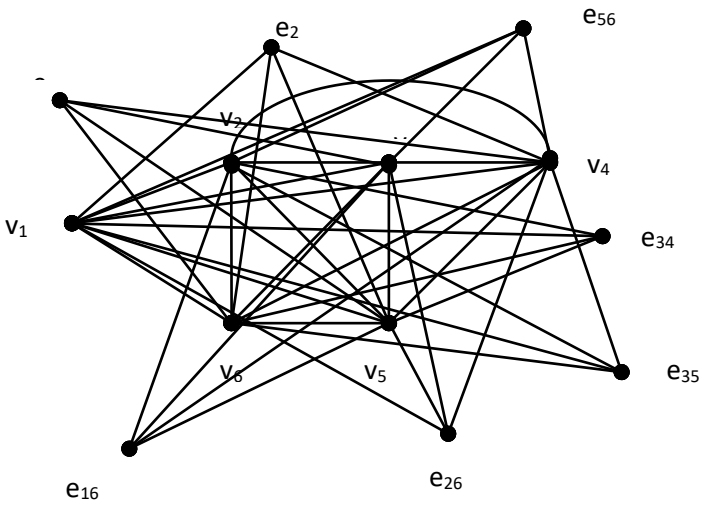
$BG_5(G) = BG(G) \cup BG_1(G)$.

Vertex set of $BG_5(G) = V(G) \cup E(G)$ and two vertices are adjacent in $BG_5(G)$ if and only if they correspond to two vertices of G or to a vertex and an edge not incident to it in G. $BG_5(G)$ has p + q vertices and p point vertices with degree $p - 1 + (q - \deg v_i)$, q line vertices with degree p – 2. $BG_5(G)$ has $q(p - 2) + \frac{p(p-1)}{2}$ edges.

Example 2.1



G



3. Domination parameters of $BG_5(G)$ and $\overline{BG_5(G)}$

In this section, we study some domination parameters of $BG_5(G)$ and $\overline{BG_5(G)}$.

Theorem 3.1: If $G = K_n$, then $\gamma(BG_5(G)) = \gamma_c(BG_5(G)) = 3$, $n \geq 3$.

Proof: Suppose $G = K_n$, a point vertex v dominates all other point vertices and other line vertices which represent lines not incident to v.

Hence to dominate other line vertices, we need two more vertices. Thus $\gamma(BG_5(G)) \geq 3$

$D = \{v_1, v_2, v_3\} \subset V(G)$ is a minimum dominating set. Thus $\gamma(BG_5(G)) \leq 3$. Therefore, $\gamma(BG_5(G)) = 3$.

The subgraph <D> is also connected in $BG_5(G)$.

Hence, $\gamma_c(BG_5(G)) = 3$.

Therefore, $\gamma(BG_5(G)) = \gamma_c(BG_5(G)) = 3$.

Theorem 3.2: If G is connected and $G \neq K_n$, then $\gamma(BG_5(G)) = \gamma_c(BG_5(G)) = 2$.

Proof: If $G \neq K_n$ then G has atleast two vertices v_1, v_2 which are not adjacent in G.

Hence in $BG_5(G)$, $D = \{v_1, v_2\}$ is a minimum dominating set. The subgraph <D> is also connected in $BG_5(G)$. Thus, $\gamma(BG_5(G)) \leq 2$. Also, since G is connected, $\gamma(BG_5(G)) \geq 2$. Hence $\gamma(BG_5(G)) = \gamma_c(BG_5(G)) = 2$.

Remark 3.1: $\gamma(BG_5(G))$ = if and only if G has an isolated vertex.

Independent domination of $BG_5(G)$ and $\overline{BG_5(G)}$

Theorem 3.3: $D = \{u, \text{edges incident with u in G}\}$, $u \in V(G)$ is an independent dominating set for $BG_5(G)$.

Proof: Let $u \in V(G)$ and $D = \{u, \text{edges incident with u in G}\}$. Vertex u dominates all the point vertices and line vertices which are not incident with u in $BG_5(G)$. Therefore, D is a dominating set of $BG_5(G)$. Also D is independent in $BG_5(G)$. Hence the result.

Remark 3.2: (i) $\gamma_i(BG_5(G)) = 1 + \delta(G)$.

Let $u \in V(G)$ with $\deg_G u = \delta(G)$. Then D is a Independent dominating set of $G_5(G)$.Therefore, $\gamma_i(BG_5(G)) = 1 + \delta(G)$.

(iii) $\gamma_i(BG_5(G)) = 2$ if and only if G has a pendant vertex.

Theorem 3.4: Let G be a connected graph. (i) D = V(G) is an independent dominating set for $\overline{BG_5(G)}$.

(ii) If $e = v_1v_2 \in E(G)$ and $V(G) = \{v_1, v_2, \ldots, v_p\}$ then $D = \{e, v_3, v_4, \ldots, v_p\}$ is an independent dominating set for $\overline{BG_5(G)}$.

Proof: (i) In $\overline{BG_5(G)}$, each line vertex is adjacent to its incident point vertices. Also V(G) is independent in $\overline{BG_5(G)}$. Therefore, V(G) is an independent dominating set of $\overline{BG_5(G)}$

(ii) e dominates v_1, v_2 and line vertices in $\overline{BG_5(G)}$ and e is not adjacent to any other point vertex of $\overline{BG_5(G)}$ and $\{v_3, \ldots, v_p\}$ dominates all other line vertices. Therefore, D is a dominating set of $\overline{BG_5(G)}$ and is independent. Therefore, D is an independent dominating set of $\overline{BG_5(G)}$.

Remark 3.3: $\gamma_i(\overline{BG_5(G)}) \leq p - 1$.

Theorem 3.5: $\gamma_i(\overline{BG_5(G)}) = p - 1$.

Proof: Any independent dominating set cannot contain more than one line vertex and a line vertex is adjacent to exactly two point vertices and all other line vertices. To dominate (p – 2) other point vertices, we have to take all of them. Therefore, $D = \{e, v_3, \ldots, v_p\}$is a minimal independent dominating set with minimum cardinality. Therefore, $\gamma_i(\overline{BG_5(G)}) = p - 1$.

Point set domination of $BG_5(G)$ and $\overline{BG_5(G)}$

Theorem 3.6: $\gamma_{psd}(BG_5(G)) = 1 + \delta(G)$.

Proof: Let u ∈ V(G) with $\deg_G u = \delta(G)$. Consider D = {u, edges incident with u in G}. In $BG_5(G)$, u dominates all elements in V – D.

Therefore, D is a point set domination set for $BG_5(G)$.

Hence $\gamma_{psd}(BG_5(G)) \leq 1 + \delta(G)$. ----------(1)

Now the line vertices are incident in $BG_5(G)$. Therefore to dominate W ⊆ E(G), W independent in $BG_5(G)$, any point set dominating set D must contain a point vertex, which is not incident with every element of W. That is D must contain a point vertex and its incident edges.

Therefore, $\gamma_{psd}(BG_5(G)) \geq 1 + \delta(G)$ ----------(2)

From (1) and (2) $\gamma_{psd}(BG_5(G)) = 1 + \delta(G)$.

Theorem 3.7: (i) $BG_5(G)$ has a point set dominating set D ⊆ V(G) if and only if G has an isolated vertex.

(ii) Set of all point vertices is a point set dominating set if and only if G has an isolated vertex.

(iii) Set of all line vertices is a point set dominating set for $BG_5(G)$ if and only if $G \neq K_{1,n}$, $q \geq 2$.

Proof: Let D ⊆ V(G). Any independent set of $BG_5(G)$ must contain atmost one point vertex. Let W be the set of all line vertices, W ⊆ V – D. Then W ⊆ N(x) ∩ (V – D) for x ∈ D implies that x is an isolated vertex of G.

This proves (i) and (ii).

(iii) If $G = K_{1,n}$, set of all line vertices cannot dominate $BG_5(G)$.

Assume $G \neq K_{1,n}$, $q \geq 2$. D = E(G) and V – D = V(G). Let W be any independent set in V(G). W must be singleton. Let W = {u}, u ∈ V(G). Let e ∈ E(G) such that e is not incident with u, then W ⊆ N(e) ∩ (V – D). Therefore, D is a point set dominating set.

Theorem 3.8: Let $e = v_1v_2 \in E(G)$, $v_1, v_2 \in V(G)$ then $D = \{e, v_3, v_4, \ldots, v_p\}$ is a point set dominating set for $\overline{BG_5(G)}$ and $\gamma_{psd} \leq p - 1$.

Proof: $D = \{e, v_3, v_4, \ldots, v_p\}$. Consider V – D = {$v_1$, v_2} ∪ (E(G) –{e}). Let W ⊆ V – D be an independent set of elements of V – D.

case(i): W ⊆ V(G). Then W = {v_1} or {v_2} or {v_1, v_2}. W is dominated by e ∈ D.

case(ii): W ⊆ E(G). Then W must be a singleton and e dominates W.

case(iii): W contains both point vertices and line vertices. W = {v_i, edges not incident with v_i where i = 1, 2} or W ={v_1, v_2, edges not incident with v_1 and v_2}. In all the cases, e dominates W. Therefore, D is a point set dominating set of $\overline{BG_5(G)}$ and $\gamma_{psd} \leq p - 1$.

Theorem 3.9: $\gamma_{psd}(\overline{BG_5(G)}) > p - 2$.

Proof: Let D be a point set dominating set of $\overline{BG_5(G)}$. If V – D contains more than two point vertices then they form an independent set W, but W is not dominated by any other point vertex or line vertex.

Therefore, if D is a point set dominating set, then it must contains atleast p – 2 point vertices (since it must contain one line vertex to dominate w = {v_1, v_2}). Therefore, $\gamma_{psd}(\overline{BG_5(G)}) > p - 2$.

Theorem 3.10 : $\gamma_{psd}(\overline{BG_5(G)}) = p - 1$.

Proof: From the previous two theorems, we get this theorem.

Theorem 3.11: Let D be a minimal point cover for G. then D is a point set dominating set for $\overline{BG_5(G)}$ if and only if $G = K_2$.

Proof: D is a point set dominating set if and only if for every independent set W in V – D there exist x ∈ D such that W ⊆ N(x) ∩ V – D. Now take W as the set of all point vertices. Therefore, W ⊆ N(e) ∩ (V – D) which implies |W| ≤ 2. Therefore p = 2, that is $G = K_2$.

This proves the result.

Remark 3.4: (i) Set of all line vertices is a point set dominating set for $\overline{BG_5(G)}$ if and only if $G = K_2$.

(ii) Set of all point vertices is a point set dominating set for $\overline{BG_5(G)}$ (since <E(G)> forms a complete subgraph).

Perfect domination of $BG_5(G)$ and $\overline{BG_5(G)}$

Theorem 3.12: Let G be a graph with p > 2. Then any perfect dominating set of $BG_5(G)$ must contain atmost one point vertex or all point vertices.

Proof: Assume G has no isolated vertices.

Case(i): There is no point vertex in D.

Then D must contain only the line vertices and $G \neq K_{1,n}$, since D is a dominating set and line vertices are independent. Suppose there exist $u \in V(G)$ such that u is not incident with more than one line vertex, then D is not perfect. That is every point vertex is incident with q – 1 line vertices and $G \neq K_{1,n}$.

Therefore, $G = K_3$ or $2K_2$.

Case(ii): D has only one point vertex u. D is a dominating set of $BG_5(G)$.

Therefore, D must contain all the line vertices incident with u, every point vertex is adjacent to u and the edges not incident with it.

Therefore, D is perfect if and only if $G = K_2$.

That is D = {u, e} is a perfect dominating set if and only if $G = K_2$.

Case(iii): D contains all the point vertices of G. $V(G) \subseteq D$.

A line vertex not in D must be adjacent to all point vertices except one.

Therefore, p = 3 and $G = K_3, K_{1,2}$. In this case, D is the set of all point vertices.

Therefore, $BG_5(G)$ has a perfect dominating set if and only if $G = K_3$, $2K_2$ or $K_{1,2}$

Theorem 3.13: Let G be a connected graph with no isolated vertices. Then V(G) is a perfect dominating set of $BG_5(G)$ if and only if $G = K_3$ or $K_{1,2}$.

Proof: If $G = K_3, K_{1,2}$ then D = V(G) is a perfect dominating set.

On the other hand suppose V(G) = D is a perfect dominating set of $BG_5(G)$. Then every element of E(G) is incident with p – 1 elements of D .

This implies that p – 1 = 2, p = 3. This proves that $G = K_3$ or $K_{1,2}$.

Theorem 3.14: Let G be a graph without isolated vertices. E(G) is a perfect dominating set of $BG_5(G)$ if and only if $G = K_3$ or $2K_2$.

Proof: If $G = K_3$, $2K_2$ then D = E(G) is a perfect dominating set of $BG_5(G)$.

On the other hand Let D = E(G) be a perfect dominating set of $BG_5(G)$. Then every point vertex is adjacent to only one element of D in $BG_5(G)$.

This implies that every point vertex is incident with other elements of D.

Therefore, D must contain atmost three elements.

When |D| = 1, $G = K_2$ and E(G) is not a dominating set.

When |D| = 2, $G = K_{1\,2}$ and E(G) is not a dominating set or $G = 2K_2$ and E(G) is a dominating set.

When |D| = 3, $G = K_3$ or every point vertex is incident with two elements of D.

Therefore, $G = K_3$ or $2K_2$ only.

Remark 3.5: $\gamma_p(\overline{BG_5(G)}) = 1$ if and only if $G = K_2$. Also, D = {e} is a perfect dominating set for $\overline{BG_5(G)}$.

Theorem 3.16: Let G be a graph without isolated vertices. Let D be a line cover for G, then D is a perfect dominating set for $\overline{BG_5(G)}$ if and only if $G = nK_2$.

Proof: Suppose $D \neq E(G)$, then a line vertex in V – D is adjacent to all elements of D ($|D| \geq 2$ if $G \neq K_2$).

Therefore, D is not perfect. Hence D = E(G). Now suppose $\deg_G u > 1$ then u is adjacent to more than one line vertex.

Therefore, D is perfect if and only if $\deg_G u = 1$ for all $u \in V(G)$. Thus $G = nK_2$.

Converse is obvious.

Theorem 3.17: (i) D = E(G) is a perfect dominating set of $\overline{BG_5(G)}$ if and only if $G = nK_2$.

(ii) Set of all point vertices is not a perfect dominating set for $\overline{BG_5(G)}$.

Proof: (i) Proof follows from the previous result.

(ii) Every line vertex is adjacent to two point vertices in $\overline{BG_5(G)}$. Hence the result.

Remark 3.6: (i) If a minimal perfect dominating set of $\overline{BG_5(G)}$ contains more than one line vertex, then it must contain all the line vertices, since line vertices form a complete subgraph.

(ii) If D contains all the line vertices and δ(G) ≥ 2 then D must contain all the point vertices also. Therefore, D is trivial and D = V($\overline{BG_5(G)}$).

Theorem 3.18: If G = K_{1n} then $\gamma_p(\overline{BG_5(G)})$ = n + 1.

Proof: Let D′ = set of all line vertices of G and Let D = D′ ∪ {u} where u is a central vertex of G. Then clearly D is a minimum perfect dominating set for $\overline{BG_5(G)}$**.** Therefore, $\gamma_p(\overline{BG_5(G)})$ = n + 1.

Theorem 3.19: If G has k pendant vertices, then D = E(G) ∪ (V(G) – S) is a perfect dominating set for $\overline{BG_5(G)}$**,** where S is the set of all pendant vertices of G. Therefore, $\gamma_p(\overline{BG_5(G)})$ ≤ p + q– k. where |S| = k.

Proof: Each element in V – D, that is the set of pendant point vertices are adjacent to exactly one line vertex of D in $\overline{BG_5(G)}$**.** Therefore, D is a perfect dominating set and hence $\gamma_p(\overline{BG_5(G)})$ ≤ p + q – k.

Remark 3.7: If G has no pendant vertex, $\overline{BG_5(G)}$ has no non trivial perfect dominating set.

Locating domination in Boolean Graph $BG_5(G)$ of a Graph.

Theorem 3.20: If G is a connected (p, q) graph then $\gamma_L(BG_5(G))$ ≤ p –1.

Proof : If G has p vertices, $BG_5(G)$ has a clique on p point vertices and an independent set on q line vertices.

Consider D = {v_1, v_2, …, v_{n-1}}. D is a dominating set. Also, V – D = E(G) ∪ {v_n} and N(x) ∩ D ≠ N(y) ∩ D ≠ ϕ for any two x, y ∈ V – D . Hence D = {v_1, …, v_{n-1}} is a locating dominating set of $BG_5(G)$.

Therefore, $\gamma_L(BG_5(G))$ ≤ p – 1.

Eccentric Domination in $BG_5(G)$

Theorem 3.21: If G is a connected graph with p ≥ 5, then $\gamma_{ed}(BG_5(G))$ ≤ p – 1.

Proof: If G is a connected graph with p ≥ 5, then $BG_5(G)$ is two self centered and degree of every line vertex is p – 2. Hence, by Theorem 1.2, $\gamma_{ed}(BG_5(G))$ ≤ 1 + δ($BG_5(G)$) = 1+ p–2 = p–1.

Edge domination in Boolean graph of $BG_5(G)$.

Theorem 3.22: Let G be a connected graph on p vertices. Then γ′($BG_5(G)$) = $\frac{p}{2}$ if p is even

$\left\lceil\frac{p}{2}\right\rceil$ if p is odd

Proof: $BG_5(G)$ contains a clique (complete subgraph) on p vertices and an independent set on q vertices. Since $BG_5(G)$ has K_p as a subgraph, by Theorem 1.3, γ′($BG_5(G)$) ≥ $\frac{p}{2}$ if p is even

$\left\lceil\frac{p}{2}\right\rceil$ if p is odd

Now, Let V(G) = {v_1, v_2, …, v_p}.

If p is even, $BG_5(G)$ the edges b_1 = v_1v_2, b_2 = v_3v_4, …., $b_{\frac{n}{2}}$ = v_{p-1} v_p form an edge dominating set. So, D′ = {b_1, …, $b_{\frac{n}{2}}$} ⊆ E($BG_5(G)$) is an edge dominating set of $BG_5(G)$. Edge joining the line vertices to point vertices are also dominated by these edges in D.

Hence γ′($BG_5(G)$) ≤ $\frac{p}{2}$ if p is even.

If p is odd, the edges b_1 = v_1v_2, …, $b_{\frac{n-1}{2}}$ = $v_{n-1}v_n$, $b_{\frac{n+1}{2}}$ = v_nv_1.(any edge incident with v_n) form an edge dominating set of $BG_5(G)$.

Hence γ′($BG_5(G)$) ≤ $\frac{p+1}{2}$ = $\left\lceil\frac{p}{2}\right\rceil$.

This proves the theorem.

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SOME MORE RESULTS ON SPLIT TREE DOMINATION NUMBER IN CONNECTED GRAPHS

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ABSTRACT

Let G = (V, E) be a connected graph. A subset D of V is called a dominating set of G if N[D] = V. The minimum cardinality of a dominating set of G is called the domination number of G and is denoted by γ(G). A dominating set D of a graph G is called a tree dominating set (tr - set) if the induced subgraph ⟨D⟩ is a tree. The tree domination number $\gamma_{tr}(G)$ of G is the minimum cardinality of a tree dominating set. A tree dominating set D of a graph G is called a split tree dominating set (std - set) if the induced subgraph ⟨ V – D ⟩ is disconnected. The split tree domination number $\gamma_{std}(G)$ of G is the minimum cardinality of a split tree dominating set. In this paper, bounds for $\gamma_{str}(G)$ and its exact values for some unicyclic graphs are found.

Keywords: *Domination number, connected domination number, tree domination number, split domination number.*

Mathematics Subject Classification: 05C69

INTRODUCTION

The graphs considered here are nontrivial, finite and undirected. The order and size of G are denoted by n and m respectively. If $D \subseteq V$, then $N(D) = \bigcup_{v \in D} N(v)$ and $N[D] = N(D) \cup D$ where N(v) is the set of vertices of G which are adjacent to v. The concept of domination in graphs was introduced by Ore[13]. A subset D of V is called a dominating set of G if N[D] = V. The minimum cardinality of a dominating set of G is called the domination number of G and is denoted by γ(G). Xuegang Chen, Liang Sun and Alice McRac [14] introduced the concept of tree domination in graphs. A dominating set D of G is called a tree dominating set, if the induced subgraph ⟨D⟩ is a tree. The minimum cardinality of a tree dominating set of G is called the tree domination number of G and is denoted by $\gamma_{tr}(G)$. Kulli and Janakiram [8, 9] introduced the concept of split and nonsplit domination in graphs.

A dominating set D of a graph G is called a split dominating set if the induced subgraph ⟨V – D⟩ is disconnected. The split domination number $\gamma_{sd}(G)$ of G is the minimum cardinality of a split dominating set. Muthammai and Chitiravalli [11, 12] defined the concept of split and nonsplit tree domination in graphs. A tree dominating set D of a graph G is called a split tree dominating set if the induced subgraph ⟨V – D⟩ is disconnected. The split tree domination number $\gamma_{std}(G)$ of G is the minimum cardinality of a split tree dominating set.

In this paper, bounds for $\gamma_{str}(G)$ and its exact values for some unicyclic graphs are found.

PRIOR RESULTS

Theorem 2.1: [2] For any graph G, $\kappa(G) \leq \delta(G)$.

Theorem 2.2: [14] For any connected graph G with $n \geq 3$, $\gamma_{tr}(G) \leq n - 2$.

Theorem 2.3: [14] For any connected graph G with $\gamma_{tr}(G) = n - 2$ iff $G \cong P_n$ (or) C_n.

Theorem 2.4: [12] For any cycle C_n on n vertices, $\gamma_{std}(C_n) = n - 1$, $n \geq 3$.

Theorem 2.5: [12] For any path P_n on n vertices $\gamma_{std}(P_n) = n - 2$, $n \geq 3$.

Theorem 2.6: [12] For any graph G, $\gamma(G) \leq \gamma_s(G) \leq \gamma_{std}(G)$ and $\gamma(G) \leq \gamma_{tr}(G) \leq \gamma_{std}(G)$. Also $\kappa(G) \leq \gamma_{tr}(G) \leq \gamma_{std}(G)$.

Theorem 2.7: [12] Let G is a wounded spider and if s is the number of supports, then $\gamma_{std}(G) = s$.

Theorem 2.8: [12] Let G is a bistar, then $\gamma_{std}(G) = 2$, since the set containing two supports is a std-set of G.

Theorem 2.9: [12]

$$\gamma_{std}(\overline{P_n}) = \begin{cases} 2, & \text{if } n = 4,5 \\ 3, & \text{if } n = 6 \\ 4, & \text{if } n = 7 \\ 0, & \text{if } n \geq 8 \end{cases}$$ where $\overline{P_n}$ is the complement of P_n.

Theorem 2.10: [12]

$$\gamma_{std}(\overline{C_n}) = \begin{cases} 4, & \text{if } 4 \leq n \leq 7 \\ 0, & \text{if } n \geq 8 \end{cases}$$ where $\overline{C_n}$ is the complement of C_n.

Theorem 2.11: [12] For any connected graph G, $\frac{n}{\Delta(G)+1} \leq \gamma(G)$

Theorem 2.12: [12] For any connected graph G on n vertices, if $\gamma_{std}(G) > 0$, then $1 \leq \gamma_{std}(G) \leq n - 2$.

MAIN RSSULTS

In this section, bounds for $\gamma_{str}(G)$ and its exact values for some unicyclic graphs are found.

Theorem 3.1:

Let D be a γ_{std} - set of a connected graph G. Then there exist two vertices u_1, u_2 in V(G) – D such that $d(u_1, u_2) \geq 2$.

Proof:

Assume that for any two vertices u_1, u_2 in V(G) – D, $d(u_1, u_2) = 1$. Then ⟨V(G) – D⟩ is connected, which is a cont33radiction to D is a std - set. Therefore, for any two vertices u_1, u_2 in V(G) – D, $d(u_1, u_2) \geq 2$.

Theorem 3.2:

A dominating set D of a connected graph G is a std-set of G if and only if

(i) there exist two vertices u_1, u_2 in V(G) – D such that every u_1 - u_2 path contains a vertex of D and

(ii) for any two vertices v_1 and v_2 in D, there is a unique path connecting v_1 and v_2 in D.

Proof:

Assume conditions (i) and (ii). By (i), D is a split dominating set of G and by (ii), ⟨D⟩ is a tree. Therefore, D is a std-set of G.

Conversely, let D be a dominating set of G. If (i) does not hold, then ⟨V(G) – D⟩ is connected. If (ii) does not hold, then ⟨D⟩ is not a tree.

In the following, the graphs for which $\gamma_{std}(G) = 1$, 2 and n – 2 are characterized

Theorem 3.3:

For any connected graph G with n vertices and $\gamma_{std}(G) > 0$, $\gamma_{std}(G) = 1$ if and only if there exists a unique cutvertex v in G with degree n – 1.

Proof:

Let $\gamma_{std}(G) = 1$ and D = {u} be a std - set of G. Then

⟨V(G) – D⟩ = ⟨V(G) – {u}⟩ is disconnected and u dominates all the other vertices of G. Thus, u is a cutvertex of G and is of degree n – 1. Suppose there exists another cutvertex w and deg(w) = n – 1, then ⟨V(G) – {w}⟩ is connected, which is a contradiction. Therefore, u is the only cutvertex in G.

Conversely, let u be a unique cutvertex in G of degree n – 1. Then {u} is a dominating set and ⟨V(G) – {u}⟩ is disconnected. Therefore, {u} is a std-set of G and hence $\gamma_{std}(G) = 1$.

Theorem 3.4:

Let G be a connected graph such that $\gamma_{std}(G) > 1$. Then $\gamma_{std}(G) = 2$ if and only if there exist two adjacent vertices u, v in G such that ⟨V(G) – {u, v}⟩ is disconnected and either

(i) there exist two vertices w_1 and w_2 in V(G) – {u, v} such that

$N(w_1) \cap \{u, v\} = \{u\}$ (say) and $N(w_2) \cap \{u, v\} = \{v\}$ (or)

(ii) all the vertices of $V(G) - \{u, v\}$ are adjacent to both u and v.

Proof:

Assume $\gamma_{std}(G) = 2$. Let $D = \{u, v\} \subseteq V(G)$ be a minimum std-set of G. Then u and v are adjacent in G and $\langle V(G) - \{u, v\}\rangle$ is disconnected.

If (i) is not true, then either $N(w_1) \cap \{u, v\} = \{u, v\}$ or $N(w_2) \cap \{u, v\} = \{u, v\}$and $\{u\}$ or $\{v\}$ is split tree dominating set of G.

If (ii) is not true, then there exists a vertex $w \in V(G) - D$, which is adjacent to exactly one of u and v. Then also $\gamma_{std}(G) = 1$

Therefore, (i) or (ii) holds.

Conversely, if the given conditions are true, then $\gamma_{std}(G) = 2$.

Theorem 3.5:

Let G be a connected graph on n vertices ($n \geq 6$) such that $\gamma_{std}(G) > 1$. Then $\gamma_{std}(G) = n - 2$ if and only if either G is a path on n vertices or G is isomorphic to $T + 2K_1$, where T is a tree on $n - 2$ vertices.

Proof:

If either G is a path on n vertices or G is isomorphic to $T + 2K_1$, where T is a tree on $n - 2$ vertices, then $\gamma_{std}(G) = n - 2$.

Conversely, assume $\gamma_{std}(G) = n - 2$. Let D be a std-set of G such that $|D| = n - 2$. Then $\langle V(G) - D\rangle \cong 2K_1$.

Case 1. G is a tree

Then $V(G) - \{\text{pendant vertices}\}$ is a minimum std-set of G. Since $|V(G) - D| = 2$, G contains two pendant vertices. Therefore, T is a path on n vertices.

Case 2. G contains cycles.

Let $V(G) - D = \{w_1, w_2\}$. If $\delta(G) = 1$, then atleast one of w_1 and w_2 is a pendant vertex of G. Let it be w_1 and $v_1 \in D$ be adjacent to w_1. Since $\gamma_{std}(G) > 1$, w_2 is adjacent to a vertex other than v_1. Since G contains cycles, $\langle D\rangle$ is a tree and $\langle V(G) - D\rangle \cong 2K_1$, w_2 is adjacent to atleast two vertices of D. In that case $\gamma_{std}(G) \leq n - 3$. Therefore $\delta(G) \geq 2$. Let w_1 be adjacent to all the vertices of D and w_2 be adjacent to $|D| - 1$ vertices of D. Let $v \in D$ be not adjacent to w_2. Since $\langle D\rangle$ is a tree, $d_{\langle D\rangle}(v) \geq 1$. If $d_{\langle D\rangle}(v) = 1$, then $N(w_2)$ is a std-set of G. Therefore, $\gamma_{std}(G) \leq |N(w_2)| \leq n - 3$.

Assume $d_{\langle D\rangle}(v) \geq 2$. Then $N(v) \cup \{w_1\}$ is a std-set of G. Therefore, $\gamma_{std}(G) \leq |N(v) \cup \{w_1\}| \leq n - 3$. Similarly, it can be proved that, if w_2 is adjacent to atleast two vertices of D, then also $\gamma_{std}(G) \leq n - 3$. Therefore, $G \cong T + 2K_1$, where T is a tree on $n - 2$ vertices.

By Case 1 and Case 2, G is a path on n vertices or G is isomorphic to $T + 2K_1$, where T is a tree on $n - 2$ vertices.

In the following, the connected unicyclic graphs for which $\gamma_{std}(G) = 2, 3, n - 3$ and $n - 4$ are obtained.

Theorem 3.6:

Let G be a connected unicyclic graph such that $\gamma_{std}(G) > 0$. Then $\gamma_{std}(G) = 2$ if and only if G is one of the following graphs.

(i) G is obtained from C_3 by attaching pendant edges at two vertices of C_3.

(ii) G is obtained from C_3 by attaching a path of length 2 at a vertex v of C_3 and attaching k pendant edges at v, where $k \geq 0$

(iii) G is obtained from C_4 by attaching atleast one pendant edge at one vertex or two adjacent vertices of C_4.

Proof:

Let G be one of the graphs mentioned in the theorem.

If G is a graph as in (i), then the set containing two supports of G is a minimum std - set of G and $\gamma_{std}(G) = 2$.

Let G be a graph as in (ii). Let u be the central vertex of the path and let v be the vertex of C_3 adjacent to u. Then $\{u, v\}$ is a minimum std-set of G and $\gamma_{std}(G) = 2$.

Let G be a graph as in (iii). If G is a graph obtained from C_4 by attaching atleast one pendant edge at a vertex of C_4, then a set containing the support of G and a vertex of C_4 adjacent to the support is a minimum std-set of G and $\gamma_{std}(G) = 2$. If G is a graph obtained from C_4 by attaching atleast one pendant edge at any two adjacent vertices of C_4, then the set containing the two supports is a minimum std-set of G and $\gamma_{std}(G) = 2$.

Conversely, assume $\gamma_{std}(G) = 2$. Let $D = \{u, v\}$ be a $\gamma_{std}(G)$ – set of G. For $n \geq 3$, if $G \cong C_n$, then $\gamma_{std}(G) = 0$. Let G be a graph

obtained from C_n ($n \geq 5$) by attaching atleast one pendant edge at a vertex of C_n, then $\gamma_{std}(G) \geq 3$. The cycle in G is either C_3 or C_4.

Case 1. Cycle in G is C_3

If a path of length t ($t \geq 3$) is attached at a vertex of C_3, then $\gamma_{std}(G) \geq 3$. If a path of length 2 is attached at two vertices of C_3, then $\gamma_{std}(G) \geq 4$. If a path of length 2 is attached at a vertex and a pendant edge is attached at another vertex of C_3, then $\gamma_{std}(G) = 3$. If G is obtained from C_3 by attaching pendant edges at one of the vertices of C_3, then $\gamma_{std}(G) = 4$. Therefore, G is one of the graphs mentioned in (i) and (ii).

Case 2. Cycle in G is C_4

If a path of length atleast 2 is attached at a vertex of C_4, then $\gamma_{std}(G) \geq 3$. If pendant edges are attached at either three vertices or any two nonadjacent vertices of C_4, then $\gamma_{std}(G) = 3$. Therefore, G is a graph obtained from C_4 by attaching atleast one pendant edge at one vertex or two adjacent vertices of C_4.

If G is C_n, $n \geq 5$, then $\gamma_{std}(G) = n - 1$. Therefore, there exists no connected unicyclic graph with the cycle C_n, ($n \geq 5$) having $\gamma_{std}(G) = 2$.

As in Theorem 3.6, the following theorem can be proved

Theorem 3.7:

Let G be a connected unicyclic graph such that $\gamma_{std}(G) > 0$. Then $\gamma_{std}(G) = 3$ if and only if G is one of the following graphs.

(i) G is obtained from C_3 by attaching a path of length 3 and k ($k \geq 0$) pendant edges at a vertex of C_3

(ii) G is obtained from C_3 by attaching a path of length 2 together with t ($t \geq 0$) pendant edges at avertex of C_3 and attaching k ($k \geq 1$) pendant edges at another vertex of C_3.

(iii) G is obtained from C_4 by attaching a path of length 2 together with r ($r \geq 0$) pendant edges at a vertex v of C_4 and attaching s ($s \geq 0$) pendant edges at a vertex of C_4 adjacent to v.

(iv) Let u, v, w be any three vertices of C_4, where u and v are nonadjacent. G is obtained from C_4 by attaching atleast one pendant edge at u and v and t pendant edges at w, where $t \geq 0$.

(v) Let u, v, w be any three vertices of C_5 such that $\langle\{u, v, w\}\rangle \cong P_3$. G is obtained from C_5 by attaching pendant edges at atleast one of the vertices u, v and w.

Theorem 3.8:

Let G be a connected unicyclic graph on n ($n \geq 4$) vertices. Then $\gamma_{std}(G) = n - 3$ if and only if G is one of the following graphs,

(i) G is obtained from C_3 by attaching a path of length atleast one at a vertex or attaching a path of length atleast one each at any two vertices of C_3.

(ii) G is obtained from C_4 by attaching a path of length atleast one at a vertex of C_4 or any two nonadjacent vertices of C_4.

(iii) G is obtained from C_p by attaching a path of length atleast one at a vertex of C_p, where $p \geq 5$.

Proof:

Let G be one of the graphs mentioned in the theorem.

(i) a) If G is a graph obtained by attaching a path of length atleast one at a vertex of C_3, then the set $V(G) - \{u, v, w\}$, where u, v are vertices of C_3 of degree 2 and w is a pendant vertex of G; is a γ_{std}-set of G and $\gamma_{std}(G) = n - 3$.

b) If G is a graph obtained by attaching a path of length atleast one at two adjacent vertices of C_3, then the set $V(G) - \{u, w_1, w_2\}$, where u is a vertex of C_3 of degree 2 and w_1, w_2 are pendant vertices of C_3; is a γ_{std}-set of G and $\gamma_{std}(G) = n - 3$.

Similarly, it can be proved that $\gamma_{std}(G) = n - 3$, if G is one of the graphs as in (ii) or (iii).

Conversely, assume $\gamma_{std}(G) = n - 3$, where G is a connected unicyclic graph on n ($n \geq 4$) vertices.

Case 1. Cycle in G is C_3.

If G is obtained from C_3 by attaching atleast one path at all the vertices of C_3, then $\gamma_{std}(G) = 0$.

Therefore, paths can be attached at one or two vertices of C_3. If G has more than two pendant vertices, then $\gamma_{std}(G) \leq n - 4$ and G has one or two pendant vertices. If a tree is attached at a vertex of C_3 such that G has two pendant vertices, then $\gamma_{std}(G) = n - 4$.

Therefore, a path can be attached at a vertex of C_3 and G is obtained from C_3 either by attaching a path of length atleast one at a vertex of C_3 or attaching a path at any two vertices of C_3.

Case 2. Cycle in G is C_4.

If G is obtained from C_4 by attaching a path of length atleast one at all the vertices of C_4, then $\gamma_{std}(G) = 0$.

If G is obtained from C_4 by attaching a path each at either three vertices or two adjacent vertices of C_4, then $\gamma_{std}(G) = n - 4$.

Therefore, G is obtained from C_4 by attaching a path of length atleast one at a vertex of C_4 or two nonadjacent vertices of C_4.

Case 3. Cycle in G is C_p, $p \geq 5$.

If G is obtained from C_p ($p \geq 5$) by attaching a path of length atleast one each at atleast two vertices of C_p, then $\gamma_{std}(G) \leq n - 4$.

Therefore, G is obtained from C_p ($p \geq 5$) by attaching a path of length atleast one at a vertex of C_p ($p \geq 5$).

Theorem 3.9:

Let G be a connected unicyclic graph on n ($n \geq 5$) vertices. Then $\gamma_{std}(G) = n - 4$ if and only if G is one of the following graphs.

(i) G is obtained from C_3 by attaching two paths of length atleast one at a vertex of C_3 and a path of length atleast zero at another vertex of C_3.

(ii) G is obtained from C_4 by attaching
   (a) two paths of length atleast one at a vertex of C_4
   (b) a path of length atleast one either each at two adjacent vertices or three vertices of C_4.

(iii) G is obtained from C_5 by attaching
   (a) a path of length one each at any two vertices of C_5
   (b) a path of length atleast one each at three vertices u, v, w of C_5 such that $\langle\{u, v, w\}\rangle$ is isomorphic to $K_2 \cup K_1$.

(iv) G is obtained from C_p ($n < p \geq 6$) by attaching
   (a) a path of length atleast one each at any two vertices of C_p.
   (b) two paths of length atleast one at a vertex of C_p.
   (c) a tree at a vertex of C_p such that G has two pendant vertices, where $p \geq 6$.

Proof:

Assume $\gamma_{std}(G) = n - 4$, where G is a connected unicyclic graph on n ($n \geq 5$) vertices.

Case 1. Cycle in G is C_3.

If G is obtained from C_3 by attaching a path of length atleast one at all the vertices of C_3, then $\gamma_{std}(G) = 0$.

If a path is attached each at two vertices of C_3, then $\gamma_{std}(G) = n - 3$. If atleast three paths are attached at a vertex of C_3, then $\gamma_{std}(G) \leq n - 5$. Therefore, G is one of the graphs as in (i).

Case 2. Cycle in G is C_4.

If G is obtained from C_4 by attaching a path of length atleast one at all the vertices of C_4, then $\gamma_{std}(G) = 0$. If either a path is attached at a vertex of C_4 or two nonadjacent vertices of C_4, then $\gamma_{std}(G) = n - 3$.

Therefore, G is one of the graphs as in (ii).

Case 3. Cycle in G is C_5.

If a path of length atleast one is attached at all the vertices of C_5, then $\gamma_{std}(G) = 0$. If a path is attached at a vertex or any three vertices of C_5, then $\gamma_{std}(G) = n - 3$ or $n - 5$. If atleast two paths are attached at a vertex of C_5, then $\gamma_{std}(G) \leq n - 5$.

Therefore, G is one of the graphs as in (iii).

Case 4. Cycle in G is C_p, $p \geq 6$.

If G is obtained from C_p ($p \geq 6$) by attaching a path of length atleast one at all the vertices of C_p, then $\gamma_{std}(G) = 0$. If G has more than two pendant vertices, then $\gamma_{std}(G) \leq n - 5$. Therefore, G is one of the graphs as in (iv).

Conversely, if G is one of the graphs given in the theorem, it can be proved that $\gamma_{std}(G) = n - 4$.

Theorem 3.10:

If G is a graph obtained by attaching a path of length $k - n + 3$ ($k - n + 3 \geq 2$) together with t pendant edges ($t \geq 0$) at a vertex of C_n ($3 \leq n \leq k + 2$), then $\gamma_{std}(G) = k$.

Proof:

Let $v \in V(G) \cap V(C_n)$ be such $\deg(v) \geq 3$ and let $D_1 \subseteq V(C_n)$ be such that $v \in D_1$ and $\langle D_1 \rangle \cong P_{n-2}$. Let D_2 be a set containing $k - n + 2$ vertices of degree 2 of the path and $D = D_1 \cup D_2$. Then D is a dominating set of G, $\langle D \rangle \cong P_k$ and $\langle V(G) - D \rangle \cong K_2 \cup (t + 1) K_1$. D is a std - set of G and is also minimum.

Therefore, $\gamma_{std}(G) = |D| = k$.

As in Theorem 4.1.20, the following theorem can be proved.

Theorem 3.11:

Let H be a graph obtained by attaching t ($t \geq 0$) pendant edges at all $n - 2$ vertices except two adjacent vertices of C_n ($3 \leq n \leq k+2$), where k is an integer. If G is a graph obtained by attaching a path of length $k - n + 3$ ($k \geq 1$) at one of the $n - 2$ vertices of H, then $\gamma_{std}(G) = k$.

In the following, the connected cubic graphs for which $\gamma_{std}(G) = 2$, 3 and 4 are characterized.

Theorem 3.12:

There exists no connected cubic graph G with $\gamma_{std}(G) = 2$ or 3.

Proof:

(a) Let D be a $\gamma_{std}(G)$ – set of G such that $|D| = 2$. Then $\langle D \rangle \cong K_2$.

Since G is cubic, $\langle V(G) - D \rangle$ has either 2 or 4 vertices. If $\langle V(G) - D \rangle$ has an isolated vertex v, then $d_G(v) \leq 2$. Therefore, $\langle V(G) - D \rangle$ has no isolated vertices and $\langle V(G) - D \rangle \cong 2K_2$. In that case, G is not cubic.

(b) Let D be a $\gamma_{std}(G)$ - set of G such that $|D| = 3$. Then $V(G) - D$ has atmost 5 vertices. Since G is cubic, G has an even number of vertices.

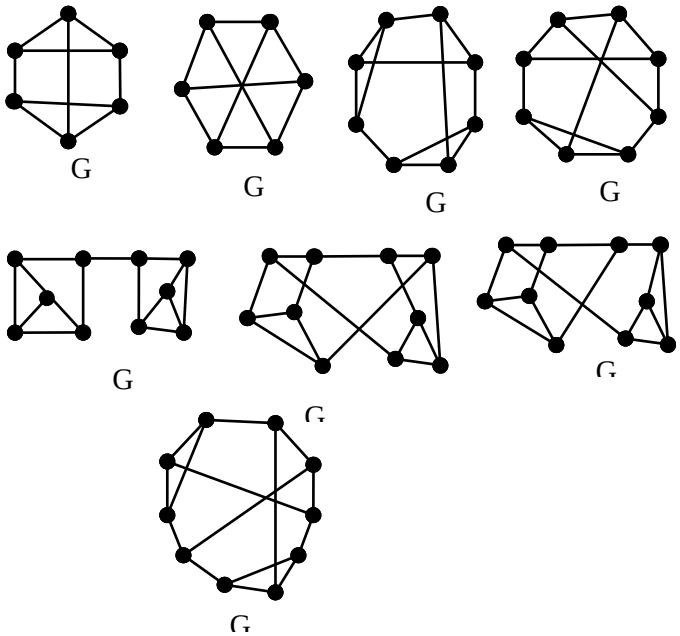
Therefore, $|V(G) - D| = 3$ or 5.

Let $|V(G) - D| = 3$. Then $\langle V(G) - D \rangle \cong 3K_1$ or $K_2 \cup K_1$. In this case also, G is not cubic. Since there exists no cubic graph on 8 vertices, $|V(G) - D| \neq 5$.

Hence, there exists no connected cubic graph G with $\gamma_{std}(G) = 2$ or 3.

Theorem 3.13:

Let G be a connected cubic graph such that $\gamma_{std}(G) > 0$. Then $\gamma_{std}(G) = 4$ if and only if G is one of the following graphs G_1, G_2, G_3, G_4, G_5, G_6, G_7 and G_8, where



Proof:

If G is one of the graphs mentioned in the theorem, then $\gamma_{std}(G) = 4$.

Let D be a $\gamma_{std}(G)$ - set of G with $|D| = 4$. Then $V(G) - D$ has atmost six vertices. Since $|V(G)|$ is even, $|V(G) - D| = 2$, 4 or 6. Also $\langle D \rangle$ is a tree implies $\langle D \rangle \cong P_4$ or $K_{1,3}$.

If $\langle D \rangle \cong P_4$, then the number of edges between D and $V(G) - D$ is 6, since each of the two pendant vertices of P_4 can be adjacent to two vertices and each of the two supports of P_4 can be adjacent to only one vertex of $V(G) - D$.

Similarly, if $\langle D \rangle \cong K_{1,3}$, then also the number of edges between D and $V(G) - D$ is 6, since each of the three pendant vertices of

$K_{1,3}$ can be adjacent to two vertices of $V(G) - D$.

Case 1. $|V(G) - D| = 2$

Then $\langle V(G) - D\rangle \cong 2K_1$.

Subcase 1.1. $\langle D\rangle \cong P_4$

Since G is cubic, each vertex of $2K_1$ is adjacent to two pendant vertices and a vertex of degree 2 in P_4. Then, $G \cong G_1$.

Subcase 1.2. $\langle D\rangle \cong K_{1,3}$.

Each vertex of $2K_1$ is adjacent to three pendant vertices of $K_{1,3}$ and $G \cong G_2$.

Case 2. $|V(G) - D| = 4$

Since $\langle V(G) - D\rangle$ is disconnected, $\langle V(G) - D\rangle$ can be one of the graphs: $4K_1$, $K_2 \cup 2K_1$, $P_3 \cup K_1$, $C_3 \cup K_1$ and $2K_2$.

Subcase 2.1. $\langle D\rangle \cong P_4$

If $\langle V(G) - D\rangle$ is one of the graphs given above, then there must be atleast 6 edges from $V(G) - D$ to D. Since $\langle D\rangle \cong P_4$, there are 6 edges from D to $V(G) - D$. This is possible, when $\langle V(G) - D\rangle$ is isomorphic to $C_3 \cup K_1$ and in that case $G \cong G_2$ (or) G_3.

Subcase 2.2. $\langle D\rangle \cong K_{1,3}$

In this case also, $\langle V(G) - D\rangle \cong C_3 \cup K_1$ and $G \cong G_4$.

Case 3. $|V(G) - D| = 6$

Subcase 3.1. $\langle D\rangle \cong P_4$

Then there can be only 6 edges from D to $V(G) - D$. Since G is cubic, degree of each vertex in $\langle V(G) - D\rangle$ is atmost 2. If $\langle V(G) - D\rangle$ contains a pendant vertex, say u, then u is adjacent to three vertices of D. That is, there are three edges from u to D. If each of the remaining five vertices of $\langle V(G) - D\rangle$ is adjacent to exactly one vertex of D, then five edges are needed from $V(G) - D$ to D. That is not possible.

If $\langle V(G) - D\rangle$ contains K_2 as one of its components, then each of two vertices of K_2 are adjacent to two vertices of D, which gives four edges from K_2 to $V(G) - D$. From the remaining four vertices of $\langle V(G) - D\rangle$, there must be atleast four edges from $\langle (V(G) - D) - V(K_2)\rangle$ to D. That is also not possible.

Similarly is the case, when $\langle V(G) - D\rangle$ contains P_3 as one of its components. Therefore, $\langle V(G) - D\rangle \cong 2C_3$ and G is one of the graphs G_5, G_6 and G_7.

Subcase 3.2. $\langle D\rangle \cong K_{1,3}$

As in Subcase 2.1, none of the graphs K_1, K_2 and P_3 can be a component of $\langle V(G) - D\rangle$. Therefore, $\langle V(G) - D\rangle \cong 2C_3$ and $G \cong G_8$.

Theorem 3.14:

Let G_1 and G_2 be two connected graphs such that G_1 is a tree and $|V(G_1)| \leq |V(G_2)|$ Then $\gamma_{std}(G_1 \circ G_2) = |V(G_1)|$, where $G_1 \circ G_2$ is the Corona of G_1 and G_2.

Proof:

The set $V(G_1)$ of vertices of G_1 is a split tree dominating set of $G_1 \circ G_2$. Since G_1 is a tree, $V(G_1)$ is a minimum std-set of $G_1 \circ G_2$. Therefore, $\gamma_{std}(G_1 \circ G_2) = |V(G_1)|$

In the following, bounds of split tree domination number are obtained.

Theorem 3.15:

Let G be a connected graph on n vertices and m edges and $\gamma_{std}(G) > 0$. Then $\left\lceil \frac{n}{(\Delta+1)} \right\rceil \leq \gamma_{std}(G) \leq 2m - n$. If $\gamma_{std}(G) = 2m - n$, then G is a tree.

Proof:

By Theorem 1.4.5, $\left\lceil \frac{n}{(\Delta+1)} \right\rceil \leq \gamma(G)$ and by Remarks 4.1.1, $\gamma(G) \leq \gamma_{std}(G)$.

$$\left\lceil \frac{n}{(\Delta+1)} \right\rceil \leq \gamma(G) \leq \gamma_{std}(G) \leq n - 2 = 2(n - 1) - n.$$

Since G is connected, $m \geq n - 1$. Therefore, $\gamma_{std}(G) \leq 2m - n$.

If $\gamma_{std}(G) = 2m - n$, then $2m - n \leq n - 2$. That is, $m \leq n - 1$. Therefore, $m = n - 1$ and G is a tree.

Theorem 3.16:

Let G be a connected graph with $\gamma_{std}(G) > 0$ and let v be a vertex of degree k. If $\langle N(v)\rangle$ is disconnected and $\langle V(G) - N(v)\rangle$ is a tree, then $\gamma_{std}(G) \leq n - k$.

Proof:

Since $\langle N(v)\rangle$ is disconnected, $V(G) - N(v)$ is a split dominating set of G and since $\langle V(G) - N(v)\rangle$ is a tree, $V(G) - N(v)$ is a std-set of G.

Therefore, $\gamma_{std}(G) \leq |V(G) - N(v)| = n - k$.

Theorem 3.17:

Let G be a connected graph with $\delta(G) = 1$ and $\gamma_{std}(G) > 0$ and let t be the number of

supports of G. If the subgraph of G induced by all the supports of G is a tree, then $\gamma_{std}(G) \leq t$.

Proof:

Let S be the set of all supports of G. Since $\langle S \rangle$ is a tree and $\langle V(G) - S \rangle$ is disconnected, S is a split tree dominating set of G and hence $\gamma_{std}(G) \leq |S| = t$.

Equality holds, if $G \cong P_n^+$, $n \geq 3$.

Theorem 3.18:

Let G be a bipartite graph with bipartition [A, B] and $|A| \leq |B|$ and let the complement $\bar{G}$ of G be connected. Let $a_1, a_2, ., a_k$ $(k \geq 1)$ be vertices in A adjacent to all the vertices in B. If all the vertices in $A - \{a_1, a_2, \ldots, a_k\}$ are adjacent to a vertex in B, then $\gamma_{std}(G) \leq |A| + 1 - k$.

Proof:

Since $\bar{G}$ is connected, $1 \leq k \leq |A|$.

Let $b \in B$ be such that all the vertices in $A - \{a_1, a_2, \ldots, a_k\}$ are adjacent to b. Then $(A - \{a_1, a_2, \ldots, a_k\}) \cup \{b\}$ is a split dominating set of $\bar{G}$.

Since $\langle (A - \{a_1, a_2, \ldots, a_k\}) \cup \{b\} \rangle \cong K_{1, |A| - k}$, $(A - \{a_1, a_2, \ldots, a_k\}) \cup \{b\}$ is a std-set of $\bar{G}$. Therefore, $\gamma_{std}(\bar{G}) \leq |A| + 1 - k$.

Theorem 3.19:

Let G be a connected graph with $\gamma_{std}(G) > 0$ and let V(G) can be partitioned into two sets, say A and B, where $\langle A \rangle$ is a tree and $\langle B \rangle$ is disconnected. If all the vertices of A are adjacent to all the vertices of B, then $\gamma_{std}(G) = |A|$.

Proof:

Since the set A is a minimum std-set of G, $\gamma_{std}(G) = |A|$.

In the following, split tree domination in trees is dicussed.

Theorem 3.20:

Let T be a tree with atleast two vertices and $\gamma_{std}(G) > 0$. Then $\gamma_{std}(T + 2K_1) = |T|$.

Proof:

Let T be a tree with atleast two vertices and $\gamma_{std}(G) > 0$ and let $v \in T$ and $w \in 2K_1$. Then $\langle V(T) \cup \{w\} \rangle$ is not a tree and $\langle V(2K_1) \cup \{v\} \rangle \cong P_3$ and is connected Therefore, T is a minimum std-set of $T + 2K_1$ and hence $\gamma_{std}(T + 2K_1) = |T|$.

Theorem 3.21:

Let G be a connected graph on n vertices and m edges and *l* be the number of vertices of degree 1. If $\gamma_{std}(G) > 0$, then $\gamma_{std}(G) \geq 3n - 2m - l - 2$ and the bound is sharp.

Proof:

By Theorem 1.4.9, $\gamma_{tr}(G) \geq 3n - 2m - l - 2$. Since any std-set set of G is also a tree dominating set, $\gamma_{tr}(G) \leq \gamma_{std}(G)$, $\gamma_{std}(G) \geq 3n - 2m - l - 2$.

Since $\gamma_{std}(P_n) = n - 2 = 3n - 2m - l - 2$, the bound is sharp.

Theorem 3.22:

Let G be a connected graph on n vertices and m edges with $\delta(G) \geq 2$. If $\gamma_{std}(G) > 0$, then $\gamma_{std}(G) \geq ((\delta(G) + 1) n - 2m - 2) / (\delta(G) - 1)$.

Proof:

The Theorem follows, since $\gamma_{tr}(G) \leq \gamma_{std}(G)$ and $\gamma_{tr}(G) \geq ((\delta(G) + 1) n - 2m - 2) / (\delta(G) - 1)$.

Theorem 3.23:

If there exists a minimum split tree dominating set D of G such that $\langle V(G) - D \rangle$ is totally disconnected, then $\gamma_{std}(G) \geq \alpha_0(G)$.

Proof:

Let D be a minimum split tree dominating set of G such that $\langle V(G) - D \rangle$ is totally disconnected. Then $|D| = \gamma_{std}(G)$ and $\langle D \rangle$ is a tree and D is a point cover of G and therefore $|D| \geq \alpha_0(G)$. Hence, $\gamma_{std}(G) \geq \alpha_0(G)$.

In the following, bounds of split tree domination number are obtained.

Theorem 3.24:

For any tree T with an end vertex, $\gamma_{std}(G) \leq n\left[\frac{\Delta(G)}{1 + \Delta(G)}\right]$, where $\Delta(G)$ is the maximum degree of G.

Proof:

Let D be a γ_{std}- set of T. Since D is a dominating set, for every vertex $v \in D$, there exists a vertex $u \in V(T) - D$ such that $u \in N(v)$. This implies that V(T) – D is a dominating set of G.

Therefore, $\gamma(G) \leq |V(T) - D| = n - |D| = n - \gamma_{std}(G)$.

$\gamma_{std}(G) \leq n - \gamma(G) = n - (n/(1+\Delta(G)))$. Hence $\gamma_{std}(G) \leq n\left[\frac{\Delta(G)}{1+\Delta(G)}\right]$.

Theorem 3.25:

Let T be a tree on n vertices and let k be the number of pendant vertices of T. Then $\gamma_{std}(T) = n - k$.

Proof:

Let P be the set of all pendant vertices of T. Then $\langle V(T) - P \rangle$ is a tree and $\langle P \rangle$ is totally disconnected. Therefore, V(T) – P is a std - set of G and hence $\gamma_{std}(T) \leq |V(T) - P| = n - k$.

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SPLIT NEIGHBOURHOOD TREE DOMINATION NUMBER IN CONNECTED GRAPHS

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ABSTRACT

Let G = (V, E) be a connected graph. A subset D of V is called a dominating set of G if N[D] = V. The minimum cardinality of a dominating set of G is called the domination number of G and is denoted by $\gamma(G)$. A dominating set D of a graph G is called a tree dominating set (tr - set) if the induced subgraph $\langle D \rangle$ is a tree. The tree domination number $\gamma_{tr}(G)$ of G is the minimum cardinality of a tree dominating set. A tree dominating set D of a graph G is called a neighbourhood tree dominating set (ntr - set) if the induced subgraph $\langle N(D) \rangle$ is a tree. The neighbourhood tree domination number $\gamma_{ntr}(G)$ of G is the minimum cardinality of a neighbourhood tree dominating set. A tree dominating set D of a graph G is called a split tree dominating set (std - set) if the induced subgraph $\langle V - D \rangle$ is disconnected. The split tree domination number $\gamma_{std}(G)$ of G is the minimum cardinality of a split tree dominating set. A neighbourhood tree dominating set D of G is called a split neighbourhood tree dominating set, if the induced subgraph $\langle V(G) - D \rangle$ is disconnected. The split neighbourhood tree domination number $\gamma_{sntr}(G)$ of G is the minimum cardinality of a split neighbourhood tree dominating set of G. In this paper, bounds for $\gamma_{sntr}(G)$ and its exact values for some particular classes of graphs are found.

Keywords: *Domination number, connected domination number, tree domination number, neighbourhood tree domination number, split domination number*.

Mathematics Subject Classification: 05C69

INTRODUCTION

The graphs considered here are nontrivial, finite and undirected. The order and size of G are denoted by n and m respectively. If $D \subseteq V$, then $N(D) = \bigcup_{v \in D} N(v)$ and $N[D] = N(D) \cup D$ where N(v) is the set of vertices of G which are adjacent to v. The concept of domination in graphs was introduced by Ore[13]. A subset D of V is called a dominating set of G if N[D] = V. The minimum cardinality of a dominating set of G is called the domination number of G and is denoted by $\gamma(G)$. Xuegang Chen, Liang Sun and Alice McRac [14] introduced the concept of tree domination in graphs. A dominating set D of G is called a tree dominating set, if the induced subgraph $\langle D \rangle$ is a tree. The minimum cardinality of a tree dominating set of G is called the tree domination number of G and is denoted by $\gamma_{tr}(G)$. Kulli and Janakiram [8, 9] introduced the concept of split and nonsplit domination in graphs.

A dominating set D of a graph G is called a split dominating set if the induced subgraph $\langle V - D \rangle$ is disconnected. The split domination number $\gamma_{sd}(G)$ of G is the minimum cardinality of a split dominating set. Muthammai and Chitiravalli [11, 12] defined the concept of split and nonsplit tree domination in graphs. A tree dominating set D of a graph G is called a split tree dominating set if the induced subgraph $\langle V - D \rangle$ is disconnected. The split tree domination number $\gamma_{std}(G)$ of G is the minimum cardinality of a split tree dominating set.

V.R. Kulli introduced the concepts of split and nonsplit neighbourhood connected domination in graph. A neighbourhood dominating set D of a graph G is called a split neighbourhood dominating set if the induced subgraph $\langle V - D \rangle$ is disconnected. The split neighbourhood domination number $\gamma_{sntd}(G)$ of G is the minimum cardinality of a split neighbourhood dominating set.

In this paper, bounds for $\gamma_{sntr}(G)$ and its exact values for some particular classes of graphs are found.

PRIOR RESULTS

Theorem 2.1: [2] For any graph G, $\kappa(G) \leq \delta(G)$.

Theorem 2.2: [14] For any connected graph G with $n \geq 3$, $\gamma_{tr}(G) \leq n - 2$.

Theorem 2.3: [14] For any connected graph G with $\gamma_{tr}(G) = n - 2$ iff $G \cong P_n$ (or) C_n.

Theorem 2.4: [12] For any cycle C_n on n vertices, $\gamma_{std}(C_n) = n - 1$, $n \geq 3$.

Theorem 2.5: [12] For any path P_n on n vertices $\gamma_{std}(P_n) = n - 2$, $n \geq 3$.

Theorem 2.6: [12] For any graph G, $\gamma(G) \leq \gamma_s(G) \leq \gamma_{std}(G)$ and $\gamma(G) \leq \gamma_{tr}(G) \leq \gamma_{std}(G)$. Also $\kappa(G) \leq \gamma_{tr}(G) \leq \gamma_{std}(G)$.

Theorem 2.7: [12] Let G is a wounded spider and if s is the number of supports, then $\gamma_{std}(G) = s$.

Theorem 2.8: [12] Let G is a bistar, then $\gamma_{std}(G) = 2$, since the set containing two supports is a std-set of G.

Theorem 2.9: [12]

$$\gamma_{std}(\overline{P_n}) = \begin{cases} 2, & \text{if } n = 4,5 \\ 3, & \text{if } n = 6 \\ 4, & \text{if } n = 7 \\ 0, & \text{if } n \geq 8 \end{cases}$$ where $\overline{P_n}$ is the complement of P_n.

Theorem 2.10: [12]

$$\gamma_{std}(\overline{C_n}) = \begin{cases} 4, & \text{if } 4 \leq n \leq 7 \\ 0, & \text{if } n \geq 8 \end{cases}$$ where $\overline{C_n}$ is the complement of C_n.

Theorem 2.11: [12] For any connected graph G, $\frac{n}{\Delta(G)+1} \leq \gamma(G)$

Theorem 2.12: [12] For any connected graph G on n vertices, if $\gamma_{std}(G) > 0$, then $1 \leq \gamma_{std}(G) \leq n - 2$.

MAIN RESULTS

In this section, split neighbourhood tree domination number is defined and studied.

3. Split Neighbourhood Tree Domination Number in Connected Graphs

In this section, split neighbourhood tree domination number is defined and studied.

Definition 3.1:

A neighbourhood tree dominating set D of G is called a split neighbourhood tree dominating set, if the induced subgraph $\langle V(G) - D \rangle$ is disconnected. The split neighbourhood tree domination number $\gamma_{sntr}(G)$ of G is the minimum cardinality of a split neighbourhood tree dominating set of G.

Not all connected graphs have a split neighbourhood tree dominating set. For example, the cycle C_3 has a neighbourhood tree dominating set, but no split neighbourhood tree dominating set.

If the split neighbourhood tree domination number does not exist for a given connected graph G, $\gamma_{sntr}(G)$ is defined to be zero.

Example 3.1:

G:

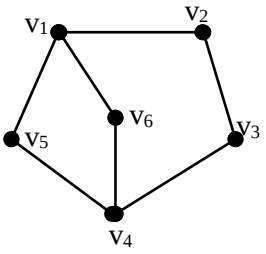

Figure 3.1

In the graph G given in Figure 3.1, D = {v_1, v_2, v_4} is a minimum split neighbourhood tree dominating set, where the induced subgraph $\langle N(D) \rangle = \langle \{v_1, v_2, v_3, v_5, v_6\} \rangle$ is a tree and $\langle V(G) - D \rangle$ is disconnected and $\gamma_{sntr}(G) = 3$.

Example 3.2:

G:

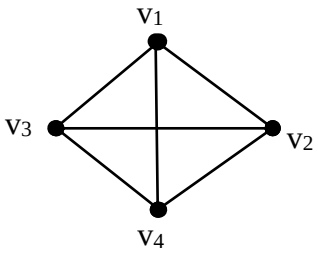

Figure 3.2

In the graph G given in Figure 3.2, for any subset D of V(G), $\langle N(D) \rangle$ is not a tree and $\langle V(G) - D \rangle$ is connected and hence $\gamma_{sntr}(G) = 0$.

Example 3.3:

G:

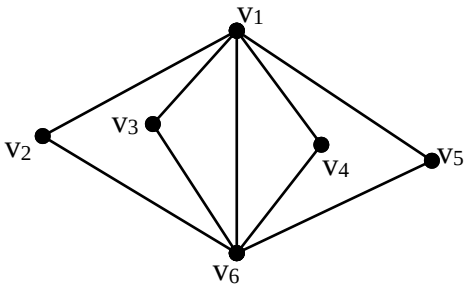

Figure 3.3

In the graph G given in Figure 3.3, for any dominating set D of G, ⟨N(D)⟩ is a tree but the subgraph ⟨V(G) – D⟩ is connected and hence $\gamma_{sntr}(G) = 0$.

Remark 3.1:

Every split neighbourhood tree dominating set is a dominating set and also a neighbourhood tree dominating set. Therefore, $\gamma(G) \leq \gamma_{ntr}(G) \leq \gamma_{sntr}(G)$. These are illustrated below.

Example 3.4:

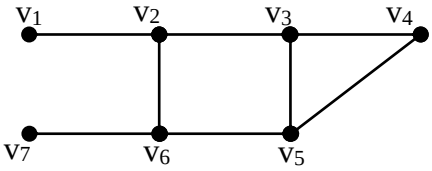

Figure 3.4 (a)

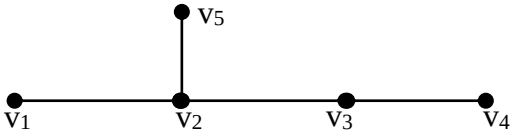

Figure 3.4(b)

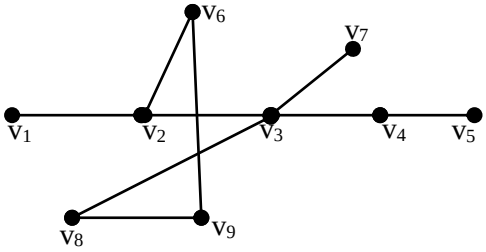

Figure 3.4(c)

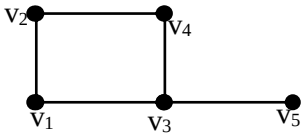

Figure 3.4(d)

In Figure 3.4(a), $D_1 = \{v_1, v_3, v_7\}$ is a minimum neighbourhood tree dominating set. $V - D_1 = \{v_2, v_4, v_5, v_6\}$ and $\gamma(G) = \gamma_{ntr}(G) = 3$.

In Figure 3.4(b), $D_2 = \{v_2, v_3\}$ is a minimum neighbourhood tree dominating set. $V - D_2 = \{v_1, v_4, v_5\}$ and $\gamma(G) = \gamma_{tr}(G) = \gamma_{ntr}(G) = \gamma_{sntr}(G) = 2$.

In Figure 3.4(c), $D_3 = \{v_1, v_2, v_3, v_4\}$ is a minimum neighbourhood tree dominating set. $V - D_3 = \{v_5, v_6, v_7, v_8, v_9\}$, $\gamma(G) = \gamma_{tr}(G) = 3$, $\gamma_{ntr}(G) = \gamma_{sntr}(G) = 4$. Here, $\gamma(G) < \gamma_{ntr}(G)$, $\gamma(G) < \gamma_{sntr}(G)$.

In Figure 3.4(d), $D_4 = \{v_2, v_5\}$ is a minimum neighbourhood tree dominating set. $V - D_5 = \{v_1, v_3, v_5\}$, $\gamma(G) = \gamma_{tr}(G) = \gamma_{ntr}(G) = 2$, $\gamma_{sntr}(G) = 3$. Here, $\gamma(G) = \gamma_{ntr}(G)$, $\gamma(G) < \gamma_{sntr}(G)$, $\gamma_{ntr}(G) < \gamma_{sntr}(G)$.

Theorem 3.1:

A neighbourhood tree dominating set D of a connected graph G is a split neighbourhood tree dominating set of G if and only if there exist two vertices u, v ∈V(G) – D such that every u - v path contains a vertex of D.

Proof:

Let D be a ntr - dominating set of G and is also a sntr - dominating set. For every pair of vertices u, v∈V(G) – D, if no u - v path contains a vertex of D, then ⟨V(G) – D⟩ is connected, which is a contradiction.

Conversely, let D be a neighbourhood tree dominating set of G. Assume there exist two vertices u, v∈ V(G) – D such that every u - v path contain a vertex of D. Then ⟨V(G) – D⟩ is disconnected. Therefore, D is a split neighbourhood tree dominating set of G.

Theorem 3.2: For any tree T of order n ≥ 4 having a split neighbourhood tree dominating set, $\gamma_s(T) \leq \gamma_{sntr}(T)$.

Proof:

By Remark 3.1, $\gamma(G) \leq \gamma_{sntr}(G)$ and from Theorem 1.4.13 (v), $\gamma(T) = \gamma_s(T)$.
Thus, $\gamma_s(T) \leq \gamma_{sntr}(T)$.

Example 3.5:

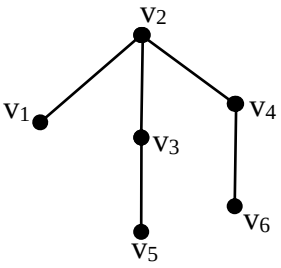

Figure 3.5(a)

Figure 3.5(b)

In Figure 3.5(a), $D_1 = \{v_2, v_3, v_4\}$ is a minimum neighbourhood tree dominating set. $V(G) - D_1 = \{v_1, v_5, v_6\}$, $\gamma(G) = \gamma_s(G) = \gamma_{ntr}(G) = \gamma_{sntr}(G) = 3$.

In Figure 3.5(b), $D_2 = \{v_2, v_3\}$ is a minimum neighbourhood tree dominating set. $V(G) - D_2 = \{v_1\}$, $\gamma(G) = \gamma_s(G) = 1$, $\gamma_{ntr}(G) = \gamma_{sntr}(G) = 2$. Here, $\gamma_s(G) < \gamma_{sntr}(G)$.

Theorem 3.3: Let G be a connected graph. If a γ_{sntr} - set in G exists, then $\kappa(G) \leq \gamma_{sntr}(G)$.

Proof:

Since any sntr - dominating set of a connected graph G is a split dominating set, $\gamma_s(G) \leq \gamma_{sntr}(G)$. But by theorem 1.4.14, $\kappa(G) \leq \gamma_s(G)$.

Therefore, $\kappa(G) \leq \gamma_{sntr}(G)$.

Example 3.6:

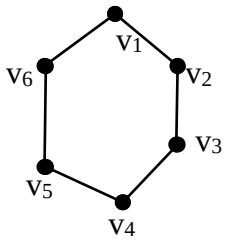

Figure 3.6(a)

In Figure 3.6(a), $D_1 = \{v_2, v_3, v_5\}$ is a neighbourhood tree dominating set. $V(G) - D_1 = \{v_1, v_4, v_6\}$, $\kappa(G) = 2$, $\gamma_{sntr}(G) = 3$. Here, $\kappa(G) < \gamma_{ntr}(G)$.

In Figure 3.6(b), $D_2 = \{v_2, v_3\}$ is a neighbourhood tree dominating set. $V(G) - D_2 = \{v_1, v_4\}$, $\kappa(G) = \gamma_{sntr}(G) = 2$.

In the following, the exact values of $\gamma_{sntr}(G)$ for some standard graphs are given.

Observation 3.1:

(a) For any path P_n on n vertices, $\gamma_{sntr}(P_n) = \lceil n/2 \rceil$, $n \geq 4$.

(b) $\gamma_{sntr}(\overline{P}_4) = 2$.

(c) For any cycle C_n with n ($n > 5$) vertices,

$$\gamma_{sntr}(C_n) = \begin{cases} \left\lceil \frac{n}{2} \right\rceil & \text{if } n \equiv 0, 1, 2 \pmod 4 \\ \left\lfloor \frac{n}{2} \right\rfloor & \text{if } n \equiv 3 \pmod 4 \end{cases}$$

(d) $\gamma_{sntr}(\overline{C}_5) = 3$.

(e) If G is a spider, then $\gamma_{sntr}(G) = n + 1$.

(f) If G is a wounded spider, then $\gamma_{sntr}(G) = s + 1$, where s is the number of supports which are adjacent to wounded legs.

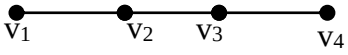

Figure 3.6(b)

(g) If $S_{m,n}$, $(1 \leq m \leq n)$ is a double star, then $\gamma_{sntr}(S_{m,n}) = 2$.

(h) For any connected graph G, $\gamma_{sntr}(G) = n - 1$ if and only if $G \cong P_3$.

Theorem 3.4:

If G has a split neighbourhood tree dominating set, then $\frac{n}{\Delta(G) + 1} \leq \gamma_{sntr}(G) \leq n$.

Proof:

By Theorem 2.8, $\frac{n}{\Delta(G) + 1} \leq \gamma(G)$ and by Remark 7.2.1., $\gamma(G) \leq \gamma_{ntr}(G) \leq \gamma_{sntr}(G)$. Therefore, $\frac{n}{\Delta(G) + 1} \leq \gamma_{sntr}(G)$. Since the vertex set V(G) can be a split neighbourhood tree dominating set of G, $\gamma_{ntr}(G) \leq n$.

Theorem 3.5:

If T is a tree of radius 2 and v is a central vertex of T, then $\gamma_{sntr}(G) \leq d(v)$.

Proof:

Let $r(T) = 2$ and v be a central vertex of T. Then $\langle N(v) \rangle$ is a tree and $\langle V(T) - N(v) \rangle$ is disconnected, the vertex v is isolated in $\langle V(T) - N(v) \rangle$. Therefore, N(v) is a split

neighbourhood tree dominating set of T. Therefore, $\gamma_{ntr}(G) \leq |N(v)| = d(v)$.

Theorem 3.6:

Let G be a graph such that both G and $\bar{G}$ are connected. Then

(i) $\gamma_{sntr}(G) + \gamma_{sntr}(\bar{G}) \leq 2n$

(ii) $\gamma_{sntr}(G) \cdot \gamma_{sntr}(\bar{G}) \leq n^2$

Proof:

This follows from Theorem 3.5.

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THE PREDICAMENT OF HEALTH CARE WORKERS IN INDIA DURING COVID-19 PANDEMIC SCENARIO-ELUCIDATED THROUGHA OBSERVEDCASE STUDY MODEL(METHOD)

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ABSTRACT

The outbreak of novel corona virus disease, originated from Wuhan city in china in the month of December 2019 has now termed as global pandemic within a short span of time almost spread across 200 countries with the victims of 85 lakh people. This article aims to give a detailed description about the predicament of Health care workers by elucidating the Dr. Simon, the 55 year- old Managing Director of New hope hospital Chennai, died from COVID-19 infection on April 20th of 2020 who was denied with dignity in death sparks outrage in Doctors fraternity. Case study methods are widely used to provide detailed qualitative information neither by observing nor through interview confined to a contemporary phenomenon of individual or as a whole community with their activities, life situation or a problem of real-life context. This article attempts to give a comprehensive description of Dr. Simon's case to elucidate the predicament of Health Care Workers in discharging their duties as warriors at the forefront in the battle of COVID- 19 pandemic scenarios.

Keywords: *case study method, COVID-19, Health Care Workers (HCW), pandemic, predicament*

INTRODUCTION

India being an abode of global leaders and world class medical practitioners still lacks qualitative aspects in Health Care Industry. Across the globe many countries are facing quality techniques in health care system especially India being a populous nation with increased chronic type of patients and frequency of exposure to contagious diseases due to its density.

HEALTH CARE SYSTEM IN INDIA

In India the Health Care workers are over-burdened with an overwhelming volume of patients by lacking with the deficiency of infrastructure and unmanageable manageable shortage of manpower in perspectives of all level of Medical profession. It is also imperative to understand that the clinicians having lack of clinical knowledge management technology. The past two decades the world is engulfed with severe acute respiratory syndrome like SARS, MERS, avian flu and the ongoing COVID-19 due to SARS-COV-2. This situation enables Indian health care system to be more disrupted. Hospitals and health facilities are overburdened with increased patients of pandemic situation however HCWs are prone to higher quantum of risks, needs additional intervention approaches for protection. In nutshell the health care workers meet out many challenges such aspatient and too few Doctors/Staff nurse ratio results in inadequate time with the patients, lack of advancement of opportunities, Training and mentoring systems weakens the health care profession. Above all the pandemic situation accelerated their situation to be more challengeable. Health care professionals have paramount importance in prevention of rapidly spreading transmission of infection.(chatterjee, Anand, & Jitenkumar singh, 2020)

HEALTH CARE WORKERS EMERGED PROBLEMS DURING PANDEMIC IN INDIA

Health care workers are more susceptible to this pandemic scenario because of their occupational exposure in practical sense. Most of the HCW's (Health Care Workers) are facing shortages of Personal Protective Equipment (PPE) a mandatory protocol suggested by World Health organisation and Indian Medical Association

in attending the victims of COVID-19 inclusive of face masks, gowns(aprons), gloves and goggles. Either the Government or the Private hospitals should ensure with the adequacy PPE kidwho safeguards them as themselves as well as their family members fromcontagious. As the virus spreads it is importance that HCW (Health Care Worker) has to protect them and it is also impossible to identify the infected unless he or she displays symptoms otherwise observed as asymptomatic cases.(Vaishya, 2020)

A report from the hospitals across in India reveals that HCW's held with prolonged working hours is highly a risk factor to acquire the infection easily. Recent report exhibits that the numerical figure of infected doctors and nurses have crossed thousands. Health care workers are almost sacrificing their family members especially their children who were totally discarded from their relationship and restricted within the quarantined areas of Corona Wards.

VIOLENCE AGAINST HEALTH CARE WORKERS

The Health Care Workersface violence from the irresponsible public and the corona virus infected patients, out of their mental agony they express their brutality with the doctors and nurses and dampen the work of HCW which becomes serious factor during this pandemic situation and may ultimately affect the health care of the public. Several HCW were asked to vacate their rented accommodation on the presumption that they may spread this virus from hospitals to the society. The HCW may be the heroes of this pandemic but not martyrs at least they could be deserve their professional dignity.(Vaishya, 2020)

BRIEF HISTORY OF CASE STUDY METHOD

Case studies were one of the first types of research to be used in the field of qualitative methodology. Case studies are replica of the contemporary issue. In recent times most of the empirical works are presented as qualitative research method. Case study methods are widely used in the field of psychology and social sciences and amongst the best known were clinical case study carried out by Sigmund Freud.(Mcleod, 2014)

Case study model is basically confined to the study of a particular individual are about a community in their contemporary context. Through case study the researcher provides a description of the behaviour. The researcher interprets the case study and gives clear picture which is factual, description an inference of the researcher.

Through this case study a contemporary issue during this pandemic has been taken and observed. The facts of the case study are discussed below

FACTS OF THE CASE

A 55 year old Dr.Simon Hercules a neurosurgeon and chairman of New Hope Medical Centre in Chennai was a victim of Corona Virus. In General the health care workers were working as frontline warriorswho are facing more risk in their lives, Dr, Simon is one of such person, who has succumbed to the disease and died. On Sunday April'19 his body was handed over to his family to Appolohospitals after a proper medication. Dr.Simon's dead body was taken in ambulance that belong to New Hope accompanied by two menial health care workers and two police people two the crematorium in Kilpauk area, where a group of people arrived to the crematorium to protest against the cremation as they feared the spread of disease. Before discussing the facts of this case, a statement made by Dr. Bagayaraj, a closer associate of Dr. Simon has to be considered here. That is Dr.Simon contracted the disease from one of his patient to whom he treated. He would have not been infected, if he would have refused to treat his patients. Dr. Pradeep who had accompanied thebody of Dr.Simon, shared his experience that atleast fifty people gathered to attack with stones and sticks. Almost they got injured including the sanitary inspector. Immediately the cops arrived to the spot out of their intimation and arrested 21 persons

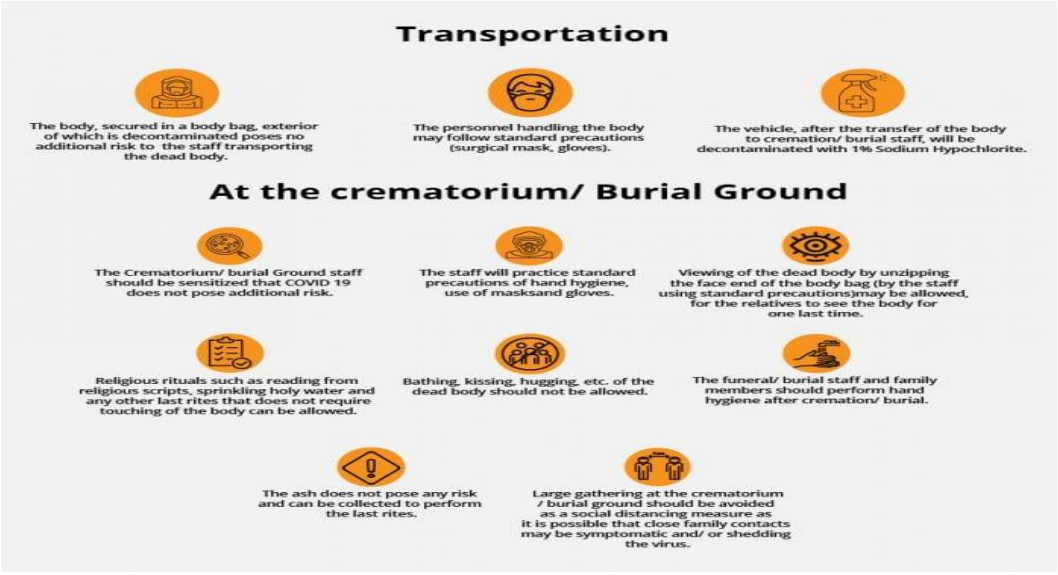
including women for indulging in such violent activities. Again on April 20th the body was taken to the corporation cemetery at TP Chathram. There also his burial was refused by the anti-social elements of the community and finally Dr. Pradeep who himself drew the ambulance wearing the PPE kit and buried Dr.Simon with his own hands in Velangadu Burial ground on new avadi road. Dr. Pradeep out of this bitter terrific experience stated that this should not happen to even his enemy. (Ilangovan, 2020)

The state government has condemned this brutal behaviour of the people. The state high court has taken this case suyomotta manner and instructed the state government to produce the arrested people before the court of law where they have been sentenced under Goondas act. The similar incidents happened to the medical professionals in other part of the world also. This case more sensitized the issue.

IMA (Indian Medical Association) made a statement related to this issue, Doctors are rendering services at extreme risk to themselves, the IMA said, adding, No nation sends its arm to war without weapons". Doctors, nurses, and healthcare workers are fighting COVID-19 without PPEs and dying in the process.(Jyothi, 2020)

CREMATION OR BURRIAL OF COVID 19 VICTIMS PROVIDED WITH SAFETY STEPS AND OR OTHER TO

The World Health Organization in its guidance on burials of COVID-19 victims says dead bodies are not generally infectious. But according to its recommendations the relatives have to follow the rules of social distancing



(Janani, 2020)

prescribed by the government, as a precautious step. *In* funeral pyres, usually people used to gather in groups, after pandemic this was restricted. In India the Indian Medical Association and the Central Government has provided guidelines for the disposal of bodies with fewer attendees by maintaining the distance among them.

CONCLUSION

During this pandemic situation the healthcareworkers are more prone to this COVID 19 virus where they get contracted intreating their patients. More reports about such violence have become a frequent issue which has been reported from across the countries in various forms. The IMA (Indian Medical Association) has warned of retaliation if cremations are obstructed and the proposed law should be stringent in punishing those who perpetuate violence against the doctors who are rendering their services at extreme risk. And thus instructed

the government to excise powertowards such incidents.

From this case study it is observed and discussed that people should be with more humanitarian considerations. Almost the people around the world united to fight against this pandemic situation. Such above stated incidents discloses the psychological influenced merciless and immoral behaviours towards the medical practitioners and the victims of COVID 19. But as per the reports of WHO & IMA it is observed that there is an only remote possibility of spreading corona virus from the corpuses if it is taken with the necessary precautionary steps in cremating the bodies. In this Dr.Simon's case due the brutal attack of the mob, though his wife and teenage son who accompanied the corpus in the ambulance but were not able to say proper goodbye to their loved one. From the above facts it can be suggested that atleast a peaceful cremation or burial can be allowed with a decent and dignified manner.

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A STUDY ON COMPETENCY MAPPING AMONG THE EMPLOYEES WORKING IN VEE TECHNOLOGIES PRIVATE LIMITED, SALEM

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ABSTRACT

Background:*The process of Competency mapping is used to define, explain and prioritize the critical competencies required for performance in a job scenario.****Objective:*** *The study aims to explore the competency mappingamong the employees of Vee Technologies Private Limited, Salem.* ***Methodology:****The research adopts an analytical as well as a descriptive research design. The Census method was adopted in the collection of data from individual respondents. The sample collected from 111 respondents (45.9 percent of men and 54.1 percent of females) were asked to respond to the questionnaire. In the analytical process, the collected data were examined using SPSS V.23.* ***Results:****The study's findings reveal that the respondents with more experience undergo high relationship management with their customers and task proficiency than the respondents with less experience. The research hypothesis shows that the respondents who have more experience are more likely to succeed in their workplace.* ***Conclusion:****Competency mapping is one of the easiest ways to improve work competence among workers.In the IT field, we need workers to hold such personality and psychological competencies to communicate with customers, so competency mapping is essential in this industry.*

Keywords:"Competency Mapping", "Relationship Management", "Communication", "Task Proficiency", "leadership", "adaptability".

INTRODUCTION

The process of Competency mapping is used to define, explain and prioritize the key competencies required for performance in a job scenario. In today's corporate environment, competency evaluation is gaining in popularity, as many companies invested in training their staff and other resources to retain their employees.Competency is the willingness to execute appropriate actions for the work demands and consistent with the parameters of the operational setting in producing optimal outcomes. The competencies of the workforce include knowledge, skills, and attitude.The method of competency mapping is intended to systematically assess and measure employee and group success as it applies to the organization's and its clients' prospects. Two fields are typically examined: emotional intelligence or emotional quotient (EQ) and individual abilities in team management, leadership, and decision-making.The study aims to explore the competency mapping among the employees of Vee Technologies Private Limited, Salem.

Scope of the Study

Human capital has been the most valuable factor in the new dynamic field of industry. Therefore, separate instruments of proper human resource management ought to be understood. Competency mapping, which is still unexplored in India, is one of the most potent human capital tools, contributing to the most appropriate recruitment and selection of an employee. The research is also carried out to provide an in-depth understanding of competency mapping. And aside from that, the meaning and implementations in an organization need to be found as well. In addition to this, the research is conducted to recognize an employee's competency mapping.

Review of Related Studies

Competency was described by Boyatzis (1982) as the underlying function of a person for successful results. Competencies are the qualities of a manager for success within an occupational area Hogg B (1989). The above definition reveals that the requisite knowledge, skill, and attitude to do a task effectively is the fundamental sense of competency. Competency is the underlying characteristic of an individual that is causally connected to outstandingwork success(David McClelland, 1973).

Yuvaraj (2011) has emphasized that competency mapping describes a person's strengths and weaknesses to help them recognize themselves better and explain what needs to be accomplished. Competency mapping is one of the most precise ways of describing an individual's role and interpersonal abilities in an organization.

In their paper, Nagaraju and Gowda (2012) concluded that competence is theprimary conduct of employees in the sample organizations that helps organizations as a whole to perform superiorly. Competency mapping offers the opportunity to evolve, incorporate emerging technology, and consider customers' desires.

In his paper, Jain (2013) argued that the term of competencies contained attributes, skills, and knowledge parameters in detail and allowed a gap analysis of the existing and required skills and measures employee training needs.

In their research, Balaji and Vimala (2012) revealed that the competency differences in the skills, performance, and meta characteristics of employees in the organization are considered to be higher. These will be developed by providing the training to the employees.

Suguna and Tamilselvi (2013) found that competency mapping can not be used as compensation, and it is not only performed for the verified staff of an organization, and it may also be done for contingent jobs or for others pursuing careers to demonstrate their skills.

Objectives of the Study

- To find out the competency mapping and its impact onthe productivity of the employees.
- To analyze the level of competency among the employeesworking in Vee Technologies Private Limited, Salem.

Testing Hypothesis

- There is no robust association between the demographic profile of the sample respondents and their several competencies

METHODS AND MATERIALS

The analytical approach is an inquiry technique, which involves going from the underlying theories to the design of research and data collection (Myers, 1999).

Participants and Procedure

The present research adopts an analytical as well as a descriptive research design. It is based on a case study of one selected BPO industries in a given district in Tamil Nadu. In this regard, Vee Technologies Private Limited, Salem was chosen as the study area. All the employees working in the IT field were contacted for the study. The Census method was adopted in the collection of data from individual respondents.

Tools for Data Collection

Overall, 119 questionnaires were distributed to sample respondents from the employees working in Vee Technologies Private Limited's IT field. However, we cannot accept eightquestionnaires due to unfilled, tick multiple opinions, incomplete, and other reasons. Finally, 111 questionnaires(93 percent) were taken up for further analysis for the study. In the analytical process, the collection of data was examined using SPSS v.23. the questions were based on a 5-point Likert scale with responses ranging from *Strongly Disagree*, *Disagree*, *Agree*,and *Strongly Agree*, with *Neutral* being three points for enabling statistics. In the analytical process, statistical tools such as mean, standard deviation, chi-square test, and one-way ANOVA are applied to examine the relationship among several competencies.

RESULTS AND DISCUSSION

The sample respondents' demographic profile like gender, age, marital status, family type, educational qualification, income, and experience is presented in Table 1.

Table – 1: Demographic Profile of the Sample Respondents

(N = 111)

		Frequency	Percentage
Gender	Male	51	45.9

	Female	60	54.1
Age	20 – 30 years	40	36.0
	31 – 40 years	35	31.5
	41 – 50 years	23	20.7
	More than 51 years	13	11.7
Marital Status	Married	69	62.2
	Unmarried	42	37.8
Family Type	Joint Family	44	39.6
	Nuclear Family	67	60.4
Educational Qualification	Under Graduation	95	85.6
	Post-Graduation	16	14.4
Income	Less than ₹20,000	19	17.1
	₹20,001 to ₹30,000	34	30.6
	₹30,001 to ₹40,000	49	44.1
	More than ₹40,001	9	8.1
Experience	Less than 2 years	21	18.9
	2 to 5 years	66	59.5
	More than 5 years	24	21.6

Source:*Primary data*

(i) Gender: It was observed that the majority of the female sample respondents are accounted for a higher percentage (54.1 percent) while compared with the male respondents (45.9 percent).

(ii) Age: Concerning the respondents' age distribution, they are classified into four different levels. Among the four different levels of age group, 36.0 percent of the sample respondents belong to the age group of 20 – 30 years, followed by 31.5 percent of the sample respondents are belonging to the age group of 31 – 40 years, which shows that the organization preferred to recruit the youngsters for better performance. While 20.7 percent of the sample respondents belong to the age group of 41 – 50 years, 11.7 percent of the sample respondents belong to more than 51 years.

(iii) Marital Status: Table 1 reveals that the married respondents are accounted a higher percentage (62.2 percent) in the organization while compared with the unmarried sample respondents (37.8 percent).

(iv) Family Type: It was found that the majority (60.4 percent) of the sample respondents are lived with their dependents like father and mother, or husband with/without a child. The rest, which accounted for 39.6 percent of the sample respondents, live their whole family members like grandfather/grandmother, father, mother, brother, sister,etc.

(v) Educational Qualification: A close look at table 1 shows that the majority (85.6 percent) of the sample respondents are completed theirs under graduation in computer science/information technology. In contrast, 14.4 percent of the sample respondents are finished their post-graduation in computer science/information technology. It shows that the organization highly prefers to recruit candidates who completed theirs under graduation or post-graduation in computer science/information technology.

(vi) Income: It is clear from table 1, 44.1 percent of the sample respondents are earned around ₹30,001 - ₹40,000 as their monthly salary, while 30.6 percent of the sample respondents are received ₹20,001 to ₹30,000 as their monthly salary, 17.1 percent

of the sample respondent's monthly income is less than ₹20,000 and the rest 8.1 percent of the sample respondents are getting more than ₹40,001 as their monthly income.

(vii) Experience: It is observed that the majority (59.5 percent) of the sample respondents had 2 to 5 years of experience in the relevant field, while 21.6 percent of the sample respondents are working in the same areafor more than five years, at last, 18.9 percent of the sample respondents had lesser than two years of experience. It shows that the organization preferred to recruit the experienced candidate for giving their best performance to the organization.

Table – 2: Result of Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
0.947	0.946	19

Source: Primary data

Table 2 found the value of Cronbach's Alpha is 0.947 (that is, 94.7 percent of reliability in the questionnaire), which indicates a high level of internal consistency for our scale with this specific sample.

Table – 3: Respondents opinion towards Relationship Management in the Organisation

	SDA	DA	N	A	SA	Mean Score	SD	Rank
Believe that clients are the backbone of the organization	18 (16.2)	22 (19.8)	23 (20.7)	22 (19.8)	26 (23.4)	3.144	1.407	IV
Necessity of understanding of client requirements	10 (9.0)	26 (23.4)	27 (24.3)	20 (18.0)	28 (25.2)	3.270	1.314	II
Rapport building with clients	10 (9.0)	30 (27.0)	23 (20.7)	26 (23.4)	22 (19.8)	3.180	1.281	III
Maintain healthy competition	18 (16.2)	19 (17.1)	31 (27.9)	15 (13.5)	28 (25.2)	3.144	1.400	IV
Providing premier client services and excellent helpdesk management	16 (14.4)	10 (9.0)	22 (19.8)	28 (25.2)	35 (31.5)	3.505	1.394	I

Note: Figure in parentheses is the percentage to N, and Rank is assigned based on mean score / SDA – Strongly Disagree, DA – Disagree, N – Neutral, A – Agree, and SA – Strongly Agree.

Table 3 represents the respondents' opinion towards relationship management in the organization.

It is also clear from the mean score results that the employees positively favored all the organization's relationship management. The mean score lies between 3.144 and 3.505. However, a majority of the employees are recommended the following level of relationship management has increased the competency in the organization are: (a) providing premier client services and excellent helpdesk management (3.505); (b) Necessity of understanding of client requirements (3.270); (c) Rapport building with clients (3.180); (d) Believe that clients are the backbone of the organization (3.144); and (e) Maintain healthy competition (3.144).

Table – 3.1: Respondents opinion towards Relationship Management: Chi-square Statistics of Significance

Independent Variables	Calculated Value		Sig.	Result
	Pearson Chi-square	df		
Gender	1.332	8	0.995	Accepted

Age	22.162	24	0.570	Accepted
Marital Status	5.048	8	0.752	Accepted
Family Type	7.077	8	0.528	Accepted
Educational Qualification	3.933	8	0.863	Accepted
Income	23.343	24	0.500	Accepted
Experience	27.634	16	0.035	Rejected

The Chi-square statistics (*vide* Table 3.1) indicate that the gender, age, marital status, family type, educational qualification, and income of the sample respondents are found to have an insignificant relationship with the respondent's opinion towards the relationship management in the organization. In contrast,the experience is associated with the respondent'sview towards relationship management in the organization. Thus, relationship management is found to vary with the changes in the knowledge of the employees. Hence, the research hypothesis H_a shows that the respondents with more experience undergo high relationship management than the respondents with less experience is proved.

Table – 4: Respondents opinion towards Communication in the Organisation

	SDA	DA	N	A	SA	Mean Score	SD	Rank
I encourage open discussion through questioning	16 (14.4)	29 (26.1)	11 (9.9)	27 (24.2)	28 (25.2)	3.198	1.439	II
I listen carefully to our customers / colleagues and try to help them	16 (14.4)	21 (18.9)	16 (14.4)	11 (9.9)	47 (42.3)	3.469	1.536	I
I can negotiate with my superiors in the best possible way about the grievances of the company	18 (16.2)	30 (27.0)	21 (18.9)	20 (18.0)	22 (19.8)	2.982	1.382	III

Note: As in Table – 3.

Table 4 represents the respondents' opinion towards communication in the organization.

It is also clear from the mean score results that the employees positively favored all the organization's communication. The mean score lies between 2.982 and 3.469. However, a majority of the employees are recommended the following level of communication has increased the competency in the organization are: (a) I listen carefully to our customers/colleagues and try to help them (3.469); (b) I encourage open discussion through questioning (3.198),and (c) I can negotiate with my superiors in the best possible way about the grievances of the company (2.982).

Table – 4.1: Respondents opinion towards Communication: Chi-square Statistics of Significance

Independent Variables	Calculated Value		Sig.	Result
	Pearson Chi-square	df		
Gender	1.226	8	0.996	Accepted
Age	22.793	24	0.532	Accepted
Marital Status	5.706	8	0.680	Accepted
Family Type	6.343	8	0.609	Accepted
Educational Qualification	5.722	8	0.678	Accepted
Income	19.421	24	0.729	Accepted

Experience	18.696	16	0.285	Accepted

The result of Chi-square statistics is presented in Table 4.1. The work reveals that the sample respondents' demographic variables such as gender, age, marital status, family type, educational qualification, income, and experience are found to have an insignificant relationship with the respondent's opinion towards the organization's communication. Its shows that the communication is not found to vary with any demographic variables of the employees. Hence, the research hypothesis H_0 shows that the sample respondents' demographic variable does not create any impact on competency through communication in the organization.

Table – 5: Respondents opinion towards Task Proficiency in the Organisation

	SDA	DA	N	A	SA	Mean Score	SD	Rank
Acceptance of challenging jobs in short/long term	26 (23.4)	22 (19.8)	20 (18.0)	22 (19.8)	21 (18.9)	2.909	1.449	IV
Clear understanding of duties and responsibilities	10 (9.0)	24 (21.6)	19 (17.1)	23 (20.7)	35 (31.5)	3.441	1.366	I
Commitment toward targets	18 (16.2)	28 (25.2)	28 (25.2)	18 (16.2)	19 (17.1)	2.928	1.326	III
Exercising the duties with responsibility and accountability	10 (9.0)	16 (14.4)	36 (32.4)	26 (23.4)	23 (20.7)	3.324	1.215	II

Note: As in Table – 3

The level of competency through task proficiency in the organization is presented in Table 5.

It is found that the mean score results that the employees favoredall the task proficiency positively in the organization. The mean score lies between 2.909 and 3.441. However, a majority of the employees are recommended the following level of task proficiency has increased the competency in the organization are: (a) clear understanding of duties and responsibilities (3.441); (b) exercising the duties with responsibility and accountability(3.324); (c) commitment toward targets(2.928); and (d) acceptance of challenging jobs in short/long term (2.909).

Table – 5.1: Respondents opinion towards Task Proficiency: Chi-square Statistics of Significance

Independent Variables	Calculated Value Pearson Chi-square	df	Sig.	Result
Gender	1.106	6	0.981	Accepted
Age	19.328	18	0.372	Accepted
Marital Status	4.733	6	0.578	Accepted
Family Type	3.957	6	0.682	Accepted
Educational Qualification	5.093	6	0.532	Accepted
Income	15.092	18	0.656	Accepted
Experience	25.966	12	0.011	Rejected

The Chi-square statistics (*vide* Table 5.1) indicate that the gender, age, marital status, family type, educational qualification, and income of the sample respondents are found to have an insignificant relationship with the respondent's opinion towards the task proficiency in the organization. In contrast,the experience is associated with the respondent's view towards task proficiency in the organization. Thus, the task proficiency is found to vary with the changes in the knowledge of the employees. Hence, the research hypothesis H_a shows that the respondents with more experience undergo high relationship management than the respondents with less experience is proved.

Table – 6: Respondents opinion towards Leadership in the Organisation

	SDA	DA	N	A	SA	Mean Score	SD	Rank
Initiation for task performance	11 (9.9)	29 (26.1)	26 (23.4)	19 (17.1)	26 (23.4)	3.180	1.323	I
Recognition of team members for performing task	18 (16.2)	16 (14.4)	22 (19.8)	47 (42.3)	8 (7.2)	3.099	1.228	II
Encouragement and supporting team members	18 (16.2)	16 (14.4)	42 (37.8)	21 (18.9)	14 (12.6)	2.973	1.224	III
Resolving the conflicts among team members	25 (22.5)	27 (24.3)	19 (17.1)	14 (12.6)	26 (23.4)	2.901	1.489	IV

Note: As in Table – 3.

Table 6 represents the respondents' opinion towards leadership in the organization.

It is also clear from the mean score results that the employees positively favored all the organization's leadership. The mean score lies between 2.901 and 3.180. However, a majority of the employees are recommended the following level of leadership has increased the competency in the organization are: (a) initiation for task performance(3.180); (b) recognition of team members for performing the task (3.099); (c) encouragement and supporting team members (2.973); and (d) resolving the conflicts among team members (2.901).

Table – 6.1: Respondents opinion towards Leadership: Chi-square Statistics of Significance

Independent Variables	Calculated Value		Sig.	Result
	Pearson Chi-square	df		
Gender	10.913	13	0.618	Accepted
Age	40.512	39	0.403	Accepted
Marital Status	6.826	13	0.911	Accepted
Family Type	12.638	13	0.476	Accepted
Educational Qualification	12.808	13	0.463	Accepted
Income	42.418	39	0.326	Accepted
Experience	31.710	26	0.203	Accepted

The result of Chi-square statistics is presented in Table 6.1. The work reveals that the sample respondents' demographic variables such as gender, age, marital status, family type, educational qualification, income, and experience are found to have an insignificant relationship with the respondent's opinion towards the organization's leadership. Its shows that the leadership is not found to vary with any demographic variables of the employees. Hence, the research hypothesis H_0 shows that the sample respondents' demographic variable does not create any impact on competency through leadership in the organization.

Table – 7: Respondents opinion towards Adaptability in the Organisation

	SDA	DA	N	A	SA	Mean Score	SD	Rank
Believe in team working	16 (14.4)	18 (16.2)	15 (13.5)	48 (43.2)	14 (12.6)	3.234	1.279	I

Collaborating and coordination among team members	18 (16.2)	27 (24.3)	8 (7.2)	33 (29.7)	25 (22.5)	3.180	1.441	II
Environmental adaptability	34 (30.6)	8 (7.2)	25 (22.5)	23 (20.7)	21 (18.9)	2.901	1.507	III

Note: As in Table – 3.

Table 7 represents the respondents' opinion towards adaptability in the organization.

It is also clear from the mean score results that the employees positively favored all the organization's adaptability. The mean score lies between 2.901 and 3.234. However, a majority of the employees are recommended the following level of adaptability has increased the competency in the organization are: (a) believe in team working(3.234); (b) collaborating and coordination among team members (3.180); (c) environmental adaptability (2.901).

Table – 7.1: Respondents opinion towards Adaptability: Chi-square Statistics of Significance

Independent Variables	Calculated Value Pearson Chi-square	df	Sig.	Result
Gender	1.153	7	0.992	Accepted
Age	23.321	21	0.327	Accepted
Marital Status	3.559	7	0.829	Accepted
Family Type	5.846	7	0.558	Accepted
Educational Qualification	3.868	7	0.795	Accepted
Income	14.696	21	0.838	Accepted
Experience	15.409	14	0.351	Accepted

The result of Chi-square statistics is presented in Table 7.1. The work reveals that the sample respondents' demographic variables such as gender, age, marital status, family type, educational qualification, income, and experience are found to have an insignificant relationship with the respondent's opinion towards the organization's adaptability. Its shows that the adaptability is not found to vary with any demographic variables of the employees. Hence, the research hypothesis H_0 shows that the sample respondents' demographic variable does not create any impact on competency through adaptability in the organization.

CONCLUSION

Competency mapping is one of the easiest ways to improve work competence among workers. It is also useful in defining the job and psychological competencies of an individual in an organization. Organizations ought to realize that competency mapping is not a one-time consideration. It is a primary method for employee capacity growth, but it needs to be a continuous practice. In the IT field, we need workers to hold such personality and psychological competencies to communicate with customers, so competency mapping is essential in this industry.

The factors of competencies like "relationship management", "communication", "task proficiency", "leadership" and "adaptability" among the employees working in Vee Technologies Private Limited, Salem are satisfactory. All the organization and development of employees' competency mapping are essential for maximizing their talents to gain a competitive advantage.

LIMITATIONS AND SCOPE FOR FURTHER RESEARCH

The sample size in the study was limited to the employees working in the IT Sector only. Based on the findings of this research, the below-listed scope for further research is highlighted:

(a) The relationship between competency mapping and its impact on organization effectiveness in BPO Sector

(b) Competency Mapping and its effect on Employee Development in BPO Sector located in Tamil Nadu

(c) Competency Mapping and its implications on Deliverables among the employees working in Voice and Non-Voice Section in BPOs in and around Tamil Nadu

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A STUDY ON WORK LIFE BALANCE OF WOMEN POLICE PERSONNEL WITH SPECIAL REFERENCE TO VILLUPURAM TOWN, VILLUPURAM DISTRICT

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ABSTRACT

Which is very important whether the body for the soul? Similarly, which is important whether the work or the life? Both are amalgamated in the life of each and every human being. Without work, life will not be running smooth, without a smooth life one cannot concentrate on work. Based on this hypothesis the thesis focuses how far the police men and police women tend to balance the work and the life.

Keywords: *Work Life Balance, Police Personnel, Job Satisfaction, Family Satisfaction, Working Environment and Career Satisfaction.*

INTRODUCTION

As an introductory part this segment is going to deal many things related to the different contents of work and life. If at all we understand what is the meaning of work and its dimensions we cannot understand the meaning of the work, similarly and also life. What is life, it is the normal process of an individual enjoying as well as not enjoying the life in the lifespan which is allocated for him. Several stages in life and the satisfaction in the life will be different.

MEANING OF WORK LIFE BALANCE

The term Work-life balance can mean different things to different persons – and different things to same person at various points in his/her career. Work-life balance is about creating and maintaining supportive and healthy work environments, which will enable employees to have balance between work and personal responsibilities and thus strengthen employee loyalty and productivity.

DEFINITION OF WORK LIFE BALANCE

The Work-Life Balance Trust States Work-life balance means different things to different people and different things at different stages of life. However, any definition for anyone must include the problems of lack of time and exhaustion. Research indicates that failure to achieve the correct balance of effort and rest is linked to a feeling of lack of control over your workload, plus lack of energy to fulfill personal goals and commitments. If the balance is wrong, the result may include fatigue, poor performance and a poor quality of life.

A BALANCE OF FAMILY, LIFE AND WORK

In recent years, the term 'work/life balance' has replaced what used to be known as 'work/family balance'. Although the concept of family has broadened to encompass extended families, shared parenting and a wide range of social and support networks and communities, the semantic shift from work/family to work/life arises from a recognition that care of dependent children is by no means the only important non-work function. Other life activities that need to be balanced with employment may include study, sport and exercise, volunteer work, hobbies or care of the elderly. 'Eldercare' in particular is becoming a growing issue for employers.

COMPONENT OF WORK- LIFE BALANCE

At this early stage in the twenty-first century there is increasing evidence that, for some, the value of work is changing. 41 percent of managers in an institute of management survey felt that the quality of working life had got worse over the last three years (Institute of Management, 2001). Jeff Davidson an expert of work-life balance explains six components of work-life balance:

Self-Management

Sufficiently managing one's self can be challenging, particularly in getting proper sleep, exercise, and nutrition. Self-management is the recognition that effectively using the spaces in an individual's live is vital, and that available resources; time and life are finite. It means becoming a captain of one's own ship because no one is coming to steer for us.

Time Management

Effective time management involves making optimal use of your day and the supporting resources that can be summoned – you keep pace when your resources match your challenges. Time management is enhanced through appropriate goals and discerning what is both important and urgent, versus important or urgent. It entails knowing what you do best and when, and assembling the appropriate tools to accomplish specific tasks.

Stress Management

Societies tend to become more complex over time, naturally. In the face of increasing complexity, stress on the individual is inevitable. More people, distractions, and noise require each of us to become adept at maintaining tranquillity and working ourselves out of pressure-filled situations. Most forms of multi-tasking ultimately increase our stress, versus focusing on one thing at a time.

Change Management

In our fast-paced world, change is virtually the only constant. Continually adopting new methods and re-adapting others is vital to a successful career and a happy home life. Effective change management involves making periodic and concerted efforts to ensure that the volume and rate of change at work and at home does not overwhelm or defeat you.

Technology Management

Effectively managing technology means ensuring that technology serves you, rather than abuses you. Technology has always been with us, since the first walking stick, flint, spear, and wheel. Now, the rate of change is accelerating, brought on by vendors seeking expanding market share. Often there is no choice but to keep up with the technological Joneses, but you must rule technology, not vice versa.

Leisure Management

The most overlooked of the work-life balance supporting disciplines, leisure management acknowledges the importance of rest and relaxation- that one can't short-change leisure, and that "time off" is a vital component of the human experience. Curiously, too much of the same leisure activity, however enjoyable, can lead to monotony. Thus, effective leisure management requires varying one's activities.

JOB SATISFACTION

Job satisfaction is a highly oscillating phenomenon. At times the police personnel may be satisfied, at some other moments they tend to get dis-satisfied. It was found out that police officers' attitude toward human rights forms a significant predictor of their attitude towards use of excessive force by the past researches. Job satisfaction and education levels are the two significant variables affecting their attitude toward the use of their excessive power and force. By this moment, they are stressed not only in executing the power of the police force, but their humanitarian feelings hinder their execution on their superiors' orders; by then stress is not avoidable. They are forced to work not on their own conscience but on the orders of the superiors.

WORK/CAREER SATISFACTION

Two terms are involved in this sub-title one is the work and the other is satisfaction. In this section we have to know what the meaning of the work is. Career/work is a lifetime process towards winning the bread and butter. Work is the process in which the economic development is promoted. Work is also a process in which the self is exposed and to favor their own self to

satisfy themselves. At times, work is carried out on the compulsion of the basic needs. This can be stated as the force work without having a better attitude a positive attitude towards a particular work. Majority of the police personals are compelled to take this work as police. The environmental forces like poverty, lack of social status, ascending age and reduced job opportunity had pushed them to this work in the service sector. If an individual is involving in an uninterested sector it will develop stress, it will be having several types of tolls in the health of the police personals. Work satisfaction is the one which incorporates several dimensions.

NEED AND IMPORTANCE OF THE STUDY

The study focusses on identifying the work life balance by working women. Women place an important part in the society, in the modern world women are entrusted with dual roles. These dual roles have caused the need of work life balance for working women which in turn leads to many physical and psychological problem etc.

The many significances of this study is to identify the area and factors which makes women to balance her work and family. The research also attempts to find out the variables which helps women for her effective balance of work and family life.

The special significance of the study is that in the modern age where women are the greatest asset to the society must be in more productive and also should be able to balance both work life and family life.

Further the study will give a clear picture about the various factors which makes an employee to balance her work and family life.

PROFILE OF THE STUDY

The researcher has chosen the area of women employees working in TamilNadu police service in especially Villupuram town, Villupuram district.However, the areas mainly include the employees' health and their commitments in family and organization. Hence the researcher work towards the objective of the research by the way concentrating on the area and field of study.

About villupuram

Viluppuram, **Villupuram** or **Vizhuppuram** is one of the 38 districts that make up the state of Tamil Nadu, India. It was founded on 30 September 1993, prior to which it was part of the Cuddalore district district.[2] Vizhuppuram district lies between the national highways of Tiruchirappalli and Chennai, and contains some historical landmarks, such as the Gingee Fort that is over 500 years old.

About police department

Even though the Police systems could be traced from the Vedic times onwards, it is of considerable interest as also a matter of parochial pride that the Madras Act XXlV of 1859 attracted the attention of all other provincial governments in India prompting them to reform their police forces on the Madras Model.

The beginnings of the Madras city police could be seen as early in 1659 when the East India Company had no political designs but only a profit-making motive. The genesis of the mofussil police starts where the history of the Madras city police in the nineteenth century ends and became a model for other police Forces in India in 1859 and it continued to grow in strength till the end of 18th century. The Madras city police and mofussil police were amalgamated at the beginning of 19th century.

About women police

Tamil Nadu police has the largest strength of women police personnel and women police stations in the country, the first women police battalion of special police and commando force, the first established finger print lab, the first integrated modern control room in the country and has the greatest number of computers amongst police departments in the Country.

REVIEW OF LITERATURE

A number of studies have addressed this issue from different perspectives.

Higgins et al.(1992), Hochschild (1989),Kelley and Voydanoff (1985),Hochschild (1989)Thompson & Walker (1989) revealed that working women face well-documented conflicts due to their continuing role as primary caretakers for their homes, children, and/or elderly parents being women's greater responsibility for children and other family members and they experience more interruptions than men resulting common household problems.

Higgins and Duxbury (1992) expressed that work conflict is a greater source of work-family conflict whereas personal or family lives, interfere with work are associated for fewer hours but work that interferes with life matters

Goodstein (1994) and **Ingram and Simons (1995)** presented an institutional perspective on organizations 'responses to work-family issues. In addition, Campbell, Campbell and Kennard (1994) have studied the effects of family responsibilities on the work commitment and job performance of women. The work-family issue is even further expanded to address the relationship of business-marriage partners (Foley & Powell, 1997).

Milkie and Peltola (1999) stated that one will feel less successful in achieving their own work-family balance if spouse has to do the smaller portion of housework.

Cunningham (2001) stated that Today 's working men seek the dual objective of maintaining a successful career while being involved in their children 's lives.

Barnett and Hyde (2001) found that women who had multiple life roles were less depressed and had higher self-esteem than women who had fewer life roles.

Vloeberghs (2002) revealed that there is a need for a practical instrument to measure the present situation of work- life balance of women irrespective of their employment status.

Kiecolt (2003) found that who find work a haven spends no more hours at work than those with high work-home satisfaction.

Scott-Ladd and Marshall (2004) emphasized that participative decision making contributes to performance effectiveness and led to greater gains in the workplace.

McDonald et al. (2005) there are five dimensions that affect organizational work-life culture these are lack of managerial support for work-life balance; perception of negative career consequences; organizational time expectations; the gendered nature of policy utilization; and perceptions of unfairness by employees with limited non-work responsibilities whereas changing the habits of employees does not necessarily imply a change in ―work-life balance‖ particularly if the culture of the work environment does not change (Jim Bird, CEO of Worklifebalance.com).

RESEARCH METHODOLOGY

This part deals with the methodological part of the research on women employees working in TamilNadu police service, Villupuram town, Villupuram district. It contains the field of study, research design, sampling method, tools of data collection, Sources of data, Actual data collection, and organization of the study.

Research Design

As the researcher aim to study and describe the various aspects of work life balance of the women employee and also seeks to find out the contributing factors and association with selected socio-demographic variables with women work life balance he has adopted descriptive research design.

Sampling Method

The researcher has adopted random sampling technique by lottery method to select the sample from the universe.

Sample Size Determination

This study preserves determining sample size as 100 because of the short time as well as the respondents are only women.

Tools for data collection

In this study we used the following statistical tools namely percentage analysis.

Percentage Analysis

Percentage analysis is use to find percentage value for this entirely different question used for all. The question used in making comparison between two or more series of data.

$$\text{No. of respondent} = \frac{\%\ \text{ofRespondents}}{\text{Total no. of respondents}}$$

SOURCES OF DATA

Primary Source

The primary source of data was collected by the researcher using the questionnaire method.

Secondary Source

Personnel records, journals, books, periodicals and web sites constitute the secondary source of data for the study.

STATEMENT OF THE PROBLEM

The TAMILNADU POLICE SERVICE included with so many problems for employees at various significant factors. This study considered the major women employee's problem of their work life balance. Also, the researcher has studied the health problems of the women employees. Both the psychological and physiological problems of the women have been analyzed and identified in the study. The problems of work life balance have a greater impact in each individual's personal and work life. However, the study also analyzed the various policies and programs initiated by the police service for the women work life balance has been identified. The finding and suggestions will be helpful for the police service to proceeds with the better work life balance policies and programs for both the women and police service welfare.

GENERAL OBJECTIVES OF THE STUDY

DATA ANALYSIS

"A study on work life balance of women employees in Tamilnadu police service.

Specific Objectives of the study:

1. To find out the effect of work life balance among women police.
2. To identify the problems of TamilNadu women police service.
3. To understand the factors for balance of work & family Commitment.
4. To suggest measures to improve work life balance among women police.

RESEARCH HYPOTHESIS

Research hypothesis - I

There is no significant association between the employment of spouse of the respondents and the managing of work & family.

Research hypothesis – II

There is no significant association between the working days in a week of the respondents and the managing of work & family.

Research hypothesis - III

There is no significant one-way analysis of variance among the work experience of the respondents and the factors affecting the women work life balance.

S. No	Factors	Particular	No. of Respondents	% of the Respondents
1	Age Group of The Respondent	Below-30	50	50%
		40-50	41	41%
		Above -50	9	9%
2	Marital Status of The Respondents	Married	83	83%
		Unmarried	17	17%
3	Academic Qualification of The Respondents	PG	25	25%
		UG	33	33%
		HSE	42	42%
		DIPLOMA	0	0
4	Present Designation	RI	17	17%
		RSI	8	8%
		HC	17	17%
		Grade-I PC	42	42%
		THG	17	17%
5	Year of Services	Below 5	39	39%
		5-10	33	33%
		Above 10	28	28%
6	Daily Working Hours	8-9 hrs.	50	50%
		9-10 hrs.	8	8%
		More than 10 hrs.	42	42%
7	Salary Per Month	Below 10,000	9	9%
		10,000-15,000	33	33%
		Above 15,000	58	58%
8	Size of The Family	Up to 3	68	68%
		4-5	20	20%
		Above 5	12	12%

FINDINGS

- 50% of the Respondents age group is Below30.
- 83% of the Respondents are married.
- 42% of the Respondents qualification was HSE.
- 42% of the Respondents present designation is Grade 1 PC.
- 39% of the Respondents years of services are Below 5.
- 50% of the Respondents daily working hours are 8-9hours.
- 58% of the Respondents salary was above15,000.
- 68% of the Respondents family size is up to 3members.

SUGGESTIONS

Based on the findings of the study the researcher has enlisted the below suggestions in regards to the effective work life balance of Women police in Tamil Nadu

Increase in pay scale

The major driving force for any working community is salary. This will have a direct impact towards the employees work life balance too. However, it is very much necessary for the organization to consider the pay scale effectively towards the standard of living. Hence the organization should increase the pay scale for the employees to have a better work life balance.

Effective scheduling of working days for the employees

From the findings it is clearly visible that there is no balance in the working days of the employees. The organization needs to

concentrate on the effective scheduling on the working days to make sure the easy management of working by the employees in their work.

Fixed working hours or Flexible working hours

The working hours of the employees are very important to have a better life balance. Being a women employee the work life balance of them will be effective towards their management of working hours. Hence the organization needs to concentrate more in regards to the management of working hours to create flexibility for them.

Regulation on shift timings of employees

Of course, it is not an easy thing to provide regulated shift timings for the police service. However, it is also very important for the employees to have a suitable working hour for effective working. Hence the organization needs to identify and consider the suitability of shift timings for the employees.

Utility of leave policy

Since the majority of respondents are not availing their leave policy effectively. Hence it is advisable for the employees to have a note towards their leave policy to make avail for their needful purposes. The leave policy is always a major consideration for the employees to have a tab on their work life balance.

Providing comfortable working hours

The organization should maintain uniform timings towards the employees working hours and working days. Since significant number of employees is extending their shift timings and also working more than 5 days in a week may cause imbalance in their work life.

Creating awareness of organizational policies

It is the organization responsibility to create better awareness among employees about their special policies and programs in regards to the women work life balance. This may create more confidence for the women employees.

Concentrating on psychological health of employees

The organization must conduct more programs for the employees to make them mentally happy in their work place. By conducting different innovative programs on the women employee mental health will definitely result in the higher work life balance.

Upgraded program in regards to women employees' physical health

Since working women are prone to different physical ailment, the employer should come up with more policies and programs for the better physical comforts and health at a work place.

CONCLUSION

This study is much useful for the organization to update their work life balance policies & programs and also to come up with more contribution towards the work life balance of working women. The study has satisfied the expectation of research thought the best findings from analysis. The scope of further research is possible in this area by considering the need of timely changes & alteration towards the organization policies and programs in relation to the enhancement of the work life balance of working women.

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Jaya Optimization Algorithm Based Load Frequency Control of Interconnected Power Systems with Static Synchronous Series Compensator and Hydrogen Aqua Electrolizer

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ABSTRACT

This article presents the design of the Jaya Optimization Algorithm tuned Proportional- Derivative (PD) with Proportional-Integral (PI) Interacting controlled based Load-Frequency Control (LFC) of a two-area multi-source thermal-thermal interconnected restructured power system with Hydrogen Aqua Electrolizer (HAE) and Static Synchronous Series Compensator (SSSC) units. The improvement of the LFC execution of a multi-source restructured power system a sophisticated utilizes of HAE unit is connected in its control area and SSSC unit is introduced in series with tie-line of the interconnected areas. The control parameters of the PD with PI interacting Controller are tuned using the JAYA technique and its execution in the test system without and with HAE and SSSC units. The Power System Restoration Indices (PSRI) are processed which relies upon the dynamic response of the control input deviations and change in power generation of Gencos of each area. The reproduction results reveal that the usage of HAE-SSSC units coordinated in the LFC loop of the test system arrests the initial fall in frequency as well as the tie-line power deviations for a sudden increased in load demand scheduled condition. The dynamic performance of LFC loop have found to have superior in terms of less peak deviation and settling time of area frequencies and tie-line power deviations of the test system with HAE and SSSC units and the outcomes demonstrate that the PSRI are considerably minimized in order to provide a good margin of stability as compared with that the test system without HAE and SSSC units.

Keywords: *Load-Frequency Control, restructured system, Jaya Algorithm, PD with PI integrating controller, Hydrogen Aqua Electrolizer, SSSC, two area interconnected thermal system.*

Introduction

The Load Frequency Control (LFC) for a two area multisource restructured interconnected power system model incorporating Flexible AC Transmission System (FACTs) devices is presented. Unified Power Flow Controller (UPFC) [1, 2] is found to be one of the most apt series and shunt compensating device in the FACT Controller family. It is considered in series with the tie-line where as Hydrogen Aqua Electrolizer (HAE) is installed near the load at the terminal of an area. In paper [3,4] The effects of flexible AC transmission system devices on automatic generation control using a metaheuristic-based fuzzy PID controller were examined in depth. For optimising the gains of the PID controller, a hybrid particle swarm optimization (PSO) and gravitational search algorithm (GSA) [4] is suggested and compared to various standard controllers. A bacterial foraging optimisation algorithm (BFOA)-based proportional integral derivative controller with derivative filter (PIDF) [5] is proposed for frequency regulation of multi-source hybrid power system. The use of PIDF controllers in a two-area, unequal-area power system is initially investigated. To compensate for system frequency and tie-line power oscillations under load distribution, Superconducting Magnetic Energy Storage (SMES), Thyristor Controlled Phase Shifter (TCPS), Unified Power Flow Controller (UPFC), and Electric Vehicle (EV) implementations are connected in series with the tie-line [6-8].

As a result, the TCPS is primarily employed to modulate active power flow in power systems, and its fast speed makes it appealing for use in improving system operation and control. A state variable formulation is used to derive the UPFC's frequency response characteristics. The operating point, as well as the UPFC parameters, are found to affect these features [9-12].

LFC control in restructured power system

The Load-Frequency Control in the restructured environment is intended to provide the main energy transactions such as polo-based, bilateral, and a combination of these two. In a VIU, it must also meet the well-known LFC objectives. These include retaining the system frequency at its nominal value, maintaining tie-line power interchange between control zones, and keeping each generating unit at its most cost-effective value.

The number of rows in DPM must equal the number of GENCOs in the system, and the number of columns must equal the number of DISCOs. Any entry in this matrix represents a percentage of a Disco's total load power contracted to Genco. As a result, total of entries of column belong to Disco$_i$ of DPM is $\sum_i cpf_{ij} = 1$. In this study two-area interconnected power system in which each area has two GENCOs and two DISCOs. Let Genco1, Genco2, Disco1, Disco2 be in area 1and Genco3, Genco4, Disco3, Disco4 be in area 2 as shown in Fig. 1. The corresponding DPM is given as follows

$$\boldsymbol{DPM} = \begin{vmatrix} cpf_{11} & cpf_{12} & cpf_{13} & cpf_{14} \\ cpf_{21} & cpf_{22} & cpf_{23} & cpf_{24} \\ cpf_{31} & cpf_{32} & cpf_{33} & cpf_{34} \\ cpf_{41} & cpf_{42} & cpf_{43} & cpf_{44} \end{vmatrix}$$

(1)

Where, *cpf* represents ‘‘Contract Participation Factor” and is like signals that carry information as to which the GENCO has to follow the load demanded by the Disco. The actual and scheduled steady state power flow through the tie-line are given

$$\Delta P_{tie,1-2,schduled} = \sum_{i=1}^{2}\sum_{j=3}^{4} cpf_{ij} * \Delta P_{Lj} - \sum_{i=3}^{4}\sum_{j=1}^{2} cpf_{ij} * \Delta P_{Lj} \quad (2)$$

$$\Delta P_{tie,1-2,actual} = (2\pi T_{12}/S) * (\Delta F_1 - \Delta F_2) \quad (3)$$

And at any given time, the tie-line power error $\Delta P_{tie,1-2,error}$ is defined as

$$\Delta P_{tie,1-2,error} = \Delta P_{tie,1-2,actual} - \Delta P_{tie,1-2,schduled} \quad (4)$$

The error signal is used to generate the respective ACE signals as in the traditional scenario

$$ACE_1 = \beta_1 * \Delta F_1 + \Delta P_{tie,1-2,error} \quad (5)$$

$$ACE_2 = \beta_2 * \Delta F_2 + \Delta P_{tie,2-1,error} \quad (6)$$

For two area system as shown in Fig. 1, the contracted power supplied by ithGenco is

$$\Delta P_{gi} = \sum_{j=3}^{4} cpf_{ij} * \Delta P_{Lj} \quad (7)$$

Also note that $\Delta P_{L1,Loc} = \Delta P_{L1} + \Delta P_{L2}$and $\Delta P_{L2,Loc} = \Delta P_{L3} + \Delta P_{L4}$. In the proposed LFC implementation, the contracted load is fed forward through the DPM matrix to Genco set points. The actual loads affect system dynamics via the input $\Delta P_{L,Loc}$to the power system blocks. Any mismatch between actual and contracted demands will result in frequency deviations that will drive LFC to dispatch the GENCOs according to ACE participation factors, i.e., apf$_{11}$, apf$_{12}$, apf$_{21}$ and apf$_{22}$

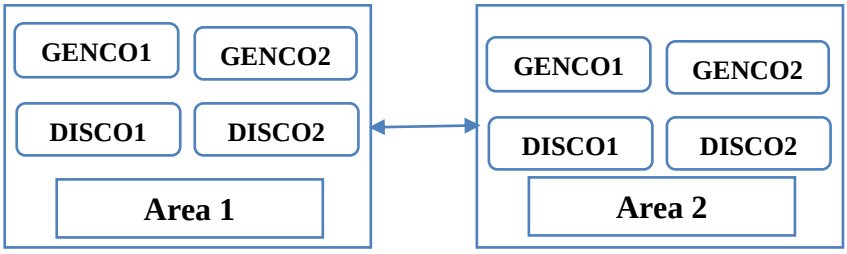


Figure.1 Schematic diagram of restructured interconnected system

Development of control strategy for LFC

Design and development of PD interacted PI controller.

An integral term is almost always used for the feedback controller to eliminate steady-state offset. The integral term is dominant at low frequencies compared with the proportional and derivative terms; hence, the term may be applied at a slower rate. With this concept, Lee and Edgar proposed a dual-rate control system with improved stability robustness where the integral action is sampled more slowly. The sample and hold in Lee and Edgar may be approximated with a time delay or a low pass filter. A filtered integral term will also have better stability robustness. A time delay or a low pass filter added to the integral term which can increase the gain and phase margins for some processes.

Use of a time delay element in feedback controller is not new. Some controllers such as the Smith predictor, PID_{T_d} controller and the internalmodel controller use time delays intentionally in their structures. PID_{T_d}Controlleris functionally equivalent to the Smith predictor, but it can betuned more easilypresented the proportional minus delay controller, which performsan averaged derivative action, and thus, can replacet he conventional proportional derivative controller. A proportional-hereditary controller for a multivariable process with guaranteed stability and improved performance. Further, a time delay filter for an input shaping of the reference signal was proposed. These references show that time delay can be used in the controller design for improved performances. A time delay or a low pass filter is applied here to the integral term for better performances and robustness of the closed-loop system. The derivative term in the proportional-integral-derivative controller produces phase lead, lowering the overshoot of the proportional-integral control system and enhancing robustness. However, the derivative term amplifies the high frequency noise and may cause vigorous control actions.

Alternatively, a time delay or a low pass filter added to the integral term also shows phase lead for a certain frequency range and can replace the derivative term without differentiating signals. It expands bandwidths of control systems without increasing the peak amplitude ratios much. Because there is no explicit differentiation of process output signals, the proposed controllers can be used for processes under noisy environments.

The transfer function form of ideal PID controller is as follows,

$$G_i(s) = \frac{U(s)}{E(s)} = K_C\left(1 + \frac{1}{T_i s} + T_d s\right) \quad (8)$$

The transfer function of this controller is given as

$$G_s(s) = \frac{U(s)}{E(s)} = K_{C1}\left(1 + \frac{1}{T_{i1}s}\right)(1 + T_{d1}s) \quad (9)$$

In this structure, the three control actions are completely separated and the transfer function is given as

$$G_p(s) = \frac{U(s)}{E(s)} = K_p + \frac{K_i}{S} + K_d s) \quad (10)$$

In fact, this parallel structure of PID controller is the most general form. This is because the integral action (derivative action) can be switched off by letting $K_i = 0$ ($K_d = 0$). Note that in the ideal and classical structures of PID, to switch off the integral action, the integral time must reach infinity.

Proposed PD interacted PI Controller

The basic PID controller structures given by (8), (9), and (10) are not suitable for practical applications. There are two main coupled reasons behind this fact. First, the controller transfer function is not proper and therefore it cannot be implemented in practice. This problem is due to the derivative action, which may cause difficulties if there is a high-frequency measurement noise.
Practically speaking, this term of the control signal with high amplitude and frequency may cause damage to the actuator. These problems can be rectified by including at least a first-order low-pass filter to filter out the derivative control action [14]. In this regard,

we may have two possibilities. One possibility is to replace the derivative action Tds of the ideal structure by Tds/(1 + (Td/N)s) or the term (1 + Td1s) of the classical structure by (1 + Td1s)/(1 + (Td1/N1)s). Therefore, the modified versions of (11) and (12) take the following forms [15], respectively:

$$G_{cm}(s) = K_{c1}\left(1 + \frac{1}{T_{i1}s}\right)\left(\frac{1+T_{d1}s}{1+(T_{d1}s/N_1 s)}\right) \quad (11)$$

The block diagrams of (11) are presented in Fig 5,

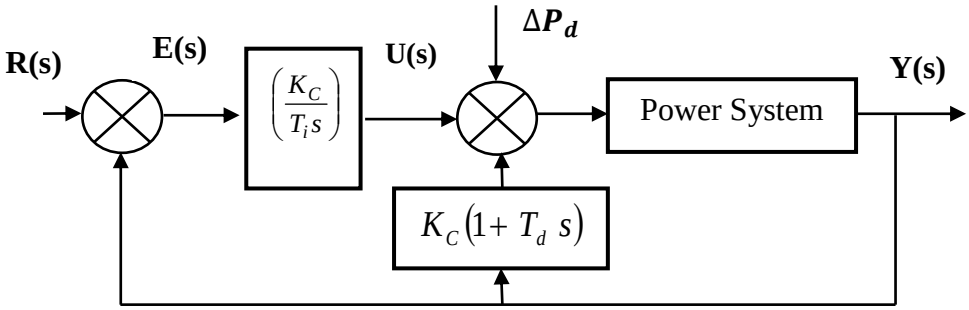


Figure.2. LFC loop using Interacting PI Controller with Proportional – Derivative terms acting on the output for closed loop control structure

Design of Hydrogen Aqua Electrolyser Unit

The Hydrogen Aqua Electrolyser (HAE), hydrogen storage tank, and fuel cell (FC) combination is designed to provide long-term and large-scale load demand support to the power grid system. During normal time, the HAE is used to produce hydrogen (H_2) by electrolyzing water and compressing it before storing it in the tank. A proton exchange membrane FC absorbs stored H_2 and produces electricity directly, which can be used to satisfy immediate load demands.

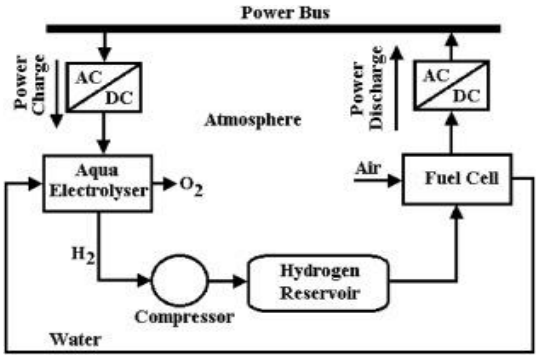


Fig. 3 Energy exchange processes of the hydrogen aqua electrolyser unit

The method produces water and heat as by-products. As compared to any single energy conversion method, this process is extremely effective. The HAE-FC unit performs well in Hybrid Renewable Energy Systems (HRES) that include wind turbines, Photo Voltaic (PV) arrays, and/or Battery Stacks (BS).

Thus, the transfer functions of HAE and FC are represented by first-order lag as follows

The transfer function of HAE is given by

$$G_{HAE}(s) = \frac{K_{HAE}}{1+sT_{HAE}} \quad (12)$$

The transfer function of HAE is given by

$$G_{FC}(s) = \frac{K_{FC}}{1+sT_{FC}} \quad (13)$$

Where, K_{HAE} and K_{FC} are the gains of HAE and FC, respectively. T_{HAE} and T_{FC} are the time constants of HAE and FC, respectively. The values of these parameters are taken from [16] as given in Appendix.

Application of FACTS device in LFC

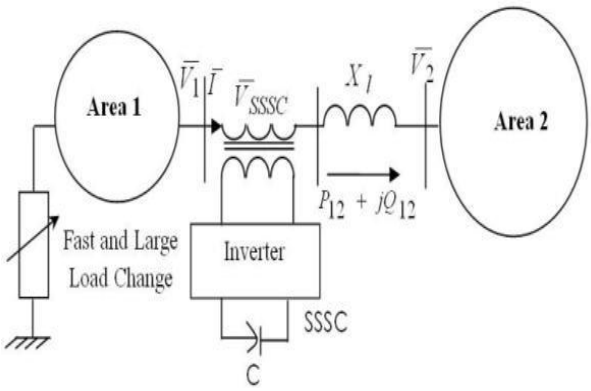


Fig. 4SSSC in a two-area interconnected power system

Figure.4 shows the two-area interconnected power system with a configuration of SSSC used for the proposed control design. It is assumed that a large load with rapid step load change has been experienced by area1.This load change causes serious frequency oscillations in the system. Under this situation, the governors in an area 1 cannot sufficiently provide adequate frequency control. On the other hand, the area 2 has large control capability enough to spare for other area.

Mathematical Model of SSSC Unit

In this study, the mathematical model of the SSSC for stabilization of frequency oscillations is derived from the characteristics of power flow control by SSSC [17]. By adjusting the output voltage of SSSC ($\bar{V}_{SSSC}$), the tie-line power flow ($P_{12} + jQ_{12}$), can be directly controlled as shown in figure 4. Since the SSSC fundamentally controls only the reactive power, then the phasor ($\bar{V}_{SSSC}$) is perpendicular to the phasor of line current $\bar{I}$, which can be expressed as

$$\bar{V}_{SSSC} = \mathrm{j}V_{SSSC}\bar{I}/\,I \qquad (14)$$

Where V_{SSSC} and I are magnitudes of $\bar{V}_{SSSC}$ and $\bar{I}$ respectively. Note That Where $\bar{I}/\,I$ is a unit vector of line current. Therefore, the current $\bar{I}$ in fig 4, can be expressed as

$$\bar{I} = (\bar{V}_1 - \bar{V}_2 - jV_{SSSC}\bar{I}/\,I)\,/jX_l \qquad (15)$$

Where $X_l$is the reactance of the tie line, $\bar{V}_1$and $\bar{V}_2$are the bus voltages at bus 1 & 2 respectively? The active power and reactive power flow through bus 1 are

$$P_{12} + jQ_{12} = \bar{V}_1\bar{I}^* \qquad (16)$$

Where $\bar{I}^*$ and is conjugate of $\bar{I}$. Substituting from (15) in (16),

$$P_{12} + jQ_{12} = \frac{V_1V_2}{X_l}\sin(\delta_1 - \delta_2) - V_{SSSC}\frac{\bar{V}_1\bar{I}^*}{X_lI} + j\left(\frac{V_1^2}{X_l} - \frac{V_1V_2}{X_l}\cos(\delta_1 - \delta_2)\right) \qquad (17)$$

Where $\bar{V}_1 = V_1e^{j\delta_1} and \bar{V}_2 = V_2e^{j\delta_2}$

From eqn (17) and (16), gives

$$P_{12} = \frac{V_1V_2}{X_l}\sin(\delta_1 - \delta_2) - \frac{P_{12}}{X_lI}V_{SSSC} \qquad (18)$$

The second term of right-hand side of eqn(18) is the active power controlled by SSSC. Here, it is assumed that V1 and V2 are constant, and the initial value of VSSSC is zero. i.e., V_{SSSC}=0. By linearzing (17) about an initial operating point

$$\Delta P_{12} = \frac{V_1V_2}{X_l}\cos(\delta_{10} - \delta_{20})(\Delta\delta_1 - \Delta\delta_2) - \frac{P_{120}}{X_lI_0}\Delta V_{SSSC} \qquad (19)$$

where subscript "0" denotes the value at the initial operating point by varying the SSSC output voltage ΔV_{SSSC}, the power output of SSSC can be controlled as $\Delta P_{SSSC} = \frac{P_{120}}{X_lI_0}\Delta V_{SSSC}$. In equation (19) implies that the SSSC is capable of controlling the active power independently. In this study, the SSSC is represented by the power flow controller where the control effect of active power by SSSC is expressed by ΔPSSSC instead of $\frac{P_{120}}{X_lI_0}\Delta V_{SSSC}$. Eqn (19) can also be expressed as

$$\Delta P_{12} = \Delta P_{T12} + \Delta P_{SSSC} \qquad (20)$$

Where, $\Delta P_{12} = \frac{V_1 V_2}{X_l}\cos(\delta_{10} - \delta_{20})(\Delta\delta_1 - \Delta\delta_2)$

$=T_{12}(\Delta\delta_1 - \Delta\delta_2)$

(21)

WhereT_{12} is the synchronizing power co-efficient

Control design of SSSC unit.

The controller for the SSSC is design to enhance the damping of the inter-area mode. In order to extract the inter-area mode from the system in the concept of overlapping decompositions is applied. First, the state variables of the system are classified into three groups, i.e.,$x_1 = [\Delta F_1], x_2 = [\Delta P_{T12}], x_3 = [\Delta F_2]$, next, the system is decomposed into two decoupled subsystems, where the state variable ΔP_{T12} isduplicated included in both subsystems, which is the reasonthat this process is called overlapping decompositions. Then, one subsystem which preserves the inter-area mode is represented by

$$\begin{bmatrix}\Delta F_1 \\ \Delta P_{T12}\end{bmatrix} = \begin{bmatrix}\frac{-1}{T_{p1}} & \frac{-K_{p1}}{T_{p1}} \\ 2\pi T_{12} & 0\end{bmatrix}\begin{bmatrix}\Delta F_1 \\ \Delta P_{T12}\end{bmatrix} + \begin{bmatrix}\frac{-K_{p1}}{T_{p1}} \\ 0\end{bmatrix}[\Delta P_{SSSC}]$$

(22)

It has been proved that the stability of original system is guaranteed by stabilizing every subsystem. Therefore, the control scheme of SSSC is designed to enhance the stability of the system (22) by eigenvalue assignment method. Here let the conjugate eigenvalue pair of the system (22)be $\alpha \pm j\beta$, which corresponds to the inter-area mode (22).

$$\text{Mp (new)} = e^{(-\pi\delta/\sqrt{1-\delta^2})}$$

(23)

The real and imaginary parts of eigenvalue after the control are expressed by

$$\alpha_s = \delta\omega_n$$

(24)

$$\beta_s = \omega_n\sqrt{1-\delta^2}$$

(25)

Whereω_n is the undamped natural frequency, by specifying Mpand assuming β_s=β, the desired pair of eigenvalues is fixed. Asa result, the eigenvalue assignment method derives to feedback scheme as

$$\Delta P_{UPFC} = -k_1\Delta F_1 - k_2\Delta P_{T12}$$

(26)

The characteristic polynomial of the system (14) with state feed back, is given by

$$|\lambda I - (A - BK)| = 0$$

(27)

where state feedback gain matrix K = $[k_1, k_2]$. The desiredcharacteristic polynomial from the specified eigenvalue $(\mu_1, \mu_2)$is given by

$$(\lambda - \mu_1)(\lambda - \mu_2) = 0$$

(28)

By equating the coefficients of (19) and (20) the elements k1, k2 of state feedback gain matrix K are obtained.

Modelling of SSSC based damping controller

The active power controller of SSSC has a structure of Lead-Lag compensator with output signal ΔP_{ref}. In this study the dynamic characteristics of SSSC is modelled as the first order controller with time constant *Tsssc*. It is to be noted that the injected power deviations of SSSC, ΔP_{SSSC}acts positively forarea 1 and reacts negatively for area 2. Therefore ΔP_{SSSC}flowinto both of the areas with different signs (+, -) simultaneously. The commonly used Lead-Lag structure is chosen in this study as SSSC based supplementary damping controller as shown in Fig. 5.

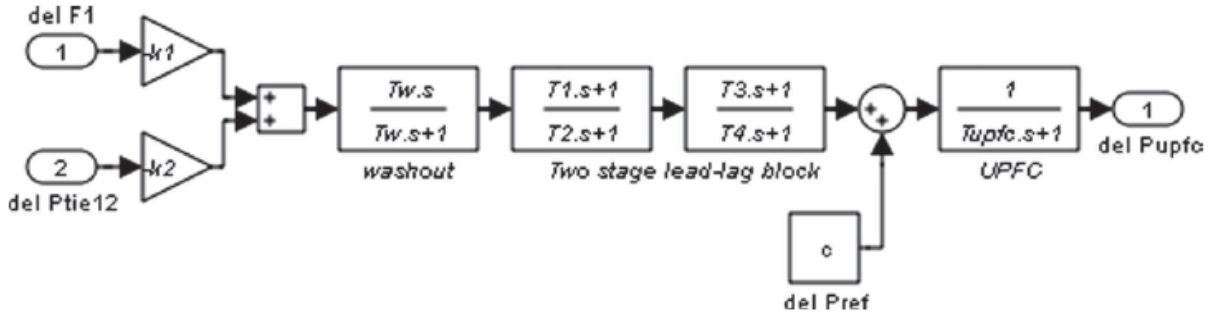


Fig. 5 Transfer function model of SSSC based damping controller

Jaya Algorithm for solving the LFC problem

Venkata Rao developed a newer form of simpler optimization technique [18] called Jaya which means victory. For the first time, Jaya AGC strategy is used to optimize PID structured regulator for interconnected diverse-source power system [19]. The advantage of this algorithm is that it involves very less control parameters, whereas the entire evolutionary and swarm intelligence are probabilistic algorithms and it considers a large number of algorithm-specific parameters along. Jaya algorithm is inspired by TLBO technique. Unlike two phases in TLBO, Jaya has one phase, which makes it a simple algorithm. It works on the simple concept of an approaching best solution and avoiding worst solution. The process of updating solution, during optimization of PID structured regulator,

$$x_{j,k,i}^{new} = x_{j,k,i} + r_{1,j,i}\left(x_j, Best_{,i} - |x_{j,k,i}|\right) - r_{2,j,i}\left(x_j, Worst_{,i} - |x_{j,k,i}|\right), \quad (29)$$

Where $x_{j,k,i}$ is the value of j[th] variable for k[th] population during i[th] iteration; $x_j, Best_{,i}$ and $x_j, Worst_{,i}$ are the values of j[th] variable for best and worst population.

The optimization from which the performance index value of Equation. (29) is minimum in the last iteration predicts the optimized PID structured regulator parameters to be applied in simulation.

Assessment of Power System Restoration

Power System Restoration Indices such as Feasible Restoration Indices (FRI) is stated as when the system is operating in a normal condition with GENCOs units in operation and Comprehensive Restoration Indices (CRI) are one or more GENCOs unit outage in any area. From these Restoration Indices the restorative measures like the magnitude of control input, rate of change of control input required can be adjudged.

The Feasible Restoration Indices [20] are calculated as follows,

The FRI_1 (ε_1) is defined as the ratio between the settling time of frequency deviation in area1 (ζ_{s1}) and power system time constant (T_{p1}) of area 1

$$\varepsilon_1 = \frac{\zeta_{s1}}{T_{p1}} \quad (30)$$

The FRI_2 (ε_2) obtained as theratio between the settling time of frequency deviation in area

2 (ζ_{s2}) and power system time constant $(T_{p2})$of area 2

$$\varepsilon_2 = \frac{\zeta_{s1}}{T_{p1}} \quad (31)$$

The FRI_3 (ε_3) is obtained as theratio between the settling time of tie-line power deviation

(ζ_{s3}) and synchronous power coefficient T_{12}

$$\varepsilon_3 = \frac{\zeta_{s3}}{T_{12}} \quad (32)$$

The FRI_4 (ε_4) is obtained as thepeak value frequency deviation$\Delta F_1(\zeta_p)$ response of area 1

exceeds the final value $\Delta F_1(\zeta_s)$

$$\varepsilon_4 = \Delta F_1(\zeta_p) - \Delta F_1(\zeta_s)$$

(33)

The FRI_5 (ε_5) is obtained as thepeak value frequency deviation$\Delta F_2(\zeta_p)$ response of area 2

exceeds the final value $\Delta F_2(\zeta_s)$

$$\varepsilon_5 = \Delta F_2(\zeta_p) - \Delta F_2(\zeta_s)$$

(34)

The FRI_6 (ε_6) is obtained as thepeak value tie-line power deviation $\Delta P_{tie}(\zeta_p)$ response exceedsthe final value $\Delta P_{tie}(\zeta_s)$

$$\varepsilon_6 = \Delta P_{tie}(\zeta_p) - \Delta P_{tie}(\zeta_s)$$

(35)

The FRI_7 (ε_7) is obtained from thepeak value of the control input deviation $\Delta P_{c1}(\zeta_p)$ response ofarea 1 with respect to the final value $\Delta P_{c1}(\zeta_s)$

$$\varepsilon_7 = \Delta P_{c1}(\zeta_p) - \Delta P_{c1}(\zeta_s)$$

(36)

The FRI_8 (ε_8) is obtained from thepeak value of the control input deviation $\Delta P_{c2}(\zeta_p)$ response ofarea 2 with respect to the final value $\Delta P_{c2}(\zeta_s)$

$$\varepsilon_8 = \Delta P_{c2}(\zeta_p) - \Delta P_{c2}(\zeta_s)$$

(37)

The optimal controller gains and their performance of the system various case studies the corresponding the Comprehensive Restoration Indices (CRI) $(\varepsilon_9; \varepsilon_{10}; \varepsilon_{11}; \varepsilon_{12}; \varepsilon_{13}; \varepsilon_{14}; \varepsilon_{15}; \varepsilon_{16})$ is obtained from (30)– (37).

Feasible Restoration Indices

Poolco based transaction.

In poolco based transaction, the DISCOs should contract with the GENCOs in the similar area only. It is presumed that the two DISCOs in controlarea-1 demands 0.1 p.u.MW of power from the GENCOs of the same control area and the DISCOs in control area-2 have not any contract with the GENCOs in area-2. Hence, the load deviation inarea-1 is 0.2 p.u.MW and that in area-2 is zero. Based on DPM (1) the DISCOs and GENCOs is simulated in case of poolco based contracts is as follows

$$DPM = \begin{vmatrix} 0.5 & 0.5 & 0 & 0 \\ 0.5 & 0.5 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{vmatrix}$$

(38)

Each GENCO participated in AGC as defined by following contract participation factors (CPFs) and in this case, it is presumed that all the DISCOs participated equally in their respective areas i.e. cpf11 = cpf12 = cpf21 = cpf22 = 0.5. In this case the scheduled tie-line power is zero.Considerscenario-1 again with a modification that Disco demands as given in Tables 2 and 3 which shows the tuning parameters of the existing and proposed controllers. From the simulation results Power System Restoration Indices such as Feasible Restoration Indices are evaluated using in (30)– (37) from dynamic output responses of the proposed test system T-TIPS using PID interacting controller is shown in Tables1 Case (1-4) and test system -TIPS with HAE -FC and SSSC using Modified PID controller is shown in Table 3.

Bilateral transaction

In bilateral based transaction, the DISCOs can contract with any GENCOs of any area. It is assumed that all the DISCOs having a demand of 0.1 p.u.MW and therefore, load deviations in each area becomes 0.2 p.u.MW. Based on the following DPM the system is simulated

$$DPM = \begin{vmatrix} 0.5 & 0.25 & 0.5 & 0.4 \\ 0.2 & 0.25 & 0.2 & 0.2 \\ 0 & 0.3 & 0.2 & 0.25 \\ 0.3 & 0.2 & 0.1 & 0.15 \end{vmatrix}$$

(39)

In this case, the Disco1, Disco2, Disco3 and Disco 4,demand 0.15 pu.MW, 0.05 pu.MW,

0.15 pu.MW and 0.05pu.MW from Gencos as defined by cpf in the DPM matrix and each Gencos participates in LFC as defined by the following ACE participation factor apf11= apf12= 0.5 andapf21= apf22 = 0.5.The comparative transient performances of two-area Power System using PID interacting controller for given load perturbation with and without HAE and SSSC unit is shown in Fig.7. The corresponding Feasible Restoration Indices are evaluated from dynamic output responses of the proposed test system T-TIPS using PID interacting controller is shown in Table 2 and test system -TIPS with HAE -FC and SSSC using Modified PID controller is shown in Table 4. (case 5-8).

Comprehensive Restoration Indices

Apart from the normal operating condition of the test systems few other cases such as outage generating unit in any area and uncontracted power demand in any area during outage the corresponding Power System Restoration Indices is called Comprehensive Restoration Indices (CRI). In this study, Genco-4 in area 2 is outage and uncontracted power demand in any area and Disco Participation Matrix (39) is considered. The comparative transient performances of two-area Power System using PID interacting controller for given load perturbation and corresponding Comprehensive Restoration Indices (CRI) with HAE and SSSC unit are calculated and tabulated in Tables 5.

Simulation and Discussion

In this test system all the Gencos in each area consists of thermal reheat units with different capacity and the active power model of HEA is places in area 1 and SSSC unit located in series with the tie-line is shown in Fig.6. The nominal parameters are given in Appendix [16, 21]. The proposed controllers are designed and implemented in Two-Area Thermal Interconnected Power System (T-TIPS) without and with HAE and SSSC units for different types of transactions. The Proportional Derivative (PD) interacted with Proportional Integral (PI) are designed and implemented in the two-area interconnected power system. Power system restoration based modified PID controller is designed and implemented in the above-mentioned power system for a step load disturbance in area 1/area 2 and the corresponding frequency deviations, tie-line power deviations and control input deviations are plotted for easy comparison and are presented in Figs. 11-12. It is observed from the output responses that, FRI and CRI based modified controller when incorporated in the two-area interconnected power system has not only improved the transient response of the system but also has reduced the settling time. Various control strategies have been proposed to optimize the AGC to enhance a better control over not only the inter-area tie- line power flow but also to optimize the control input requirements. Simulation results reveals that the output response with the proposed controller (PD interacting PI controller) with and without HAE and SSSC units provide a high-quality transient and steady state response when compared to that of the output response obtained using proposed controller of the system. The gain value of HAE (K_{HAE}) is calculated for the given value of speed regulation coefficient (R). The purpose of utilizing SSSC unit is to damp out the peak value of frequency deviations in the both areas and tie-line power deviations. Then Modified PD interacting PI controller gain values for each area and parameters of SSSC unit are optimized and tuned simultaneously with help of Jaya algorithm for both traditional and bilateral based LFC schemes in T-TIPS with a wide range of load changes for different case studies.

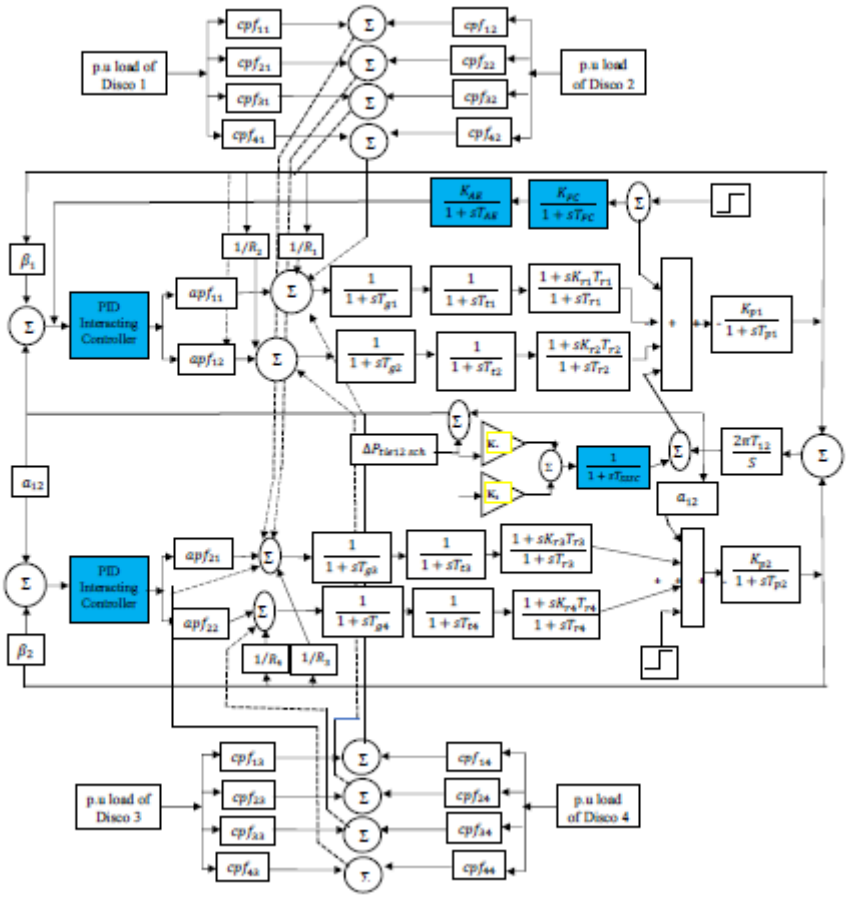


Fig.6.Block diagram of a two-area interconnected power system with Hydrogen Aqua Electrolyser (HAE) with Fuel cell and SSSC units

Table. 1 Tuned control parameters for the corresponding Load demand change of the T-TIPS using PD interacting PI controller

T-TIPS	PI^{2}controller gain of area 1			PI^{2}controller gain of area 2			Load demand in p.u.				Uncontracted load demand in p.u.	
	K_P	K_I	K_d	K_P	K_I	K_d	Disco 1	Disco 2	Disco 3	Disco 4	Area 1	Area 2
Case1	0.394	0.461	0.401	0.311	0.529	0.499	0.1	0.1	0	0	0	0
Case2	0.419	0.389	0.218	0.356	0.371	0.667	0.1	0.1	0	0	0.1	0
Case3	0.505	0.469	0.897	0.228	0.406	0.168	0.1	0.1	0	0	0	0.1
Case4	0.423	0.432	0.828	0.342	0.302	0.221	0.1	0.1	0	0	0.1	0.1
Case5	0.369	0.586	0.251	0.380	0.221	0.243	0.15	0.05	0.15	0.05	0	0
Case6	0.482	0.641	0.311	0.311	0.508	0.127	0.15	0.05	0.15	0.05	0.1	0

Case7	0.393	0.559	0.458	0.294	0.483	0.328	0.15	0.05	0.15	0.05	0	0.1
Case8	0.396	0.618	0.624	0.238	0.403	0.795	0.15	0.05	0.15	0.05	0.1	0.1
Case9	0.529	0.819	0.618	0.366	0.387	0.467	0.12	0.08	0.14	0.06	0	0
Case10	0.529	0.856	0.822	0.447	0.361	0.203	0.12	0.08	0.14	0.06	0.1	0
Case11	0.519	0.647	0.764	0.491	0.340	0.488	0.12	0.08	0.14	0.06	0	0.1
Case 12	0.529	0.734	0.886	0.237	0.418	0.361	0.12	0.08	0.14	0.06	0.1	0.1

Table. 2 FRI for T-TIPS using PD interacting PI controller for different case studies

T-TIPS	Settling time(ζ_s)			Peak Over/ under shoot (m_p)			Control input deviation (ΔP_c)	
	ε_1	ε_2	ε_3	ε_4	ε_5	ε_6	ε_7	ε_8
Case1	0.822	0.814	39.12	0.316	0.278	0.031	0.114	0.094
Case2	0.884	0.842	40.54	0.524	0.342	0.041	0.209	0.104
Case3	0.855	0.923	42.56	0.409	0.398	0.048	0.123	0.223
Case4	1.074	1.117	49.85	0.577	0.658	0.067	0.199	0.208
Case5	0.894	0.868	37.23	0.285	0.278	0.049	0.103	0.052
Case6	0.914	0.872	38.54	0.514	0.443	0.058	0.222	0.103
Case7	0.895	0.945	41.87	0.347	0.608	0.065	0.117	0.112
Case8	1.190	1.192	49.72	0.526	0.924	0.066	0.207	0.121

Table. 3 FRI for T-TIPS for HAE and SSSC unit using PD interacting PI controller for different case studies

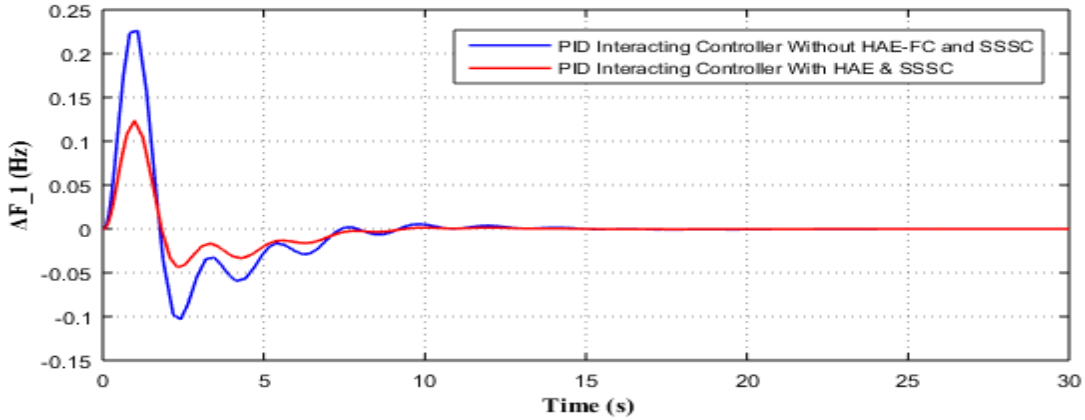
T-TIPS	Settling time(ζ_s)			Peak Over/ under shoot (m_p)			Control input deviation (ΔP_c)	
	ε_1	ε_2	ε_3	ε_4	ε_5	ε_6	ε_7	ε_8
Case1	0.815	0.797	26.358	0.364	0.497	0.057	0.110	0.072
Case2	0.772	0.849	21.230	0.510	0.578	0.043	0.083	0.087
Case3	0.653	0.749	21.923	0.478	0.635	0.043	0.118	0.083
Case4	0.808	0.834	26.959	0.438	0.664	0.033	0.084	0.100
Case5	0.799	0.888	22.003	0.355	0.650	0.041	0.078	0.113
Case6	0.643	0.850	26.485	0.572	0.484	0.047	0.114	0.104
Case7	0.617	0.850	26.105	0.576	0.435	0.034	0.060	0.092
Case8	0.881	0.886	24.448	0.354	0.500	0.052	0.082	0.097

Table.4 CRI for T-TIPS using PD interacting PI controller for different case studies

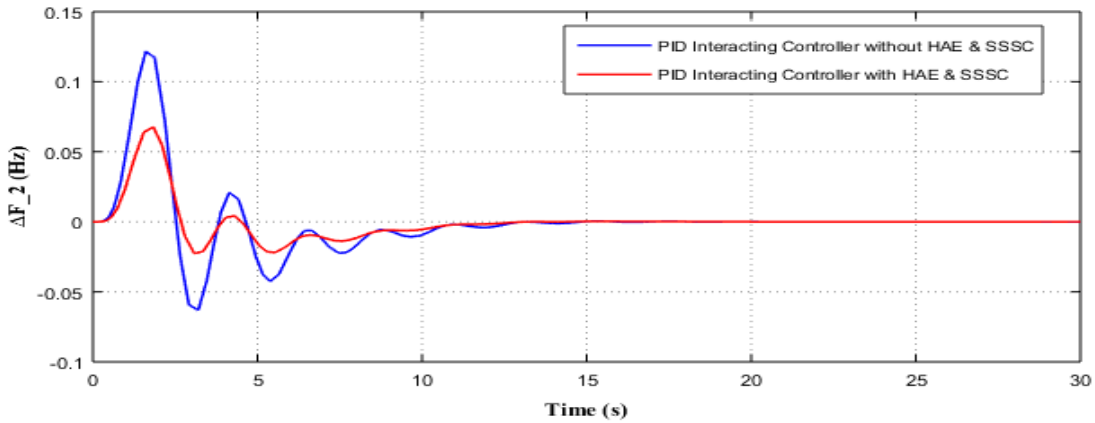
T-TIPS	Settling time(ζ_s)			Peak Over/ under shoot (m_p)			Control input deviation (ΔP_c)	
	ε_9	ε_{10}	ε_{11}	ε_{12}	ε_{13}	ε_{14}	ε_{15}	ε_{16}
Case9	1.367	1.432	54.26	0.487	0.508	0.129	0.180	0.149
Case10	1.622	1.580	54.13	0.524	0.599	0.146	0.188	0.161
Case11	1.435	1.610	57.79	0.569	0.789	0.147	0.171	0.158
Case12	1.671	1.626	58.54	1.108	1.114	0.159	0.197	0.174

Table.5 CRI for T-TIPS for HAE and SSSC unit using PD interacting PI controller for different case studies

T-TIPS	Settling time(ζ_s)			Peak Over/ under shoot (m_p)			Control input deviation (ΔP_c)	
	ε_9	ε_{10}	ε_{11}	ε_{12}	ε_{13}	ε_{14}	ε_{15}	ε_{16}
Case9	1.091	1.454	44.249	0.503	0.531	0.529	0.112	0.170
Case10	0.917	1.322	44.037	0.477	0.679	0.379	0.103	0.170
Case11	1.108	1.591	44.047	0.571	0.526	0.334	0.102	0.172
Case12	1.015	1.565	44.610	0.805	0.661	0.511	0.118	0.158



(a)



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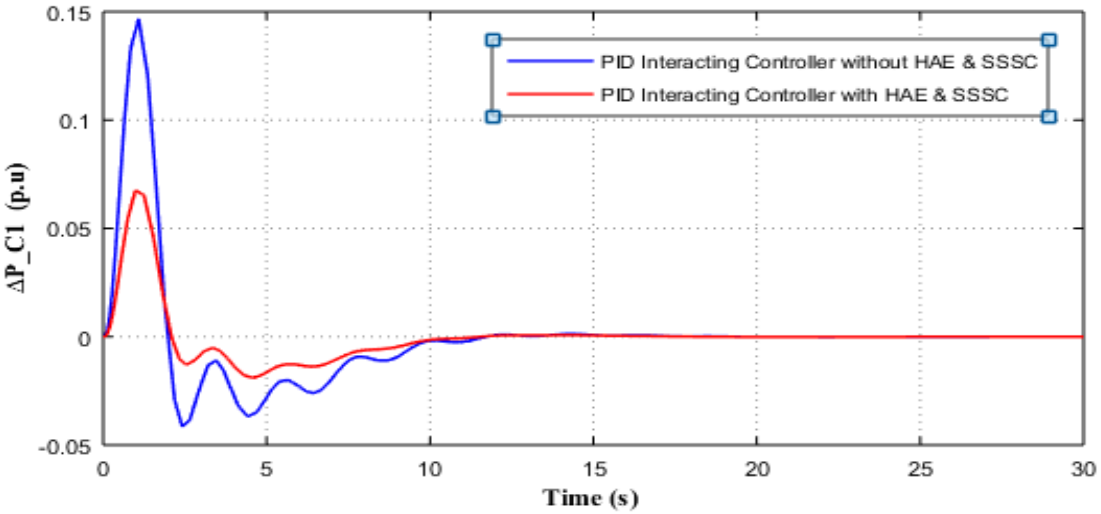
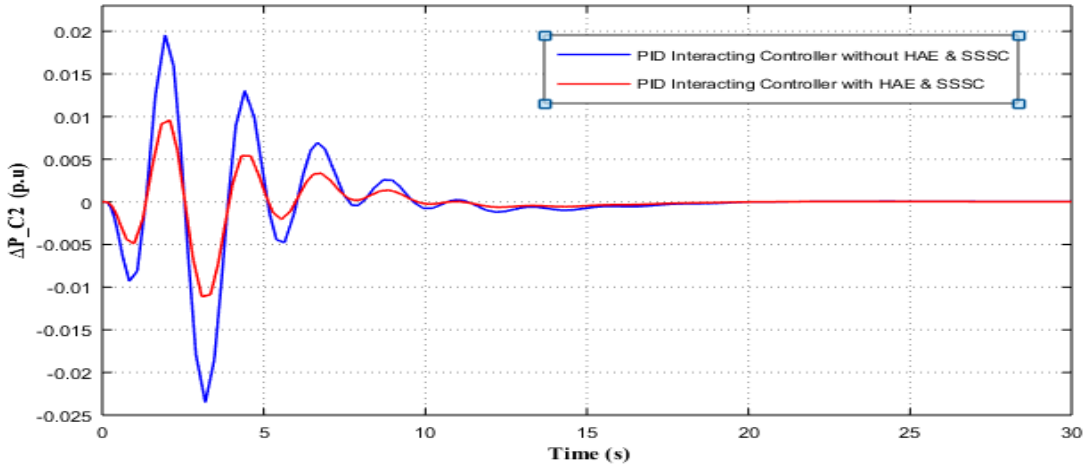
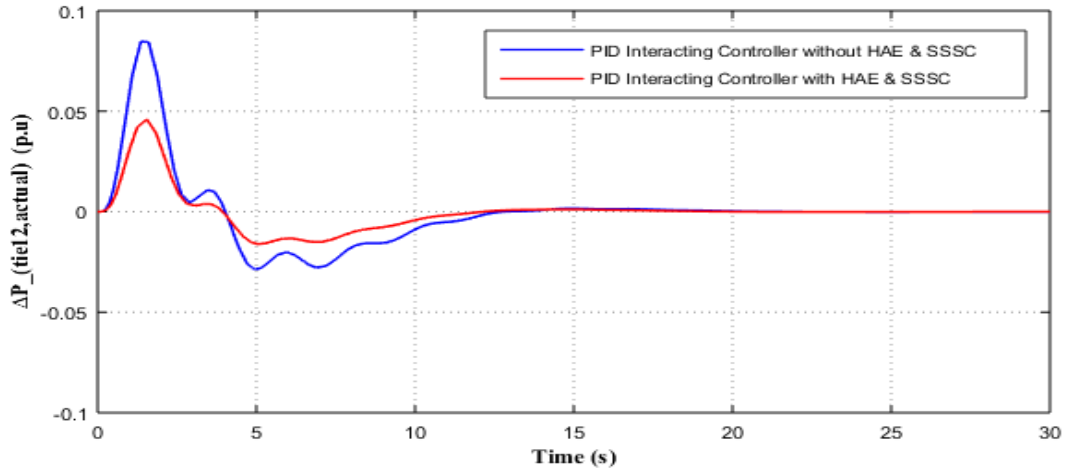

PID Interacting Controller without HAE & SSSC
PID Interacting Controller with HAE & SSSC
ΔP_C1 (p.u)
Time (s)

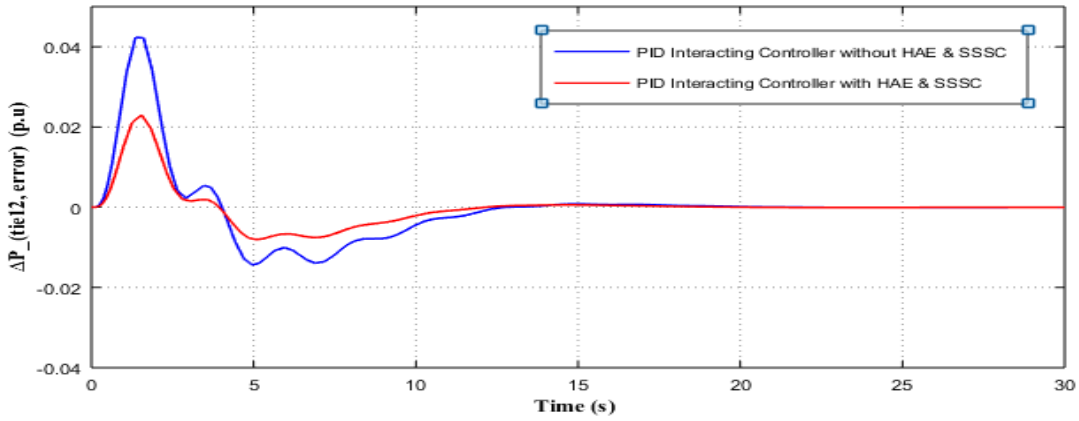
(c)


PID Interacting Controller without HAE & SSSC
PID Interacting Controller with HAE & SSSC
ΔP_C2 (p.u)
Time (s)

(d)


PID Interacting Controller without HAE & SSSC
PID Interacting Controller with HAE & SSSC
ΔP_(tie12,actual) (p.u)
Time (s)

(e)



(f)

Fig. 7Dynamic responses of the frequency deviations, tie-line power deviations, and control input deviations for a two area LFC system using PI^2controller and PD interacted PI controller in the restructured scenario(A) DF1 (Hz) Vs Time (s), (B) DF2 (Hz) Vs Time (s), (C) DPtie12; actual (p.u.MW) Vs Time (s), (D) DPtie12; error (p.u.MW) Vs Time (s), (E) DPc1 (p.u.MW) Vs Time (s), and (F) DPc2 (p.u.MW) Vs Time (s).

Conclusion

The proposed PD with PI interacting controllers are designed utilizing the JAYA technique and implemented in a two-area multi-source thermal-thermal interconnected restructured power system without and with HAE and SSSC units. In this study, a sophisticated LFC using HAE coordinated with SSSC units has been proposed for the test system, HAE unit is incorporated into area-1 and the SSSC unit in series with the tie-line so as to improve the system transient performance. The frequency deviations of each area and tie-line power deviations have been diminished as it results in less peak over/undershoot and decreased settling time on account of the implementation and coordination of HAE and SSSC units which guarantees the prime requirement of LFC. It may be concluded that the design concept of damping the inertia mode and inter-area mode, the co-ordinate control of HAE and SSSC units are effective in suppressing the area frequency deviations and tie-line power oscillations of the test system simultaneously for the various un-contracted step load demand change conditions. Furthermore, the restoration procedure for the test system with HAE and SSSC units ensures improved PSRI which provides more robustness also. These PSRI indicate that the ancillary services are necessary to improve the effectiveness of the physical activity of the power system with the expanded transmission limit in the network.

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Appendix

Table A1 Control area parameter [21]

Parameters	Area 1	Area 2
K_p (Hz / p.u. MW)	120	72
$T_p(s)$	20	14.3
β (p.u. MW / Hz)	0.8675	0.785
T_{ij} (p.u. MW / Hz)	$T_{12} = 0.545$	
F (Hz)	60	
a_{12}	-1	

Table A2 GENCOs parameter (Thermal Generating Unit) [21]

MVA_{Base} (1000 MW) Parameters	GENCOs (*k* in area *i*)			
	1-1	1-2	2-1	2-2
Rate (MW)	1100	1100	800	900
$T_g(s)$	0.06	0.06	0.07	0.08
$T_t(s)$	0.36	0.44	0.42	0.4
$T_r(s)$	10	10	10	10
K_r	0.5	0.5	0.5	0.5
R (Hz / p.u. MW)	2.4	2.5	3.3	2.4
APF	0.5	0.5	0. 5	0.5

Table A3 HAE-FC unit parameters [16]

Parameters	Values
K_{HAE}	0.02
T	0.5s
K_{FC}	0.01
T_{FC}	4s

Table A4 SSSC unit parameters [17]

Parameters	Values
T_{SSSC}	0.01 s
T_w	10 s

MERGER STRATEGIES USED FOR BUSINESS ALLIANCES: A POST-MERGER STUDY FOR SERVICE EXPERIENCE OF CONSUMER WITH SPECIAL REFERENCE TO VI TELECOM COMPANY IN INDIA

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ABSTRACT

Most of the studies on mergers focuses upon the companies' financial performances in the modern academics. In the present research, researchers have made an extensive literature review to find the consumers aspect in the context of telecom industry in India. To understand the impact of mergers on the consumers researcher have selected the recent Vodafone and Idea merger in India. The researchers have used a self-developed questionnaire. The validity of questionnaire has been established with Cronbach's Alpha (.805). The comparison of pre-merger and post-merger consumer experience have been made for Price Experience, Network Experience, Customer Care Expectation and Calling Experience. Significant difference has been found in all the comparative parameter except price experience.

Key Words: *Mergers, Telecom industry in India*

Introduction

Business operations have turned much complex now a days. Businesses are addressing multiple needs of a buyer. Consumerism has made things much worse. **Haney, L.H. (1931)**defines the business combination strategy as, "To combine is simply to become one of the parts of a whole; a combination is merely a union of persons, to make a whole or group for the prosecution of some common purpose." Actually, combination strategies are part of grand strategies. Stability, expansion, or retrenchment are the parts of grand strategies decision that a company can make. The objective of the combination strategy is to improve the efficiency of organizations.

Combination strategies are very important now a days. No production technology is hidden now a days. Reverse engineering technologies tell all the substitute ways of production of the same good. It became almost difficult take long run competitive advantages. After a long era of competitive relations companies started to think for the combination strategies. Patents, licencing and copyrights can protect the uniqueness of a product and its manufacturer. But the real competitor of the firm is its customer not the neighbouring company.

It is difficult to understand that when and where the combination strategies started. researcher has tried to find few meaningful reasons of the selection of combination strategies by companies. Researchers have done content analysis for the evaluation of the reasons for combination strategies. Interviews of CEO's, CFO's, Chairpersons and MD of big firms have been selected. Magazine editorials, news articles and research papers have been considered for the purpose.

Dranove D., Shanley, M., & Simon, C. (1992), argue about the wasteful competition in the context of hospitals. They insisted upon the replication of work and discuss the scope of unified organization. the major drawback in modern organizations is the useless competition. Companies tries to compete with other organization, price discounting is the most common tool. Thus, they reduce the profitability of business. In photocopy business this issue was seen with retail shopkeepers. In the wave of competition, they reduced the price per copy. Gradually the loss went too high that in a specific area they have to fix the price per copy so that they should survive in business.

Lambrecht, B. M. (2004)in his workfocused upon the economies of scale. His work shows that the way merger synergies are divided not only influences the acquirer's and the acquiree's returns from merging, but also the timing of the restructuring.Economies of large scale has been considered as a major factor of merger by **O'Brien, A. P.**

(1988),Ambrose, B. W., Highfield, M. J., &Linneman, P. D. (2005), Gort, M. (1969).

Karier T. M. (1993)in his book 'Beyond competition: the economics of mergers and monopoly power' has detailed about the desire for monopoly power by companies. In Indian context we can see the example of telecommunication industry. after the advent of Jio most of the companies tried come together to beat the competition by Jio. **Galbraith, C. S., & Stiles, C. H. (1984), Trautwein, F. (1990)** supported the monopoly attainment as a major reason forcombination strategy and mergers.

Saravia J. (2013), observed the Business cycle as the important factor behind the mergers. Businesses follow a life cycle of introduction, growth, maturity and decline. Due to technological advances and time to time innovations these stages have been reduced significantly. Software industry in highly prone to life cycle saturation. Many applications at social networking have not even seen the few of these stages before dying (Orkut shut down by Google 2014). **BeckettiS. (1986), Benzing, C. (1991)**remained in favour of business cycle as a cause of combination strategy and merger.

Joint stock companies'formation, influence of tariff and enhanced efficiency and effectiveness are some other benefits that are looked forward at the time of merger. Based upon the content analysis the objectives of combination strategies are as follows:

- Achieving sustained growth and profits
- Reduction in competition turn the red ocean into blue
- Creating entry barrier
- Increase stability
- withstand the effect of business cycle

The **Combination Strategy** means making the use of other grand strategies (stability, expansion or retrenchment) simultaneously. Simply, the combination of any grand strategy used by an organization in different businesses at the same time or in the same business at different times with an aim to improve its efficiency is called as a combination strategy.The **Grand Strategies** are the corporate level strategies designed to identify the firm's choice with respect to the direction it follows to accomplish its set objectives. Simply, it involves the decision of choosing the long-term plans from the set of available alternatives. The Grand Strategies are also called as **Master Strategies** or **Corporate Strategies**.In the present serious worldwide business environment, the expanding number of Mergers and Acquisitions has given organizations another arrangement of chances and difficulties to consider. This has caused the business world to turn out to be more demanding as authoritative pioneers' endeavours to incorporate the business procedures, tasks, and societies of the various organizations to endure and develop. Thus, a few organizations are meeting up to confront the difficulties.

The globalization of worldwide economies and the resultant decrease in exchange hindrances has made mergers and acquisitions an appealing development methodology for internationalizing associations **(Hitt, Harrison and Ireland, 2001).** A consolidation or securing can build the capacities of an organization inside a moderately brief timeframe; a benefit over natural or inner development which is by and large slower at conveying comparative development results **(Lynch and Lind, 2002).**Merger indicates any kind of transaction that results in the formation of one entity from two or more units **(Weston & Chung, 2000).** India, as the fastest growing nation in the world, has witnessed substantial number of deals postliberalization in 1991 leading to global exposure **(Basant, 2000).** Systematic review **(Petticrew& Roberts, 2006)** of literature aims at understanding the precise nature of existing literature and explores avenues for future research. In order to advance any expanding discipline, a frequent re-examination of the current state of the research is required **(Cooper, 2010).**These procedures have consistently assumed a fundamental part in corporate history, going from 'insatiability is acceptable' corporate bandits purchasing organizations in an unfriendly way and splitting them up, to the

present pattern to utilize mergers and obtaining for outer and industry solidification **(Sherman and Hart, 2006).**The terms mergers and obtaining are regularly utilized conversely however understand the contrast between the two. In the scholarly writing, there is various writers, who characterize consolidation, securing, and takeover in an unexpected way. As per **Sudarsanam (1995)**, a consolidation happens when at least two companies meet up to contribute and share their assets to accomplish normal targets. The investors of the consolidating structures frequently stay as joint proprietors of the joined element. However, as indicated by **Sherman and Hart (2006),** a consolidation is a mix of at least two organizations in which the resources and liabilities of the selling firms are consumed by the purchasing firm. As per **Gaughan (2002),** a consolidation is a cycle where two organizations join and just one endures and the combined company stops to exist. At times there is a mix of two organizations where both the organizations stop to exist and an altogether new organization is made. A procurement, then again, is the acquisition of a resource like a plant, a division, or a whole organization. **Sudarsanam (1995)** characterizes obtaining as 'a manageable distance bargain' where one organization buys the portions of another organization and the procured organization is as of now not the proprietor of the firm.

The term 'takeover' is some of the time used to allude an unfriendly circumstance. As per **Gaughan (2002),** this happens when one organization attempts to procure one more organization against the desire of the organization's administration. In any case, as indicated by **Sudarsanam (1995),** a takeover is like obtaining and likewise infers that the acquirer is a lot bigger than the procured. As per **Gaughan (2002),** mergers and acquisitions are well disposed exchanges in which the senior administration of the organizations arranges the details of the arrangement and the terms are then placed before the investors of the objective organization for their endorsement. While in a takeover, an alternate arrangement of correspondence happens between the objective and the bidder, which includes lawyers and courts. Bidders here attempt to bid straightforwardly to the investors regularly against the suggestions of the administration.

On 7 September 2020, Vodafone Idea unveiled its new brand identity. The new brand leverages on the legacy of two of the most loved brands of the country - Vodafone and Idea, which have brand saliency established over decades. Vi™ is built to be strong, ever-dependable, agile, intuitive, and a brand in tune with the needs of the customers, in these ever-changing times.The standalone and consolidated financial highlights of your Company for the Financial Year ended March 31, 2021 are summarized as follows:

(in ₹ Mn)

Particulars	Standalone		Consolidated	
	2020-21	2019-20	2020-21	2019-20
Income from sale of goods and services	**416,589**	446,830	**419,382**	449,167
Other Operating Income	**138**	320	**140**	408
Other Income	**2,584**	10,861	**1,742**	10,393
Total Revenue	**419,311**	458,011	**421,264**	459,968
Operating Expenses	**252,442**	300,976	**250,065**	300,450
EBITDA	**166,869**	157,035	**171,199**	159,518
Depreciation and Amortisation	**229,062**	238,888	**236,385**	243,564
EBIT	**(62,193)**	(81,853)	**(65,186)**	(84,046)
Interest and Finance charges	**179,916**	153,772	**179,981**	153,920
EBT	**(242,109)**	(235,625)	**(245,167)**	(237,966)
Exceptional Items (Net)	**(221,036)**	(387,242)	**(199,681)**	(383,557)
Share of JV/Associates	**-**	-	**2,314**	3,553
Profit / (Loss) Before Tax	**(463,145)**	(622,867)	**(442,534)**	(617,970)
Taxes	**(208)**	108,448	**(203)**	120,811
Profit / (Loss) after Tax	**(462,937)**	(731,315)	**(442,331)**	(738,781)
Other Comprehensive Income, net of tax	**(4,152)**	(18,242)	**368**	(90)
Total Comprehensive Income	**(467,089)**	(749,557)	**(441,963)**	(738,871)

Source: Vi annual report 2020-21

Table 1.1: Vi Annual Financial Performance

Standalone revenue of your Company stood at ` 416,727 Mn, a decrease of 6.8% over previous year. The EBITDA stood at ` 166,869 Mn, registering an increase of 6.3% over the previous year. The Net Loss including amount specified in other comprehensive income of the Company for the Financial Year March 31, 2021 stood at ` 467,088 Mn, vis-à-vis ` 749,557 Mn, for the previous year. On a consolidated basis, the revenue of your Company stood at ` 419,522 Mn, a decrease of 6.7% over the previous year. The EBITDA at ` 171,198 Mn reflects increase of 7.3% as compared to the previous year. The Consolidated Net Loss including amount specified in other comprehensive income of the Company stood at ` 441,964 Mn, for Financial Year 2019-20 vis-à-vis ` 738,871 Mn for the previous year.

With the above discussion on the different aspects of merger, its need and telecom sector in India, the researchers have decided the problem statement as 'the study to merger strategies with respect to service experience of consumer with Vi telecom company'

Literature Review

For executing any research and avoiding duplication of research an extensive literature review is required. The review is based on exploratory, implying that the specialist looks for new bits of knowledge of another marvel, discovers 'what's going on' and looks for new experiences into the space. The review is subjective commonly as the analyst intends to foster an understanding of a complicated marvel. A contextual investigation approach was picked to accomplish the reason. In order to identify relevant studies for this systematic reviewanalysis, and in accordance with procedures in other meta-analysis studies the following steps were undertaken. First, a search using keywords such as "Mergers" OR "Organizational Performance" OR "Telecom Sector in India" etc. As a result, more than 600 articles were identified, published between 2010 and 2021. Second, a manual search was conducted for the articles relevant to mergers in India were selected.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total
Level -II	12	13	15	15	17	11	10	10	14	15	15	15	162

Level -III	12	13	3	7	5	3	5	5	10	2	2	3	70
Level -IV	2	5	2	3	2	2	3	3	6	2	1	1	32

Table-2.1: Number of Articles Used for Review

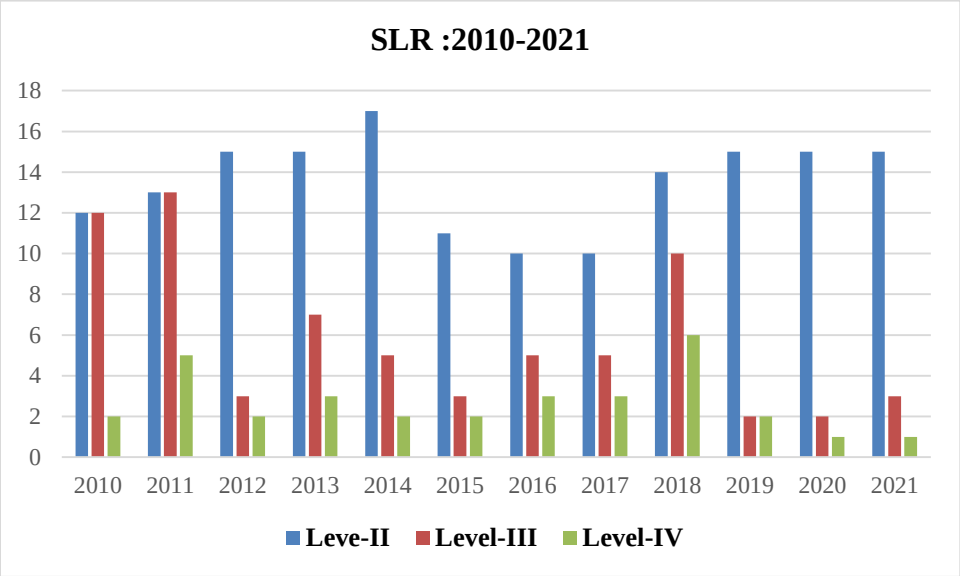


Table-2.2: Number of Articles Used for Review (Y): Year-wise (X)

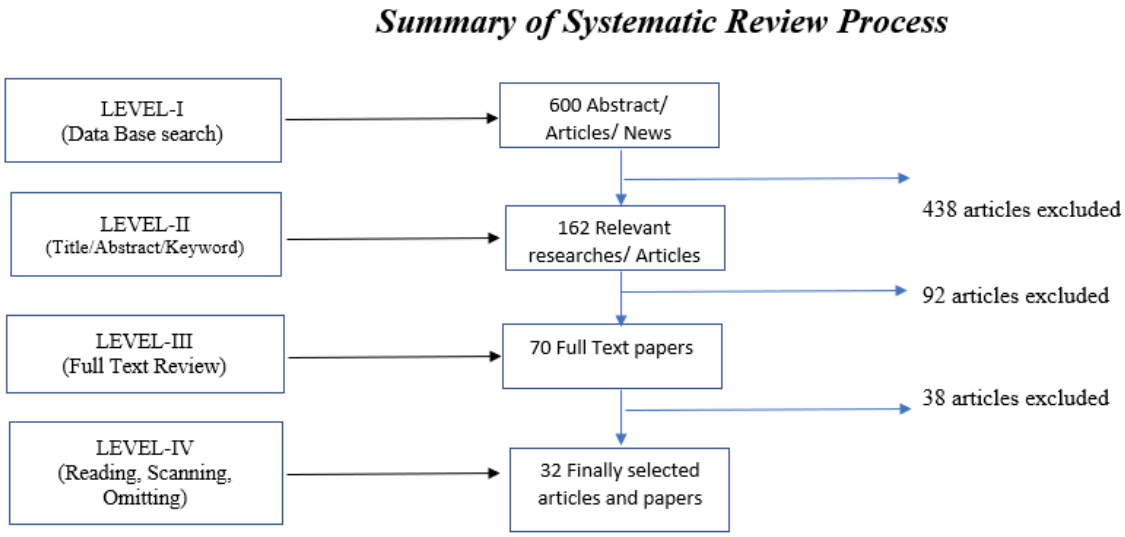


Fig 2.1: Systematic Review Process

K. Ravichandran (2010), analyses the efficiency and performance using CRAMEL–type variables, before and after the merger for the selected public and private banks which are initiated by the market forces. **Dr.Neena Sinha (2010**), examines the impact of mergers and acquisitions on the financial efficiency of the selected financial institutions in India.**Smita, M. (2011)** tried to understand the impact of mergers and acquisitions (M&A) on corporate sector in India. There are three research objectives first trends of

M&A in India second to examine the financial performance of selected companies after M&A and third to study the impact of companies after M&A on Indian corporate sector. **Puneet Jain, (2011)** suggests mergers and acquisitions in the telecommunications field have become a booming business as large companies scramble to acquire new IP technology companies. **Shekhar, E., & Sharma, V. (2011)** in their work Cross-Border Mergers in Light of the Fallout of the Bharti-MTN Deal explores those mergers and acquisitions are increasingly being used and getting accepted by Indian business entities as a critical tool of business strategy. **Jain, S., & Garg, H. (2011),** With more than 14 mobile operators operational in India in 2011 and many more likely to join, ARPU (average revenue per user) for operators is declining every hour, competition is getting more and more cut throat, and the quality of service becoming a serious question. **Reddy, K. S., Nangia, V. K., & Agrawal, R. (2012)** describe and track critical factors behind the failure of mega cross-border deal between Bharti Airtel (India) and MTN Group (South Africa) in the global telecom industry.**Verma, N., & Sharma, R. (2013),** suggests mergers and acquisitions (M&A) are the leading corporate strategies followed by organizations looking for improved value creation and profitability. This research paper aims to study the impact of types of mergers on the performance of Indian Telecom industry, by examining some pre- and post-merger financial and operating variables. **Aruna, G., &Nirmala, S. (2013),** Indian IT and Outsourcing industry has come into focus. Outsourcing involves the transfer of the management or day to day execution of an entire business function to an external service provider. **Ghosh, M. S., & Dutta, S. (2014),** found that reforms implemented by Telecom Regulatory Authority of India (TRAI) and Department of Telecommunications (DoT) post liberalization have drastically altered the business environment in the Indian telecom sector. This sector has emerged as a significant performer in the Indian services domain. **Nalwaya, N., & Vyas, R. (2014**), the service sector is in the process of an unprecedented restructuring exercise globally and merger and acquisition are preferred choice for the same. The pre-merger average return on investment for the acquirer Company was 3.35% while the average of return on investment for the acquiring company was 5.46%. **Mishra, A. K., & Rao, G. (2015),** wrote about mergers and combination strategies. Anti-competitive behaviour, despite helping its practitioners reap rich benefits, is generally believed to have adverse effects on the consumers and the economy as a whole. Their paper studies anti-competitive behaviour with specific focus on the Indian Telecom Industry. **Mohanty, L., & Das, B. (2015),** have worked on Pre- and Post-Merger Financial Analysis of Industry wise Firms in India. In the new economic environment, especially with the global depression and economic slowdown, size and focus of a company matter even for mere survival. **Megnani, N. (2016),** intended to study the change of business ownership and its effects on employee relationship with reference to information technology industries in India. **Pranathi, K., Noor, A., &Priyadarshini, B. I. (2016)** focussed upon the impact of Merger and Acquisition in Mobile Industry with reference to “Vodafone and Hutch”. Mergers and Acquisitions in Global Scenario is the way for the companies to undergo the process of amalgamation, takeover, reconstruction and re-organization. **Verma, N., & Sharma, R. (2017),** focused on creating shareholders' value utilising capital in post-merger and acquisition of Indian Telecom Industry. **Kittilaksanawong, W., &Kandaswamy, S. (2018)**worked uponVodafone-Idea merger. The Indian telecom market was witnessing a fierce price war, especially from an aggressive entry of a new player Reliance JioInfocomm Limited (Jio) with a predatory pricing strategy. **Bedi, A. (2018)** has worked on Post acquisition performance of Indian telecom companies. Mergers and Acquisitions (M&A) are the most popular means of corporate restructuring or business combinations and are a big part of today's corporate finance world. **Sakshi Gupta (2019),** The process of mergers and acquisitions has gained substantial

importance in today's corporate world as a way of corporate restructuring. **Raju, R., &Madhuri, G. (2020)**, worked upon Vodafone and Idea Merger. The Indian telecommunication market has a subscriber base of 1.20 billion and is rapidly growing. The country's wireless subscriptions have witnessed compound annual growth rate (CAGR) of 19.62 per cent to reach 1,183.41 million in the year 2018. **Pai, V. S. (2021),** focused on Vodafone India Ltd. Along with the global telecom sector, the Indian telecom market has evolved over the past three decades. From the first-generation technology in the 1990s, the telecom industry in India offered 4G services in 2012. From microwave technology it has moved into underground fibre optic cables, enhancing the quality and variety of telecom services.

Based upon the above literature researchers have found that the most of the researches are concentrated on financial performance and the wealth of companies. Researchers have found a research gap to conduct a study that helps to understand the improvement of service quality after the merger of telecom companies.

Research Methodology

Objective: To study the difference between post-merger service experience of consumer with pre-merger service experience of consumer

The model of service quality, popularly known as the *gaps model* was developed by a group of American authors, A. Parasuraman, Valarie A. Zeithaml and Len Berry, in a systematic research program carried out between 1983 and 1988. Based upon the GAP model researchers have selected following variables for comparison:

1. Price Experience
2. Network Experience
3. Customer Care Expectation
4. Calling Experience

Based upon the problem statement and research gap researchers have developed following hypothesis:

$_1H^0$- There is no significant difference between post-merger service experience of consumer with pre-merger price experience of consumer

$_2H^0$- There is no significant difference between post-merger service experience of consumer with pre-merger network experience of consumer

$_3H^0$- There is no significant difference between post-merger service experience of consumer with pre-merger Customer Care Expectation experience of consumer

$_4H^0$- There is no significant difference between post-merger service experience of consumer with pre-merger calling experience of consumer

Based upon respondents' response about Consumer Experience (Pre & Post merger Response) these four parameters have been compared for significant difference. total 60 respondents have been asked to share pre- and post-merger Response. To collect their experience a self-developed tool has been used. the researchers have tested the tool with 28 item form reliability with the help of Cronbach's' Alpha value. the value for the present tool was found valid (above 0.700).

Reliability Statistics	
Cronbach's Alpha	N of Items
.805	28

Scale Statistics			
Mean	Variance	Std. Deviation	N of Items
78.4667	220.738	14.85727	28

Table 3.1 Reliability Statistics of questionnaire

Sample Location: Delhi NCR

Sampling technique: Non probability techniques (random sampling)

Analysis and findings

$_1H^0$- There is no significant difference between post-merger service experience of consumer with pre-merger price experience of consumer

Group Statistics					
	ConsumerExperience(Pre & Post Response)	N	Mean	Std. Deviation	Std. Error Mean
Price Experience	Post-Merger Experience	60	20.8667	3.84208	.49601
	Pre-Merger Experience	60	20.0667	5.01140	.64697

Independent Samples Test										
		Levene's Test		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig.	Mean Difference	Std. Error Difference	Lower	Upper
Price Experience	Equal variances assumed	3.942	.049	.981	118	.328	.80000	.81523	-.81437	2.41437
	Equal variances not assumed			.981	110.549	.329	.80000	.81523	-.81550	2.41550

Table 4.1 Testing of hypothesis 01

At test was conducted to compare the ConsumerExperience(Pre & Post Response)for Price Experience. There was no significant difference in the score for both as Post merger price experience (M=20.886, SD=3.84) and Pre-merger price experience (M=20.06, SD=5.01) conditions; t (118) =.981, p= Sig (0.328). These results shows that respondents feel no price change in the services of Vi. The response bias can be understood as the respondents may be replying with taking reference of Jio prices. The questions have been asked to find the difference between pre-merger and post-merger qualities. But the pricing of Jio have certain impact on people perception. So, researchers failed to reject null hypothesis and it can be said that, 'There is no significant difference between post-merger service experience of consumer with pre-merger price experience of consumer'.

$_2H^0$- There is no significant difference between post-merger service experience of consumer with pre-merger network experience of consumer

Group Statistics					
	ConsumerExperience(Pre & Post Response)	N	Mean	Std. Deviation	Std. Error Mean
Network Experience	Post-Merger Experience	60	21.0500	3.82864	.49428
	Pre-Merger Experience	60	18.0333	4.83969	.62480

Independent Samples Test		
	Levene's Test	t-test for Equality of Means

		F	Sig.	t	df	Sig	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Network Experience	Equal variances assumed	6.488	.012	3.787	118	.000	3.01667	.79667	1.43904	4.59429
	Equal variances not assumed			3.787	112.064	.000	3.01667	.79667	1.43818	4.59516

Table 4.2 Testing of hypothesis 02

At test was conducted to compare the ConsumerExperience(Pre & Post Response)for Network Experience. There was significant difference in the score for both as Post merger Network experience (M=21.05, SD=3.82) and Pre-merger Network experience (M=18.03, SD=4.83) conditions; t (118) =3.78, p= Sig (0.00). These results shows that respondents feel significant change in the services of Vi.

So, researchers rejected null hypothesis and it can be said that, 'There is significant difference between post-merger network experience of consumer with pre-merger network experience of consumer'.

$_3H^0$- There is no significant difference between post-merger service experience of consumer with pre-merger Customer Care Expectation experience of consumer

Group Statistics					
	ConsumerExperience(Pre & Post Response)	N	Mean	Std. Deviation	Std. Error Mean
CustomerCareExpectation	Post-Merger Experience	60	20.4500	5.71179	.73739
	Pre-Merger Experience	60	17.7333	7.23191	.93364

Independent Samples Test										
		Levene's Test		t-test for Equality of Means						
		F	Sig.	t	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
CustomerCare Expectation	Equal variances assumed	8.664	.004	2.283	118	.024	2.71667	1.18971	.36071	5.07262
	Equal variances not assumed			2.283	111.989	.024	2.71667	1.18971	.35940	5.07393

Table 4.3 Testing of hypothesis 03

At test was conducted to compare the ConsumerExperience (Pre & Post Response)for CustomerCare Experience. There was significant difference in the score for both as Post merger CustomerCare experience (M=20.45, SD=5.71) and Pre-

merger CustomerCare experience (M=17.33, SD=7.2) conditions; t (118) =2.28, p= Sig (0.00). These results shows that respondents feel significant change in the services of Vi.

So, researchers rejected null hypothesis and it can be said that, 'There is significant difference between post-merger customercareexperience of consumer with pre-merger customer care experience of consumer'.

$_4H^0$- There is no significant difference between post-merger service experience of consumer with pre-merger calling experience of consumer

Group Statistics					
	ConsumerExperience(Pre & Post Response)	N	Mean	Std. Deviation	Std. Error Mean
Calling Experience	Post-Merger Experience	60	23.4833	5.03712	.65029
	Pre-Merger Experience	60	15.2500	4.48963	.57961

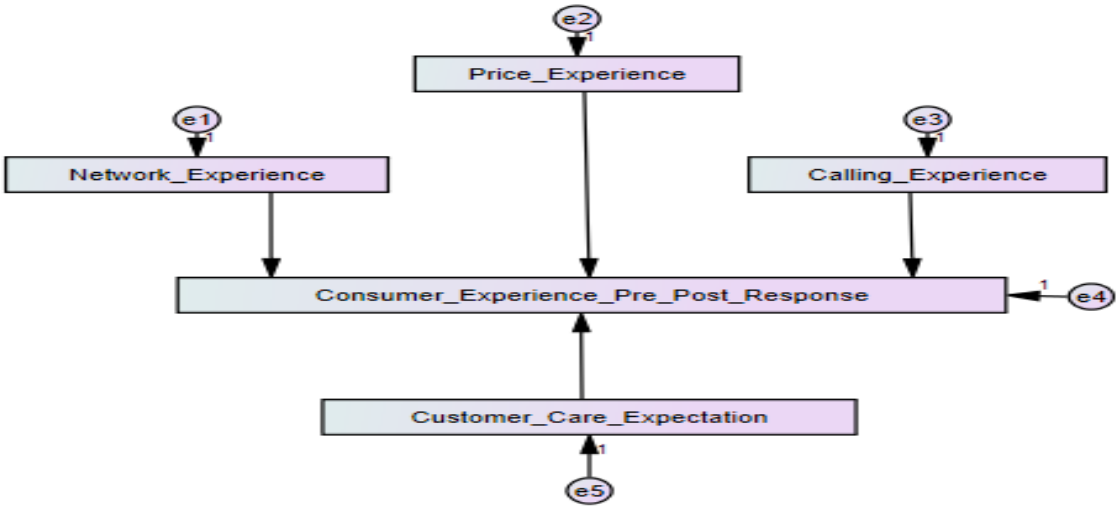
Independent Samples Test										
		Levene's Test		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig.	Mean Difference	Std. Error Difference	Lower	Upper
Calling Experience	Equal variances assumed	.087	.769	9.452	118	.000	8.23333	.87110	6.50831	9.95836
	Equal variances not assumed			9.452	116.471	.000	8.23333	.87110	6.50807	9.95859

Table 4.4 Testing of hypothesis 04

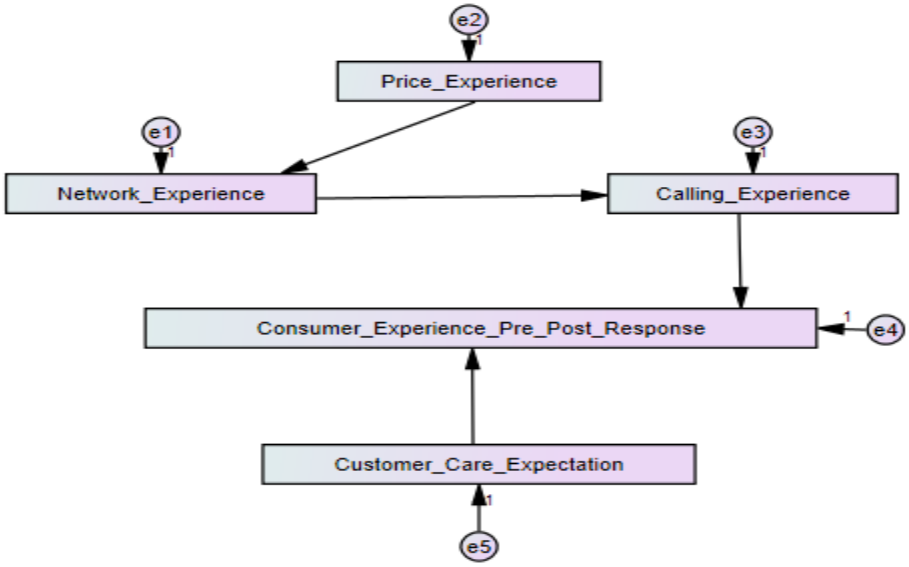
At test was conducted to compare the ConsumerExperience(Pre & Post Response)for callingexperience. There was significant difference in the score for both as Post merger calling experience (M=21.05, SD=3.82) and Pre-merger calling experience (M=18.03, SD=4.83) conditions; t (118) =3.78, p= Sig (0.00). These results shows that respondents feel significant change in the services of Vi.

So, researchers rejected null hypothesis and it can be said that, 'There is significant difference between post-merger calling experience of consumer with pre-merger calling experience of consumer'.

Researchers have further extended the exploration of post-merger activities. it was expected that all the variables in the study have direct effect on consumer overall experience. To understand the actual effect path AMOS has been used by researcher. the researchers have found that Price experience and network experience of respondents have mediation effect on Consumer experience. Further the improved structural model just acceptable fit as RAMSEA value is beyond acceptable range. This can be understood on the basis of fact the there are other factors too that effect the consumer experience in telecom sector.



Hypothesised Model:CMIN/df 12.808, CFI .481, GFI.797, RMSEA .315



Actual Model:CMIN/df 3.493, CFI .939, GFI.879, RMSEA .145

Conclusion

Present research has found that Vodafone and Idea merger has improved their acceptance among the consumers. This is good for the Indian telecom industry. The pricing tactics of Jio has affected the telecom market badly. Aircel and many other companies were not even able to sustain the market. They have to get eliminated form the industry. In such a competitive and customer friendly market the companies need to form big collaborative structure. The other companies in different sector can take a lesson form the Vodafone and Idea merger. They should stop seeing their competitor as rival but they should form alliance with them. This will help them to mitigate the excessive consumerism. extremely low switch over cost is also killing the telecom industry.

Benefits of mergers and acquisitions in theIndian telecommunication industryMergers and acquisitions in the telecom sector inIndia provide certain benefits in terms of:

Infrastructure: Building infrastructure fortelecommunications is not easy. Moreover, itconsumes much time. Mergers and acquisitionprovide access to infrastructure much easily.

Network: Benefits of existing network areavailable much easily through mergers andacquisitions.

License: In certain regions there may berestrictions on getting new license. In such a case,mergers and acquisitions provide an option to runservices in that region.

Customer base, Brand value and Spectrum benefits are the other advantages of mergers. India has become a hotbed of telecom mergers andacquisitions in the last decade. Foreign investors andtelecom majors look at India as one of the fastestgrowing telecom markets in the world. Sweepingreforms introduced by successive governments overthe last decade have dramatically changed the face ofthe telecommunication industry. M&A in TelecomIndustry are subject to various statutory guidelinesand Industry Specific provisions e.g. Companies Act,1956; Income Tax Act, 1961; Competition Act, 2002;MRTP Act; Indian Telegraph Act; FEMA Act; FEMARegulations; SEBI Takeover Regulation; etc.Telecom Regulatory Authority of India (TRAI) isof the view that while on one hand mergers encourageefficiencies of scope and scale and, hence, aredesirable, care has to be taken those monopolies do notemerge as a consequence.So, it can be concluded that telecom industry needs much more than mergers. the decreasing number of market players may never be fruitful for the consumers at first play.

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IMPROVED CLASSIFICATION OF MR IMAGES FOR CERVICAL CANCER IN HUMAN USING CAPSULE NETWORK (CAPSNET)

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ABSTRACT

Cervical cancer is a frequently occurring gynecology malignancy that leads to frequent deaths. The stages of tumor decides the patient outcomes, where it depends on nodal status, size of tumor and histological grade. It is hence necessary to consider all these parameters as input and develop certain rules to classify the Medical Resonance Imaging (MRI) of cervical region. In this paper, we develop a classification model using capsule network (CapsNet). The simulation is conducted in python environment on a high end computing engine, where the CapsNetis trained and tested on multistate colposcopy image (MSCI) dataset. The classification of cancer in MR images show that the CapsNetobtains increased classification accuracy than other methods.

Keywords: *Classification, MR Image, Cervical Cancer, CapsNet*

Introduction

Cervical cancer is one of the most frequent gynaecological malignancies and the second most prevalent female cancer, although the cure rate is nearly 100% with early identification and treatment. The prevalence of cervical cancer is 70%-90% malignant in some poor countries due to insufficient screening in the cervical system and the neglect of cervical diseases by women [1]. What is particularly remarkable is that cervical cancer, which previously occurred in women about 50, now occurs at much earlier age due to environmental contamination and inadequate hygiene practices [4]. Due to early identification and treatment in industrialised nations there is a considerable reduction in the incidence of cervical pre-cancer lesions [2] [3].

The world health organization three-stage diagnostic method is the gold standard for cervical cancer detection: cervical cytology, colposcopy and biopsy. In the past, the most common screening method was cervical smear cytology for uterine lesions. The method was used to remove exfoliated cells from the cervix, send them to the pathology unit for glass slide preparation through complex procedures and then an experienced doctor who used the nude eye to check whether the cells were normal under a microphone [14] [16]. In traditional Pap smears, there is a false negative rate of up to 50%. Screening process colposcopy is the second phase and plays a crucial part in the best cervical cancer screening technique [17].

Colposcopy is a naked eye and colposcope examination procedure that magnifies the cervix 10-40 times in bright light to detect small lesions in the cervix and the lower genital tract. With this magnifying effect, the blood vessels on the cervix epidermis can clearly be seen by the doctors and the cervical cancer is early injured. Increasing diagnosis rates, complemented by microscopic biopsies and cervical lesion pathology, lead to efficient early treatment in the case of patients, which eventually enhances the rate of diagnosis [18]-[20].

The lack of educated and competent pathologists now overwork doctors. Colposcopy digital and image materials analysis systems can lower the workload of doctors and increase working efficiency, while helping health institutes in impoverished regions to make better treatment decisions. A number of studies have shown the possibility for improving or replacing traditional colposcopy using automated imaging analyses. Digital image materials analysis allows doctors with less expertise to offer the same standards of treatment as colposcopy specialists because of the consistent and reliable diagnostics available.

In this paper, we develop a classification model using capsule network (CapsNet). The simulation is conducted in python environment on a high end computing engine, where the CapsNet is trained and tested on multistate colposcopy image (MSCI) dataset.

Related works

In the beginning of the 1990s, research showed that colposcopy image materials might be automatically interpreted using digital image materials processing techniques.

The approach employed by Shafi et al. [5] is a classic example of these early experimental systems, namely a computer image materials capture system that can improve and analyse different image materials modes and provide more detailed information on unusual conversion areas. Among them, the interpretation of diagnostic image materials relies largely on qualitative colposcopy expert image materials and minimal quantitative analysis [6].

Dickman et al. [7] applied human vision computer simulation for the classification of cervical image materials. Dickman et al. [8] utilised a relatively short data set with 100% sensitivity to identify cervical intraepithelial neaplasia.

Gordon et al. [9] created a colour and texture-driven algorithm for the segmentation of cervix anatomical areas. However, spatial connections between tissue types were not included or algorithm precise evaluation.

Gordon et al. [10] focused on segmentation of elongated and non-cervix areas inside the cervix to convert pixel-based segmentation into super-pixel grouping for regionally-based methods, including the utilisation of region and edge information.

A novel framework of image materials analysis for cervical cancer or precancer lesions was proposed by Park et al. [11]. They employed diverse information, such as pre-acetic acid image materialscolour and texture, aberrant vascular characteristics, and acetylcholine-related statistical data.

Alush et al. [12] developed a technique for cervical image materials for detecting and segmenting lesion regions using a limit-based method instead of a classification method. A deep-learning model was used by Center et al. [13]. For the classification of postoperative diagnostics using colposcopyimage materials; final verification accuracy was 50 percent.

Although earlier image materials analysis colposcopy studies have achieved tremendous strides, they still face a number of difficulties.

First, the properties of most image materials were identified by professionals in earlier machine-learning methods and afterwards stored in a data format. The performance is dependent on the exactness of the extracted characteristics, and for each issue, a function extractor must be created. Thus, the present work has employed a thorough strategy for problem-solving and for the direct obtaining of high-level data features.

Second, previous machine-learning algorithms have typically trained and tested a small quantity of image materials data, and the test time would increase with an increasing amount of data, so that large amounts of data could be predicted with the present procedure once the model was trained and the processing of large data sets in real time could be achieved.

Furthermore, each pixel has not been placed into the cervix in other methods; the quality

of the image materials influences the performance of the classification. However, the current algorithm has a better classification effect because of the classification of image materials for preprocessing segmentation.

Proposed Method

Based on the correct classification of cervical image materials types, an algorithmic model was constructed. These diverse forms of cervix were considered normal in our data set, but some patients had to be tested and some were not, as the transformation zone was not always evident. It is not an easy process for healthcare providers to identify the transformation zones, thus an algorithm-assisted choice can considerably improve the cervical cancer screening quality and efficiency of these individuals. The data sets employed represented different types of cervical lesions in the various transformation zones where the cervical lesions were located. The architecture of the proposed model is given in Figure 1.

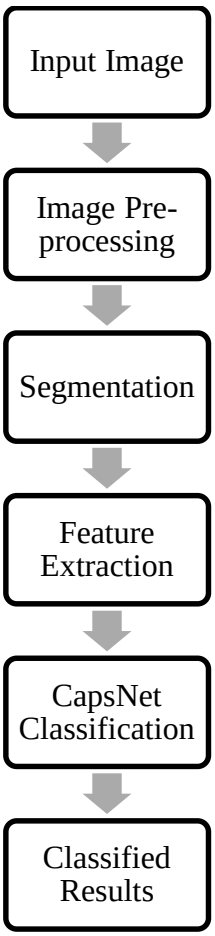

Figure 1: Proposed Classification Model

Image Preprocessing

The preprocessing phase will enhance image consistency and operate on the MRI brain image. Read the image path and resize the pixel image (800×500).

Noise Removal

In digital images, the noise is unwanted information. Noise-free images are crucial for additional diagnosis. It is a tough challenge to remove noise from the original MR images. In numerous ways, this noise can affect visuals like fluttering, devices, etc. Now, noise can be classified into many types, depending on the source and cause. The noise during the image acquisition is primarily suppressed using filters. Filters improve image processing by decreasing undesirable frequencies and smoothing an image. There are several different types of filters, such as average filters, adaptive filters, etc.

Adaptive filters minimise noise without changing the original image. Statistical characteristics such as medium and variance are calculated in this filtering procedure. These parameter values are then adjusted to change the pixel values. We utilise a median adaptive filter to eliminate noise during our job. Calculate the filter size median, minimum and maximum pixel value. Then compare the value of each pixel to either replace the value of the pixel or to maintain it. The window size of the filter then increases. The adaptive median filter solely influences the noise content of the pixels. It works effectively for low and high concentrations of noise.

Image Enhancement

For improved visibility, the min-max contrast extended algorithm is used. With the subsequent change, the linear contrast expanded.

$$DN_{st} = 255\times [(DN\text{-}DN_{min}) / (DN_{max} - DN_{min})] \quad (1)$$

where

*DN*is the the pixel number,

$DN_{st}$is the output image corresponding to *DN*

$DN_{max}$is the maximum *DN*

$DN_{min}$is the minimum *DN*

Segmentation

The technique via which tumour regions are sorted into different groups is the segmentation of the image. The clustering of K-means is employed for the grouping of brain elements. The output of the clustering technique, k-means, is employed for separating the brain tumour surface. The Euclidian Distance Formula is often the following:

$$L^2 = \sum_{i=1}^{n} (x_i - y_i)^2 \qquad (2)$$

where

*L*is the co-ordinate distance between $(x_1;x_2)$ and $(y_1;y_2)$.

$$L = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2} \qquad (3)$$

If you find the data point closest to the cluster, you can halt and pass to the next data point, if you are not close to the cluster.

Conversion of Gray Scale and Binary Image

For practical extraction, a segmented image can be converted into grey and binary images. The grey scale represents the image grey shadow. An 8-bit integer with 256 unique grey chromatic colours is saved for grey strength. For binary images, there are just two potential values of 0 or 1, Black or White for each pixel.

Feature Extraction

The statistically most secure approach to getting aimage is the GLCM. The matrix of spatial addiction is called the grey scale. Shape, colour, and texture are the essential extraction characteristics. The statistical value is updated on the basis of these forms for each input image.

CapsNet Classification

The final stage in this study is the classification phase. Throughout segmental tumour areas and in benign areas, the marker is malignant or benign in the CapsNet classification. The database was divided into two stages during preparation and study in which the tumour regions of your brain were analysed. This stage entails forming the vectors of the data set functions and their respective groups, while deciding whether the image input is malignant or benign in nature.

The capsule can include qualities and characteristics of the creature in CapsNet neural network, such as posture, deformity, speed, reflectivity, texture, colour and other spatial information. The consistency of orientation and the size between features can be defined by this space information. Instead of catching features of certain versions, capsules are trained to capture the options and their variants. The capsule therefore aims not only to identify the characteristics, but also to train the model so that variants can be learned so that the same capsule can detect the same objects class in a different direction.

Capsules are a set of neurons that help predict or classify objects by employing a vector of activation based on the given criteria. The vector of activation tends to capture its direction which defines the orientation and position information of aimage. The length is developed using an activation vector which makes things likely to fall within the area of interest. Based on the image rotation, the activation vector tends to change while the vector length is still the same.

The CapsNet addresses the weakness of CNN associated with pooling layers and improves classification criteria by proper modifications of pooling layers in CapsNet. The coupling coefficients however can vary and can change as the parent capsules are increased. The parent capsule thus classifies the event by raising the coefficient between the capsules when the prediction is consistent with the output of the parent capsule.

A nonlinear function exceeds each output vector of each capsule and then employs the

initial vector to produce the output, which defines its non-linear function as:

$$v_j = \frac{\|s_j\|^2}{1+\|s_j\|^2} \frac{s_j}{\|s_j\|} \qquad (4)$$

where,

$s_j$is the input vector and

$v_j$is theoutput vector.

The hyperparameters are therefore estimated, including during the training phase. Therefore, the real labels are produced highly with the CapsNet three layers, which contain a convolutionary layer and two capsules.

The CapsNet model is generally used as a regularisation function in the form of a reconstruction loss model to reduce overfitting difficulties in the training of CapsNet parameters. Therefore, the capsules can encode the input as much as feasible, and the reconstruction is performed by feeding 16D output into a neural network via their capsules.

Results and Discussions

In this section, the experiments are conducted on a workstation with a memory of 2 terra bytes that runs on a primary memory of 16 GB accelerated by a Geforce GTX 1070 8G graphics processors. The implementation is conducted on anUbuntu 16.04 operating system, tensorflowandkeras and Pycharm with gpu_device, and CUDA8.0. The images (Figure 2) considered for the study is given below:

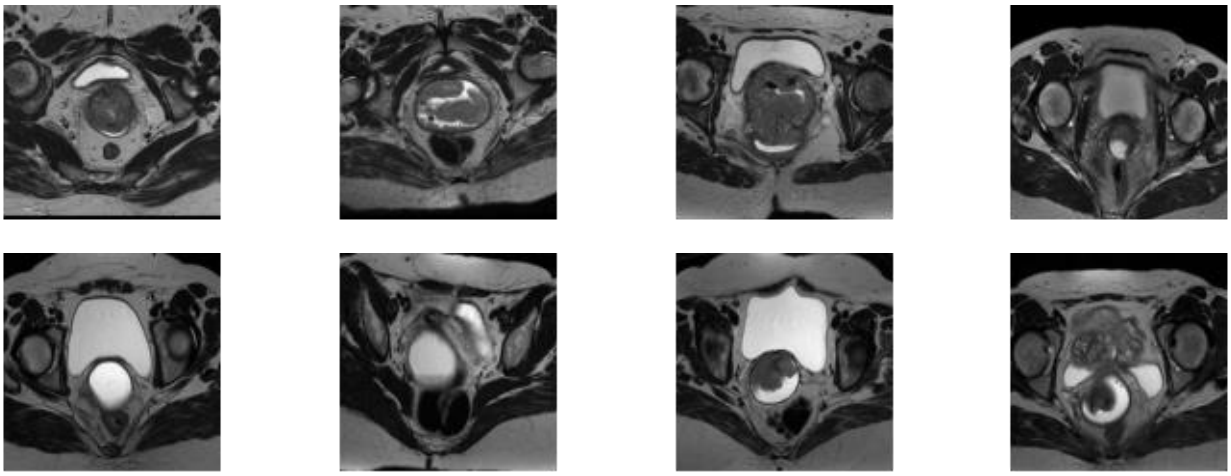

Figure 2: Images considered for classification

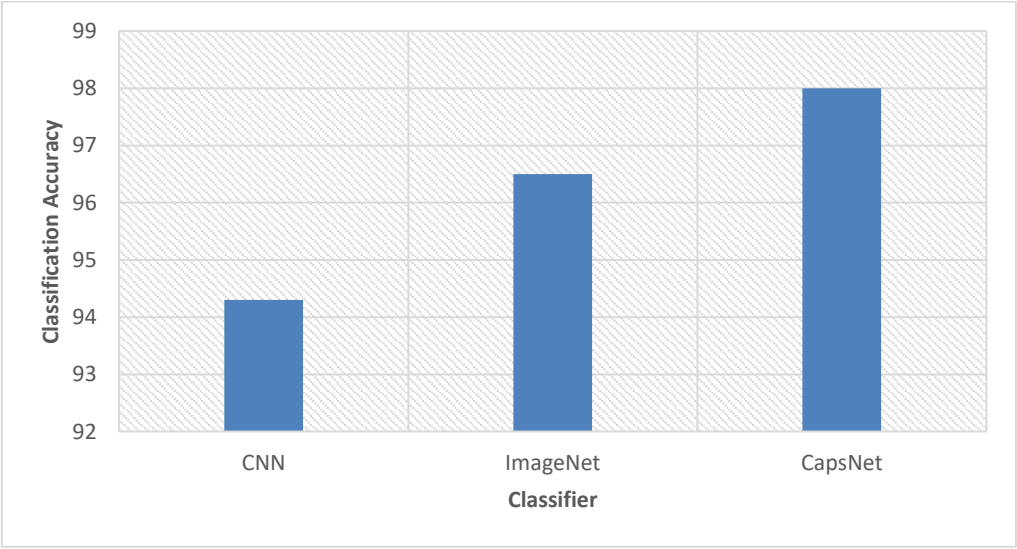

Figure 3: Classification Accuracy

The Figure 3shows the classification accuracy between the proposed CapsNet is compared with existing ImageNet and CNN. The results of Figure 3 shows that the proposed CapsNet obtains improved classification rate than other methods on various images.

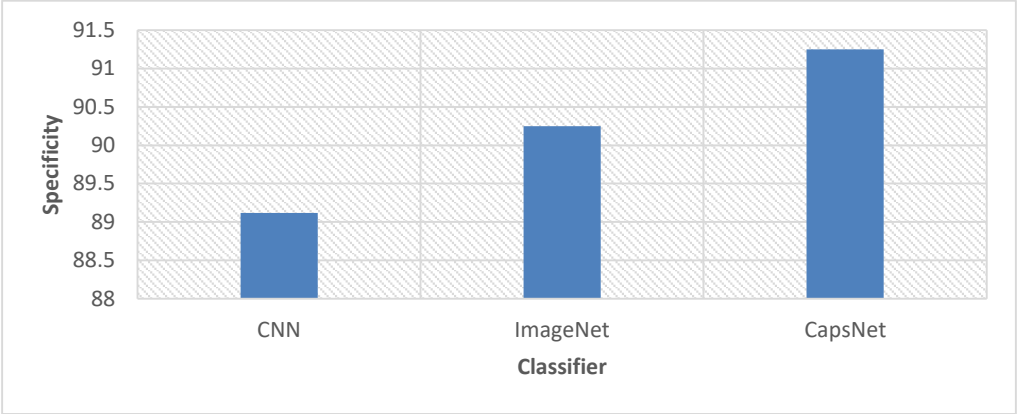

Figure 4: Specificity

The Figure 4 shows the specificity between the proposed CapsNet is compared with existing ImageNet and CNN. The results of Figure 3 shows that the proposed CapsNet obtains improved specificity rate than other methods on various images.

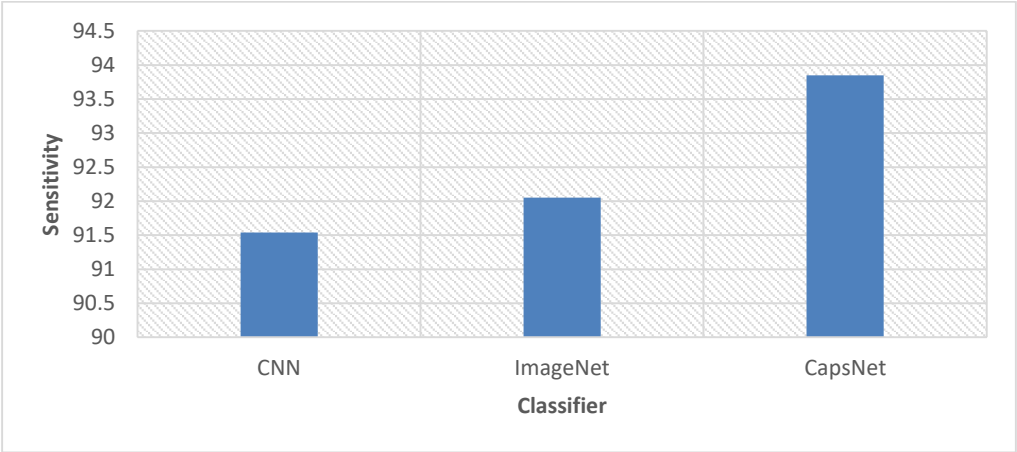

Figure 5: Sensitivity

The Figure 4 shows the sensitivity between the proposed CapsNet is compared with existing ImageNet and CNN. The results of Figure 5 shows that the proposed CapsNet obtains improved sensitivity rate than other methods on various images.

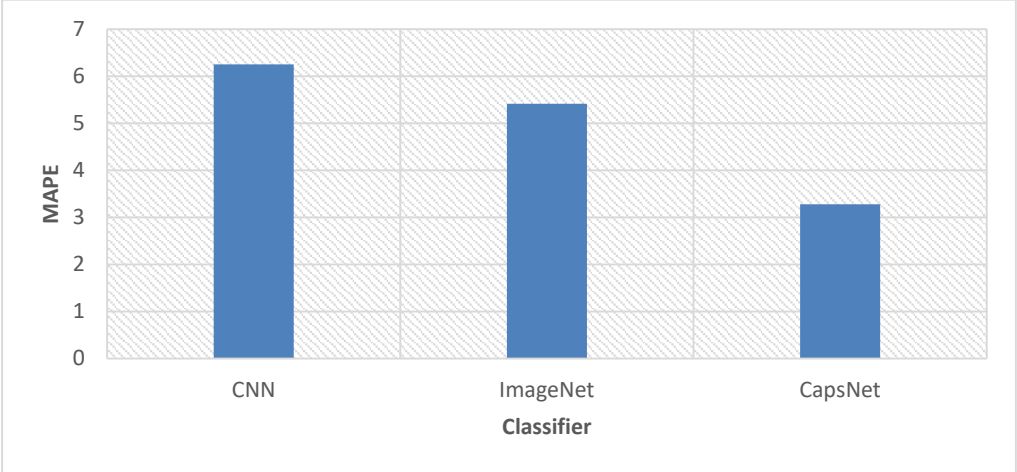

Figure 6: MAPE

The Figure 6 shows the MAPE between the proposed CapsNet is compared with existing ImageNet and CNN. The results of Figure 6 shows that the proposed CapsNet obtains reduced MAPE than other methods on various images.

Conclusions

In this paper, we CapsNet classification model is used to classify the instances of the cervical cancer. The input data is pre-processed, feature extracted and classified in order to obtain the needed classification. The simulation using python on a high end computing engine for training the CapsNetmodel over dataset is conducted to test the efficacy of the model. The classification of cancer in MR images show that the CapsNet obtains increased classification accuracy than other methods.

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CONSTRUCTION AND VALIDATION OF SCALE TO MEASURE THE TEACHING COMPETENCY OF B.Ed TRAINEES

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ABSTRACT

The study has been conducted to investigate the level of Teaching Competency of B.Ed trainees. The sample consists of 100 B.Ed trainees from various B.Ed colleges in Thanjavur District. Samples of 100 B.Ed trainees were selected for the investigation. The main objective of the present study is to develop a research tool to measure the Teaching competency of B.Ed trainees. The investigator has used normative survey method for the study. The researcher had attempted to construct and standardize the teaching competency scale to measure the teaching competency of B.Ed trainees.

KEYWORDS*: Teaching competency, B.Ed trainees.*

INTRODUCTION

No nation can develop without the appropriate development of its citizens. The citizens are molded by the teachers and teachers are prepared through the teacher training programme. The strength of the educational system depends upon the quality of teachers; the quality of Teachers depends on the quality of teacher training programs. Humanity is changing very fast. The new inventions and discoveries are influencing not only society but the educational system also. There are several recent techniques for the modification and improvement of a teacher's effectiveness. Motivate of all these recent techniques other best efforts are also made in teacher training institutions to improve the teaching competency among pupil teachers. The researcher thought that besides some personality factors, emotion and stress also affects the teaching competency of a teacher studying in the aided and self-financed institutions. So it was a need to study the teaching competency of B.Ed trainees.

OBJECTIVE

To develop a research tool to measure the Teaching competency of B.Ed trainees.

TEACHING COMPETENCY

Teaching competency scale has been developed and validated by the investigator. A lot of literature on Teaching competency, test construction procedures was used for the construction of the tool. The Teaching competency was constructed after having discussions with teacher educators of B.Ed colleges, psychologists and experts in the field of education. The test has been prepared on five point rating scale based on Likert's type. Initially positive and negative statements were prepared in both Tamil and English version.

The scoring procedure for the tool for the option Strongly Agree is given a score of 5, Agree is given a score of 4, Neutral is given a score of 3, Disagree is given a score of 2, and Strongly Disagree is given score 1 for positive statements. For negative statements it is reversed as strongly agree is given a score of 1, Agree is given a score of 2, Undecided is given a score of 3, Disagree is given a score of 4, and Strongly Disagree 5. The minimum score for the tool is 55 and maximum score of the tool is 275.

ITEM ANALYSIS

The draft tool prepared by the investigator was administered on a sample of 100 B.Ed trainees. B.Ed trainees were asked to mark their opinion among the given alternatives. Each statement has five alternative responses; namely strongly agree, agree undecided, disagree and strongly disagree. Scoring was done for all the statements. The minimum score would be 55

and the maximum score would be 275. It is most efficient to do the checking as a single operation after all booklets have been scored.

Item analysis was adopted for the final selection of statements. The total scores were calculated separately and they were arranged in the descending order. The top 25% and the bottom 25% of scores alone were taken into account. The difference in means of the high and low groups for each item was tested for significance by computing the t-ratios. Items with t-value of 1.96 and above were selected for the final tool. Thus, the final tool contains 45 items; the list of items with the t-value is presented in Table-1. Split-half method was also used to find out the consistency of the test.

TABLE 1: TEACHING COMPETENCY

S.No	t-value	Selected / Not Selected
1	2.046	Selected
2	4.157	Selected
3	3.633	Selected
4	4.321	Selected
5	2.633	Selected
6	1.178	Selected
7	3.267	Selected
9	3.631	Selected
10	4.71	Selected
11	4.067	Selected
12	3.523	Selected
13	2.657	Selected
14	3.244	Selected
15	4.167	Selected
16	3.123	Selected
17	1.133	Selected
18	0.329	Not selected
19	1.142	Selected
20	4.6	Selected
21	3.11	Selected
22	4.263	Selected
23	2.133	Selected
24	4.173	Selected
25	5.522	Selected
26	0.823	Not selected
27	3.548	Selected
28	4.451	Selected
29	4.05	Selected
30	1.212	Not selected
31	4.714	Selected
32	1.691	Not selected
33	7.626	Selected

S.No	t-value	Selected / Not Selected
34	3.803	Selected
35	3.406	Selected
36	2.245	Selected
37	1.211	Selected
38	1.301	Not selected
39	1.186	Not selected
40	4.735	Selected
41	3.364	Selected
42	0.956	Not selected
43	3.438	Selected
44	5.487	Selected
45	3.755	Selected
46	1.831	Not selected
47	2.274	Selected
48	1.431	Not selected
49	1.996	Selected
52	3.085	Selected
53	4.18	Selected
54	2.604	Selected
55	1.229	Not selected
56	2.629	Selected
58	3.323	Selected
60	3.542	Selected

Reliability

The reliability of test can be defined as the correlation between two or more sets of scores on equivalent tests from the same group of individuals. A test score is called reliable when we have reasons for believing the score to be stable and trust worthy. Stability and trust worthiness depend upon the degree to which the score is an index of "true-ability" free from chance error. Test-retest (repetition) method was used to arrive at the reliability of the tool. Repetition of a test is the simplest method of determining the agreement between the two set of scores; the test is given and repeated on the same group; and the correlation computed between the first and second set of scores. Given sufficient time between the two tests the administration results show the stability of the test scores. The value of correlation co-efficient shows that there is high positive degree of correlation between the two tests and are given in Table-2.

Table 2: Reliability Co-Efficient of Teaching competency

S.No.	Method of Reliability	Values
1.	Test-retest (Repetition)	0.89
2	Split-Half	0.90

Validity

The appropriateness, meaningfulness and usefulness of the specific inferences made form test scores. In research, if findings are to be appropriate, meaningful and useful, they need to be valid. The first essential

quality of valid test is that it should be highly reliable. Besides, the content or face validity, the investigator intended to arrive intrinsic validity. Guilford (1950) defined the intrinsic validity as "the degree to which a test measures what it measures." The square root of reliability gives the intrinsic validity. Therefore, the intrinsic validity of Teaching competency inventory is 0.89.

DESCRIPTION OF THE FINAL TOOL

The final tool with 45 positive and negative statements was prepared in both Tamil and English version. The final tool has been prepared on a 5-point rating scale based on Likert's type. Initially, positive and negative statements were prepared in both Tamil and English version. The scoring procedure for the tool with the option Strongly Agree as 5, Agree as 4, Undecided as 3, Disagree 2 and Strongly Disagree as 1, for positive statements. For negative statements it is reversed as strongly disagree is given 5, disagree is given 4, Undecided score as 3, agree score as 2, and Strongly agree 1. The minimum score for the tool is '45' and maximum score of the tool is 225.

FINAL TOOL

S.No	Content	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	I plan the lesson with the objectives of the lesson in mind.					
2	I plan and lead the students to perform innovative activities.					
3	I prepare charts and models to make the teaching-learning process easier.					
4	I render different types of learning activities to students.					
5	Teaching- learning materials are designed to achieve the goal of the lesson.					
6	I plan the strategies for dealing with difficult topics.					
7	I always present my lesson content reasonable.					
8	I am frequently updating my subject knowledge.					
9	My teaching will always depend on student centered learning.					
10	I clearly state the teaching objectives for students in my classroom.					
11	I teach the lesson based on the pervious knowledge of the students.					
12	The explanations and examples of my lesson will be easy for students to comprehend.					
13	I will use the teaching – learning materials in the proper way during my teaching.					

14	I will try to attract the students' attention by using various stimuli.					
15	I will change my teaching strategies depending on the feedback of the students.					
16	I will handle the class more efficiently.					
17	I will induce the interest of the students for learning new concept.					
18	I will ask appropriate questions to create concept of the lesson in my classroom.					
19	The interaction of teacher and students will be good in my class.					
20	I will reinforce the learning behavior of students through some interaction.					
21	I will use different types of evaluation techniques during teaching.					
22	I will always try to keep my students alert and enthusiastic in my teaching.					
23	I have to shout and scream to maintain discipline in my class.					
24	I will give the right examples are related to the lesson.					
25	While writing on the blackboard I used to write beautifully and legibly.					
26	I will use the ICT effectively in my classroom teaching.					
27	I use the right pace with appropriate sound and pronunciation during my teaching.					
28	I will use contemporary knowledge and new ideas in my classroom teaching.					
29	I will monitor continuous assessment system according to the studentsunderstanding.					
30	I will check the students progress towards the aim of the lesson.					
31	I don't agree with the current assessment system.					
32	I got feedback from students after each class of my teaching.					
33	I make realise the students the importance of standardized assessmentfor evaluation.					
34	I give homework to the students to					

	bring out their creativity.					
35	I often use the ability of reinforcement skill in my teaching.					
36	I always have been maintaining good relationships with my students.					
37	I develop my leadership qualities for the development of the students.					
38	I always arrive on time so my students also follow the habit of arriving on time.					
39	Always I would like to use my resources in a unique way.					
40	I will maintain the discipline in my classroom.					
41	I will give full freedom to my students to express their opinions in the classroom.					
42	I will give rewards to students who active by participate in the class room.					
43	I will not show any discrimination to my students.					
44	I always lead the class without any distraction.					
45	Always I encourage the students to participate in the classroom discussion.					

CONCLUSION

This research tool focuses on gathering information about the Teaching competency. Teaching competency plays a vital role in effecting a change or otherwise it becomes an indicator for effecting a change. This research tool will be of immense use for the Teaching competency of B.Ed trainees which will throw light upon the Teaching competency.

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A STUDY ON ACADEMIC BUOYANCY OF GOVERNMENT HIGHER SECONDARY STUDENTS - A SURVEY

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ABSTRACT

Academic buoyancy refers to how an individual responds to and attempts to deal with everyday challenges.The present study focussed to study the Academic buoyancy of Government Higher Secondary Students . Tool developed by the investigator was used to collect data from 112 Higher Secondary Students belonging to Government Schools. Data was chosen using Stratified Random Sampling Techniques. The Survey method was adopted to carry out the study.Descriptive and Differential Analysis was computed and revealed that students who actively involve in sports are found to be academically buoyant.

Key Words: *academic Buoyancy, challenges &survey method.*

INTRODUCTION

Today, education has been assigned as an industry for human resource development for various walks of life. The students constitute the heart of the education system and they are the most affected ones by the strengths and weaknesses of the education system.. Some of the most common risks faced by a student during his/her school days are psychological, emotional, social, academic, and career risks.

Students encounter number of academic challenges in school, including getting time to study, understanding the study material and maintaining a high degree of motivation. Students face the most important competition when it involves examinations and scores. Often, students also find it difficult to manage their academic demands with work, own responsibilities and social experiences. The way they handle their day- to- day academicsetbacks is said to be Academic Buoyancy.

CONCEPTUAL DEFINITION

Andrew j Martin (2008) has defined Academic buoyancy asa capacity to manage setbacks, challenges, and difficulties that are part of everyday academic life. It is defined as 'the ability of students to successfully deal with academic setbacks and difficulties that are 'typical of the ordinary course of school life (e.g. poor grades, competing deadlines, exam pressure and difficult schoolwork)-Academic buoyancy refers to a positive, constructive, and adaptive response to the types of challenges and setbacks experienced in a typical and everyday academic setting.

Academic buoyancy is defined by Martin et al. (2010) as "students' ability to successfully deal with setbacks and challenges typical of academic life" (p. 473). It enables students to get back up, recover, and continue despite setbacks (Martin & Marsh, 2003). It is important to note that, regardless of their nature, the challenges that students face can devastate them, resulting in academic failure.More specifically academic buoyancy is defined as "the process of dealing with isolated poor grades and patches of poor performance, typical stress levels and daily pressures, threats to confidence due to poor scores, anxiety and self esteem, decreased level ofmotivation and engagement and the way in which learners deal with negative feedback on schoolwork".

RATIONALE

Challenges and struggles are part of everyone's lives. Like all others, the life of students too is filled with many barriers. Students are inexperienced when it comes to dealing with challenges and end up being victims to stress, anxiety and depression. Not knowing the proper way to deal with challenges can become a big barrier in the lives of the students.

The fore most challenge faced by students is in terms of academics. Students face a lot of stress when it comes to their learning process. The pressure of increasing cut-offs, parent's expectations, doing home

works, regular tests, exams, competition, peer pressure, learning disabilities, focus, goal achievement, bias, special classes, competitions strict admissions etc. makes the lives of the students much more taxing. These hurdles affect the academics of the pupils and act as a great challenge in their progress. Students have to compete to prove themselves in their school. The challenges faced by the students define who they become in the future. If they are assisted or taught to deal various challenges positively from their childhood, they can become self-motivated individuals in the future who aren't afraid to take risks.

Majority of the students strive and try to handle their responsibilities in a positive way. Whereas, some of the students do not know, the ways to deal their problems and; therefore, adopt unhealthy ways. Thus, the factors of coping strategies should be studied from a development perspective.

Thus, the present study was made to understand the ways in which school students differ in tackling their academic works experienced by them and to examine how effectively they manage or handle their academic pressures.

A study was conducted by**Martin & Marsh (2008)** onAcademic buoyancy towards an understanding of students' everyday academic resilience.Academic buoyancy was developed as a construct reflecting everyday academic resilience within a positive psychology context and stated as ability of students to successfully cope with academic setbacks and challenges that are common of the ordinary course of school life (e.g., poor scores, competing deadlines, exam stress, difficult class work). Data from 598 students in Years 8 and 10 at five Australian high schools were collected. In the Mid of the school year and then again at the end of the year, students were asked to rate their academic buoyancy as well as a set of various hypothesized factors such as self-efficacy, control, academic engagement, anxiety, teacher-student relationship in the area of mathematics.The bulk of variance in academic buoyancy was explained at the student level using Multilevel modelling. (a) Time 1 anxiety (negatively), self-efficacy, and academic engagement significantly predicted Time 1 academic buoyancy; (b) Time 2 anxiety (negatively), self-efficacy, academic engagement was computed by confirmatory factor analysis and structural equation modelling and teacher-student relationships explained variance in Time 2 academic buoyancy over and above that explained by academic buoyancy at Time 1; and (c) of the significant predictors, anxiety explained the bulk of variance in academic buoyancy.

STATEMENT OF THE PROBLEM

Students encounter lot of academic problems in their daily school life. The way they cope with those problems plays a significant role in their success of achievement. Hence the topic has emerged and titled as "Academic Buoyancy of Government Higher Secondary Students".

OBJECTIVES OF THE STUDY

- To identify the level of Academic Buoyancy of Higher secondary Students.
- To assess the significant difference in the Academic Buoyancy among Government Higher Secondary Students based on Gender, Involvement in Sports, Opted Group and Mobile Usage.

HYPOTHESES OF THE STUDY

- High level of Academic Buoyancy exists among Government Higher Secondary Students.
- There is no significant difference in the Academic Buoyancy of Government Higher Secondary Students based on Gender, Involvement in Sports, Opted Group and Mobile Usage.

METHOD OF STUDY

Normative Survey method was adopted to carry out the study.

SAMPLE

A sample of 112 Government Higher Secondary students was selected through Stratified Random sampling Technique.

TOOL USED

Investigator developed Academic Buoyancy Scale with 40 items on a five point scale after the careful examination of Pilot study.

DATA ANALYSIS AND INTERPRETATION

Table 1 Frequency and Percentage of Government Higher Secondary Students in each category of Academic Buoyancy

Variable	Categories	Range	Frequency	Percentage
Academic Buoyancy	Low	110-121	31	27.7%
	Moderate	122-138	52	46.4%
	High	139-189	29	25.9%

Table 1 reveals that maximum number of students lies in the moderate category of Academic Buoyancy not as hypothesized and hence the null hypothesis is rejected.

Mean score for total sample is 132.98, Standard Deviation is 16.95 and Mean Percentage was calculated to be 74.03 % for Academic Buoyancy of Government Higher secondary Students.

Table 2 Mean S.D and t value of Academic Buoyancy based on Gender, Involvement in Sports and Opted Group

Sub Variable		N	Mean	S.D	't' Value	L.S
Gender	**Male**	54	130.04	16.944	1.310	NS
	Female	58	134.22	16.866		
Involvement in Sports	**Active**	105	132.63	17.39	2.73	**S at 0.05**
	Inactive	7	125.86	4.77		
GroupOpted	**Science**	57	130.98	16.18	0.77	NS
	Non Science	55	133.47	17.78		

It is observed from the above table that Female Students are more Academically Buoyant than Male with respect to their mean scores. The observed t- value (1.31) is less than the table value showing no significant difference between the means. Hence the null hypothesis is accepted.

Students those who are actively involved in sports are Academically Buoyant than who were not involved. The obtained t- value (2.73) is greater than the table value showing significant difference in their mean scores. Hence the null hypothesis is accepted.

Mean scores of Non science group students are found to be higher than Science group students stating that the former ones are more Academically Buoyant. The t- value is less than the table value implying no significant difference between the means. Therefore the null hypothesis is accepted.

Table 3 ANOVA forAcademic Buoyancy– Mobile Usage

Variable	Source of variance	df	Sum of Squares	MSS	F value	L.S
Academic Buoyancy	Between groups	2	1111.49	555.745	1.966	NS

	Within groups	109	30808.78	282.649		

Above table 3 shows that there exists no significant difference among the groups as the F- value (1.966) is less than the table value. No significant difference is found between the students mean score of using mobile for one hour, two hours and above and also for students who never use mobile at all. Hence the null hypothesis is accepted.

FINDINGS

1. Moderate level of Academic Buoyancy is observed among the Government Higher Secondary Students.
2. Gender and Opted Group are not influenced by Academic Buoyancy.
3. Actively involved students in sports are observed to be influenced by Academic Buoyancy.
4. Mobile usage has not influenced the Academic Buoyancy of Government Higher Secondary Students.

IMPLICATIONS

Teachers play a key role in making students to cope their academic challenges. Teachers can help students to become academically buoyant by the following ways.

- Time Management should be practised.
- Encourage students for their efforts.
- Teaching mindfulness.
- Physical Activities to be entertained.
- Constant rapport with their Parents.

CONCLUSION

Success at school increases self-esteem. Any difficulty will have consequential effects on the psychological health of the students. Conducive environment for learning would bring the child with better confidence. If students feel safe at school, achievement shows progress. It's the paramount duty of stake holders and every individual in the community to help create safe learning spaces.

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ADAPTIVE BUSINESS INTELLIGENCE FOR HEALTHCARE 4.0 USING INTERNET OF THINGS BASED WIRELESS BODY AREA NETWORKS

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ABSTRACT

Since decades, the debate on how the process and operations of future healthcare system would be. Recently there exist a multiple solutions to overcome such concern after the evolution of covid-19 pandemic. Such certain solution enables the new healthcare practices say healthcare 4.0 to adopt business intelligence to play a major role in integration of technological solutions with hospital services. In this paper, we develop a robust platform named adaptive artificial business intelligence (AABI) to create an effective healthcare monitoring and support environment for medical professional in case of emergencies. Here, initially we amend a suitable machine learning model namely artificial neural network (ANN) is used to enable optimal data delivery to the destination using Internet of Thing (IoT) sensors. Such collection of real-time data from the patients at Intensive Care Units or Critical Care Units (ICUs or CCUs) are analysed and reported to hospital management system (HMS) via cloud. The experiments are conducted through several IoT sensor nodes that develops a Wireless Body Area Network (WBAN) architecture to collect, and forward and updates the HMS at real-time to create a network surveillance system.

Keywords: *Adaptive Artificial Business Intelligence, Artificial Neural Network, Internet of Thing, Hospital Management System, Wireless Body Area Network*

Introduction

An intelligent hospital is a notion emerging from the increasing digitalisation of major technologies throughout the health care industry, particularly the Internet of Things (IoT), data analysis, the provision of customer-oriented services, and artificial intelligence (AI) [1] [2]. The IoT system is expanding and may utilise distributed computing to share information for quick system requirements decision-making across a wide network [3]-5]. IoT technology is increasing around the world. This technology links common items, such as sensors, actuators, and things, over existing networks to enable patients to be diagnosed and monitored while enhancing the effective use of hospital resources. To exploit this linked network, IoT apps are built on a digital basis [6] [7]. This enables new ways of providing quick and accurate answers through the provision of information. This intelligent network is able to receive data from several sources, process it locally using lower computer power to make intelligent choices and/or centralise it with greater digital computer resources. Smart suggestions, predictive analysis or identification of patterns can be formed from this [8] [9].

IoT technology can also enhance service quality with these intelligent skills (QoS). The exchange of information ensures a constant flow of information among patients, pharmaceutical providers, biological providers, etc. [10]-[12] IoT employs modern IT technology in order to connect different components of a collaborative network [18] [19] [20] [21] [22] in order to make smart devices more efficient, better able, and more flexible. These intelligent gadgets can

monitor, sense and measure the actions or operations on the deployed platforms.

The data collected can subsequently be transmitted for further processing to a management unit/decision support system. Sensory data collected may be utilised to comprehend the present condition of the system by monitoring the status and status of each device in the network. As an initial stage, technology for data processing may also be used for raw data input [18]-[22].

Input data processed can be transformed into meaningful information using the techniques of information processing. Eventually, this information can enable the system to operate on its own without human participation by applying knowledge processing approaches [1]. This means that IoT systems can establish independent systems through self-government and self-management [2].

In this paper, we develop a robust platform named adaptive artificial business intelligence (AABI) to create an effective healthcare monitoring and support environment for medical professional in case of emergencies. Here, initially we amend a suitable machine learning model namely artificial neural network (ANN) enables optimal data delivery to the destination at regular instances using IoT sensors. Such collection of real-time data from the patients at Intensive Care Units or Critical Care Units are analysed and reported to hospital management system via cloud.

Related works

Increasingly, IoT-based intellectual hospital studies are interested in literature. Several IoT technology and intelligent hospital studies have been published, which provide new solutions and technical progress. However, there was no mention of the holistic approach to smart hospital design and of the development process that takes care of the processes required in each tier.

Park et al. [13] have carried out research in which IoT has been employed to improve the quality of health care in various business circles are the omnipresent services in hospitals. The four phases of their research were diagnosis, planning, action, and the definition of learning phases. In the first two phases, NFC and iBeacon developed 8 service models to discover a solution for the diagnosis of healthcare problems. In the 3rd stage, wearable lamps and NFC tags were fitted. The applications and the service models have been assessed by the stakeholders in the fourth and fifth phases. These new forms of service have greatly enhanced hospital staff efficiency and improved healthcare management.

Chaudhury et al. [14] suggested health metrics monitoring systems and wireless communication networks. The system informed the necessary employees and guaranteed confidentiality and safety through limited data bases in the case of an irregularity or an emergency. Temperature, pulse, and motion sensors were some of the sensors in this system. The writers say the TV system is efficient and easy to use.

The medical platform for remote health monitoring systems was created by de Fazio et al. [15]. With reduced residues and lower medical management costs, the IoT idea demonstrated remote control. In addition, patient satisfaction and illness predictions were enhanced in order to improve therapy. Its IoT architecture was separated into three levels, dubbed perception, including the physical and data gathering interfaces, the network gateway and the integrated application. For automated monitoring of patients, personnel, and biomedical devices in hospitals, Catarunucci et al. [16] created an IoT-based intelligent hospital system architecture.

In a built-in data base, Dhariwal and Mehta [17] suggested a smart IoT hospital concept. The approach suggested in the paper emphasises the relevance of the IoT as an effective health care provider for current institutions. The provision of an intelligent hospital has a beneficial influence on the way a doctor is treated.

Proposed Method

This study is based on five IoT layers that are combined and assessed on the elements needed to enhance IoT-based intelligent hospital architecture. A 3-layer infrastructure architecture is the usual method in literature. For system design and modelling, the structure of three layers is not sufficient to reflect the system components properly. Although the three-lag architecture for IoT technology is an essential structure and allows devices to be linked to the internet, due to its high energy consumption, limited integration and communication capabilities, it is not appropriate for all applications. Moreover, this design provides no dependable solutions and hides several features and data flow specifics. The five-layer design gives less storage and energy capacity, on the other hand. In view of these features, the five-layer design is more suited for IoT applications. The layers were divided into five levels because of the necessary limits and technology (Figure 1).

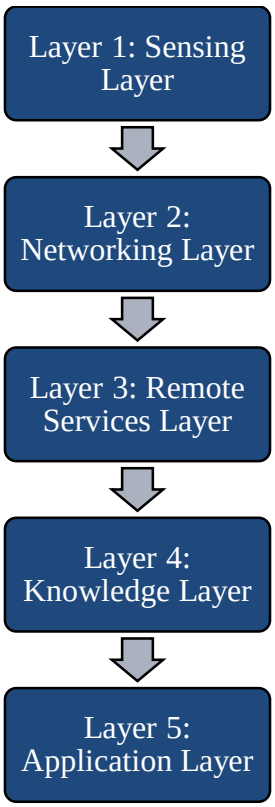

Figure 1: Protocol Layers used in Proposed AABI

Sensing Layer: This layer comprises data collection methods showing the required system and application architecture, and information gathering at the information production points. The information needed by stakeholders for the prospective stakeholders of intelligent hospitals is covered in this layer depending on the kind, efficiency and sharing. It will give a distinct degree of authorisation and authentication for each stakeholder group to provide an interchange of information. It collects, makes available and updates structural or non-structural information created, updated or produced for the first time.

Networking Layer: This layer manages data transmission to external servers and systems and platforms.

Remote server layer: represents IoT system remote computer technology.

Knowledge Layer: that layer contains intelligent IoT systems' decision-making and analysis for processing knowledge.

Layer of applications: contains service platforms utilised by stakeholders of each system.

Once each layer is determined, relevant elements which must be taken into account in every layer are specified and shown in Figure 2. The system method and vision of optimization are therefore identified in each layer structure. The primary strategy is to teach readers about existing technologies while describing layer hierarchies. These processes must be accomplished in each layer, as well as the restrictions faced in the layer design. These restrictions identify areas in which a researcher may help to develop and optimise IoT-based intelligent hospital architecture, as seen in Figure 3.

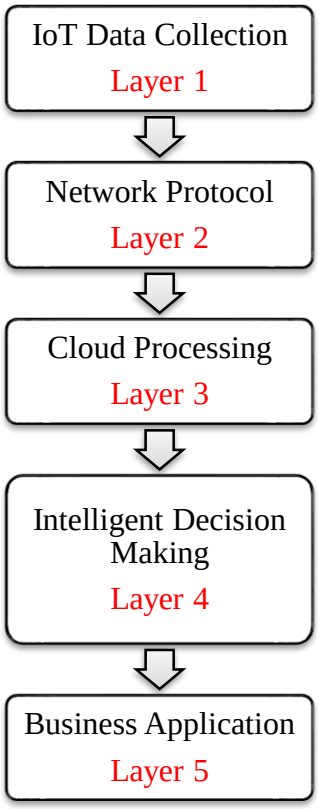

Figure 2: Proposed Architecture with Protocol Layer

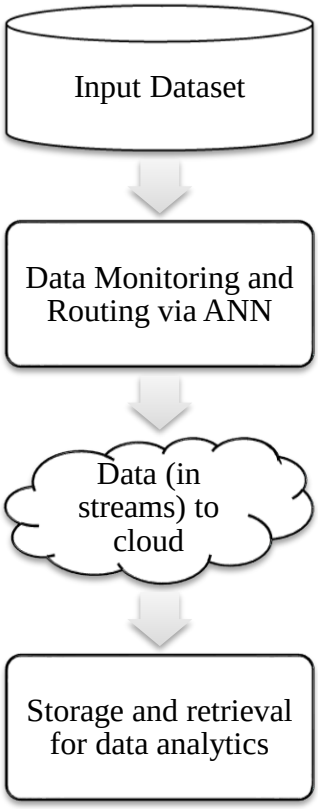

Figure 3: Data Processing using AABI

Sensing layer

For intelligent hospital design, the first step is to identify system stakeholders. Then it will be possible to examine which data is accessed by which system stakeholders and which data is shared in the system. Finally, it is necessary to establish which data analytics techniques are utilised for analysing sensitive data, including how the data is acquired from each stakeholder. Those stages are a precise design of the perception system and enhance not only the quality of the service (QoS) but also guarantee the timely and exact delivery of the information requested by each stakeholder.

The sensing layer defines how health data may be monitored, stored, or analysed using omnipresent and distributed computer technologies. This layer indicates nodes in which primary-level data is created and utilised. At this level, the optimization challenges include all phases of data collection, determination of the data collection technologies, frequency of data collection and analysis. It is also vital that the data collected and processed is communicated with the stakeholders in terms of how much and when. This problem is a system design problem. All system actors require some data to be generated in the system primarily. An insurance firm, for instance, needs to identify an individual who wants life insurance in general. The hospital, on the other hand, wishes to swiftly gain information about how much the assurance firm provides diagnostic and treatment services. It is vital to guarantee that this sharing of intelligent hospitals' mutual information is done in real time and that appropriate infrastructure is given to ensure that relevant information is communicated promptly to the system.

The other key components of the sensors are implanted devices which, on the other hand, may be utilised to transfer patient data into a smart hospital database and are fully equipped with artificial intelligence algorithms without a doctor's operation.

Networking layer

The development of IoT nets defines a means of employing resource-limited devices to transport packets from source to destination.

The proposed network must be able to gather, analyse, and transfer enormous data on the dispersed system for a long period of time. The following four elements should be analysed for the definition of network layer infrastructures. Firstly, the specification of forms of communications; secondly, the choice of the technology to link; thirdly, the development of an environment of interoperability utilising network technologies; and fourthly, the selection of real network protocols. Each factor is described below in depth;

Communication Types:

In the same or heterogeneous networks, IoT devices may communicate. The primary difficulty for a communication network is the lack of a common platform that is widely recognised, with diverse applications working to create successful communication across topics. The network should be designed in standard form.

Network Protocol Selection - HTTP: Selection of the Network Protocol-HTTP: Basically, four HTTP headers are available:

- general header for request and response messages, which can be utilised.
- request header for request messages can be used exclusively.
- Answer header for answering messages only.
- Header of entity who defines metadata.

Connection Technologies:

The selection of a suitable linkage technology that meets the communication and interoperability requirements between resource-limited devices is another key feature of the network layer architecture. We looked at WBAN services at several levels in this study.

Remote services layer

A number of simultaneous connected nodes (devices) that communicate with one another in a dispersed environment should be managed by the IoT remote service layer. The design group must take three key elements into account in establishing an efficient remote services layer architecture. The first is computational technology. The second is nodes. The third is design parameters, which are to be used to specify enhanced interaction.

Knowledge layer

The combination of big data and analytical methodologies have enabled the construction of self-repair, self-healing, self-protection, and self-organisation autonomous IoT structures. This capacity was utilised to decide on system requirements in due course, as the manner of working became simpler and easier.

Knowledge Layer:

For optimum data transmission, adaptive routing may be employed by taking the routing pathways across IoT nodes into account. In this way, network efficiency is improved by boosting the use of resources. With the suggested approach, the transfer speed can be increased with a minimum route and, at the same time, the throughput rate can be improved and security can be considerably guaranteed.

ANN for Routing

Machine learning techniques are neural networks. They are the same as biological neural networks. There are many neurons and neuronal connections. First, what the neuron is, we must know. In biology, the inputs, thresholds, and output of neurons are present. The neuron will be triggered and a signal delivered to the output when the input voltage exceeds the threshold. The neuron may have multiple inputs, but only one output signal is available. The neuron operating model is extremely similar in biology to that in machine learning. The inputs and outputs are also available.

There are, of course, certain distinctions. In place of the threshold, a function is used to transfer the inputs to the output by the neurons in machine learning. The activation

function has several possibilities. We frequently select it as the primary feature $\sigma(x)$.

$$\sigma(x) = \frac{1}{1+e^{-x}} \qquad (1)$$

The sigmoid function is quite similar to the thresholding step function. If x is a big number, the Sigmoid function result is close to 1. If x is significantly lower than 0, the result is close to 0. Another nice feature is the continuous and differentiable sigmoid function.

Weight is another distinction. The weights show the effect of every input on the neuron. In other words, not all inputs are only placed in the activation function. A linear combination of the inputs is the value of the activation function input. The following is the mathematical representation:

$$\sigma(w_1x_1 + w_2x_2 + \cdots + w_Nx_N) \qquad (2)$$

where

N- amount of the inputs,

w_i - weights of x_i , and

$\sigma(\,)$ - activation function.

The outcome of the Sigmoid function with bias is

$$\sigma(\theta + w_1x_1 + w_2x_2 + \cdots + w_Nx_N) \qquad (3)$$

The parameter θ is the same as above. There are parameters $\theta, w_1, ..., w_n$ which must be taught. So work the neurons. Neural networks arise when we link numerous neurons. The layer includes one or many neurons, and these neurons are not interconnected. Often, the first layer is called the input layer and the last layer is called the output layer. The hidden layers are called the layers between the input and the output layer.

In the neural networks, there are numerous neurons. The weights of every neuron are many. The aim is, therefore, to determine the correct weights to suit the information. The networks are trained to get the outputs close to the intended outputs.

1. Results and Discussions

This section discusses the evaluation of the proposed routing model for AABI with other existing machine learning models. The results are compared in terms of various network metrics that includes energy usage, overhead control, packet delivery rate and end-to-end latency.

Average control packet overhead

The sensor node delivers driving packets to build and manage flexibility in the clustered zone. The total electricity consumption of different protocols of control packets at a different rate of decrease as illustrated in figure 4. In the ANN, the control overhead is slightly lower compared to the other protocols, as seen in the figure. Connecting to the sink location is necessary for the controller packets. Overhead power in the suggested ANN would nevertheless be minimised. The average distance from the source or sink between the cluster areas is smaller than the other protocols.

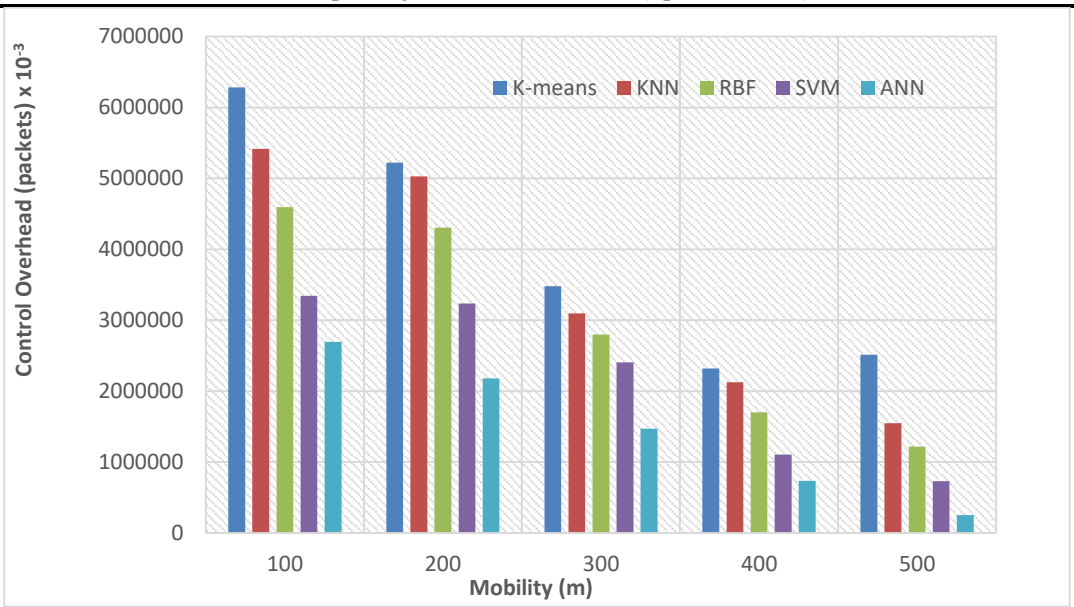

Figure 4 Average Control Overhead

Average energy consumption

The overall energy use of the various protocols in each node is shown in Figure 5. The enhanced management showed that alternative techniques consume more energy. The data from the source node is processed and the sink application in this region is clustered. As the decrease rate increases, the power consumption might grow alone.

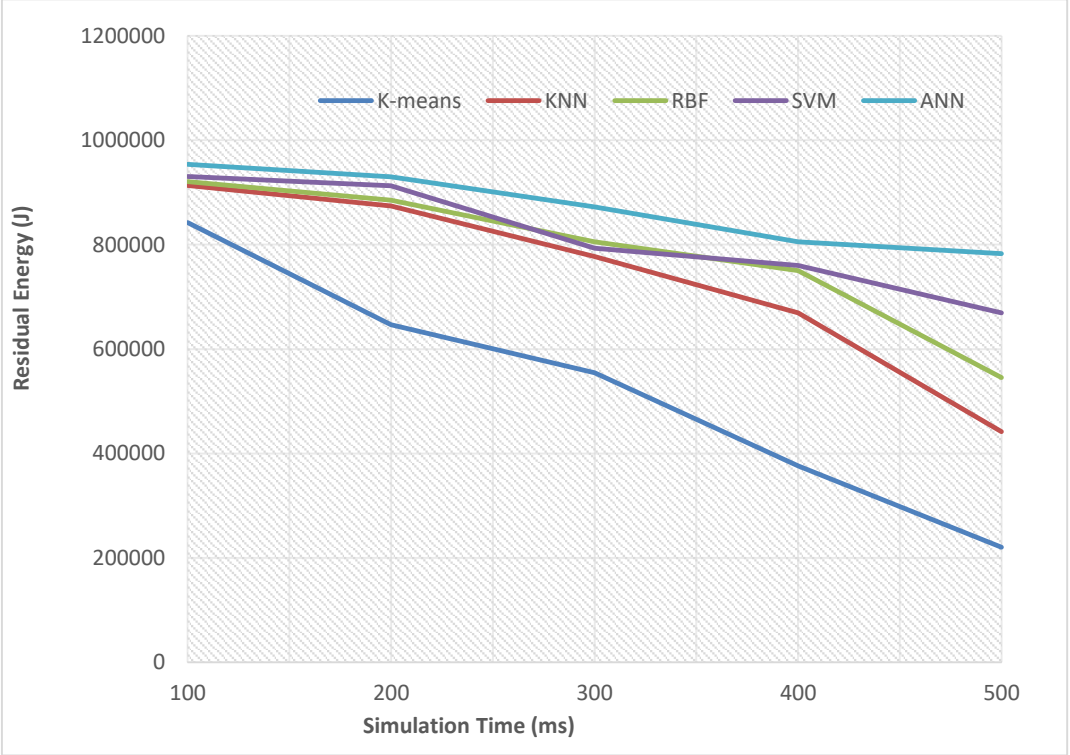

Figure 5: Average energy consumption

Average end-to-end latency

Figure 6 shows the average delay for different drop rates of different protocols. It depends on how long it takes to identify the sink and deliver information to the sink. The suggested ANN immediately transfers data to the sink node. The model transferred the data to the sink, while the sink remained connected. As a

consequence, the delays are greatly reduced at the end of the day.

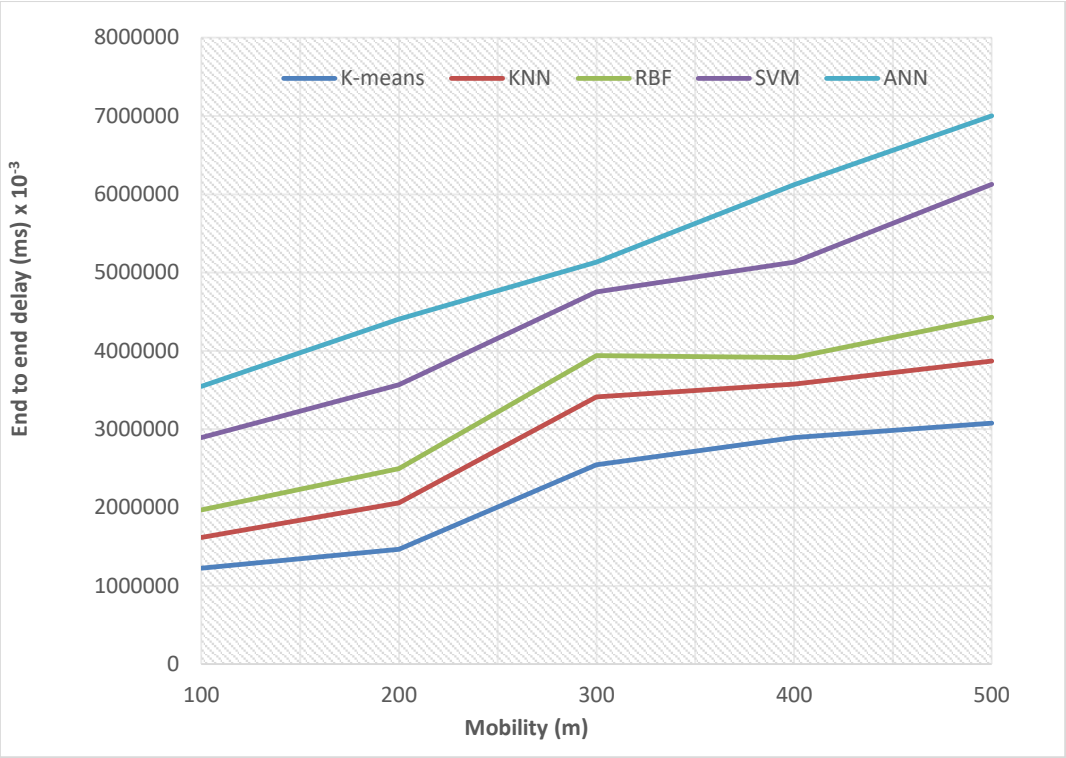

Figure 6: Average end-to-end latency

Packet delivery ratio

Figure 7 shows several protocols in the packet distribution ratio. Data receipt on the sink has been reported at a good pace. The ANN maintains the tree-drain connection. This compares the transmission rate with other protocols. In this way, the data will be stored and delivered to the sink node when the destination is reached.

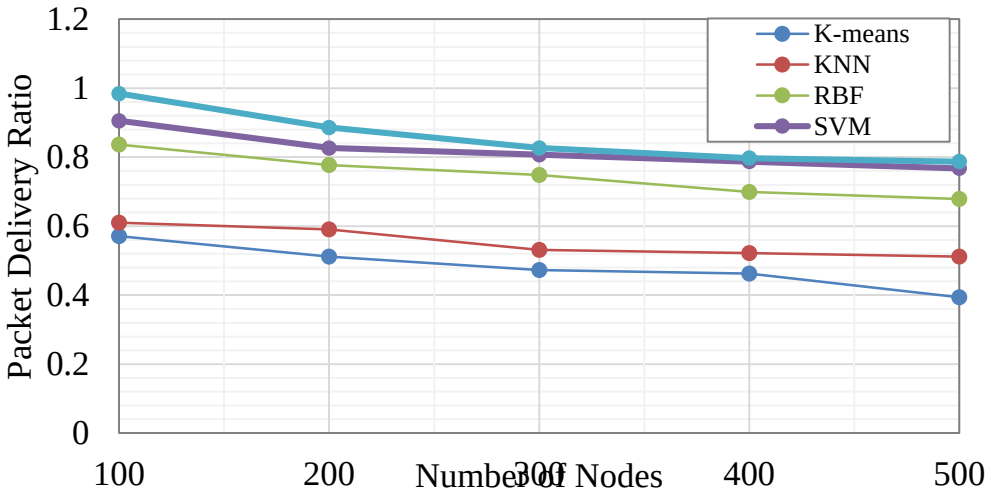

Figure 7: Packet Delivery Ratio

Conclusions

In this paper, we develop a robust platform named AABI to create an effective healthcare monitoring and support environment for medical professional in case of emergencies. Here, initially we amend a suitable machine learning model namely ANN is used to enable optimal data delivery to the destination at regular instances using IoT sensors. Such collection of real-time data from the patients at ICUs are analysed and reported to HMS via cloud. The experiments are conducted through several IoT sensor nodes that

develops a WBAN architecture to collect, and forward and updates the HMS at real-time to create a network surveillance system.

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OPERATIONAL, LOGISTICS AND MARKETING PROBLEMS FOR FARMERS OF PERISHABLE AGRICULTURAL PRODUCTS IN SALEM DISTRICT DUE TO COVID-19 CRISIS

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ABSTRACT

Due to COVID-19 disaster and lockdown imposed by the government, farmers find difficult to harvest, transport and sell them at competitive prices. Farmers cultivating perishable agricultural products (Tomato, Brinjal, Ladies Finger, Bitter Gourd, Leafy vegetables and Flowers) face lots of difficulties and problems in Salem district due to the curfew conditions. These products are cultivated around 10,000 Hectares and 1,30,000 metric tonnes are produced. Farmers face problems in operational, logistics and marketing problems due to COVID-19 conditions. Measures have been suggested to reinstate the cultivation activities of farmers in Salem district.

Key Words: *Perishable Agricultural Products, COVID-19, Curfew Conditions, Farmers Problems, Post-Corano Measures*

INTRODUCTION

In India as well as in Tamil Nadu, perishable agricultural products sector is the most profitable activity in farming as it provides daily income and low investment to the farmers. Perishable agro products play an important role in India's economy by improving the income of rural people. While considering the agricultural perishables, managing the freshness and delivery of these products paly a crucial role. These products have to be transported overnight, sold within a day and consumed within limited time. Whether it is tomato or vegetables or flowers, when they are delivered freshly, they fetch good prices. Due to COVID-19 disaster and lockdown imposed by the governments farmers find difficult to harvest, transport and sell them at competitive prices. Farmers face lots of difficulties and problems due to the curfew conditions. This article covers the study about the problems faced by the farmers of perishable products in Salem district due to lockdown. It also discusses the post-lockdown effects in terms of operational and logistics disruptions.

BACKGROUND OF THE STUDY

The COVID-19 (Corona Virus) pandemic has set foot in India as across economic sectors. The governments (Central and State) imposed a 21-day countrywide lockdown to stop the spread of the Corona virus pandemic. Further it is extended up to May 3, due to more positive cases in most of the country. There are more than 17,000 confirmed cases of Corona virus in the country as on 20th April, 2020 (MoHFW, India). While the government has exempted many agricultural operations from harvesting to movement of produce markets and mandis from lockdown rules.

COVID-19 is disrupting some activities in agriculture and supply chain. Preliminary reports show that the non-availability of migrant labour is interrupting the harvesting activities. Also new farming activities are also affected. There are also disruptions in supply chains because of transportation problems and other restrictions. There are price fluctuations in these disaster period. Media reports show that the closure of hotels and restaurants during the lockdown is depressing the sales of agricultural commodities. Further household consumption is also reduced due to decline or no income for the unorganized labourer and daily wagers. The real situation is worrisome about the farmers on various agricultural activities.

PERISHABLE AGRICULTURAL PRODUCTS

Most of the agricultural products are of perishable nature, but all are not equally perishable within same duration of time. Some products perish with shorter time and some others remain usable for little longer.

Mil, fruits, vegetables, flowers etc. remain fresh only for shorter time, so they are quickly perishable. Such products should be supplied to market as quicker as possible.

Most of the perishable agricultural commodities are very important to meet daily needs of people. So, it is required to have daily supply of agricultural commodities like food grains, milk, fruits, vegetables, etc. The consumption of these products does not decrease or increase much due to rise or fall of their prices. Though the prices of agricultural products rise, the consumers are necessitated to go for their daily needs at minimum level. The prices of agricultural products are always unstable. The prices are affected by the supply and demand conditions and seasonality of the products.

LITERATURE BACKGROUND

S.Shanmuga Sundaram and Natarajan (2001) in their article, "A study on Uzhavar Sandhai" (With Special Reference to Beneficiaries Attitude Towards Suramangalam Uzhavar Sandhai, Salem), have examined the operations of farmers' market and found that farmers' markets help the farmers to get a reasonable price for their produce avoiding all unwanted and unreasonable charges. The consumers were facilitated to get fresh vegetables at a cheaper price without any malpractice in weighing. Their investigation prompted them to suggest establishment of telephone facilities, extension of business time (working hours) and working of the market both in the morning and evening.

News Coverages by Newspapers and Magazines

“Prices dropped for vegetables as the lockdown continues and consumption reduced. Farmers are in loss of their income. There is no bulk sale for hotels and restaurants. Also, there are no sales for functions like wedding and temple festivals” **[Daily Thanthi (Salem Edition), 27.03.2020]**

“Rs.120 crores of trade have been affected in Jasmine sales in Salem district and nearby areas. 800 farmers who cultivated the flowers in 3000 acres have lost their earnings.” **[Daily Thanthi (Salem Edition), 28.03.2020]**

“Flowers become fertilizers in 200 acres of farmlands. Farmers of flower cultivation are in tears. They expected good sales for Rama Navami festival; but due to Corano virus crisis all went in loss”. **[Dinakaran (Salem Edition), 12.04.2020]**

Ananthan lives in a small village called Pannapatti of Omalur Taluk. He has three children who are at home due to the lockdown. They accompany him to the field which is in full bloom right now. But even Ananthan talks to us about the losses he incurred this season.

“Anathan usually makes a lakh as profit from his marigold and other flowers cultivation. However, Ananthan has not harvested a single flower this year due to unavailability of labourers. Moreover, he has to pay his farmlands Rs.150 each day”.

"The government has not helped us yet. I have cultivated two-and-a-half acres. I have lost everything. All the flowers are wilting. We don't have food at home. The government has given us Rs 1,000. Nothing else," Ananthan said.

"There are no temples or shops open. Where do we pluck these flowers and go? All temples and shops are closed. There were a few shops which needed garlands. They are also closed. We cannot go to the markets also", he said. **[India Today, 17.04.2020]**

“Nearly 400 acres of Tomato are left to spoil in the plants due to unavailability of labourers to harvest and transport them to market. Button Rose flowers are kept to dry in the plants since there are no buyers. The harvesting cost will be more than selling price” **[Daily Thanthi (Salem Edition), 16.04.2020]**

Mr.Deivasigamani, President of Tamil Nadu Farmers Federation said, “Labourers refused to come for agricultural works due to curfew. No new crops are cultivated for the past 60 days. No takers available for agricultural

produces". **[Dinakaran (Salem Edition), 19.04.2020]**

It is the time of the year when marigold flowers are in full bloom. For three months of summer, the fields are bright and yellow and farmers look over their fields with a smile on their faces. This year, the fields are bright but the farmers stand by their fields with worry clouding their faces.

Babu walks to his field with his family. He has cultivated marigold in about 2 acres of leased land. The marigold saplings have been bought from Hosur. Babu pays 3,000 rupees a year for the land. In addition, Rs 700 a week for water. Fertilizers and labour are an additional expense. His hard work has paid off. His field is full of flowers, but due to the lockdown, the only question in Babu's head is how does he make up for the loss of Rs 1.5 lakh.

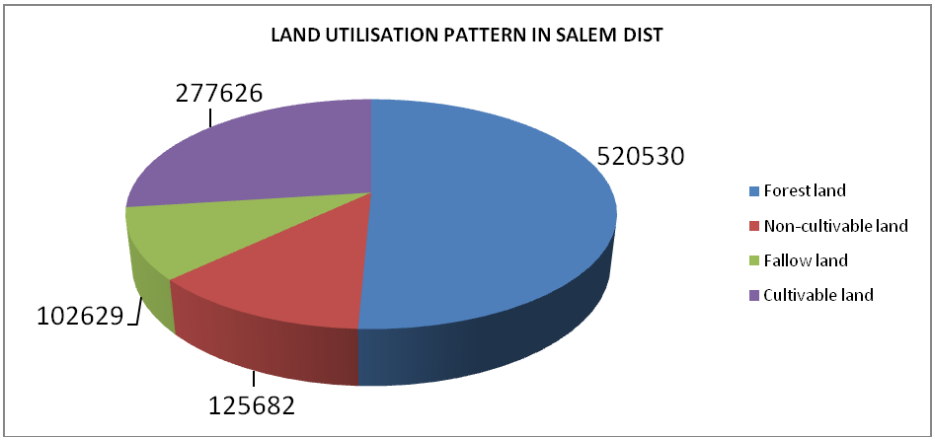
"It is Rs 2 for each sapling. For 40 cents of land, the saplings cost Rs 8,000. Fertilizer, labour and water for 40 cents come to at least Rs 50,000. That's another 70 cents. My total loss is about a lakh and a half", said Babu. **[The Hindu Businessline, 13.04.2020]**

"Farmers destroyed 50 acres of Samandhi flowers using tractors at Omalur union (Kamalapuram) as there is no possibility of sending them to Bengaluru and Thirupathi. **[Dinakaran (Salem Edition), 21.04.2020]**

STUDY AREA

The study area is Salem district of Tamil Nadu which is located between 11.14° and 12.53° North and 77.44° and 78.50° East in the north central part and it spreads about 5245 sq.km, and it is a landlocked area. The area has well marked with hills in the north and south eastern directions. The study area is an ideal location for bio-model rainfall; summer showers bring half of the seasonal rain. This area is call Geological Paradise due to the occurrence of varieties of rocks and minerals, and also famous for its rainfed and irrigated agriculture. The population of Salem district is 34,80,008 according to 2011 census and it ranked fifth among the district wise population of Tamil Nadu state. At present Salem district contains 10 Taluks, 20 blocks, 4 municipalities, one corporation, 34 town panchayats, 20 panchayat unions, 385 village panchayats and 646 revenue villages. The district has wide variety of agricultural, horticultural, industrial and business activities.

Out of the total geographical area of 5,20,530 Ha, the net cropped area accounts for 53.39%. In places where irrigation sources are good, paddy, sugarcane and turmeric are cultivated. Cash crops such as Cotton, groundnut, tapioca, gingelly, tomato, flowers and vegetables are also found significant place in the cultivation. The land utilization details given in fig. no.1.



PERISHABLE AGRICULTURAL PRODUCTS IN SALEM DISTRICT

The details of perishable agricultural products cultivated in Salem district are given in the Table no.1

Product	Places of cultivation	Area of Cultivation	Production

		(Ha) Approx.	**(MT/Annum)**
Tomato	Mecheri, Omalur, Taramangalam, Kadayampatti and Nangavalli	4200	38,000 - 40,000
Brinjal	Omalur, Attur, Thalaivasal, Vazhapadi, Sankari, Veerapandi	1100	10,000 – 12,000
Ladies Finger	Sankari, Edappadi, Omalur, Attur, Thalaivasal, Gangavalli	1200	15,000 - 16,000
Bitter Gourd	Attur, Gangavalli, Edappadi, Mecheri	700	5,000 – 6,000
Leafy Vegetables (Spinage, Coriander leaf, Dhania leaf)	Omalur, Kadampatti, Thalaivasal	1000	20,000
Flower (Jasmine, Chrysathemums - Samandhi, Rose, Button Rose, etc.)	Panamarathupatti, Kadayampatti, Omalur, Veerapandi	900 - 1200	20,000 – 22,000
Fruits (Watermelon, Mulampalam)	Mecheri, Mettur, Kolathur, Attur, Sankari	400	12,000 – 14,000
Other Vegetables (Snake Gourd, Bottle Gourd etc.)	Thalaivasal, Omalur, Aythiyapattinam, Kadayampatti, Panamarathupatti	600	6,000 – 8,000

Source: Directorate of Horticulture and Plantation Crops, Chennai

OPERATIONAL AND LOGISTICS DISRUPTIONS DUE TO COVID-19 LOCKDOWN

The prolonged COVID-19 lockdown forced to face many disruptions to the farmers of perishable agricultural products in Salem district. Few of the are listed below:

Operational Problems

- Shortage of labour for harvesting
- Unavailability of equipment and machinery for farming
- Inadequate supply of material inputs

Logistics Problems

- Inadequate Storage Facilities
- Unavailability of transportation facilities
- Restriction for movement of people and goods

Marketing Problems

- Lack of appropriate market facilities
- Lack of market information
- Reduced Demand and Consumption
- Price Fluctuations
- Lack of Support from Government Agencies

Operational Problems

1. Shortage of Labor for Harvesting

The perishable items are harvested on daily basis either in the early morning or evening time to keep the freshness and obtain the appropriate yielding. Due to COVID-19, the agricultural labourers are restricted for movement. Hence the products are spoiling in

the plants itself, which makes huge loss to the farmers.

In some areas the non-farming labourers are available at cheaper cost due to their lay-off or loss of their original jobs. But this does not result in expected yield and quality of work.

2. Unavailability of Machinery and Equipment

Due to lockdown the availability of tractors, harvesting machines and crushers is restricted. This makes problems both in sowing, cultivation and harvesting activities. Moreover, the unavailability of equipment and repairmen makes long hangover of farming activities.

3. Inadequate Supply of Material Inputs

The agricultural material inputs like seed, sapling plants (tomato, brinjal), fertilizers and pesticides are supplied nil or inadequately. This makes problem in seasonal cultivation and other operational difficulties in farming.

Logistics Problems

1.Inadequate storage Facilities

Post-Harvest Life of Few Perishable Products

Products	**Post-Harvest Life (at 30 – 35 Degrees)**	**Post-Harvest Life (at 15 Degrees)**
Tomatoes	2 – 3 Days	14 Days
Vegetables (Cabbage, Carrots, Cali – Flower etc.)	1 Week	8 Weeks
Green Leaves (Spinach)	1 Day	5 Days
Flowers	1 Day	1 Week

Source: Department of Horticultural Crops, Tamil Nadu

Farming activities of perishable products are not done in large scale. They are cultivated by small growers and they lack in storage facilities. Due to perishable nature of the products, the self-life can be expanded by cold-storage and other facilities. The following table gives the self-life expansion via cold storage facilities.

2. Unavailability of Transportation Facilities

Generally, the perishable products are moved from village farmlands to urban areas. Vegetables are directly from farmlands to market places by small vans or buses. Flowers are taken from Agri-fields to markets and airports (for exports) by vans and buses. They need to be transported as quick as possible. Leafy vegetables require to be transported overnight by two wheelers, minivans and autos. Due to lockdown and curfew restrictions, the transportation of perishable agricultural items faces difficulties.

3. Restrictions for Movements of People and Goods

Curfew restrictions have limited movements of people and goods. Particularly time restrictions imposed by authorities stopped the people to move away from their homes during 1.00 PM to 6.00 AM. Though the vegetables and fruits come under essential commodities, these restrictions result in logistics difficulties which finally resulted the wastages.

Marketing Problems

1. Lack of Appropriate Market Facilities

The perishable agricultural products are sold in common market places (Uzhavar Sandis, City Markets and Vegetable and fruit vendor shops) in normal days. Due to curfew conditions people are strictly prohibited to crowd in public places. It is also required to maintain social distancing among individuals. These measures have made the authorities to shift vendor from small markets into a larger space like bus stands and grounds temporarily. The vegetable super markets are required to follow the curfew conditions. Farmers are forced to wandering for finding appropriate market places.

2. Reduced Demand and Consumption

Corona Pandemic situation makes the closure of hotels and restaurants. Due to this the demand for vegetables and leafy vegetables got reduced. Few vegetables and flowers lose the export orders due to halting of flights. Temples are also closed for Dharshan of general public which has resulted the purchase of flowers for religious purpose. Only the household consumption is met by the market players. Due to reduced income majority of the consumers have reduced their purchase of day to day vegetable requirement. Hence the demand is reduced for all varieties of perishable agricultural products

3. Lack of Market Information

There are government agencies (Regulated market committees, Agricultural and Horticultural departments, Uzhavan App etc.) and intermediaries are available during normal market conditions. They provide the market information like the supply, demand and price information to the farmers. Also, they provide the guidelines for crop pattern for different seasons. The prolonged lockdown has disrupted the sources of information.

4. Price Fluctuations

It is a major issue for the growers of perishable agricultural products. The prices of all vegetables and other agricultural commodities surged during the previous days of curfew. The prices increased due to the panic nature of general public and all the vegetable shops were crowded. That made shortage of products and prices were raised by the sellers. That fetched good returns to the farmers for one or two days. But the situation changed because of reduced demand and consumption in the later days. Many vegetables attract below the actual cost of production in which the farmers lose their money in harvesting and selling the products. A comparative price changes is given in table no.

Table No.2 : Price Fluctuations during Lockdown period

Products	**Average Price (Rs.)/Kg**			
	23.03.2020	**31.03.2020**	**10.04.2020**	**19.04.2020**
Tomato	24	18	12	10
Brinjal	48	38	30	22
Ladies Finger	38	30	20	18
Bitter Gourd	60	45	30	24
Leafy Vegetables	5 - 10/bundle	5 – 8/bundle	3 – 5/bundle	3 – 5/bundle
Flowers	150 – 400	100 - 200	60 - 100	50 - 100

Source: Various print and visual media

5. Lack of support from Government Agencies

All the government agencies have been halted due to curfew conditions. There are no people available in agricultural and horticultural department offices to monitor and inform the important market information and carry out the facilitating activities. There are also lack of credit facilities from institutions. There is no hearing for compensation for loss of crops during cultivation and harvesting. Hence the farmers are suffering from unavailability of supportive activities.

ASSISTANCE PROVIDED TO FARMERS AFTER LOCKDOWN

Immediately after the nation-wide lockdown was announced, the Indian Finance Minister declared an INR 1.7 trillion package, mostly to protect the vulnerable sections (including farmers) from any adverse impacts of the Corona pandemic. The announcement, among a slew of benefits, contained advance release of INR 2000 to bank accounts of farmers as income support under PM-KISAN scheme. The Government also raised the wage rate for workers engaged under the NREGS, world's largest wage guarantee scheme. Under the

special scheme to take care of the vulnerable population, *Pradhan Mantri Garib Kalyan Yojana* (Prime Minister's scheme for welfare of the poor), has been announced.

The Indian Council of Agricultural Research (ICAR) has issued state-wise guidelines for farmers to be followed during the lockdown period. The advisory mentions specific practices during harvest and threshing of various *rabi* (winter sown) crops as well as post-harvest, storage and marketing of the farm produce.

The Reserve Bank of India (RBI) has also announced specific measures that address the "burden of debt servicing" due to COVID19 pandemic. Agricultural term and crop loans have been granted a moratorium of three months (till May 31) by banking institutions with 3 percent concession on the interest rate of crop loans up to INR 300,000 for borrowers with good repayment behavior.

Government of Tamil Nadu has announced a three months moratorium (till June 30, 2020) for repayment of instalments for crop loans and payment of certain charges for repayment of instalments for the crop loans availed from cooperative institutions. They have been exempted the charges of storage in cold storages.

COVID-19 MEASURES FOR FARMERS OF PERISHABLE AGRICULTURAL PRODUCTS

Farmers and agricultural wagers should be included in the Government's assistance package and other social protection programs addressing the crisis after lockdown.

The Central Home Ministry's circular relaxing restrictions for movements of farmers, agricultural labourers and harvesting and related farm machines on the inter and intra-state is a needed step in right time. While ensuring availability of farm labourers for essential farm operations, the safety from COVID-19 infection and welfare must be ensured by the government agencies.

It is required to make available the food grains, vegetables, fruits and other essential items to the consumers, both in rural and urban areas, is the priority challenge for government agencies during the lockdown and post lockdown periods. With adequate safety measures, efficient functioning of the logistics system is necessary for perishable agricultural products. Transportation of products by both rail and road and public distribution system (PDS) must be ensured by government departments.

State governments must gear up their machineries for procurement operations of farmers' surplus products through price support schemes or fixation of Minimum Support Price.

Government agencies as well the farmers should identify the alternative places of selling their products along with sandis and mandis. For example, the flower plant growers can look for selling their products to perfume manufacturing industries. Likewise, the fruit plant farmers can look for juice and pulp manufacturers for selling their fruits.

As the farmers of agricultural perishable products are small scale players, it is not adequate to provide moratorium of payment of loans for few months, but government can think of waiver of crop loans up to a certain sealing of loan amount.

Institutional lending of crop loans should be expanded and facilitated for smooth (and sufficient) flow of credit to borrowing farmers. Agricultural inputs like seeds, fertilizers, pesticides, etc. have to be made adequate availability. Private sector must play a significant role with necessary policy support.

As the lockdown conditions have increased, a new culture of home delivery of groceries and vegetables has risen in all parts of the country. But it is not in an organized manner. The home delivery of products can be clubbed with the farm pick-up with a new form of supply chain, which will become a new marketing model during the pandemic

period for maintaining safe and healthy measures.

CONCLUSION

COVID-19 is an unexpected and unprecedented challenge for all sectors of society and economy throughout the world. The lockdown conditions and social distancing would have longer impact in all forms of human life. This study has attempted the problems faced by the farmers of perishable agricultural products based on the news available in print and visual media. The real statistics of the problems have not studied, but an explorative coverage has been done. Since the study was made during the lockdown period, it is important to measure the real impact of the problems after the relaxation. The real measure will definitely provide to go for a strategy formulation for safeguard and relief measures in any form of crisis times.

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DIAGNOSIS OF CATTLE SKIN DISEASES BASED WITH IMAGE PROCESSING TECHNIQUES

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ABSTRACT

Cattle population is critical socioeconomic assets in a nation like Ethiopia where the society depends on farming and animal husbandry. However, there is huge loss of livestock population by a disease that undermines the efforts towards achieving food security and poverty reduction. To address this problem, we propose an approach for cattle disease diagnosis by integrating image processing using deep learning with an expert system. The proposed system has an expert system and an image processing component. The symptom identified by naked eyes are represented using image and its category is identified by the image processing component. The image processing component consists training and classification phase. In the training phase images collected from different source are preprocessed and feed to the classification model. The classification model used is a convolutional neural network with three convolutional and two fully connected layers. In the classification phase the trained model is used to classify the input images. The expert system have reasoning, knowledgebase and user interface component. The user interface allows communication between the system and the user. The knowledgebase contains information and facts required for diagnosis. The reasoning component reaches a final diagnosis conclusion based on classification results and other related information.

The developed classification model trained on 3990 dataset collected from different sources. To increase the dataset we apply different augmentation techniques. We split the dataset into 90% for training and 10% for testing. The model classifies the input symptom image with 95 % accuracy. The entire system has been evaluated by veterinarians and people having cattle farming, the analysis shows that the system is effective to diagnosis cattle disease.

Keywords: *Cattle disease diagnosis, Expert system, Image processing, deep learning, Convolutional neural network, Location information.*

Background

Medical diagnosis is the process of determining disease based on symptoms and signs [13]. It is an essential part of disease management and prevention. Whether it is affecting a single or an entire society disease must be controlled. A small outbreak of disease can spread and affect the entire population. As a result quick detection and diagnosis is critical to prevent any disease outbreak from further spread.

Ethiopia has the highest draft livestock population in Africa continent and is ranked first in Africa and tenth in the world [10]. Ethiopia has 59.5 million heads of cattle which contributes 40% of the annual agricultural output and 15% of the total gross domestic product [10]. Livestock are critical socio-economic assets in a nation like Ethiopia where many of the population depend on farming and animal husbandry. However, potential economic benefits are constrained by many reasons.

The most important constraints to cattle productions are widespread endemic diseases including viral, bacterial, and parasitic infestation [10]. Endemic and trans-boundary cattle diseases are usually transmittable leading into an outbreak in a short period of time [1]. The outbreak of disease reduce productivity and quality of animal products (skin, hides, milk etc.). If it is not controlled it may cause international trade restriction of animal and animal products. So it is essential to know cattle diseases and solutions to increase the productivity.

Artificial intelligence (AI) is playing a significant role in medical diagnosis. There are different AI technology used in medical domain like expert system, digital image processing etc. Expert system (ES) is a computer system or software that emulates decision-making ability of human experts in a specific field [2]. ES combines knowledge base with inference engine. This program acts as an intelligent consultant or advisor in a particular environment, based on stored knowledge. Digital image processing (DIP) is a technique which manipulates images using computer system [6]. DIP start from low level processing noise removal to high level processing like classification, recognition etc. The integration of different technology from

AI enable to design a system with high performance [15, 38].

Motivation

The Ethiopian government designed an export development strategy to generate foreign exchange [10]. The export commodities include in the strategy are livestock and their products. In the 1990s livestock sub-sector is the second major source of foreign currency through the export of live animals, meat, leather, hides, and skin [9]. Despite the amount of livestock, there has been a decline in export earnings from livestock products in comparison to other African countries. The highest portion of decline is directly related to skin diseases or secondary damage that occurs when the animal scratches itself to relieve the itching associated with some of these diseases [9]. From the total product, 65% of skin and hides are often rejected because of poor quality [9]. The high prevalence of diseases in cattle requires serious attention to minimize the effect of the problem it causes.

AI techniques are distinguished with their successful results in relation to human and animal health studies [1, 2, 4]. They provide a new perspective to solve problems which are known in the medical field. Therefore, the main motivation is the desire to minimize the decline by implementing AI technologies in the animal health sector in Ethiopia.

Research Problem

To the society whose life depends on farming and animal husbandry, the wellbeing of the animal is a major concern. Diseases are the main threats that affect normal function in animals. In Ethiopia, the diseases cause huge mortality and morbidity in the cattle population and the lost in international livestock markets is about 1.5-2.5 Billion birr annually [10].

According to UNDP (United Nations Development Program), [7] many of the diseases in Ethiopia can be controlled by vaccine technology, by timely recognition of the disease followed by the acquisition of the pharmaceuticals. However, the remoteness of the livestock holder and shortage of infrastructure facilities to support health services delivery, the diseases are not controlled easily. Consequently, in Ethiopia, the majority of disease intervention consists of mass inoculations following outbreaks rather than preventive measures.

Beyene et al. [25] studied veterinary drug prescribing practices in Adama district. They find out there is a problem of correct diagnosis and drug administration based on clinical signs observed and diseases diagnosed, which could lead to irrational drug use. The prescribing practice for antimicrobial shows deviation from the standard recommended by WHO. The findings had also shown there are problems in generic prescribing, incorrect diagnosis and standardized patient case book handling and low prescriber educational status.

Currently, many of the diagnosis systems are either text or image based on acquiring symptoms encountered. The use of text description accuracy is dependent on the person understanding and describing the conditions that occurred efficiently. The use of image description is not dependent on anyone and it is efficient form of description. Using only images as form of description lacks major diagnosis steps to follow. According to Ararsa Dugma [24] in the investigation of any animal disease, the veterinarian must undertake a careful and thorough clinical examination to recognize the nature of the affection. For completeness and accuracy of diagnosis, the following things should be considered patient data, immediate/present history, past history, management, and environmental history. We need to have a system where symptoms can be described in efficient way for correctness of diagnosis result.

There are research works that attempt to design an expert system for cattle disease diagnosis [1, 2, 4]. Their work targets a person who can understand and describe the symptoms that occurred in the cattle using text. However, the expert who understands the cases is very low in the rural area of Ethiopia in which most cattle are found. The ratio of veterinarians to animals is 1: 500,000

[34] which is not sufficient to provide an efficient and on-time diagnosis.

While the main aim of diagnosis system is giving on time and efficient diagnosis based on occurred symptoms, the works done so far are not satisfactory because:

Not designed for novice user who are the one close to the cattle's e.g. Farmers.

Text based symptom description, its accuracy is dependent on understanding of the person who describes the symptoms.

The interaction to the system is not user friendly, require many selection and form filling.

They are not implemented for mobile which can be more feasible than computers

Diagnosing diseases through text symptom description could lead to an incorrect diagnosis and difficult for someone who doesn't have veterinary knowledge. So, developing a mobile application that doesn't require assistance from the expert to describe the symptoms will help the farmer, pastoralists and anyone who don't have medical background. In this research work, we aim to integrate technology from AI like expert system, Digital image processing, and deep learning to design cattle disease diagnosis system. This is believed to have an advantage on the animal health care specifically on cattle to improve healthcare services.

LITERATURE REVIEW

Cattle in Ethiopia

Ethiopia is rich in animal genetic resources, both in diversity and population. The agricultural sample survey report of (CSA, 2016/17) revealed that about 59.5 million heads of cattle, 60.90 million sheep and goats population are found in the country. According to Tweldemedhn mekonnen [11], 98.20% of the total cattle population in Ethiopia are local breeds while hybrid and exotic breeds accounted for 1.62 and 0.18%, respectively. Ethiopia is a place for 28 recognized indigenous cattle breeds [45] in the continent. The diverse agroecology, cultural and ethnic diversity, a long-lasting agricultural practice and farming systems in the country have contributed to the diversification of the population.

Ethiopian Indigenous cattle can be broadly classified into four categories Large East African Zebu, Small East African Zebu, Sanga, and Zenga. Large East African Zebu mostly inhabit North West, South and Central highland of Ethiopia and include Begait, Boran and Arisi cattle [45]. Small East African Zebu include Bale, Jem-Jem, Harar, Ogaden, Sheko/Smad, Adwa, Jigjiga, Goffa, Guraghe, Hammer, and Ambo cattle. The Sanga breed group includes Anuak and Raya Azebo Cattles. The Zenga breed group includes Fogera, Northern Shire, Adwa and parts of Agame cattles.

Ethiopian indigenous cattle breeds have unique morphological features that distinguish them from other cattle. These include horn shape, horn size, and body size. In addition to physical features, non-visible traits such as productivity, disease and climatic stress resistance differ among breeds. These characteristics are largely the result of natural and human selection. Some breeds are already known for their unique adaptive attributes like Sheko cattle, good economic performances of Ethiopian Boran cattle. One of the well-known outstanding features of Ethiopian cattle is Trypanosomosis resistance [45].

Despite the potentials of diversified genetic resource, the huge loss of livestock population through disease undermine the efforts towards achieving food security and poverty reduction [20]. Drug administration and control authority of Ethiopia classified livestock diseases into infectious diseases, non-infectious diseases, skin conditions, pediatric problems, obstetrics and gynecology problems, ophthalmologic and Ear, Nose and Throat (ENT) disorders as well as acute/emergency problems [44]. In this research paper we will focus on skin diseases.

Skin Disease

Skin has a complex structure, being composed of many different tissues. The most important functions are control of body temperature, protects the body from physical damage and bacterial invasion etc. The animal skin comes in different kinds of textures and forms. There is the dry warty skin of toads and crocodiles, the wet slimy skin of fish and frogs, the hard shell of tortoises and the soft supple skin of snakes. Mammalian skin is covered with hair, that of birds with feathers, and fish and reptiles have scales. Pigment in the skin, hairs or feathers can make the outer surface almost any color of the rainbow. Despite their difference in texture and forms all animals are affected by skin disease. Skin is one of the first systems affected when an animal becomes sick.

Skin disease in cattle are conditions that cause inflamed, irritated or scaly skin, hair loss, changes in pigmentation of the skin and visible growths etc. [50]. Cattles are affected by various skin problems, some of which are easy to cure while others are more complicated with zoonotic importance. Due to a wide variety of diseases in cattle, the root cause of the diseases are often complex and can evolve over time. The existence of various skin diseases has been reported from many parts of Ethiopia. Lumpy skin disease (LSD) is the major reported epidemic diseases in different parts of Ethiopia. The occurrence of LSD in different regions of Ethiopia is shown in Table 1. Its transmission from infected to healthy animal is high, as a result it mostly occurs as an outbreak. Because of lack of information in disease occurred in one area its epidemic capability is significant. The epizootic characteristics of this disease has close association with climatic condition like heavy rains [22].

Table 1 occurrence of Lumpy skin disease

Zone	Years of reported outbreaks 2007	2008	2009	2010	2011
Addis Ababa			3	7	1
Afar			3	2	2
Amhara	92	68	35	40	22
Ben. Gumuz	3				5
Gambela				1	9
Oromiya	95	154	219	286	160
SNNP	18	18	14	32	17
Somali			3	9	4
Tigray	7	8	2	18	13

There are other common skin disease mainly reported in different parts of Ethiopia due to their consequences [19, 20, 21, 39]. Table 2 shows the most common skin disease in Ethiopia.

Table 2 most common skin diseases

NO	Location	Skin disease
1	Hawassa	LSD, Ringworm, Acariasus, Pediculosis, Dermatophilosos
2	Ambo	Wart, Ticks, Lice, Mange mites, Dermatophilosos, Photsentization, Branding
3	Gondar	LSD, Tick, Lice, Dermatophilosos, Mange
4	Adama	Ticks, Pediculosis, Demodicosis and Dermatophilosis
5	Bure	LSD, Pediculosis
6	Tigray(Tsegede,Welkayte, Kafta-Humera)	LSD, Lice, Tick, mange, mite

Lumpy skin disease (LSD): is an infectious, eruptive, occasionally fatal disease of cattle caused by a virus of the family Poxviridae [41]. As shown in Figure 2.1, it is characterized by nodules on the skin and other parts of the body. The nodules are well circumscribed, round, slightly raised, firm, and painful. The virus has important economic implications since affected animals tend to have permanent damage to their skin, lowering the commercial value of their hide. Additionally, the disease often results in reduced milk production, poor growth, infertility, abortion, and sometimes death. The skin nodules contain a firm, creamy-gray or yellow mass of tissue [42].

In Ethiopia, LSD was first observed in 1983 in the north-western part of the country (south-west of Lake Tana) [46]. The disease has now spread to almost all of the country. Because of the wide distribution of the disease and the size and structure of the cattle population in Ethiopia, it is likely that LSD is one of the most economically important livestock diseases in the country [46].

The control of LSD can be achieved through vaccination, restriction of animal movement and eradication of infected and exposed animals. However, this requires adequate financial, infrastructural and human resources, and information systems. Under the prevailing conditions in Ethiopia it has not been possible to implement all these strategies and thus vaccination has been adopted as the most important practical approach to LSD control for many years [22].

Figure 1 Cattle infected by LSD

Bovine Papillomatosis (Warts): are caused by an infectious and contagious virus (bovine papilloma virus, BPV) that spreads via contact from infected cattle to non-infected cattle [42]. It is a contagious neoplastic viral disease of animals characterized by the presence of multiple skin tumors or growths particularly, on head and neck areas. Although it regresses spontaneously, some cases may take a prolonged period and/or extended to malignant form. It can be exhibited as benign nodular lesions, fingerlike projections or cauliflower-like small growths on the skin arising from stratified squamous epithelium that may appear solitary or in multiples. The common sites for the development of cutaneous warts are head, eyelids, ears, neck, dewlap, brisket, shoulders and legs, occasionally on the back, para-genital region and along the lower line of the abdomen. Warts may be congenital or acquired. They are viral in origin and tend to be Species-Specific and to be most common in young animals. Young cows in winter are frequently affected in the skin of the eyelids and along the lower line of the abdomen, but the growths often drop off spontaneously from these positions when the young animals are turned out to grass in the early spring [41]. The symptoms shown when cattle is affected by Wart is shown in Figure 2

Warts are the most common tumors affecting cattle, with most cases seen on the head and dewlap between 6 and 24 months of age. The causal virus can be spread by physical contact or equipment such as halters or milking machine. Lesions vary from flat, wide based warts to cauliflower-like growths. Extensive growths that fail to resolve may be seen in immune suppressed animals (e.g. persistent BVDV infection).

Figure 2 Cattle infected by Wart

Dermatophytosis (Ringworm): is a transmissible infectious skin disease caused by Trichophyton verrucosum, a spore forming fungi [41]. Ringworm is a fungal infection of the skin with a worldwide distribution. The disease has significant economic consequence to the farmer since growth rates are affected in the active stage of infection and the disease causes hide damage. Ringworm is common in young stock and is readily transmitted to humans (zoonosis). The symptoms of Ringworm as shown in Figure 3, is greyish lesions which are slightly raised, well-circumscribed, and more common on the head and neck but may extend over much of the body. In calves most commonly found around eyes, on ears and on back, in adult cattle chest and legs more common [42].

Figure 3 Cattle infected by Ringworm

Skin Disease Diagnosis Techniques

Veterinary disease diagnosis relies on knowledge of Anatomy, Physiology, Pathology and Animal behavior, skills in the methods and techniques of clinical examination, clinical sign and pathogenesis of the diseases [24].

Disease problems in veterinary medicine are presented to the clinician through the medium of the owner's complaint, which is a request for professional assistance by giving the infected animal information. Cattle health experts use symptoms and signs as clues that can help determine the most likely diagnosis when illness is present. In order to make a good diagnosis the doctor will go through a process that involves several steps, allowing them to gather as much information as possible. The steps of the diagnostic process fall into three broad categories. The first step is Initial Diagnostic Assessment, which the expert gather information which is relevant to diagnosis the cattle infected. The causes of various skin diseases requires a detailed history, because many skin diseases that look similar are differentiated based on interpreting clinical signs and historical patterns. A complete general history including information about prior illnesses, vaccinations, husbandry (housing, feeding practices, etc.), changes in attitude and food consumption, exposure to other animals must be obtained. The second step is diagnostic Testing, performance, interpretation, and communication of test results. Finally referral, consultation, treatment & follow-up, Physician follow-up, referrals and consults will be given based on the diagnosis result.

Clinical skin disease investigations are conducted by examination of the skin of each animal through visual inspection and palpation. The kind of symptoms shown when cattle are diagnosed with skin disease is lusterless dry brittle hair, hair loss, flaking skin, rough hair coat, matted hairs, a ring-like lesion on the skin, and crust wound on the skin, etc. In our study, we include disease which is enough to be diagnosed by shown

symptoms and signs which can be captured by a camera. Palpation is a method of examination in which the examiner feels the size, shape, firmness or location of something (of body parts when the examiner is a health professional). So, for the inspection method we use image analysis techniques and for the palpation, we use text information.

Digital Image Processing

Image

Image is defined as a two-dimensional function, f(x, y), where x and y are spatial coordinates, and the amplitude at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point. When x, y, and the amplitude values of f are all finite, discrete quantities, the image is called a digital image [5]. Digital image composed of a finite number of elements, each of which has a particular location and value. These elements are referred to as picture elements (pixels).

There are two important ways to represent f(x, y). The first way is a plot of the function, with two axes determining spatial location and the third axis being the values of f which are also known as intensities as a function of the two spatial variables x and y, as shown below in Figure 4

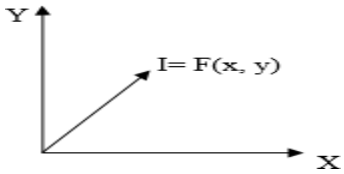

Figure 4 representation of image using coordinates

This representation is useful when working with sets whose elements are expressed as triplets of the form (x, y, z), where x and y are spatial coordinates and z is the value of f at coordinates (x, y). However, complex images generally are too detailed and difficult to interpret from such plots and need other representation. The second representation is displaying the numerical values of f(x, y) as an array called matrix with the representation of an M x N as shown in the Figure 5.

$$f(x,y) = \begin{bmatrix} f(0,0) & f(0,1) & \dots & f(0,N-1) \\ f(1,0) & f(1,1) & \dots & f(1,N-1) \\ . & . & & . \\ . & . & & . \\ . & . & & . \\ f(M-1,0) & f(M-1,1) & \dots & f(M-1,N-1) \end{bmatrix}$$

Figure 5 representation of image using matrix

In this representation, the origin of the image is at the top left. Moreover, the positive x-axis extends downward and the positive y-axis extends to the right. This is a conventional representation based on the fact that many image displays, like TV monitors, sweep an image starting at the top left and moving to the right one row at a time [6].

Digital image processing (DIP) is manipulation of digital images using computers. DIP focuses on developing a computer system that is able to perform processing on an image [5]. DIP have very wide applications in medical diagnosis, remote sensing, transmission and encoding, Machine/Robot vision, pattern recognition etc. [6].

DIP has been extensively used in various (human, animal, plant) disease diagnosis approaches and assisting experts to select the right treatment. It can either be used to recognize the symptoms of a disease on the skin or even in the molecular analysis using microscope images that display the anatomy of the tissues [40].

Digital Image processing can be seen in three levels. These levels are termed as low, mid, and high level processes. Low level processes involve primitive operations such as image preprocessing to reduce noise, contrast enhancement, and image sharpening. A low level process is characterized by the fact that both its inputs and outputs are images. Mid-level processing involves tasks such as segmentation. Unlike low level processing, in mid-level its inputs are images, but its outputs

are attributes extracted from those images. High level processing involves making sense of a group of recognized objects like classification, tracking etc. [6].

1.8.2.Steps of Digital Image Processing

Basically different image processing applications may follow different steps. However, the fundamental steps that every image processing applications pass through are shown in Figure 6.

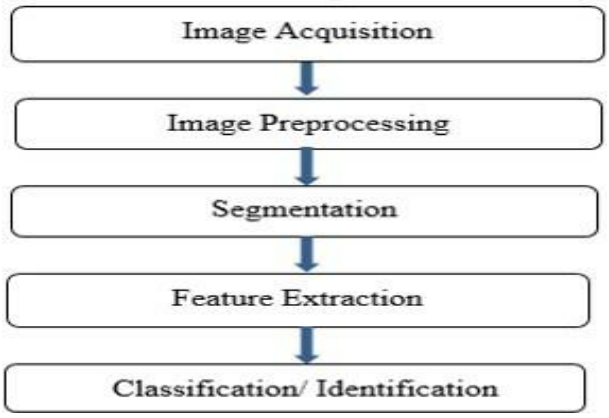

Figure 6 fundamental steps of DIP

DESIGN OF IMAGE BASED CATTLE DISEASE DIAGNOSIS APPROACH

Disease diagnosis is the major and first step in treatment and prevention of diseases. Using image processing for disease diagnosis has been a wide area of research topics. we present our image-based cattle disease diagnosis (IBCDD) approach.

Image Analysis

The image analysis module is responsible for classifying the input image into its categories. The analysis starts with preprocessing the input images and stop when the classification result found. Figure 7 shows the architecture of the image analysis module.

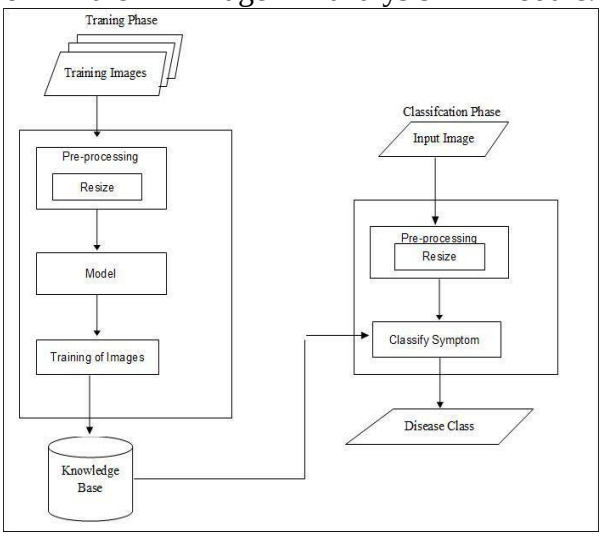

Figure 7 architecture of image analysis module

2.Dataset preparation

The process used for getting data ready for the classification model can be summarized in three steps: collect data, preprocess data and transform data. We follow this process in iterative with many loops to prepare the dataset required.

Step 1 is concerned with collecting available data needed to solve the problem. Image data is collected from D/m University, Addis Ababa veterinary school, Internet and other secondary sources. The step 2 is about getting the collected data into a form that can be easy to work. We follow formatting and cleaning steps to preprocess the data.

The formatting is about making the data selected in a format that is suitable for the work. The collected images are converted into JPEG format. JPEG format is selected because most of the collected images are in JPEG format and extraction of location information is possible with this format. The cleaning steps is about cleaning (correcting) missing data, unknown value. There are image data with unidentified labels, we remove image which we can't get the prober label for them.

In step 3 we transform the data collected. This steps is related to making the dataset suitable for the algorithm used and knowledge of the problem domain. In diagnosis we only need the part of the cattle which is infected or symptoms occurred. So,

we transform the collected image by cropping the area where symptoms are present. The original images are cropped into images containing symptoms regions. The cropping follow the following rules, constitute healthy and symptom part, isolated symptoms taken individually, widespread symptoms taken both as a whole and divided into regions. Below we are demonstrating the transformation steps we take for sample image Figure 8.

Figure 8 LSD infected cattle

After transformation based on the specified rules we transform the input images into Figure 5.2 several images. In addition to transform our data, this step also increase our dataset. The data we collect before and after transformation is shown in Table 3.

Figure 9 LSD image after transformation

Our model require large amount of labeled data. But getting enough data is a major problem in our cases which leads to use other techniques to expand our dataset. Data augmentation provides a means for increasing the quantity of training data available for machine learning, and is particularly relevant when training deep learning systems from scratch [61].

Table 3 collected data before and after transformation

No	Disease	Number of collected data	After Transformation
1	Lumpy skin disease (LSD)	84	146
2	Ringworm	57	100
3	Wart	64	124

In order to combat the high expense of collecting thousands of training images, image augmentation is used. Image Augmentation is the process of taking images that are in a training dataset and manipulating them to create many altered versions of the image. It provide more images to train and expose our classifier to a wider variety of transformed images to make the classifier more robust. It have been widely used on small datasets for combatting over-fitting [57, 62, 63].

Techniques of augmentation used in our dataset include horizontally and vertically flipping, zoom, shear and rotate. Figure 5.3 shows LSD infected cattle images after applying augmentation.

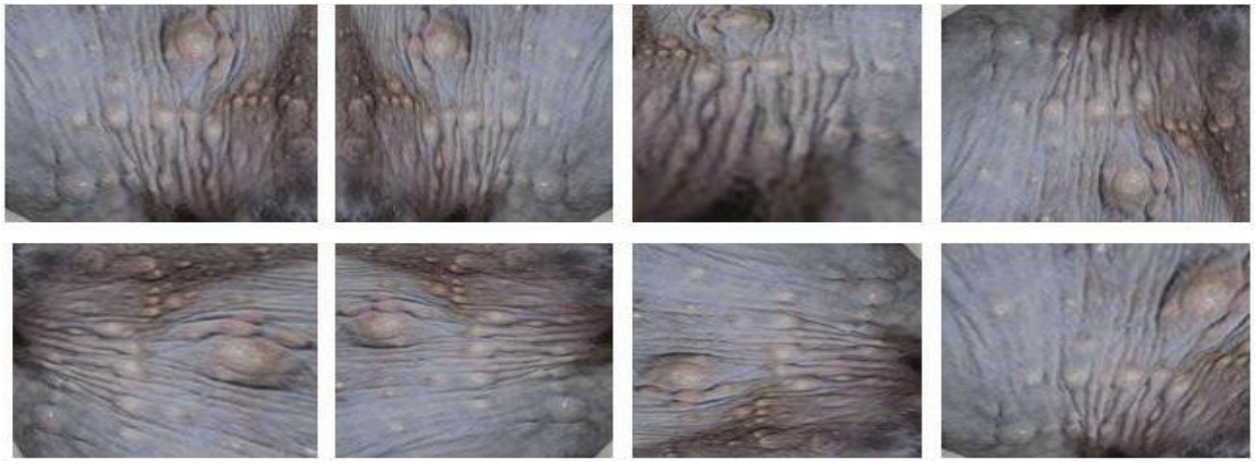

Figure 10 images after augmentation technique applied

After applying augmentation our dataset expand to 3990. From these images 90% of the dataset is used for training and 10% of the dataset is used for testing.

3.0.Development Environment

We use different development tools while developing the porotype. Java programming language with android development environment is used to work with user application. The expert system is also implemented by Java. The image analysis is done on Anaconda Keras. To bring the model to mobile environment we use TensorFlow. To augment image data we use Augmentor. Augmentor is a Python package made available under the terms of the MIT license. The package emphasis on providing operations that are typically used in the generation of image data for machine learning problems.

System evaluation

The accuracy of the system is affected by performance of the classification model, so evaluation is done on the model. We evaluate the performance of the classification model using deep learning evaluation techniques accuracy and confusion matrix. Then accuracy of entire system is evaluated with user evaluation.

The performance of the model will be poor either by overfitting or underfitting the data. The training of the model is plotted to see possibility of overfitting and underfitting in the model. Overfitting happens when a model learns the detail and noise in the training data to the extent that it negatively impacts the performance of the model on new data. When the training accuracy is above the test accuracy it means the model is overfitting. Our model is not overfitting as shown in the Figure 11. There is not significant difference between the value of training and test accuracy.

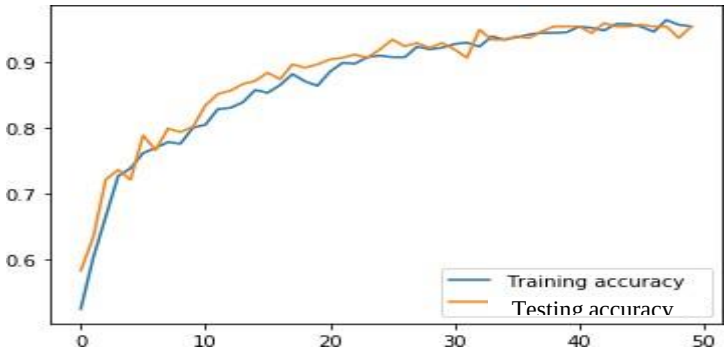

Figure 11 plot of training and testing accuracy

Underfitting refers to a model that can neither model the training data nor generalize to new data. When validation loss is below the training loss the model is underfitting. As shown in the figure our model is not underfitting.

The model achieve 95% accuracy in 50 epochs. Continuing the training above 50 epochs, the model try to learn the data and the noise and the performance is not changing but overfitting happen.

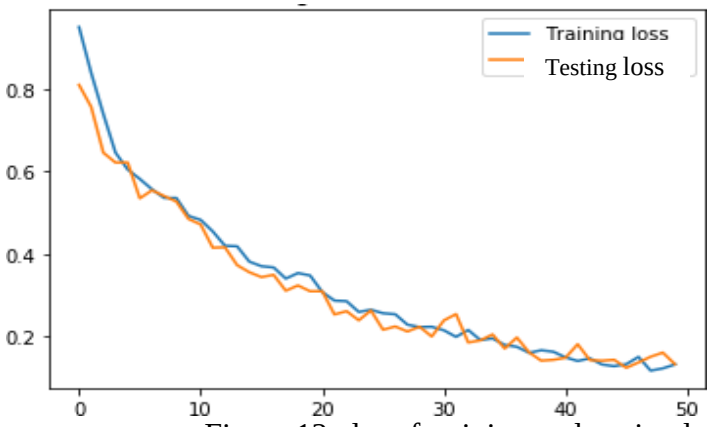

Figure 12 plot of training and testing loss

To summarize the performance of the model we use confusion matrix. In the confusion matrix the number of correct and incorrect predictions are summarized with count values and broken down by each class. Figure 12 shows how many of the images are misclassified and classified correctly.

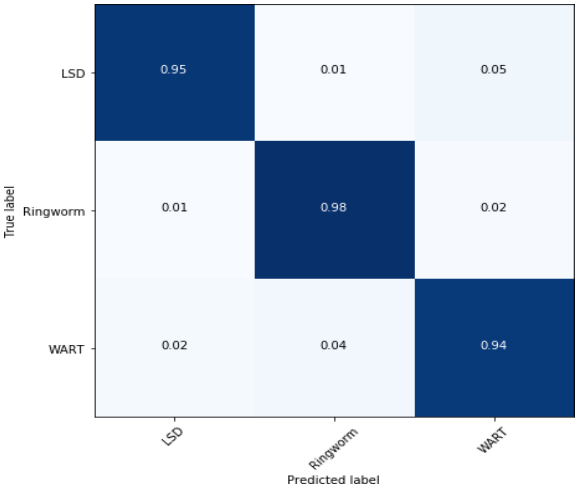

Figure 12 confusion matrix of the model

The ringworm classification is high compared to other, because it have easily distinctive feature from the other two class. The misclassification of LSD as Wart, Wart as LSD is noticed. Because LSD and ringworm have more similar symptoms which is sometimes difficult to distinguish distinctive feature among them.

The entire proposed system is evaluated by 4 people, we select randomly from different profession. 2 of them are veterinarians, and the rest are individuals who have cattle farming. The selection is based on the assumption that those with veterinary background can see and evaluate technical details while others may evaluate the applicability, accuracy and importance of the system. Before starting the evaluation process, the system was explained in detail to the evaluators. The questioner we use for system evaluation is shown in Appendix c where user puts the weight for each evaluation. Weight values shows the value of the evaluation, where 3 indicate the highest, 1 the lowest and 2 indicate medium.

Comparison with deep neural network

Comparison is done with deep neural networks using the same dataset and parameter with architectural difference in the model. The deep neural network consist five layers as our CNN model. The model achieve 71 % accuracy at 50 epochs.

The difference in the performance of the two models came with their architecture. The CNN convolutional layer extract feature which can represent the dataset effectively. In DNN the input is flattened to feed to the system and it lose spatial information about the pixels. Also DNN poor performance came because the model over fit the training data as shown in Figure 13.

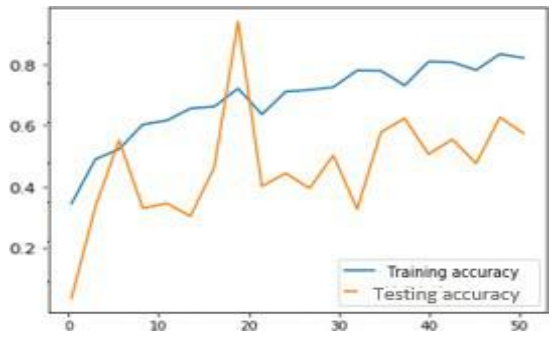

Figure 13 plot of DNN training and testing accuracy

Conclusion

Many works are done so far in the area of cattle disease diagnosis. Almost all of them consider the description of the symptom is text. Recently some works have been done to incorporate images as symptom descriptions in plant and human disease diagnosis. But they use manual feature extraction, which is not efficient because of human constraints, and imagination put when designing the feature extractor.

A diagnosis approach is proposed by integrating an expert system and image processing using deep learning models. Diagnosis starts by acquiring information on the occurred disease through image and text. Symptoms identified by inspection are acquired by capturing the image through mobile phones. Symptoms identified by palpation is presented to the system using text. To know the epidemic capability, location information is presented to the diagnosis system. Then image are preprocessed and class of the images is identified by the trained CNN model. The final diagnosis conclusion is drawn by the reasoner component of the expert system using image classification results, text and location information.

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ROLE OF LEADER'S EMOTIONAL INTELLIGENCE ON EMPLOYEE'S PERFORMANCE – A SYSTEMATIC REVIEW OF LITERATURE (1970S TO 2021)

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ABSTRACT

The main purpose of this research paper is to study the role of leader's emotional intelligence on employee's engagement, creativity and performance. This study is also attempting to develop a conceptual framework model based on various constructs such as factors influencing leader's emotional intelligence, utilization of emotions, regulation of emotions, determinants of leader's emotional intelligence, enhancement of employee performance and enhancement of employee performance after carrying out extensive related literature from 1970s to 2021 in the area of leaders emotional intelligence and its effectiveness towards employee performance. There are totally 60 research articles have been reviewed which includes keywords such as emotional intelligence, leadership qualities, employee engagement, employee creativity and employee performance. This study is based upon a systematic review of literature which is performed to identify the extant studies, based on which the findings as well as gaps in the literature are observed in the area of emotional intelligence, leadership qualities and employee performance. This study found that there is a significant influence created by leader's emotional intelligence on employee's engagement, creativity and performance. Subsequently, the study has also attempted to develop a conceptual framework model based on various variables such as factors influencing leader's emotional intelligence, utilization of emotions, regulation of emotions, determinants of leader's emotional intelligence, enhancement of employee performance through an extensive review of related literature.

Key Words: *Emotional Intelligence, Leaders, Employees, Engagement, Creativity & Performance*

Introduction

In the 21st century, the success of a business concern or business organization is measured by its constant growth. To achieve growth, it is necessary for an organization to satisfy its internal and external customers by providing high quality services. However, today's business scenario is more complex and dynamic in nature. In fact, there is enormous competition in the market; new high-tech players are entering the market to attract customers by offering them innovative products according to their needs, wants and desires. To withstand this competition, efficient use of corporate resources such as 4M (Men, Machines, Materials and Money) is required. Therefore, business organizations must plan for the future well in advance to compete with the competition. Among these 4 M's, the human resource plays a crucial role in the development of organizations or we can say that the organization which possesses the most relevant qualified human force can take up any challenge to achieve the organizational objectives of effective and efficient manner. In addition, after globalization, business organizations have the freedom to choose from the most qualified and talented men in the world. On the other hand, employee retention prevails for the same reason, as the huge opportunities for talented man power in the global marketplace are more of a concern for the modern day business managers. Therefore, it is very important to raise the key issue is to retain talent; there is a strong need for organizations to build impressive leadership. Because leaders play a vital role in creating the vision, mission of business organizations and psychologically influence employees to move towards the goal of the organization. Hence, developing potential leaders is a big challenge for business organizations in the modern day competition. Even now, there are high potential and experienced leaders who fail. Therefore, it is essential to understand the intelligence of the leader when facing

difficult situations with different people. To measure leader capacity, it is necessary to understand the relationships and coordination between leaders and their subordinates. Various researchers have conducted numerous studies on the influence of the leader on employee performance. The results of the studies predicted some of the dimensions of the relationship between leaders, followers or managers or subordinates. Emotional intelligence in an individual will positively affect their daily life. Likewise, emotional intelligence in a leader will have a positive impact on the workplace by increasing employee engagement and creativity, thereby increasing employee performance. However, it is necessary to integrate all of these multidimensional variables such as emotional intelligence, leadership qualities and employee performance to predict the association between them. Previous studies highlight the importance of emotional intelligence in terms of organizational success. It goes without saying that most of the study's results clearly show that emotional intelligence is positively correlated with performance, especially in organizations. There is a research gap that most studies focus on emotional intelligence in leaders and employees for organizational performance. There are few studies that have combined the effect of a leader's emotional intelligence with its impact on increasing employee performance. An in-depth analysis of the literature review made it possible to define the main dimensions of the influence of the leader's emotional intelligence on employee performance for this study design.

Review of Literature

This study mainly focuses on the three important aspects, namely emotional intelligence, leadership and employee performance. There are studies already conducted on this area of research related to emotional intelligence, leadership and employee performance and their relationships have been fully highlighted and discussed in this section below. The literature review has been classified and presented below.

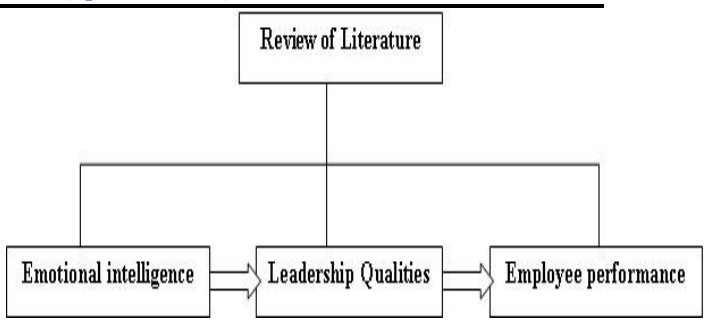

Figure 1. Literature Survey

Barton et al (1972) studied the relative importance of both ability as well as personality variables in predicting the academic achievement in an institute. Boyatzis (1982) assessed the performance of the organization's leaders, middle managers, and executives. According to the findings, samples with better relationship management skills perform better. Individual performance will also improve as a result of increased self-awareness among employees. Salovey and Mayer (1990) demonstrated that a person having the capacity to recognize the emotions and feelings of others will be the top performer by taking timely decisions and flexible with the environment even during crisis situation. The intellectual quotient (IQ) does not distinguish between performers on different scales, such as "stars" and other team members in the group, and that academic talent does not distinguish between performers. However, the study suggests that team members' interpersonal abilities might be used as a differentiator of performers (Kelley et al (1993).Daniel Goleman (1995) was a pioneer in the field of psychology, and he is credited with popularising the notion of EI. He calculated that emotional intelligence accounts for 66 percent of overall job performance and 85 percent of leadership job performance. He also demonstrated the traditional intelligence "IQ," which adds 20% to predicting life success. The author has made significant contributions to the field of emotional intelligence.

Bar On (1997) concentrates on the gender difference in terms of emotional intelligence has found that there are some distinctions in the emotional capacities but Goleman (1996) has found no differences in the gender. Cooper (1997) conducted the

study, which is concerned with the worker's emotional intelligence and job happiness. It has been discovered that employees with high levels of emotional intelligence have high levels of process satisfaction and employees with higher emotional intelligence are better able to expand approaches that are appropriate for unusual scenarios in order to overcome difficulties. In a large beverage company, McClelland (1998) evaluated the performance of personnel working in several segments. As a result, emotional intelligence has the potential to improve leadership quality and employee performance. Dulewicz and Higgs (2000) carried out a large survey on the writing of Emotional Intelligence and of course showed the effect of El on the performance of work from a research of 100 managers from a few associations out of seven years. They found clear corroboration to help consider enthusiastic knowledge aligns with the idea of skills that help administrators reach meaningful levels in their association. Aside from IQ, El, and possibly associated character attributes, they also estimated a third arrangement of components that they called the management quotient and found that emotional intuition offers more advancement than IQ.Spector and Goh (2001) studied the role of emotions in work stress. It has been speculated that a person's ability to supervise and control their emotions (especially negative emotions) in the work environment will affect the outcome of stress. Wong and Law (2002): Performed an examination on an recruitment firm on 94 individuals has inferred that the individuals who are dynamic in giving emotional help to others in the work environment would in general have a mix of managerial obligation and a high self monitoring or high certain affectivity and conversely, when individuals were low in certain effect of self-monitoring they gave less emotional help to other people, regardless of the degree of managerial responsibility. The study further expressed that women are marginally better than men in perceiving emotions and have more noteworthy capacities in social and emotional intelligence, more noteworthy uncertainty about feelings and decisions, and less interaction on intellect.

Thomas et al (2003) evaluated the benefit of emotional intelligence in matrix organizations. The study found that understanding, perception and correct use of emotions helps to overcome the interpersonal challenges that persist in matrix organizations. Carmeli (2003), the study mentions that emotionally intelligent managers have a significant level of commitment to their profession, as well as a high level of emotional commitment to the organization for which they work. Lyons (2004) examined emotional intelligence and competency-based performance in crisis situations. The study results show mixed performance for emotional understanding and emotional management for both men and women. The cognitive assessments show the inversely proportional relationship for males and females. Mary Pat McEnrue (2007) examined the impact of the training experience-based leadership development program in improving emotional intelligence levels. The results suggest that the experience of training leadership development professionals differs depending on the location of the participants. Additionally, the study offers ways to measure the best candidates for the leadership development program in an organized manner. James and Arnold (2010) studied the importance of emotional intelligence in knowledge-based organizations and its development. The outcomes of the study reveal that knowledge-based organizations use emotional intelligence in leaders, which will benefit the development of the organization.

Mohamed Ali Azouzi and Anis Jarboui (2012) examined the emotional intelligence of leaders and its effect on increasing follower performance. The study revealed that emotional intelligence is the highly necessary skill for CEOs to raise awareness and move on to alternatives. In addition, the study highlights that emotional intelligence is an important skill to reduce conflict in an organization. Finally, the study suggests that emotional intelligence can be used as a measure to identify top performing managers. According to Ioan Pastor (2014), leaders with emotional intelligence will have

high professional performance and are very able to control their emotions and are flexible to make decisions when needed. Gunu (2014) assessed the impact of emotional intelligence on employee performance and organizational engagement on workers at the Dangote plant. The result of the study reveals that there is a strong relationship between the emotional intelligence of the employee and his organizational commitment. Thus, employees with high emotional intelligence are more engaged in their work. Erkut Altindag et al (2015) study aimed to compare the relationship between emotional intelligence of managers and innovative company culture and employee performance. The study results reveal that there is a strong relationship between the emotional intelligence and the employee performance. In addition, the study shows that innovative cultures such as employee participation in decision-making, creation and sharing of new ideas and even more flexible working conditions will also have a positive and strong relationship with the performance of employees. Su Juan Zhang et al., (2015) examined the effect of emotional intelligence on the variety of conflict management practices and innovation in an organization. The study result explains that emotional intelligence has a positive association with different styles of conflict management such as integration, domination and compromise in the construction industry. And the integrative conflict management style has a positive association with innovative performance among construction workers.Zhidong Li et al., (2015) examined the effect of emotional intelligence on leadership styles and their preferences. The results of the study reveal that the influence of a leader's emotional intelligence is at the micro level in determining leadership style. The results of a major study indicate that emotional intelligence has a positive relationship with the leaders they support before pressure. The study by Asilaza Noel (2016) demonstrated the effect of emotional intelligence on the performance of private sector employees at Kinyara Sugar Limited. The results of the study suggest that constructs of emotional intelligence such as self-awareness and self-management have a positive relationship with employee performance.

Rabindra Kumar Pradhan et al., (2016) examined the impact of emotional intelligence on organizational learning and adaptive performance of manufacturing industries in India. The results of the study reveal that executives with a high level of emotional intelligence have a significant relationship with organizational learning and adaptive performance. Bassem E et al., (2016) studied the impact of EI on different leadership styles and employee performance. The study proposes a model that finds the mediating effect of emotional intelligence on various leadership styles and employee psychology. The results of the study reveal that there is a positive relationship between emotionally intelligent leaders and the leadership style adopted and employees' perception of the organization at different levels. Chao Miao et al (2017) studied the effect of emotional intelligence and its mediating effect on work resources and moderators. This study revealed that there is a strong relationship between the EI and work fulfillment is mediated by work resources. Priyam Dhani et al (2017) mainly focused on gender differences and level of performance based on emotional intelligence in the IT industry. The result of the study shows that women have more emotional intelligence than men in the IT industry. Ragini Gupta et al (2017), the study proposed the integrated framework to understand leader's emotional intelligence and its impact on employee creativity and performance. The study reveals that creativity of the employee increases depends on the psychological climate and the leadership quality. Muhammad Munir et al (2017) studied the relationship between emotional intelligence and employee performance. The study noted that after the completion of training and coaching, there is a significant increase in employee performance after their increased level of emotional intelligence emancipation.

Al Ghazo and Suifan et al., (2018) examined the effect of emotional intelligence and counterproductive work conduct through the intercessory function of the authoritarian

atmosphere among 304 regulatory representatives working in nine colleges private in Jordan. The result showed that there is a huge effect on the link between emotional intelligence and the conduct of counterproductive work. Hopkins and Deepa (2018) examined the fundamental links between emotional intelligence (EI) and ethical decision making (EDM) among 100 MBA students in the United States and India. The aftereffects of multiple relapse investigations uncovered that there is a connection between in general enthusiastic insight and their moral judgments. Age was an extra noteworthy factor for Emotional Intelligence (EI) and Ethical Decision Making (EDM).Basha and Devi et al., (2018) examined the emotional intelligence of 140 representatives of the commodity industry, Bangalore. The results revealed that emotional intelligence plays a key role in the workforce and enables representatives to understand how to control their feelings and emotions and assists in strengthening hierarchical commitment, increasing performance, profitability, maintain loyalty.

Lone and Lone (2018) studied the link between emotional intelligence and leadership in 230 supervisors and subordinates in the banking industry. The result revealed that emotional competence and emotional sensitivity are a notable precursor to effective leadership in the non-western environment. Deybbi Cuellar Molina et al., (2018) studied the association between decisions made by human resource managers with emotional intelligence and the performance of small and medium enterprises (SMEs). The results of the study reveal that there is a strong association between the decisions that HR's emotional intelligence makes with the company's bottom line and the generation of valuable HR practices. Neuza Ribeiro (2018) assessed the merits of transformational leadership and its impact on employee performance with the influences of mediation on emotional engagement. The results of the study corroborate the results of previous research, as transformational leadership has a positive influence on the emotional engagement of employees in order to increase dependent individual performance.

Shalini Srivastava et al., (2019) assessed the association linking employee silence and burnout, as well as emotional intelligence (EI) likely mediating task on affiliation with silence exhaustion. The results of the study suggest that there is a significant link between burnout and employee silence as long as there is a mediating role on the part of emotional intelligence. Wencang Zhou et al., (2020) investigated the importance of team coordination in organizational decision making and the influence of emotional intelligence on emotional team decisions. The results of the study indicate that there is a relationship between individual emotional intelligence and team decision-making performance. Raman, Peng and Chi. (2020)examined the academic leaders' emotional intelligence influences on subordinates perform. The results revealed that academic leaders' emotional intelligence influences subordinates intention to perform. Ding & EnhaiYu (2021) assessed the relationship between followers' strengths-based leadership (FSBL) and followers' strengths use (FSU) and the meditational effect of trait emotional intelligence (TEI). The outcomes showcased that FSBL has a positive relationship with FSU, and TEI significantly mediates the relationship between FSBL and FSU. Emelia Danquah (2021) study examined the influence of emotional intelligence and work engagement in clinical leaders. The outcomes of the results showcased that emotional intelligence makes a positive influence on work engagement in clinical leaders working in emergency departments.

It can be inferred from the comprehensive literature review that the constructs chosen for the study, namely leadership, emotional intelligence and employee performance are very large in nature and have remained among academia and intellectuals as issues of constant and ongoing analysis. Many renowned researchers such as Bass (1990) and Yuki (1994) argue that the leadership is the single most important factor for an organizations

success and failure. Especially in today's competitive business climate, the leader's emotional intelligence skills are important for success. Emotional Intelligence provides a framework for recognizing the role of emotions in enhancing the performance of the job. Emotionally smart leaders are balanced and regulated by their emotions and actions and are more emotionally driven to help them conduct their duties more confidently and in a relaxed manner without losing self-control. Highly emotionally intelligent leaders are often empathic to others, high in social skills and strong in relationship management, which allows them to establish successful interpersonal relationships inside and outside the organization and enables them to handle and resolve organizational disputes and issues effectively without being much affected. Therefore, a high degree of emotional intelligence in leaders helps to differentiate and increase the understanding of self and others during crisis situation. The main aim of the literature review was to identify and collect past research studies on leader's emotional intelligence and employee performance for the further understanding. Based on the above literatures reviewed, the study attempted to develop a conceptual framework model relating to the emotional intelligence of leader's influence on employee's performance.

Research Methodology

This study uses the existing literature and their results to develop a model of a conceptual framework related to the emotional intelligence of leaders and its effectiveness against employee performance. The study uses secondary data collected from various sources such as Research Gate, Google Scholar, Scopus, ABDC and Web of Science. No limitation to the period or duration of the previous study conducted includes from the year 1970s to 2021. Beyond that, we have included all studies that primarily use primary data for their analysis. Conference proceedings, review articles and the type of case studies of the work have been excluded from the critical part. The data extracted from the literature survey includes the country, organization, issues and challenges addressed in the previous study as well as the relationship between key variables such as emotional intelligence, leadership skills, and employee performance. Additionally, the tailored strategy for resolving workplace conflicts between different hierarchies in an organizational setup was captured using the bibliographic survey method. A total of 60 research articles were reviewed, including emotional intelligence, leadership qualities, employee creativity, employee engagement, and employee performance. The present study has linked the methodology adopted in the data collection, the tools used in the analysis, and an important result, suggestions and recommendations of previous studies were taken to achieve this goal. The study also develops a model conceptual framework using findings, suggestions and recommendations from previous studies.

Major Findings

After the in-depth examination of the related literature on influence of the leader's emotional intelligence on employee performance, the present study selects key variables based on the following studies to frame a conceptual model.

Influence of Leaders' Emotional Intelligence on Employees' Engagement

The relationship between leadership emotional intelligence and employee engagement can be clarified through the JD-R model. It is argued, in line with the JD-R model, that subordinates should view their emotionally intelligent leaders as a professional asset that motivates them to achieve their goals and demonstrate greater commitment. The model establishes that any organization is interconnected with job requirements and workforce resources. The demands of the job include the physical and mental capacities required by the employees while the resources of the job relate to the positive approach and support of the supervision to achieve the goal and also act as a shield against the negative forces erect due to the demands of the job (Bakker & Demerouti, (2007); Bakker & Schaufeli (2001) and Rich & Lepine (2010)). The

extensive study carried to find the relationship between the leader's emotional intelligence and the employee engagement proves there is a significant positive association.

Effect of Leaders' Emotional Intelligence on Employees' Creativity

The relationship of emotional intelligence of leaders with employee creativity can be extrapolated from the principle of expansion and construction. This theory suggests that cognitive changes occur when a person experiences positive emotions and their cognitive and emotional resources increase, encouraging them to seek out original ideas (Stringer, 2006). Since leaders with a higher emotional intelligence have the ability to correctly perceive and consider the triggers and effects of their subordinates' emotions, they use this ability to modify negative emotions of their subordinates and promote positive emotions at work (Wong& Law, 2002).Based on the theory of broaden and build, it is argued that emotionally intelligent leaders stimulate positive emotions because they have the power to turn negative emotions of their subordinates into positive emotions at work, resulting in more innovative ideas or solutions from their subordinates. While few empirical studies have been conducted to examine the relationship between executive emotional intelligence and employee creativity, the results showed that manager emotional intelligence and employee creativity are positively correlated.

Relationship between Leaders' Emotional Intelligence and Leader Member Exchange

From the theory of social exchange, the relationship of leadership emotional intelligence with Leader Member Exchange can be defined. The theory suggests that reciprocity underlies the relationship between two parties, so that when people are treated positively by others, it gives them a sense of responsibility to return in a positive and positive way (Blau, 1964). Previous emotional intelligence literature indicates that senior emotional intelligence leaders participate in the development of successful interpersonal relationships with their subordinates because they are better able to communicate knowledge, promote trust, and manage conflict in ways harmonious (George, (2000); Goleman, (1995) and Smith, (2006)). Although there is a lack of longitudinal research examining the links between Emotional Intelligence and Leader Member Exchange of leaders, there is evidence for a positive relationship.

Impact of Leaders' Emotional Intelligence on Employees' Performance

Many researchers have identified performance in several ways, but the result is the performance of a common consensus. Employee performance illustrates individual habits that contribute to the achievement of organizational goals. Employee performance is also what a staff member does in the workplace scenario. It is widely recognized that companies need and respect high performing staff, and these high performing individuals are seen as a valuable asset to the business. (Babin and Boles, (1996); Bhuian and Mengue, (2002); Rouge et al., (2006); Yang, (2010); Yucle and Bektas, (2012)). To achieve their goals, deliver exemplary programs, and ultimately gain a competitive advantage, businesses need high performing people. Unlike other variables, outstanding human resources are the strength of an organization and good job performance is important for the complex business climate (Lowler, 1996).

Conceptual Framework Model of Leader's Emotional Intelligence on Employee's Performance

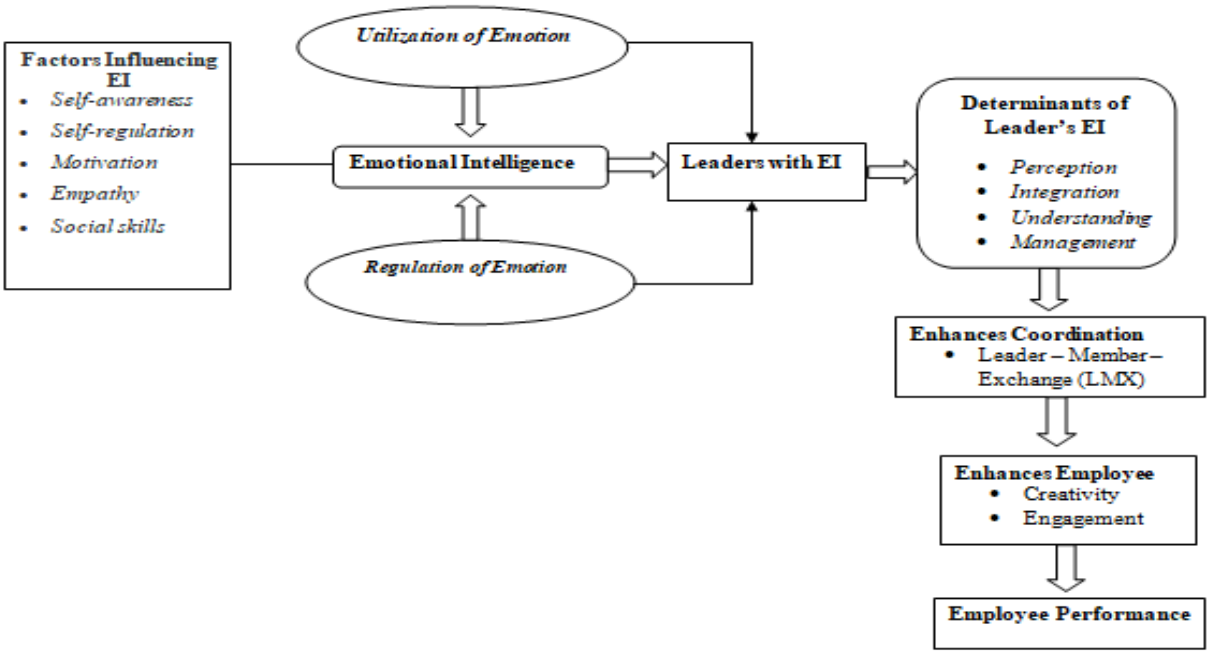

Figure 2. Conceptual Framework Model of Leader's Emotional Intelligence on Employee's Performance

Conclusion

The primary objective of this conceptual research is to study the role of leader's emotional intelligence on employee's engagement, creativity and performance. This study is also attempted to develop a conceptual framework model based various constructs such as factors inducing leader's emotional intelligence on employee's engagement, creativity and performance, after carrying out extensive related literature from 1970s to 2021 in the area of leaders emotional intelligence and its effectiveness towards employee performance. There are totally 60 research articles have been reviewed which includes keywords such as emotional intelligence, leadership qualities, employee engagement, employee creativity and employee performance. This study is based upon a systematic review of literature which is performed to identify the extant studies, based on which the findings as well as gaps in the literature are observed in the area of emotional intelligence, leadership qualities and employee performance. The study found that there is a significant influence created by leader's emotional intelligence on employee's engagement, creativity and performance. Subsequently, the study has also attempted to develop a conceptual framework model based on various variables such as factors influencing leader's emotional intelligence, utilization of emotions, regulation of emotions, determinants of leader's emotional intelligence, enhancement of employee performance through an extensive review of related literature.

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E-SEVA

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ABSTRACT

Collection of databases in the situation of management in an organization being an easy practical way where the employee with multi works being assigned to keep the track of databases. In case of Traffic cop's database management at the traffic spot it could be likely tedious. Here comes a traffic cop friendly app where the information of the both the traffic cop and public in a violation or emergency being tracked with security based databases. Especially these records information is being applied in a single app with application of online payment and Geo location tracking system in case of violators and emergency that's based on the situation happens at the traffic spot to the public. In this paper we conclude that the combination of both applications being used by traffic cop for violators and medical emergency will improve the need of use for high security data and protected payment transaction.

Keywords: *Database management GeoLocation Online payment.*

Introduction

The main purpose of the database storage is to store and retrieve information instantly at any time as it shows an evidence of any registration or compilation. Especially to the users in any organization which promote them as a forward gainer rather than having a manual databases and debug it. Hausser [1] and Lee [2][3] proposed the database semantics that makes use of DBMS. In this paper we studied with the aim of how to make auto payment transactions for those violators being registered by traffic cop and formulated better location tracker which more improve the quality of usage.

Traffic cop's daily process of data collection among the public will be dynamic and there will be no specific limits at the entry. They are needed to have a computational record to be proceed over their higher officials. This process of having an evidence at any moment promotes us to develop an app that contains multiple strategies for various deeds. Prof. Dhumal T.A1 , Miss. Deshmane V.U2 , Miss Jadhawar P.S3 , Miss.Mohite S.M4 , Miss.Chakor P.S5(2018) published the mobile app for traffic cop based on the above facts in the field of Android App.This way of computational tracking system which helps the traffic cop will create an awareness among public over the traffic rules and thereby save time for the cop.

Related work

Duties of Traffic Cop

Traffic officers are integral members of police departments, with a very specialized focus and are really responsible for making sure that the roads keep running to help police patrols manage all of the things that happen on the roads.Traffic officers are fully trained, sworn-in members of the police, but instead of dealing with crime, they are focused specifically on roads and the people on those roads. It's an important job. You may have noticed, but our roads are in pretty high demand. We use them a lot, so maintaining road safety and efficiency is kind of important to our daily lives.

Part of Traffic cop in E-SEVA application

In this E-SEVA PATROL AIDE application ,the main features of traffic cop is to check the public with rules and regulation which is followed by them or not .If not ,Traffic cop should make a record of their violations and issue an immediate fine ticket. By this Ticket, the public who violated the rules and regulations of Government can pay the fine amount too through online mode using this E-SEVA PATROLAIDE application which gets the strong security of payment method ensures the security of all the records.

Information security

The capital priority of E-SEVA PATROLAIDE application is to get connect with the end-users which is the Traffic cop to login and register which must be get security of all the user records which is registered in

the registration form and that connected with database.

User Login and Registration

The login page should be the first page that users see in the modified application. It should provide two text fields --one for entering a unique Id and one for entering a password. In addition it should have a command button that initiates the password checking action. If either of the text fields is left blank it is an error that must be reported to the user. If both fields are filled in but there is no record of the user name or the password is incorrect that must also be reported to the user.

Users that have not yet registered cannot log in. They must first register by clicking on the register command button. They should be able to do this without getting an error for an empty name or password field. All the data will stored in database.

Categories of E-SEVA

The application is categorized into

- Traffic Cop App

- Traffic Central Team

- Medical Rapid Force Team

Traffic cop App

Here, the traffic cop can register for the public who violated the rules and regulations of Government by adding the details of

- Register a Traffic Violations or Violators
- Violators Name
- Violation Type
- Driving License
- Vehicle Details – Car/Bike/Lorry/Register Number/Color/Taxi or Private Vehicle and so on.
- Data and Time
- Location – Geo location is preferred
- Repeated Offender
- Issue a Ticket
- Select a Violations created above, and issue a fine ticket
- Accept Payment – against fine
- Accept the payment via digital payments

Here the cop is demanded for padding the VIOLATION REGISTRATION FORM for the people who have violated the traffic code. This form is well adaptable to the situation where if a person or people offended the code of traffic there come the necessity to keep a record over them. It overcomes with details of vehicles and thus it requires a fine to be paid. The below Fig(4.1) shows the registration procedure for the violators.

Fig 4.1- Violators Registration Form

Succeeding the registration for emergency details such as

- Register an Emergency
- Register the location
- Type – accident, people who are in medical care
- Number of people affected
- Priority
- SOS - A button to get help from other fellow police men.

On hand the cop is in need to retort the EMERGENCY REGISTRATION FORM which is depicted below in the fig(4.2) ,in case of some people who have met an accident or emergency scenario for medi-care patients. This well customize the public under medicare where there is need of ambulance at spot by proving a geo location at the cop's region. It too tailors the unexpectable accidents occur in the traffic and it plays a major role by having a comprehensible evidence to the end users for reference.

Fig 4.2 – Emergency Registration Form

Traffic central team

Here, the application is to enable quick availability of information and details, thus enabling the concern team to co-ordinate & collaborate with related agencies. And also this enables the team to a quick and effective decision, rather than delaying due to missing information's. So that all the information get retrieved from the database and displaying data for further clarification .Making integration with other sub departments of security & public agencies such as RTO, Central Ambulance Service, and other investigating agencies.

Medical rapid force team

The Rapid force team can view the details in the dashboard by retrieving all details of emergency which is registered in emergency registration form for enabling the concern team to co- ordinate & collaborate with related agencies and send ambulance to the particular place.

Backend connectivity and database

These are some technological stuffs that we have implemented in this E-SEVA PATROLAIDE applications such as HTML, CSS, JAVASCRIPT as a frontend and PHP AND MYSQL connected with XAMPP SERVER for the backend and database connectivity.

Patrol Aid App

An app which narrates the cop's personal assistant and to delineate an accident to seek expeditious medical AID. PATROL AIDE rundown in a way where a traffic cop (specifies the end user) to have a friendly cop which steer's. The end users are cops, ambulance and medical departments where used to have a report sharing page that get them know quick information that occur at the traffic spot. This appis implemented using a flutter framework which is independent platform, where the apps used by flutter are written in dart language in advanced features and it is Google's UI toolkit for building impressive and natively compiled applications for mobile, web, desktop from a single codebase. Flutter widget's incorporate all critical platform difference such as scrolling navigation icons and fonts and the code is compiled into native ARM machine code Dart's native compiler. Dart is a client-optimized programming language for apps on multiple platforms. It is developed by Google and is used to build mobile, desktop, server, and web applications. Dart is an object-oriented, class-based, garbage-collected language with C-style syntax. Dart can compile to either native code or JavaScript. The fig(6.1)is manifested below the paragraph where the above contents technical works have be done.

Coming to the facts of backend it is developed using firebase authentication. The report home page shows the login and register options. Under the authentication site there available several methods to be sign in. We have enabled Email and password which quite required for this login. To improvise our app in future we expect to do more easy sign in through Google, Phone number and so on. This process of sign in will get stored in account automatically.

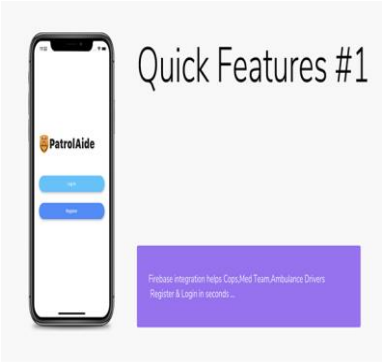

Fig 6.1- Quick Feature 1

At the page of report which is illustrated in the below fig(6.2) only specified user (cops and medical team) only can report the information where the sender and reporter mail address will be indicated to one other for more reference. The major improvised technology is the use of Stream which plays as a role of future object which reduces the time being spent with renovate the data in report. Cloud Fire Store which is one of the firebase features has been implemented at the backend. The reason for using Cloud Fire Store makes the data in the report be stored in a secured workspace with intelligible reference of specified sender's name with text.

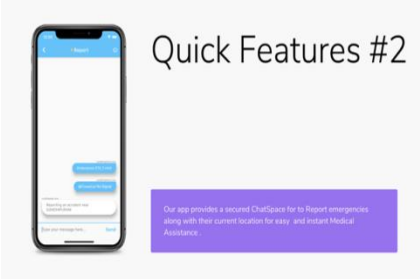

Fig 6.2- Quick Feature 2

The main feature that makes our app more usable and attractive is its User interface which is more adaptable at different platforms such that if the app is being demonstrated in iOS it converts it into Cupertino which is a material design language with imports of libraries. On the other hand its been well adaptable in android where the material UI is composed with it and in case web it adapts the features of HTML, CSS, JS though it runs natively on respective platforms. The below fig(6.3) exhibits the specifications of this app. This software application is cross platform where it works on multiple operating system or devices such as Windows, Mac OS, Android, iOS, Web.

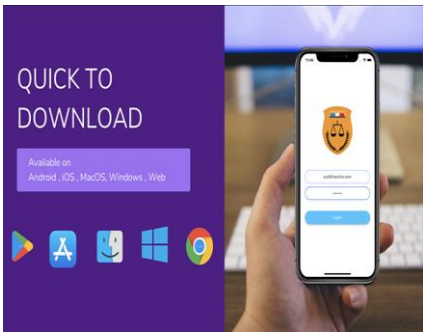

Fig 6.3- home page

At the home page in the part of reporting an icon with map symbol is made to know the live location of the sender which is specified with Google map API. It much makes the user more facile and beneficial for using this app.

Geo location

The current location of the user (traffic cop) is being tracked ,where the accident or any emergency being occurred at the location in traffic. Here the HTML GeoLocation API is applied to get the live location of the user, where the API key is needed as it is a unique identifier which authenticates requests while implementing the project. Hence there is a requirement of enabling the maps JavaScript API and Places API in the Google Cloud Platform for finding the current location.

There are some technical works involved in map project API where the user's location i.e the latitude and longitude is being fetched using HTML's GeoLocation API which is given to the navigator function of the MAP'S API package which translates the latitude and longitude points into a location coordinates and places it in the map. The below fig(7.1) reveals the live location page of the user both in windows and mobile. Thus a live position of the user is being tracked and hence it helps the cop and public in emergency situations.

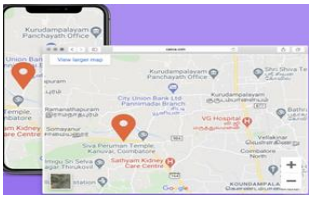

Fig 7.1 – Google Map API

Patrol Aid app for online payment

The violators under the fine of the traffic log will receive the mail and message within 24hrs along with the unique payment link comprised with due date which it automatically sync with personal calendar such as Google, Apple and so on which prevent and makes the violators easy consent for paying the fine within due date. Proceeding with the payment link the Traffic Violation Payment Port web page be shown with details of Traffic rules in India where each and every citizen must know to follow. This gives us a brief guide and correct pavement for the traffic clearance. For further verification and clarification of payment details there has been provided contact number and mail address and thereby included additional terms and conditions. The fig(8.1)conveys the payment portal view for the violators. This payment portal web app insists the violators to pay their required fine where the amount will be fixed static as per and further details of phone number, email id and Aadhar id will be required to proceed the payment.

Fig. 8.1

Succeeding with the payment process the choice under payment methods are required indicating the mode of transaction. Here provided different methods of transactions such as Net banking with various banks, cards, UPI/QR, wallet under Mobikwik, Freecharge, Jio Money, Airtel Money, PayZapp being available. Hence all features in advance are being added up in this portal which makes our app much better usage for transacting.

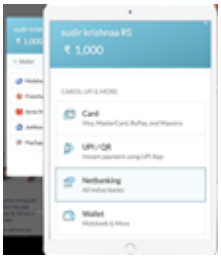

Fig. 8.2

After the successful payment is done using banking methods the violators will receive an instant message with the invoice copy and payment receipt attached in the form of pdf which can be downloaded for the future proof which is shown in the above fig(8.2). This payment portal is backed up with a secured payment gateway of Razor pay. By implementing the Payment Gateway proceed an easy add payments to our website and app with a seamless checkout experience.

Conclusion

Traffic cop app has become more accessible with its highly secured payment transaction automated with the registration and GPS locator being reached with multiple devices through wireless. This real time application developed features to help the traffic cops reduce their complexity in maintaining the records of the event. The well fitted report chart makes the app more cosy in the way they deliver the event. This is an effort to make possible solutions for the problems being recognized by the cop at the traffic peak. Hence this more be adaptable in a manifold crisis where its being a cross platform. Therefore enhanced penalties with refurbished, and conglomerated options stuffed in the online transaction process. In conclusion it enterprises with less complexity of time and untroubled with its rapid processes.

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FUZZY STATISTICAL SPATIOTEMPORAL ANALYSIS ON GROUND WATER SUPERVISION

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ABSTRACT

In recent years, the world is facing more natural disasters and there are various reasons behind it. Natural disasters such as earthquakes, tsunamis, and other geological processes are due to a great reduction in groundwater level. This decrease in groundwater level not only creates natural disaster but also it affects many agricultural-based countries like India, China, etc., to make their survival. More than three fourth of the earth's surface is covered by groundwater, but in recent days this level is gone down to an excessive level. This is what is alarming everyone. Fuzzy ***statistics*** *usually refers to a combination of fuzzy set theory the treatment of ambiguous, imprecise, or subjective data and traditional stats methods. The objective of this paper is to analyze the water table and water level using GWSDAT (Ground Water Spatiotemporal Data Analysis Tool) in a selective area. GWSDAT has been widely used in assessing groundwater conditions. The results of the analysis is been discussed and finally, suggestions to maintain and increase groundwater level are provided.*

Keywords: *Ground Water, GWSDAT, Fuzzy, Membership function and Spatiotemporal*

Introduction

Groundwater is placed in space above the soil beneath the surface. Groundwater is very important and more important to humans and human reliability. Two-thirds of the water was occupied by the planet, but it faced more water-based issues. In particular, countries focused on agriculture, such as India, China, etc. Water table level compression of the past ten years of water level evaluated by collecting and analyzing samples to track the groundwater level and check the consistency. The north-western areas of India are commonly known as the granary of the country, with states such as Haryana and Punjab accounting for a large proportion of the agricultural incomes and production of the Indian country. The agricultural farm income of the Indian country is not only shared by the north-western and eastern-southern regions. However, because of the runoff level of groundwater, agriculture in both of these areas is rapidly becoming unsustainable. Much of India's groundwater-stressed blocks account for both regions. Irrigation relies on various sources. More than 80 percent of the areas utilize Well Water Systems for Irrigation in southern India, such as Well Water Irrigation System, container Water Irrigation System, Flooding irrigation System, constant Canals Irrigation System, etc. In soils and sediments and the fractures of rock formations, groundwater is water found under the surface of the earth. In areas where the danger exists of pollution is high as well as for the safety of human being health and the atmosphere following the unintentional free of dangerous components, environmental monitoring of groundwater is regularly carried out. Groundwater monitoring techniques are structured to assess the existing status and assess patterns in ecological parameters and to allow the risk to human health and the environment to be measured. Decision making in agriculture is vulnerable to a number of human errors and biases, therefore, we assert to incorporate the use of fuzzy inferences in determining the exact decisions at demanding times. An expert system is a machine representation of a human expert at making decisions. Since, experts may differ on some aspects; therefore, we advocate the use of fuzzy numbers arithmetic in making out a safe decision under the clouds of uncertainty. Membership functions characterize fuzziness (i.e., all the information in fuzzy set), whether the elements in fuzzy sets are discrete or continuous. They can be defined as a technique to solve practical problems by experience rather than knowledge and are represented by graphical forms.

Groundwater is a key factor in reservoir bank landslides' creation, occurrence, and growth. Long-standing groundwater level Prediction is not just a long-term requirement for prediction. reservoir bank structural analysis prediction, however also the key to

ensuring the reservoir's safe operation. According to estimates, more than 90% of the damage caused by the rocky slopes and groundwater is associated with it, and 30 percent to 40 percent of the dam disaster damage from the flow of groundwater [1]. Understanding the hydrological cycle effects of irrigated agriculture is crucial for successful groundwater resource management and for encouraging more sustainable irrigated agriculture. Irrigated crop cultivation methods improve the composition of soil water and change the recharge rates of groundwater As surface water flood irrigation techniques are carried out on permeable soils, they are a major source of groundwater recharge and often the predominant one in arid terrains With dissolved salts concentrated in irrigation water and soil evapotranspiration and leached from leaky soils to groundwater as so-called 'irrigation return flow [2].

Human activity has significantly altered the planet's surface by altering land use and land cover and subsequently the associated hydrology. The global population has quadrupled in the last 100 years, from 170 crores (in 1900) to over 730 crores (in 2014), and is It is forecast to keep expanding dramatically in the years [3]. Changes in hydrological conditions, such as changes in temperatures and precipitation amid potential climate change, would have an adverse ground impact and groundwater supplies in lots of parts of the world. Dramatic shifts in surface flow regimes and drastic decreases in groundwater levels in many watersheds of that area have already been caused by increasing water withdrawals, also responding to the needs of a rapidly increasing population. Imitation and prediction of groundwater level (gl) fluctuations acting an important role in the efficient management of water supplies in this regard, thus allowing water authorities to better plan effective use of groundwater [4].

For the comparative analysis of the models, A monthly data collection consisting of hydrological and meteorological parameters (rainfall, temperature, evapotranspiration, and groundwater level) was used for 8 years between 2006 and 2014. These variables were used in various combinations for univariate and multivariate model analysis [5]. Groundwater recharge is a key part of the worldwide water balance, filling groundwater storage facilities around the world and thereby providing vast parts of the world's population with fresh water. Comparing groundwater recharge with groundwater usage and ecological water demand helps to distinguish between overused aquifer systems and aquifer systems that also allow for sustainable abstraction [6]. Groundwater recharge is one of the most difficult components to estimate in the water balance since complex spatial and temporal processes cannot be measured explicitly and are influenced. In general, models are needed to help stakeholders understand groundwater recharge, identify key processes, and affecting groundwater recharge rates, and advise sustainable water pathways [7]. In many regions across the globe, long-term over-exploitation and unsustainable practices have caused severe groundwater depletion and deterioration. This has caused several adverse effects on human populations and the natural environment. Many groundwater-related studies have bee-related studies to understand groundwater-related processes and explore ways to mitigate related problems. The research community has carried out large numbers of groundwater-related studies to understand groundwater-related processes and to explore ways to mitigate related problems. [8]. Groundwater spring potential mapping (GSPM), the method of identifying areas with a high likelihood of the existence of groundwater springs, may provide valuable information and expertise in relative safety and management programs, according to several scientists [9].

Groundwater is becoming more complicated to access in India

The height of the water table decreases within 10 meters below the sea, and this depth is the threshold away from which framers have to start using high deep water equipment, which leads to their privation. The percentage share of groundwater depth below

the surface between 1993 and 2001 is shown in the graph (Figure 1).

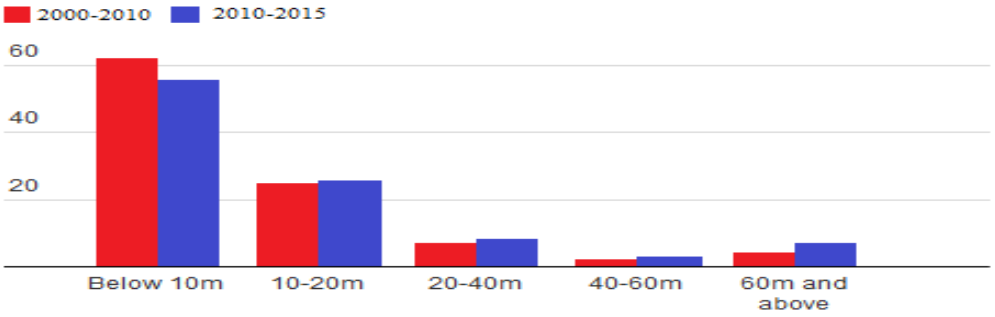
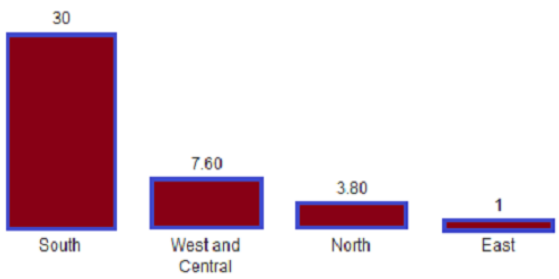


Figure 1: Groundwater deepness below the surface between 2010-2015.

The lower water table in different regions

The common nature of groundwater pools and the difficulty of directly observing them make it difficult to track and regulate this resource, especially in developing countries. Because of excessive production levels that surpass natural recharge rates, groundwater supplies are becoming exhausted. Groundwater irrigation covers over half of the total irrigated area in India. The following diagram shows a groundwater table lower than 60 meters below the ground (Figure 2).



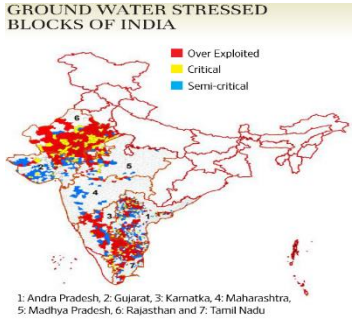


Figure 2 : Lower water table in different regions

Groundwater depletion in India worst in the world: NASA

Data from NASA's satellite Gravity Recovery and Climate Experiment (GRACE) shows that groundwater is steadily disappearing from the earth, with India among the worst affected. The Indus Basin aquifer of India and other countries, which is a resource of clean water for millions of people, is the second-most overstressed of the world's largest groundwater basins, Without natural replenishment to compensate for usage, two new studies conducted by the University of California-Irvine (UCI), using GRACE satellite statistics, said.

Dataset

Study Area

Tamil Nadu (India's State) is the more important agricultural area and providing more farm incomes. In Tamil Nadu, the Thiruvannamalai district is the agricultural-based area in southern India. Here, more than 80% of the people living based on agriculture. The Thiruvannamalai formers dependence on two Irrigations, 1. Well water irrigation system and 2. Canals Irrigation System. But most of the farmers are using a Well water Irrigation system. In Tiruvannamalai on the small village is Sanipoondi (Figure 3). This area formers are fully dependent on Well Water Irrigation. Past five to ten years most of the people are going to cities and outstations, only the reason is insufficient water for agriculture. The sanipoondi village map is shown below.

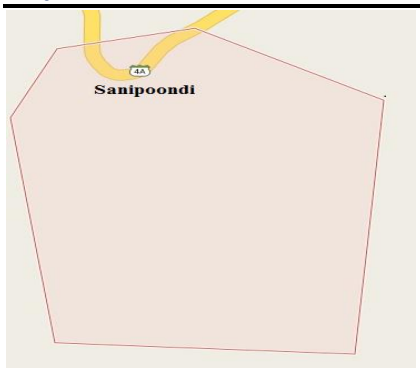


Figure 3 : Sanipoondi village map

Tables

I took this area for analyzing the water level and water table, and also what is the reason for reducing water table and water levels. I used Groundwater Spatiotemporal Data Analysis Tool (GWSDAT) for this research purpose. This tool is used for analysis of the groundwater level and monitor data (Table-1).

State: Tamil Nadu
District: Thiruvannamalai

Village: Sanipoondi Well No: MWS21622

Well Type: Bore Well Elevation: 131

Table 1. Potential factors used in this research

Monitoring Date	Water Level	Reduced Water Level
01-06-2010	2.5	128.5
02-04-2010	3.25	127.75
03-03-2010	4.5	126.5
04-07-2010	5.5	125.5
05-08-2010	5.15	125.85
06-04-2010	5.3	125.7
07-07-2010	4.9	126.1
08-04-2010	6.15	124.85
09-04-2010	6.2	124.8
10-07-2010	4.9	126.1
11-04-2010	2.8	128.2
12-04-2010	1.35	129.65
01-04-2011	1.85	129.15
02-01-2011	2.45	128.55
03-03-2011	3.3	127.7
04-04-2011	3.35	127.65
05-02-2011	2.7	128.3
06-01-2011	3.3	127.7
07-06-2011	3.5	127.5
08-05-2011	4.35	126.65
09-06-2011	3.8	127.2
10-03-2011	3.25	127.75
11-02-2011	2.5	128.5
12-02-2011	1.6	129.4
01-03-2012	1.5	129.5
02-02-2012	2.75	128.25
03-02-2012	3.5	127.5
04-03-2012	3.7	127.3

05-05-2012	6.1	124.9
06-05-2012	6.35	124.65
01-06-2010	2.5	128.5
02-04-2010	3.25	127.75
03-03-2010	4.5	126.5
04-07-2010	5.5	125.5
05-08-2010	5.15	125.85
06-04-2010	5.3	125.7
07-02-2012	6.35	124.65
08-06-2012	6.65	124.35
09-04-2012	6.8	124.2
10-06-2012	6.85	124.15
11-10-2012	3.9	127.1
12-05-2012	5.25	125.75
01-02-2013	5.5	125.5
02-04-2013	7	124
03-04-2013	7.8	123.2
04-05-2013	8.65	122.35
05-02-2013	9.45	121.55
06-08-2013	11.55	119.45
07-01-2013	11.7	119.3
08-02-2013	11.9	119.1
09-01-2013	8.5	122.5
10-01-2013	5.9	125.1
11-03-2013	4.2	126.8
12-05-2013	3.55	127.45
01-01-2014	3.65	127.35
02-01-2014	4.1	126.9
03-01-2014	4.4	126.6
04-01-2014	6.7	124.3
05-02-2014	8.6	122.4
06-02-2014	10.5	120.5
07-01-2014	9.45	121.55
08-02-2014	9.9	121.1
09-01-2014	9.3	121.7
10-01-2014	6.6	124.4
11-03-2014	4.75	126.25
12-01-2014	5	126

Input Details

Source work

A concise description of the existence of groundwater monitoring records needs to be provided before explaining the application of GWSDAT in added detail. In general, routine monitoring well sampling involves calculating the elevation of water level and taking a sample of groundwater that is then sent for laboratory analysis to determine the dissolved concentration of a set of solutes specified (e.g. Toluene, Benzene). If the attentiveness is considered lesser than what would be considered, It is graded as 'non-detect' using the procedure used by the laboratory. In such cases, the laboratory quotes the absorption value of the detection

threshold below which the solution could not be detected.

Input Data format

Groundwater management data is entered into GWSDAT using a simple Structured Microsoft Excel Entry Sheet. The following summarizes the GWSDAT input data format, however for a complete and thorough description of the GWSDAT input data specification, the reader is directed to the user handbook. Input template for GWSDAT example data. The data for historical monitoring The table collects data on concentration, levels of groundwater, and NAPL thickness, if there. The Well Coordinates Table stores the tracking well's place. On the top left, the GWSDAT includes a list of options is shown (Figure 4).

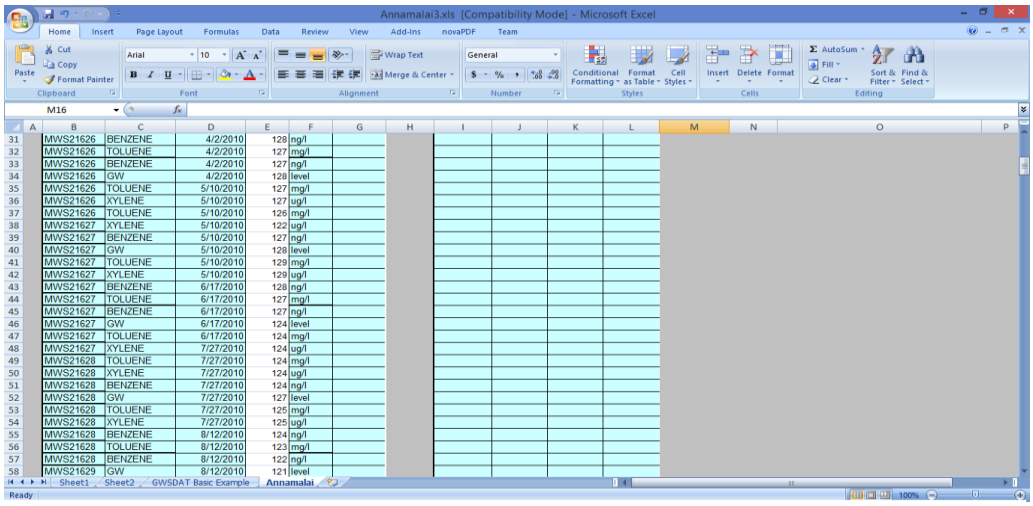


Figure 4 : GWSDAT example data input template

Data processing

The user is asked to select from a range of upon initiation of a GWSDAT study. Data processing options, including treatment of non-detects and NAPL, if they are present. The default alternative, in agreement with the general convention, is to alternate half of its detection limit for non-detected solvent concentration results. The user can pick the alternative for a more conservative decision, of replacement with the maximum limit of detection. The user is provoked to replace NAPL data points by way of utmost observed solution concentrations in the site dataset if NAPL is present.

User Graphical Interface

The effects of a GWSDATT for the sake of user-friendliness and efficiency. The GWSDAT user interface interrogates and interprets the analysis. The visual inspection of groundwater monitoring data requires a broad variety of unusual plots. The following parts explain in more detail the individual GWSDAT user interface components (Figure 5).

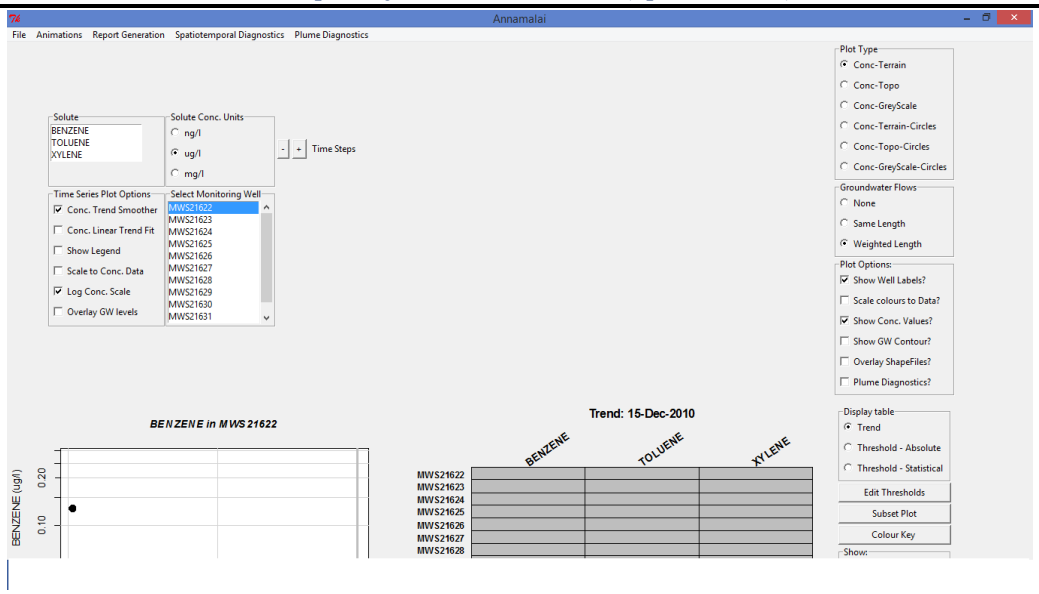


Figure 5: The GWSDAT graphical user interface

GWSDAT well trend plot

The black solid circle represents observed concentration values. A well trend plot helps the consumer to analyze patterns in solvent concentrations and groundwater level time series in individual wells. Using orange circles for non-detected data and black solid circles for detectable data, sampled concentration values are shown.

n

minimum u/v $\sum$ { x_i -u-v(y_i-y)} z(y_i-y,l)

i=1

Where a weight function with parameter l is w(yi - y; l). The weight function gives the most weight to the data points closest to the estimation point and the least weight to the most distant data points. GWSDAT uses a normally distributed probability density function with regular l-deviation for the weight function.

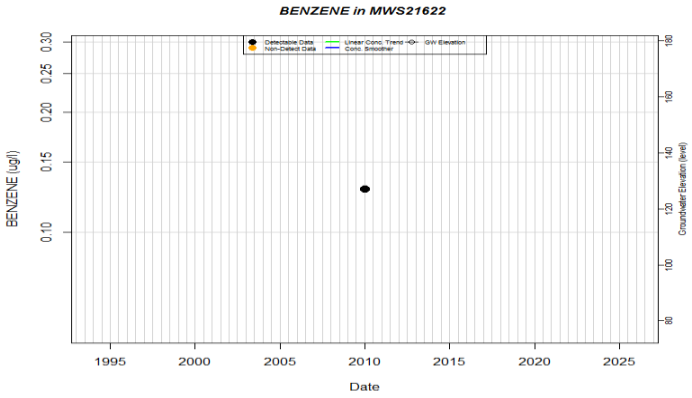


Figure 6: GWSDAT well trend plot

Spatiotemporal trend analysis

GWSDAT Well Report Plot Example. The key of color at the top each solvent is identified and name of the each well is shown at the top of each and the individual time sequence graphs in a banner. This obviously shows the connection between the various solutes in time series patterns. (Figure 7).

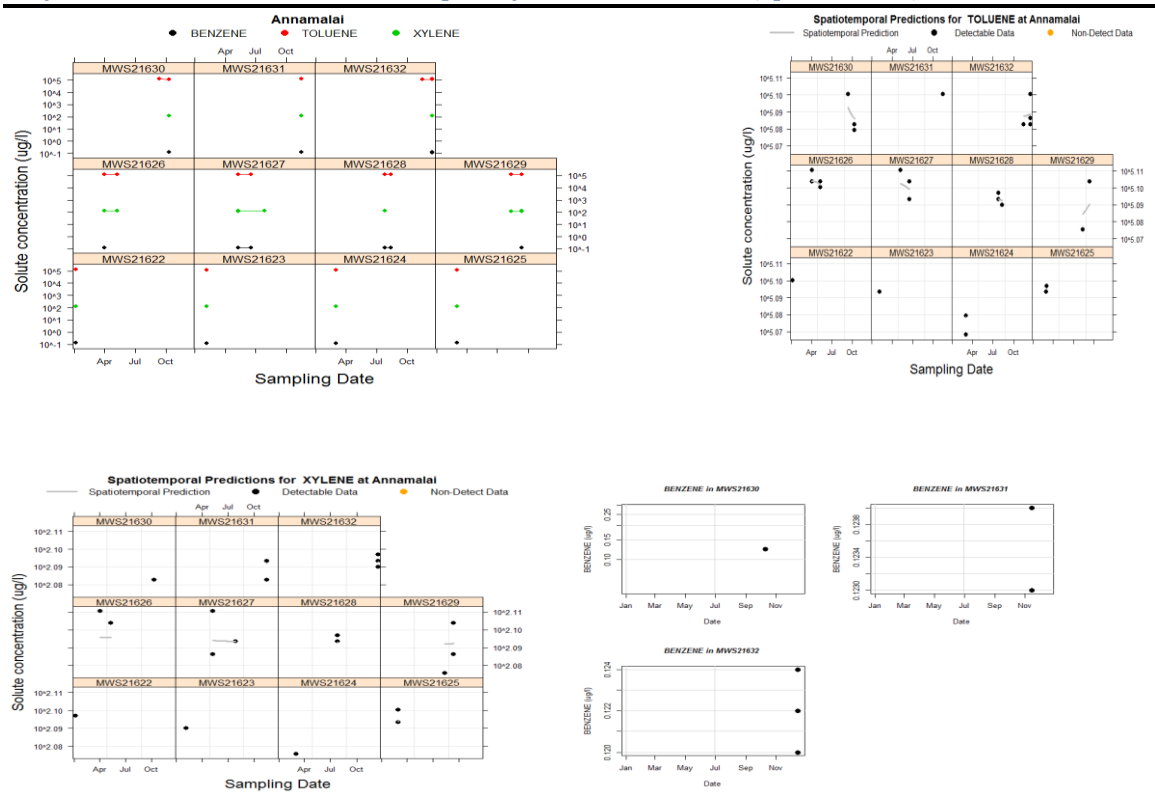


Figure 7 : Spatiotemporal trend analysis

Future work

Adding new capabilities to GWSDAT is the key field for future growth. At present, the evaluation of solvent plume stability is carried out by visually examining the evolution of smoother spatiotemporal solvent concentration. Over the monitoring period, the inspection of these amounts will more critically demonstrate whether the plume is moving and whether the plume is rising, shrinking, or stable. Future versions of GWSDAT can use standard errors of the spatiotemporal model to give the consumer a better understanding of the uncertainty and goodness of the model. The spatial distribution of standard errors of the model is of particular interest because it provides an evaluation of the nature of the network of well monitoring. There will be greater model norm errors for areas with low monitoring density. This not only tells the consumer that the forecasts in this field need to be carefully interpreted but also identifies possible locations where the installation of new monitoring wells will enhance a site's conceptual understanding and decision-making of the project.

Conclusion

The regional groundwater recharge annual time series was developed by averaging the estimates of groundwater recharge temporally for each year and spatially based on data from all available bores. These models were then produced to forecast the recharge of groundwater using the complete collection of impactful predictors. Under the three temporal models, the relative value of each predictor was calculated in predicting groundwater recharge. The findings clearly show the efficacy of the three models for the different ratios between trained data and expected data. There was also an evaluation of the relative importance of possible predictors associated with the observed variance in regional groundwater recharge. The data are analyzed using data prediction, to get more accurate results using concepts of image processing. The method studied in this

work gives more appropriate result when compared to the previous works. This study is new, when compared to the previous works done on the Ground water level. Applying the result of this work helps the farmers to the increase in their yield.

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THE EMPOWERMENT OF WOMEN, EDUCATION AND GENDER EQUALITY: AN INDIAN PERSPECTIVE

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ABSTRACT

This study is an attempt to study Gender equality in education. It highlights gender issues related to education. This paper will be relevant for further descriptive research. Equality on the basis of gender is fundamental right. Without it major share of population will be deprived education and opportunity to lead quality life. Equal access to education, while essential, does not guarantee gender equality. The frame of development of a democratic, social movements demand a gender equality perspective in all educational stages The assumption that there is a positive relationship between education and gender equality requires further empirical scrutiny. The study has also found that the Indian government has initiated several programs for women empowerment to ensure gender equality in education and society.

***Keywords**: Gender, Equality, Education, Women, Human rights, India*

Introduction

"PRAKRITI" the character, or 'The creator' itself may be a feminine word as per Indian philosophy. From sacred writing amount girls had high status, even in our scriptures too. however in real observe the standing of girls weren't satisfactory from medieval to fashionable Bharat, as well as country amount. girls direction in our gift society has become a major topic of debate with reference to development. The govt. of India is implementing variety of programmes, for rising access to employment, education, health, infrastructure development etc. a number of these ar flagship programmes like Gandhi National Rural Employment Guarantee theme, integrated kid Development theme, SarvaSikshaAbhiyanand National Rural Health Mission. It improves the position of girls in India (Hemanta Mudoi, 2020). Right to equality is fundamental human right so women should be treated equal to men. It is also an essence essential of democracy and desired for social justice. However, in present-day societies inequalities between women and men persist and it has been there since ages. This downside of difference exists within the academic field because it is there in political, economic, social, cultural and the other fields (Dahl, R. A., 1985). Within the academic field, each sexes still still target ancient gender roles that powerfully steer and cut back their decisions of education, occupation and life ideas, so reinforcing the male norms in society, the unequal power relationship of the sexes, the sex-segregation of the labour market, the sex-specific allocation of family responsibilities, the violence against ladies and girls. Within the last century, one in every of the foremost necessary problems rose in education is that the unfold of academic justice (Luzzio, C. M., 2020). With the enlargement of the women's role in social activities, sex and gender have turned into the foremost difficult field of the tutorial justice. In Iranian system, the Document on the Transformation in Iran's Education and within the international context, the 2030 Document area unit the outstanding documents within the field of academic justice (Anvar Yadollahi et al., 2019)

Objective of Study

This study is an attempt to study Gender equality in education and highlight issues related to it for further descriptive research

Methodology

The study is exploratory in nature based on secondary data.

Review of Literature

Millennium declaration known gender equality and ladies authorization united of the eight millennium development goals, that are

attempting to explore varied indicators related to gender transition, such as, education employment, property development, etc. Gender equality may be a right that entitles all persons regardless of their gender to measure with dignity and freedom. Also, women, United Nations agency area unit the dynamic transformers of society, impart valuable contributions to the sweetening of health conditions, academic status, productivity and be a precondition for the general development of the entire society that successively improves prospects for the longer term generation (Arya S.,2020).

Male ideas of gender and ethnic difference and male acts of violence recommend that the leveling method in various countries of Europe is stagnating or maybe at risk of reversing. Bearing in mind that the principles of "parity" and pluralist democracy ought to be revered because the basis of individual identity and integrity and human rights which human resources are the foremost vital consider future structural amendment and development, the report suggests associate integration of each the gender dimension and therefore the society dimension in education as norms actively promoted with a gender-sensitive approach. Subrahmanian, R. (2005) has stated that International agreement on education priorities accords a very important place to achieving gender justice within the academic sphere. each the Dakar 'Education for All' goals and also the Millennium Development goals emphasize 2 goals, during this regard. These 2 goals area unit distinguished as gender parity goals [achieving equal participation of women| ladies} and boys all told styles of education supported their proportion within the relevant age-groups within the population] and gender equality goals [ensuring academic equality between boys and girls. Gender equality suggests that the equality of ladies and boys, ladies and men on a basis of human rights and elementary freedoms within the political, economic, cultural, civil or the other field per Article one of the 1989 United Nations Convention on the Elimination of all types of Discrimination against ladies, process "the term 'discrimination against women' shall mean any distinction, exclusion or restriction created on the premise of sex that has the impact or purpose of impairing or nullifying the popularity, enjoyment or exercise by ladies, regardless of their legal status, on a basis of equality of men and girls, of human rights and elementary freedoms within the political, economic, social, cultural, civil or the other field" (Veriava, F., & Paterson, K.,2020).

The Millennium Development Goal (MDG) for gender equality in education by 2005 has been criticized for its grandiose ambition, its failure to adequately create by mental act the character of gender difference or the various forms this takes, the inadequate policies developed to place the goal into follow and therefore the restricted measurements used for observance. The paper argues for a strategic defence of the MDG as a chance to suppose additional wide regarding what the contents of rights in education ar and the way gender equality could be advanced (Unterhalter, E. ,2005).

Equal access to education, whereas essential, doesn't guarantee gender equality. Schools, as formal state establishments, tend to breed existing gender regimes and power relations instead of subvert them. What is more, gender and gender equality are often buzzwords that turn out completely different interpretations across contexts and actors. listening to the specificities of contexts during which gender equality discourses ar understood, negotiated, and enacted is, therefore, crucial to understanding the development of gender and therefore the hope of its transformation in and thru education (Durrani, N., & Halai, A., 2020). Research shows that despite improved access of girls to education, there remains several academic inequities for girls as school, for instance, most square measure focused at lower rungs of the educational ladder and really few girls reach social control and leadership positions. Feminist students have known that explanations like the woman's 'double burden' and conflict between the non-public and skilled roles aren't decent in explaining women's exclusion from senior tutorial roles. Instead they see education establishments (HEIs) square measure gendered in their organisational structures and have a inherent

ceiling. In India, the gap between girls and men within the company world is being bridged through efforts to extend the proportion of girl workers and girls in senior roles. Indian media systematically highlights these developments. However HEIs seem to be untouched by these developments. In response, the University Grants Commission (UGC) initiated a nationwide orientation and coaching programme for girls school, cutting across discipline areas. The aim of the UGC programme was to support gender inclusivity in Indian HEIs by light the gendered nature of establishments and building their capability to beat each internal constraints and barriers, in addition as general barriers to career advancement. The programme has had a major impact on the participants and helped to determine a broad-based network of girls school. many of the programme participants became visible, claimed their rightful place in senior roles in Indian HEIs, and several other additional square measure able to leave the 'sticky floor'. This chapter can discuss the programme's aims, processes and successes in supporting Indian HEIs to become gender inclusive (Chanana K.,2020)

Result and Discussion

We are a unity that gender equality is known as a matter of human rights and social justice. For this reason, within the frame of development of a democratic Europe, social movements demand a gender equality perspective altogether academic stage (Ainhoa Resa Ocio, Agnes Gonxha Bojaxhiu & Rabazas Romero, 2021). Globally gender parity in incoming remains unrealized in primary education (in over thirty third of countries), lower instruction (in fifty four of countries), and higher instruction (in seventy seven of countries) (UNESCO, 2016b).

The management of violent masculinities or management of anger/aggression were seen by some not as promoting gender equality however as compromising the state, as communities 'on the receiving finish of methods for gender equality also are on the receiving finish of the "War on Terror"(Durrani, N., & Halai, A,2020). There are unit still scarce experiences of co-ed interventions among the education system. Also, the study reveals however the co-ed interventions have focused in the main on access, and the way some sorts of discrimination supported sex still thrives among lecture rooms by hidden program. Thus, there's a requirement to push legislation reform supported the co-ed interventions still because the necessity to push specific teacher coaching in gender and equality (Aragonés-González et al., 2020).

While the gender gaps in instruction in Asian country have virtually been eliminated, we have a tendency to acquire somewhat totally different image once adjusting the gaps to the suitable school-age kids (6-14 years) and therefore the variety of the kid population. The age-adjusted gender gap in enrollment has improved, implying that over time women area unit a lot of doubtless to enter in colleges among the suitable school-age. Also, fewer women area unit expected to stay out of colleges compared to boys among the suitable school-age. Perhaps, this progress in enrollment has resulted in higher performances of ladies in transition rate, action in examinations and takes a look at scores in individual subjects. The rising girls' performance on totally different indicators of instruction indicates the potential impacts of feminine share on future labour market (Hoque, N., & Mahanta, R., 2020). The reality of gender difference of upper education in Asian nation is extremely complicated and heterogeneous, as a result of it exists in each field like education, employment opportunities, income, health, cultural problems, social problems, economic problems etc. a shot has been created to search out those factors that square measure accountable for this drawback in Indian education systems (Karak Sanjay & Sen Krishnendu ,2017).

Conclusion

The connectedness of initial teaching with a gender perspective is additionally required for the effective transformation and therefore the definitive obliteration of inequalities (Ocio, A. R., & Romero, T. R., 2021). The belief that there's a positive relationship between education and gender equality would take pleasure in empirical scrutiny. As a multidimensional issue, gender equality

cannot be achieved just by increasing women's access to education and therefore the labour market" (Durrani, N., & Halai, A,2020).Gender equality is important to realize social, political and economic development goals. Education plays a key role in difficult gender primarily based violence and unequal societies. Gender equality isn't solely between male and feminine it additionally includes transgender, gender neutral, a gender etc (Aragonés-González et al., 2020). Moreover, review various published studies have shown that India education system has undergone reform and on the path of transformation with reference to gender equality.

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TO STUDY $^{122\text{-}130}$TE (TELLURIUM) NUCLEI WITH THE HELP OF CUBIC TERMS FORMED BY THE CASIMIR INVARIANT OPERATORS AND IBM-1

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ABSTRACT

The Interacting Boson model establish the most appropriate Hamiltonian for present $^{122\text{-}130}$Te isotopes calculation. The boson numbers are found 7, 6, 5, 4 and 3 for $^{122\text{-}130}$Te isotopes respectively. The cubic terms are also formed in the Hamiltonian by the Casimir invariant operators. Ground state and the excited states of the nucleus all have triaxiality as a main property. We determined by calculating energy levels for $^{122\text{-}130}$Te using the IBM-1 Hamiltonian's better parameter values. The theoretical results are compared to the experimental data. The obtained results are in good agreement. After analyzing, there is no signature of triaxiality in $^{122\text{-}130}$Tellurium nuclei.

Key words: *IBM, Energy levels, even-even Tellurium, Triaxiality.*

INTRODUCTION

Iachello and Arima developed the Interacting Boson Model-1 [2-7], a nuclear model for the description of collective states. The nucleus is represented in the IBM in terms of interacting s and d bosons [22]. The shell model demonstrates that nucleon pairs with total spin 0 and 2 make up the majority of the low-lying states of even-even nuclei. The antisymmetric state can be seen in the spins of such couples of even number nucleons. The nucleon pairs are represented by bosons with angular momenta J = 0 or 2 according to IBM's basic assumption.

When the number of bosons is proportional to the number of active nucleon pairs, a closed shell is formed. Within the closed shell, each s- and d-boson has its unique binding energy. The even-even nuclei are described by IBM as having an inert core and bosons that represent pairs of identical nucleons. Each boson has a wave function, however due to their comparability, two bosons do not represent the wave function. Bosons are related to nucleons in the interacting boson-fermion model, which deals with odd numbers of identical nucleons. The total spin of boson is identical, even parity and also angular momenta of the bosons are even (J = 0, 2). There is no distinction is made between proton and neutron pairs, called interacting boson model-1 [1]. The models IBM1 are restricted to nuclei with even number of protons and neutrons.

Sometimes Tellurium isotopes belong to an interesting region, the closed proton shell at Z = 50, where the number of neutrons in the open shell is substantially higher, and hence these nuclei have been widely thought to exhibit important parameter [17]. The even-even tellurium isotopes have been extensively explored either theoretically and experimentally in recent years, with a particular focus on the interpretation of experimental data using collective models. The semi-microscopic model [18] used to investigate the energy levels of $^{122\text{-}130}$Te isotopes.

The purpose of this research is to look into the ^{122}Te isotope in the O (6)-SU (5) transition region, $^{124\text{-}130}$Te isotopes shows vibrational like character and calculate their energy levels with the help of cubic terms formed by Casimir invariant operators and IBM-1.

THEORETICAL CALCULATIONS

We don't get into the structure and eigenenergy of the instructional tool of the nucleus, i.e., the closed shell, while calculating the system's energy (core). The kinetic energy and potential energy of an active boson are operators, and they combine to form the Hamilton operator $H^{(1)}$ [11] of a single state $|b_{lm}>$

$$(\mathbf{T}^{(1)} + \mathbf{U}^{(1)}) |b_{lm}> = \mathbf{H}^{(1)} |b_{lm}> = \varepsilon_{lm} |b_{lm}> \quad (1)$$

The IBM-1 Hamiltonian can be expressed in terms of 36 operators since it conserves the total number of bosons, $b^{\dagger}_{lm}$ (b_{lm}) with

angular momentum l and z projection m is created (annihilated). Unitary transformations among them can yield the Lie algebra U (6).

The IBM-1 Hamiltonian can be expressed as a linear combination of the U (6) and its subgroups linear and quadratic Casimir operators [8].

$H = a_1\ C_{1,U(5)} + a_1'\ C_{2,U(5)} + a_2\ C_{1,U(6)} + a_2'\ C_{2,U(6)} + a_3\ C_{1,U(6)}\ C_{1,U(5)} + a_4\ C_{2,SO(5)} + a_5\ C_{2,SO(3)} + a_6\ C_{2,SO(6)} + a_7\ C_{2,SU(3)} + b_1[C_{1,U(5)}]^3 + b_2\ C_{2,SO(5)}\ C_{1,U(5)} + b_2'\ C_{2,SO(3)}\ C_{1,U(5)} + b_3\ C_{2,U(6)}\ C_{1,U(6)} + b_4\ C_{1,U(6)}\ C_{2,U(5)} + b_5\ C_{2,SO(5)}\ C_{1,U(6)} + b_6\ C_{2,SO(3)}\ C_{1,U(6)} + b_7\ [C_{1,U(6)}]^3$ (2)

The Casimir invariant operators of U (6) and its subgroups in the pattern are given below [7], [12]:

$C_{1,\,U(6)} = N$, $C_{1,\,U(5)} = n_d$, $C_{2,\,U(5)} = n_d\,(n_d + 4)$, $C_{2,\,U(6)} = N\,(N + 5)$,

$C_{2,\,SO(6)} = N\,(N + 4) - \{\sqrt{5}\,[d^{\dagger} \times d^{\dagger}]^{(0)} - s^{\dagger}s^{\dagger}\}\ \{\sqrt{5}\,[\tilde{d} \times \tilde{d}]^{(0)} - ss\}$

$C_{2,\,SO(5)} = n_d\,(n_d + 3) - 5\ \{[d^{\dagger} \times d^{\dagger}]^{(0)}\ [\tilde{d} \times \tilde{d}]^{(0)}\}$

$C_{2,\,SO(3)} = -10\sqrt{3}\ \{[d^{\dagger} \times \tilde{d}]^{(1)} \times [d^{\dagger} \times \tilde{d}]^{(1)}\}$

$C_{2,\,SU(3)} = \sum_{\mu} (-1)^{\mu}\ Q_{\mu}\ Q_{-\mu}$, Where $Q_{\mu} = \{d_{\mu}^{\dagger}\ \tilde{s} + s^{\dagger}\ \tilde{d}_{\mu} - \sqrt{7}/2\ [\,d^{\dagger} \times \tilde{d}]_{\mu}^{(2)}\}$

1. RESULTS AND DISCUSSION

The $^{122\text{-}130}$Te isotopes having Z = 52 and N = 70-78. The boson numbers represent the number of collective pairs of valence nucleons. The nuclei's valence proton number and neutron number have a fundamental correlation, resulting in similar spectra. The number of valence proton N_p and neutron N_n has a total $N = (N_p + N_n)/2 = n_{\pi} + n_{\nu}$ bosons.

In theoretical nuclear physics, symmetry considerations are critical, and group theory provides the mathematical tool for expressing symmetry principles. The spectrum generating algebra is a variant of symmetry in which the Hamiltonian is generated in components of Lie algebra called dynamical symmetry [9].

Table-1: The parameters of different levels for even-even $^{122\text{-}130}$Te nucleus in IBM-1

Isotopes	*N*	*Yrast states*	a_1 *(MeV)*	a_1' *(MeV)*	a_4 *(MeV)*	a_5 *(MeV)*
^{122}*Te*	*7*	*2-12*	*0.4511*	*0.0393*	*-0.02409*	*0.00205*
^{124}*Te*	*6*	*2-12*	*0.5145*	*0.0523*	*-0.0422*	*-0.00077*
^{126}*Te*	*5*	*2-12*	*0.6814*	*0.0425*	*-0.0548*	*-0.00138*
^{128}*Te*	*4*	*2-12*	*0.7916*	*0.0329*	*-0.0593*	*0.00398*
^{130}*Te*	*3*	*2-12*	*1.1415*	*-0.0266*	*-0.0481*	*0.0039*

If the Hamiltonian can be interpreted as a function of the Casimir operators corresponding to a chain of Lie-subalgebras [9], the algebraic model exhibits dynamical symmetry. For specific combinations of boson energies and boson-boson interactions, the problem can be solved analytically, but finding the eigen solutions needs a numerical approach. There are only three symmetries are solved algebraically in the interacting boson model.

U (6) ⊃ U (5) ⊃ O (5) ⊃ O (3), anharmonic spherical vibrator [4], [9] (3)

U (6) ⊃ SU (3) ⊃ O (3), axially-deformed rotor vibrator [5], [9] (4)

U (6) ⊃ O (6) ⊃ O (5) ⊃ O (3), γ-unstable deformed rotor vibrator [2] (5)

By setting $a_6 = a_7 = 0$ in equation (2), We have a vibrational Hamiltonian that only comprises Casimir operators from the chain [8]

$$H = a_1 C_{1,U(5)} + a_1' C_{2,U(5)} + a_2 C_{1,U(6)} + a_2' C_{2,U(6)} + a_3 C_{1,U(6)} C_{1,U(5)} + a_4 C_{2,SO(5)} + a_5 C_{2,SO(3)} + b_1[C_{1,U(5)}]^3 + b_2 C_{2,SO(5)} C_{1,U(5)} + b_2' C_{2,SO(3)} C_{1,U(5)} + b_3 C_{2,U(6)} C_{1,U(6)} + b_4 C_{1,U(6)} C_{2,U(5)} + b_5 C_{2,SO(5)} C_{1,U(6)} + b_6 C_{2,SO(3)} C_{1,U(6)} + b_7 [C_{1,U(6)}]^3 \quad (6)$$

Quantum numbers are labels of irreducible representations of the algebras in the chain (3), as well as the eigenstates of the Hamiltonian (6) have them.

We have

U (6) ⊃ U (5) ⊃ O (5) ⊃ O (3) ⊃ O (2)

↓ ↓ ↓ ↓ ↓ ↓

[N] n_d v n_Δ L M

Here, N is the total number of s and d-bosons, v, n_d and L are d-boson and angular momentum respectively [9]. The subgroup O (2) has been omitted because unless the nucleus is in a magnetic field, Hamiltonian does not depend on the magnetic quantum number M.

The multiplicity label n_Δ = maximum number of d-boson triplets coupled to L = 0,

The reduction rule U (6) ⊃ U (5) takes the form n_d = N, N-1…...0,

The U (5) ⊃ O (5) reduction rule takes v = n_d, n_d – 2…...1 or 0 (n_d = even or odd) [9].

There is the following algorithm for the reduction O (5) ⊃ O (3). First, partition n_d as $n_d = 2n_\beta + 3n_\Delta + \lambda$, where $n_\beta = n_d - v/2$, n_β = 0, 1……$n_d/2$ or n_d – ½ and n_Δ = 0, 1, 2…. The allowed angular momenta are L = λ, λ + 1……..,2λ – 2, 2λ. The reduction rules are exhibit in n_d – multiples of a spherical vibrator, with a two-phonon (n_d = 2), triplets states (L =0,2,4) at an energy E (n_d =2) ~ 2E (n_d =1) above the ground state (n_d =L=0) and three-phonon (n_d = 3) quintuplet of states (L = 6,4,3,2,0) at E (n_d = 3) ~ 3E (n_d = 1) [9].

To calculate the energies of some states of the ground state band by applying the eigen-value expressions for the vibrational nuclei. Now, the eigenenergy can be represented this way

$$E (N, n_d, v, L, M) = E_0 + a_1 n_d + a_1' n_d (n_d + 4) + a_4 v (v + 3) + a_5 L (L + 1). \quad (7)$$

Where, $E_0 = a_2 N + a_2' N (N + 5)$. This term contributes only to binding energies and not to excitation energies [9].

β = 0 (For the spherical symmetry).

Only levels up to spin 12^+ were considered in the computation for the ground-state bands, as yrast bands exhibit a backbend phenomenon above this spin number. To find the near excitation-energy of all positive parity levels, an appropriate free parameter has been determined (2^+, 4^+, 6^+, 8^+, 10^+ and 12^+)[12]. However, the seniority number in the ground state band is given by v = n_d = L/2, therefore the values of this number for 2^+ and 12^+, as example will be as following: v = n_d = L/2 = 1 for 2^+ and v = n_d = L/2 = 6 for 12^+ state.

Now, calculate the energy eigen value for $_{52}Te^{122}$ isotope

For $_{52}Te^{122}$ isotope,

$E^{2+} = 0.4511\times1 + 0.0393\times1(1+4) + (-0.02409)\times1(1+3) + 0.00205\times2(2+1)$

$E^{2+} = 0.563$

$E^{4+} = 0.4511\times2 + 0.0393\times2(2+4) + (-0.02409)\times2(2+3) + 0.00205\times4(4+1)$

$E^{4+} = 1.1739$

$E^{6+} = 0.4511\times3 + 0.0393\times3(3+4) + (-0.02409)\times3(3+3) + 0.00205\times6(6+1)$

$E^{6+} = 1.8311$

$E^{8+} = 0.4511\times4 + 0.0393\times4(4+4) + (-0.02409)\times4(4+3) + 0.00205\times8(8+1)$

$E^{8+} = 2.5351$

$E^{10+} = 0.4511\times5 + 0.0393\times5(5+4) + (-0.02409)\times5(5+3) + 0.00205\times10(10+1)$

$E^{10+} = 3.2859$

$E^{12+} = 0.4511\times6 + 0.0393\times6(6+4) + (-0.02409)\times6(6+3) + 0.00205\times12(12+1)$

$E^{12+} = 4.08354$

Similarly, we determined the theoretical energy levels for other $^{124\text{-}130}$Te (Tellurium) isotopes. Table-1 illustrates the values of these parameters for the isotopes [19] that are used to compute the energy of the yrast-states. Table-1 shows the energy levels that correspond to IBM-1 and compares them to experimental results [14-16,20-21]. The consistency between estimated theory and experiment is very good, and it is well reproduced [13].

J^p	$_{52}Te^{122}$		$_{52}Te^{124}$		$_{52}Te^{126}$		$_{52}Te^{128}$		$_{52}Te^{130}$	
	E_{exp}	E_{cal}	E_{exp}	E_{cal}	E_{exp}	E_{cal}	E_{exp}	E_{cal}	E_{exp}	E_{cal}
2^+	0.560	0.563	0.620	0.602	0.666	0.666	0.743	0.742	0.839	1.113
4^+	1.161	1.173	1.248	1.219	1.361	1.297	1.497	1.464	1.632	2.107
6^+	1.776	1.8311	1.747	1.8498	1.7762	1.8923	1.8112	2.1655	1.8153	2.984
8^+	2.652	2.535	2.664	2.494	2.765	2.451	2.689	2.845	2.648	3.742
10^+	3.2908	3.2859	3.1543	3.1533	2.9744	2.9757	2.7907	3.5043	4.3296	4.383
12^+	3.9788	4.0835	3.9788	3.8260	3.6879	3.4639	3.5081	4.1423	3.8635	4.905

Table-2: The experimental and calculated energies for $^{122\text{-}130}$Te

The symmetry shape of the nucleus can be predicted from the energy ratio $R = E_4^+/ E_2^+$, Where, E_4^+ is energy level at 4_1^+ and E_2^+ is energy level at 2_1^+ are good criteria for the shape transition. According to Casten triangle, the energy ratio for vibration nuclei U (5) = 2, γ- unstable nuclei O (6) = 2.5, rotational nuclei SU (3) = 3.33 [10]. We studied at U (5) symmetry as a type of symmetry, $R_{4/2}$ = 2.08, 2.02, 1.94, 1.97, and 1.89 of $_{52}Te^{122}$, $_{52}Te^{124}$, $_{52}Te^{126}$, $_{52}Te^{128}$ and $_{52}Te^{130}$ respectively.

CONCLUSION

The IBM-1 model was used to examine the yrast states band of even $^{122\text{-}130}$Te isotopes. The experimental and IBM-1 results are standardized at 2^+ and 12^+ levels. It is shown that results of R values remain constant at $R_{4/2}$ from the even-even neutron numbers. In $^{122\text{-}130}$Te isotopes, however, the energy ratio

decreases as a function of the quantity of neutrons at high spin levels. We calculated energy levels for $^{122-130}$Te using the IBM-1 Hamiltonian's best-fitted parameter values. When the results are compared to experimental and theoretical data, it is observed that they are in good agreement and that the isotopes have the symmetry of U (5). Finally, it should be emphasized that the value described in the research corresponds to the results presented. There is no sign of triaxiality in the $^{122-130}$Te nuclei.

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CLASSIFICATION OF SKIN CANCER USING MACHINE LEARNING ALGORITHMS

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ABSTRACT

Skin cancer is the most popular cancer worldwide. When detected early, it is easy to treat. The most serious type of skin cancer is melanoma. As skin lesions were observed with the naked eye, features were not noticed precisely, resulting in mistreatment and, finally, death. As a result, automated detection and classification system to MM skin cancer at early stage is required. Using machine learning and image processing approaches, we proposed an automated melanoma detection and classification system. On the ISIC dataset with 328 benign images and 672 melanoma images, the proposed classification system uses ABCD, HOG, GLCM feature extractors and ANN, KNN, SVM, and Naive Bayes classifier models. Score features are extracted using the ABCD rule, while texture features are extracted using the GLCM and HOG feature extractors. When compared to other classifiers, the GLCM+HOG feature extractors and SVM classifier achieved good classification results on the ISIC dataset with 98 percent accuracy and 0.95 percent AuC. The KNN classifier had a sensitivity of 87 percent and a specificity of 86 percent.

Keywords: *Skin cancer; Survey; Melanoma; Benign; Classification; Machine learning; Image processing; ANN; KNN; SVM; Naive Bayes;*

Introduction

Skin cancer is an abnormal growth of skin cells which often grows on sun-exposed skin, is the world's most common cancer, affecting one in every 5 people by the age of seventy [1]. Skin cancer, develops on outside and are generally visible whereas other cancers grows inside the body. The good thing is that if detected and diagnosed early, about 99% of all cases are treatable. One can lower the chances of developing skin cancer by minimizing or avoiding exposure to harmful ultraviolet (UV) radiation. However, in order to prevent skin cancer, we must detect it early. That is why regular skin examinations, both at homes also with dermatologists, are so important.

In India, approximately 5000 skin cancer patients were hospitalized each year, more than 4000 individuals die due to skin cancer. The 3 major skin cancer types: Basal Cell Carcinoma (BCC), Squamous cell carcinoma (SCC), and Melanoma (MM).

SCC signs and symptoms:

SCC is most commonly found on sun exposed parts of body like on ears, hands, and face. People having darker complexion skin are more prone to develop SCC on regions of the body that are rarely exposed to sunlight. SCC can appear as:

- Flat lesion with the crusted, scaly surface
- Hard, red lump

BCC signs and symptoms:

BCC is most commonly occurs in sun exposed regions of the body like face and neck. BCC appear as:

- The scabbing or bleeding sore which is healed but reappears again
- A flat lesion which looks like brown scar or flesh color
- The waxy or pearl liked lump

MM signs and symptoms:

MM is grown anywhere on the body, be it on healthy skin or existing mole can turn into

cancer. Melanoma is more commonly found on the face or trunk of infected men. This kind of cancer most commonly affects lower legs in women. MM may develop on skin which has not been exposed to sunlight in women and men. MM can impact persons with any skin colour. MM is more common to dark skin toned persons, and it usually appears beneath fingernails or toenails, on palms or soles. An MM symptom includes:

- Dark lesion on palms, soles, fingertips, toes.
- Dark lesion on mucous membrane lining vagina, nose, anus, mouth.
- The painful, itchy, or burning lesion
- Tiny lesion with uneven border and lesion appear as black, blue, white, pink, red in colour.
- The mole which change in size, texture, colour, or bleeds
- Big brown spot with dark speckles

MM, SCC, and BCC tumors are termed cancer if they are Malignant, which is serious kind of skin cancer that develops fast as well as extend to other regions on the skin. A benign tumor, on the other hand, is not a particularly hazardous type compared to malignant, but it grows bigger whereas does not spread to other parts on skin. As a result, manual identification of skin cancer was not particularly appropriate, because skin lesion was viewed through naked eyes, where features will not be detected precisely, resulting in maltreatment and, eventually, death. Early diagnosis of appropriate skin cancer can improve survival chances. As a result, automated detection is more dependable in terms of accuracy and efficiency.

MM is now one of the deadly skin cancer type. As per World Health Organization (WHO), the prevalence of this cancer is continuous fast growing from year to year. The high death rate for melanoma is caused due to late diagnosis. At same time, surgical treatment has an excellent prognosis and can result nearly 100 percent survival rate when neoplasms are detected in their early stages. As a result, an automatic computerized diagnosis method for MM skin cancer in its early stages is necessary. As the images of skin cancer share similar visual features, extracting features from skin cancer images is difficult and time-consuming as well and also it is challenging. The automated computerized diagnosis process aids in the correct analysis of skin cancer, allowing dermatologists to save diagnosis time [2].

In this paper, Image processing techniques and machine learning algorithms were used to extract features and classify melanoma (MM) skin cancer dermoscopy images as benign or malignant tumor. This will be useful in the detection of melanoma skin cancer effectively in the early stage.

Literature survey

Skin cancer cells might spread to other tissues and organs. Dermoscopy is the non-invasive image procedure for identifing MM skin cancer. MM is the most deadly skin cancer compared with other skin cancers. MM skin cancer has a higher death rate when compared with other skin cancer types. Dermatologists will identify skin cancer by visual inspection on dermoscopy images. From the experience, dermotologists will identify the kind of skin cancer, whereas there is not 100 percent guarantee that skin cancer will be detected, sometimes occasionally lead to possible injury. Potential damage indicates that an unneeded treatment, such as taking a skin sample for lesions, was undertaken; occasionally the biopsy results do not reveal skin cancer. Furthermore, dermatologists may fail to recommend skin biopsy, which results to death. Early diagnosis of skin cancer reduces death rate as well as shortens the diagnosis time, and to provide appropriate treatment to patients.

Advancement of modern technology in the fields of image processing, machine learning and deep learning enables the creation of systems based on artificial convolutional neural networks that outperform people in object classification tasks such as the detection of malignant skin cancers and so on.

The authors in [3] developed a technique for predicting skin cancer based on colour matching and symmetry to lesion pigments. To be more specific, the technique identifies and segment lesion edges and finds symmetrization to entire image in order to identify and isolate benign tumour. According to pigment colour match and symmetrization score table, the abnormal images were classified as MM, BCC, or SCC tumours. The test results for 2 matching procedures were compared to forty preclassified images. The first procedure obtained 80 percent of true classification and second procedure achieved 92.5 percent.

The authors in [4] demonstrated a technique for classifying pigment skin lesion on dermoscopy pictures by shape, colour, and texture features. The picture is split into the group of regions exhibiting major clinical characteristics of the lesions for texture and colour features. The collected feature data is put into the optimization framework, which ranks the features in order to identify the best subset of features. The technique detects lesion borders to distinguish lesion from background skin when it comes to shape features. The identified boundary is utilized for extracting shape features to skin lesion. On the set of 564 tested pictures, the technique achieves a specificity of 92.34 percent and a sensitivity of 93.33 percent.

The authors in [5] presented 2 methods for detecting melanoma in dermoscopy pictures. The first system categorizes skin lesions using global features, whereas the second system categorizes skin lesions using local features and bag of features classifier. When colour features were employed alone for solving skin lesion categorization problem, the experimental findings revealed that they performed better than texture features. Furthermore, on 176 dermoscopy pictures, both texture and colour features obtained better classification results with 75 percent specificity, 100 percent sensitivity to local-features, and 96 percent sensitivity, 80 percent specificity to global-features.

The authors suggested a new computer-aided diagnostic method to melanoma in [6]. The gain-ratio approach was used to prepare the feature selection. Four classifiers (hidden naive bayes, logistic model tree, random forest, and support vector machine) completed the classification task. This method is used on a collection of 289 dermoscopy pictures (175 benign, 114 malignant) and achieved 91.26 percent accuracy.

The authors in [7] presented a method to enhance melanoma diagnosis using machine vision and image processing tehniques. Pre-processing, image segmentation, feature extraction, and classification were all part of this method. The co-efficients of wavelet decomposition are used in this study for extracting image features. Mean and variance of wavelet co-efficients of pictures are used as inputs for neural network inputs to classify melanoma. The results reveal a 90% capacity to distinguish between malignant and benign tumors.

The authors in [8] presented a unique segmentation method (neuro-fuzzy model with decision-making). Image segmentation was performed on fewer image's feature values and then those were considered as parameters. This method when applied on various dermatological pictures comprising skin lesions, leads in high quality skin lesion segmentation. After employing the author's segmentation approach, it was discovered that segmentation achieved high accuracy rate.

The authors of [9,14] presented digital dermatoscopy approaches to diagnosis malignant melanoma on smart phones using macro photographic lens and the prototype app to Android phones were also presented. Otsu's technique is used by preprocessor in order to perform global image binarization. The support vector machine and difference of Gaussian (DoG) methods are utilized to extract lesion areas in digital pictures. A customized lens with the fixture to assist a user in precisely positioning smart phone may also improve accuracy of the findings.

The authors of [10,13] presented an automated segmentation technique by using clustering based histogram thresholding and colour space study for identifying boundaries in dermoscopy pictures. To determine the boundary of the lesion, each colour channel goes through preprocessing, cluster based histogram thresholding, the collection of pixel-based calculations and morphological operations. The segmentation findings were compared against automatic results and manual boundaries created by four dermatologists independently. The comparison is done using four distinct measures (similarity, specificity, sensitivity, accuracy), and also included ROC analysis.

The authors in [11,12,15] presented a computer-aided approach for segmenting melanocytes in a histopathological picture of skin. The mean-shift and the suggested local region recursive segmentation (LRRS) method are used for extracting candidate nucleus regions initially. Local double ellipse descriptor (LDED) then combines biological properties of melanocytes and offers robust parameters for identifying melanocytes. For the assessment, utilized 30 histopathology images with varying zooming factors reveals that the suggested approach can segment melanocytes of over 80 percent sensitivity and 70 percent positive predictions rate.

Methodology

In this work, we presented the effective approach in order to detect, extract features, and classifying MM skin cancer with image processing and machine learning techniques applied to dermoscopy pictures of suspicious melanoma lesions. The suggested approach has a good accuracy in detecting whether a skin lesion is malignant or benign, which will be highly useful in rapidly diagnosing MM skin cancer.

The stages of MM skin cancer detection and classify as benign or malignant is as following and flow of steps is shown in figure 1.

- Image Acquisition
- Pre processing
- Segmentation
- Feature Extraction
- Classification

Data Collection

Initial part is the collection of dataset of skin-lesion pictures from the International Skin Imaging Collaboration (ISIC). The dataset utilized in this study include malignant MM skin-lesion and benign, its count is specified in figure 2. Figure 3 (a) and (b) show pictures of malignant and benign MM skin lesion. In order to train and test the proposed system, the skin lesion pictures were split into 80:20 ratio's.

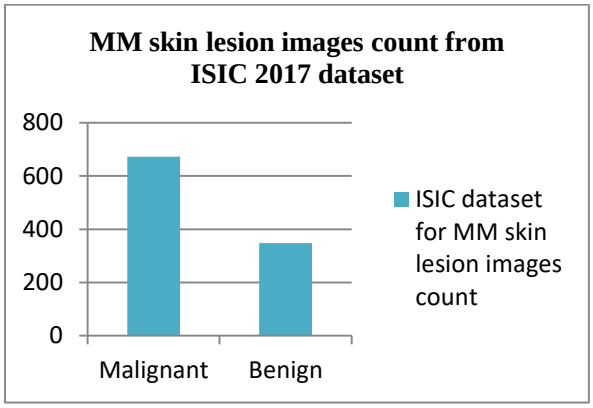
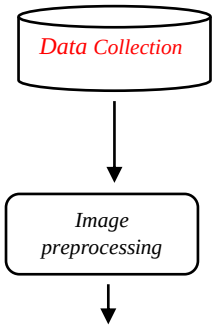


Figure 2. Total number of samples for Benign and Malignant MM skin lesion in ISIC Dataset

(a) (b)

Figure 3. Sample Skin lesion pictures of (a) Melanoma (b) Benign



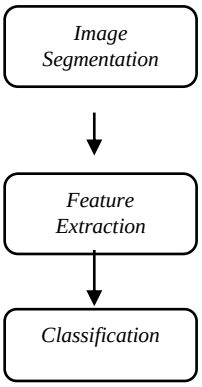


Figure 1. Steps to detect & classify Melanoma

Image preprocessing

Preprocessing is a necessary procedure that must be performed on dermoscopy pictures. It is required because acquired lesion picture may lack clarity. Hair, scars, and skin-tone variations will be on the surface of the human skin. As a result, the pictures should be preprocessed in order to correctly assess the infected skin lesion. The following methods are used to get rid of unwanted items:

i. The RGB images are transformed to Grayscale, which contains intensity information (commonly utilized by digital systems).
ii. Grayscale images were inputted to median filter in order to remove noise, which enhances the image of skin lesion; the median filtered images were then utilized for hair recognition and removal.
iii. Bottom hat filter finds the hair on skin lesion, and removes the smaller elements (e.g hair) on the image. Identified hair is eliminated by region-filling morphology, which conducted inward interpolation on the pixel.

As the benign data acquired was fewer compared to number of malignant images, we increased benign images by cropping and rotating the skin lesion images, in order to avoid overfitting and degradation.

Image Segmentation

Image Segmentation is the process of splitting the digital images into numerous parts. The goal of segmentation is to find region of interest in a given images. Segmentation is primarily used to simplify/modify the way an image is represented so that it is easier and more relevant to analyze. Geodesic Active Contours (GAC) was used to segment the MM skin lesion images in our work. GAC detects maximum changes in total skin lesion, which are often located near skin lesion's borders. Pre-processed skin images were binarized using Otsu-thresholding, then the binarized image is used with GAC. The suggested segmentation method produced a Jaccarb Index (JA) of 0.91 and a Dice Index (DI) of 0.84.

Feature extraction:

Fundamental pre-requirement for image classification is feature extraction, which is used to extract relevant image/image features from the segmented image. Several features were correlated with the image of skin cancer. The following are the different types of feature extraction utilized in this work:

Histogram of Oriented Gradients (HOG):

HOG is used to extract edge and shape information. The Orientation Histogram is used on the lesion to determine intensity of edge.

ABCD Rule:

The ABCD rule determines diameter, colour, border, and symmetry of a skin lesion. The features were extracted as the following:

- Symmetry: Skin lesion was split into 4 axes in order to screen for symmetry; When the lesion detected is Asymmetry, then lesion is considered to be malignant.
- Boundary: Detecting the border between the lesion and other parts of the skin is important to determine the exact location and lesion shape. This has been achieved by splitting the lesion into 8 axial slices.
- Color: Six colours were used to determine whether a lesion is malignant or not, including black, blue-grey, dark brown, light brown, red, and white.

- Diameter: The diameter of the skin lesion was measured, and it had to be smaller than 6mm for it to be benign.

Gray Level Co-Occurrence Matrix (GLCM):

GLCM, commonly used to analyze texture, in which distributed intensity of the object was determined. GLCM takes into account 2 pixels, one of which is a neighbor pixel and reference pixel for second one. A GLCM feature obtains shade, prominence, homogeneity, entropy, energy, and correlation.

Classification:

The images are classified based on their features by the classifier. The various machine learning algorithms like Artificial Neural (ANN), k-Nearest Neighbors (k-NN), Support Vector Machine (SVM), and Naive Bayes are utilized for classifying skin lesion into benign or malignant.

ANN is based on the notion of biological neuron system of human. ANN has two datasets, one for train and other for test. ANN is resilient and can deal with noisy data. SVM is the discriminative classifier defined with separating hyperplane. The optimal hyperplane divides label training data that might be utilized to categorize test/new data. KNN employs nearest neighbor concept in classification process. Classifier develops patterns to categorize test-patterns according to their similarity with the train patterns. KNN generates the class-membership value for which an object belongs and later vote the label, which is mostly used (in the classification scenario). The NB classifier is a Bayes variation, where each feature was considered as independent to others, and Bayes theory is used for computing posterior-probability of data belongs to the class label by multiplying conditional-probability to every feature by the product of the conditional probability to every feature.

Experimental results

Suggested approach is applied on images of skin lesions obtained from ISIC. Dataset contains 328 benign images and 672 melanoma images. The classifier's are learned using 80:20 train/test ratios. Three distinct feature extractors and four classifier models were employed, as detailed in the methodology. The ABCD rule is used to extract score features, while the GLCM and HOG techniques are used to extract texture features.

Performance measure:

The classifiers performance is evaluated by Sensitivity (SE), Specificity (SC), Accuracy (AC), which are calculated as following (refer table 1), in order to measure the ability to differentiate benign and malignant cases correctly:

Performance measure	**Formula**
Sensitivity (SE)	$\frac{TP}{TP + FN}$
Specificity (SC)	$\frac{TN}{TN + FP}$
Accuracy (AC)	$\frac{TP + TN}{TP + TN + FP + FN}$

Table 1: Performance measures along with their formulae

Here,

FN - Number of cases correctly classified as benign (False Negative)

TN - Number of cases correctly classified as benign (True Negative)

FP - Number of cases incorrectly classified as Malignant/Melanoma (False Positive)

TP - Number of cases correctly classified as Malignant/Melanoma (True Positive)

AUC (Area under Curve) is a top level metric that combines true positive rate (TPR, similar to sensitivity) and false positive rate (FPR) to indicate how effectively a system works for classification to distinguish positive and negative class. The proposed system quantitative results achieved by the 4 classifiers are shown in table 2. Classification accuracy (AC) and AuC of 4 classifiers are shown in table 3.

$$FPR = \frac{FP}{FP+TN} \quad (1)$$

Artificial Neural (ANN), k-Nearest Neighbors (k-NN), Support Vector Machine (SVM), and Naïve Bayes

Classifier	**Sensitivity percentage**	**Specificity percentage**	**Negative Predicted Value Percentage**	**Positive Predicted Value Percentage**
ANN	61	74	24	76
KNN	87	86	12	88
SVM	66	76	19	81
Naive Bayes	74	73	13	87

Table 2. Quantitative results achieved by classifiers

Features	**Classifier**							
	ANN		**KNN**		**SVM**		**Naïve Bayes**	
	AUC	**AC**	**AUC**	**AC**	**AUC**	**AC**	**AUC**	**AC**
ABCD	0.75	81	0.76	82	0.90	96	0.87	85
HOG	0.71	79	0.8	80	0.72	88	0.80	82
GLCM	0.	7	0.	7	0.	8	0.	7
	71	4	74	2	6	2	80	5
ABCD+HOG+GLCM	0.69	82	0.75	84	0.87	85	0.81	75
GLCM+HOG	0.8	91	0.82	95	0.95	98	0.9	92
Color+HOG+GLCM	0.9	85	0.88	90	0.9	93	0.95	87

Table 3. Proposed system AC and AuC achieved results

With GLCM+HOG feature extractors and SVM classifier gave good classification results on ISIC dataset with 98 percent accuracy, 0.95 percent AuC compared with other classifiers. KNN classifier gave 87 percent sensitivity, and 86 percent specificity.

Conclusion

In this work, we use machine learning to undertake an in depth examination of Skin cancer classification, and found melanoma as the serious type of skin cancer, which is need to be detected and diagnosed early to increase the survival rate. Manual identification of skin cancer was not particularly appropriate, because skin lesion was viewed through naked eyes, where features will not be detected precisely, resulting in maltreatment and, eventually, death. As the result we developed an automated melanoma skin cancer detection and classification system using machine learning and image processing techniques. Results achieved by the proposed system with SVM classifier has outperformed compared to other classifiers (ANN, KNN, Naive Bayes). In future we wanted to detect and classify other skin cancer types.

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"A STUDY ON THE IMPACT OF COVID-19 ON NON- PERFORMING ASSETS AND THE EFFECT OF PROFITABILITY OF STATE BANK OF INDIA"

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ABSTRACT

The banking sector plays a very vital role in the development of economy. At the same time banking corporations in India encounter various issues and challenges. One of the major challenges faced by the banking sector is non-performing assets and its impact on the profitability and financial conditions of the banks in India. A Non - Performing Asset (NPA) arises due to the default in payment or non-payment of loans or advances made by borrowers of the bank. The main objective of this research is to find out the reasons for non-performing assets and to analyse the level of non-performing assets. Also this study helps to know how these non-performing assets affects the profitability and financial performance of the banks with special reference to the state bank of India. The collected data is analysed by using suitable tools and results obtained. The study identified that there is a increase in non-performing assets due to covid-19 pandemic and its affect the and financial performance of banking sector and affects the growth of the nation.

Keywords: *Financial performance, Non Performing Assets, Profitability, , Public sector Banks*

BACKGROUND OF THE STUDY

The banking sector plays a very vital role in the development of economy. At the same time banking corporations in India encounter various issues and challenges. One of the major challenges faced by the banking sector is non-performing assets and its impact on the profitability and financial conditions of the banks in India. Non Performing Assets arises when a loan amount disbursed by the banking sector is not received from the borrower.

The non-performing assets are shown in the balance sheet of a banking sector or other financial institutions. After a long period of non-payment, based on the agreement, the lender will force the borrower to liquidate any assets that were pledged or mortgaged with the banks. The increase in Non-performing Asset affects not only the banking sector but also it affects the total financial system of the economy. To find a solution to these problems right decision must be taken to minimize the value of NPA. The increase in non-performing assets will reflect in the interest rate of deposits. It also gives negative impact in cash reserve ratio and liquidity ratio which affects the level of confidence among the shareholders. (Muthumeena 2019) Hence, this study is conducted on public sector banks particularly with the state bank of India to identify the impact of Non Performing Assets and its impact on the profitability of banking sector.

The State Bank of India is the largest leading bank with an accretion of Rs 16,610 crores. A portal has said 10 of the 40 banks accounted for 70 percent of the Non - Performing Asset in the system. The net NPAs of listed banks climbed 49 per cent to Rs 1.38 trillion in the first three quarters as quoted by a portal.

STATEMENT OF THE PROBLEM

NPA always affect the profit of bank and other variables of bank. So here, the problem is to identify the impact of Non - Performing Asset on the profit of the bank and to identify the action plan to reduce the Non - Performing Asset. This study focuses on Non-Performing Assets ratio's (gross Non-Performing Assets ratio and net Non-Performing Assets Ratio) and its impact on the asset quality, effectiveness of credit risk management and the profitability of the banks.

REVIEW OF LITERATURE

Barge (2002) - This study focused that "NPA as an alarming threat sending distressing signals on sustainability and tolerability of the affected banks. A high level of NPAs suggests that high probability of a large number of credit defaults that affect the profitability and net worth of bank.

Kaur (2006) in her thesis titled *"*Credit management and problem of NPAs in public sector banks*" proved* that, there is an urgent need for creating proper awareness about the negative impact of NPAs on profitability amongst bank staff, particularly the field functionaries is required. . Bankers should meet the borrowers whenever required to create better understanding and confidence.

Das, S. (2010) In this study the author has tried to identify and analyse the parameters such as market failure, willful defaults, poor follow-up and supervision, non-cooperation from banks, poor Legal framework, lack of entrepreneurial skills, and diversion of funds are some of the major reasons for raise in NPAs.

Narula and Singla (2013) say that the rise in NPA affects not only the liquidity and profitability of the banking sector and also it affects the quality of service and survival of banks. The study reveals that there is positive correlation between Net Profits and NPA of PNB.

Rao and Patel (2015) undertaken a study to analyze and interpret the management of NPA from year 2009-13 of Public Sector, Private Sector and Foreign Banks. The collected data was analysed by using statistical tools such as NPA related ratios, Least Square Method and ANOVA test. The result obtained through the study there is no significant difference between the estimated ratio of Gross NPA to Gross Advances for public, private and foreign banks and estimated Gross NPA for 2014 is higher in public banks as compared to private and foreign banks.

OBJECTIVES OF THE STUDY

PRIMARY OBJECTIVE

- To analyze the impact of Non-Performing Assets on profitability of the State Bank of India.

SECONDARY OBJECTIVES

- To study the reasons of Non-Performing Assets in banking sector.
- To identify the sources of funds and deployment of funds in particular with State Bank of India.
- To analyze the gross Non-Performing Assets and net Non-Performing Assets of State Bank of India.
- To suggest suitable measures to reduce the Non-Performing Assets.

RESEARCH METHODOLOGY

Research methodology is the systematic way to solve the research problem. It is important for the researcher to know the research methods/techniques to apply to the research problem. It is necessary for the researcher to design their own research methodology for the research problem. The research design is the conceptual structure within which research is conducted; it contributes the blueprint for the collection, measurement and analysis of data.

SOURCES OF DATA

Data for this study was collected from the published and unpublished sources of the SBI records. The bank's financial records and accounting statements were used to collect relevant data and make the analysis for the study. The data from these reports have been analysed using various tools and techniques with the view to identify the Non-Performing assets of the bank.

Tools used for analysis of Data

The data collected are classified and tabulated and further the following statistical tools such as Ratio analysis, Comparative analysis, Correlation analysis and Growth percentage analysis are used to fulfill the objectives of the study.

LIMITATIONS OF THE STUDY

- A deep analysis is made non-performing assets only. The performing assets do not pose any problems to credit management.

This study is only restricted to State Bank of India only.

- The result of the study may or may not be applicable to any other banking sector.

STATE BANK OF INDIA-AN OVERVIEW

The State Bank of India (SBI) is a largest public sector in India with a 23% market share in assets, besides a share of one-fourth of the total loan and deposits market. Formerly it is known as the imperial Bank of India. It was founded in the year 1806 and it is the oldest commercial bank in the Indian subcontinent. To form the Imperial Bank of India, the Bank of Madras merged into the other two "presidency banks" in British India, the Bank of Calcutta and the Bank of Bombay. It is named as State Bank of India in the year 1955. The Government of India took control of the Imperial Bank of India in the same year 1955, with Reserve Bank of India (India's central bank) taking a 60% stake, renaming it the State Bank of India. SBI provides a wide range of banking products all over India and overseas, including products aimed at non-resident Indians (NRIs). SBI has 16 regional hubs and 57 zonal offices that are located at important cities throughout the country.

SBI has over 24000 branches all over India. In the financial year 2012–13, its revenue was 2.005 $28 billion), out of which domestic operations contributed to 95.35% of revenue. Similarly, domestic operations contributed to 88.37% of total profits for the same financial year. Since November 2017, SBI also offers an integrated digital banking platform named YONO. Apart from this, SBI providing other banking services such as Agriculture banking / Rural Banking, NRI Services, Demat Services, Corporate Banking, Internet Banking, Mobile Banking services, Gross border Banking, Safe Deposit Locker facilities, RBIEFT, E-Pay, E-Rail, broking services etc. SBI was noted as a fifth largest employer in India

Types of Non-Performing Assets

- **Gross non-performing assets** refer to the sum of all the loans that have been defaulted by the borrowers within the provided period of ninety days. It consists of all the nonstandard assets like as sub-standard, doubtful, and loss assets. Formula is: *Gross NPAs Ratio = Gross NPAs / Gross Advances*
- **Net non-performing assets** are the amount that results after deducting provision for unpaid debts from **gross NPA**. Since in India, bank balance sheets contain a huge amount of NPAs and the process of recovery and write off of loans is very time consuming. That is why the difference between gross and net NPA is quite high. Formula is : *Net NPAs = Gross NPAs – Provisions / Gross Advances – Provisions*

REASONS FOR NON-PERFORMING ASSETS

Growth of Indian banking sector is important for a flourishing economy. If there is a failure of the banking sector may have an adverse impact on other sectors. The Indian banking system, which was operating in a closed economy, now faces the challenges and issues in an open economy. The major causes of Non-Performing Assets in banking sectors are listed below:

- **Loans taken for particular purpose are not utilized for the same purpose.**
- **Improper lending process -due to not following the three** principles of lending process like Principle of safety, liquidity and profitability.
- **Decisions on real time basis cannot be taken d**ue to improper technology and management information system.
- Due to poor credit appraisal the bank gives advances to those who are not able to repay it back. As a result, the Non-Performing Assets of the bank increases. So, the bank should maintain proper credit appraisal system.
- **Managerial deficiencies** The banker

should always select the borrower very cautiously and should take tangible assets as security to safeguard its interests.

- **Lack of regular follow up** The irregularities in spot visit also increase the Non- Performing Assets, the absence of regular visit of bank officials to the customer point decreases the collection of interest and principal on the loan.
- **Incomplete and faulty documentation** There should thorough verification by the officials on the documents submitted by the borrowers.

EFFECT OF NPA (NON- PERFORMING ASSETS) IN BANKING SECTOR

The following are the some of the major problems and challenges faced by banking sector due to Non-Performing Assets.

- **Effect of Profitability of Banks:** When Non-Performing Assets goes on increasing, the net income of the banks will decrease. The cumulative loss of public sector banks crossed a whopping Rs 87,357 crore in the 2017-18 fiscal.
- **Increase in provisions of banks:** RBI has introduced prudential norms for income recognition and asset classification for Indian banks and financial institutions, to ensure proper provisioning and transparency in the published accounts. This provision led to substantial provisioning of Rs 5.1 lakh crore in between March 2015 to march 2018
- **Liquidity position:** Non-Performing Assets affects the liquidity position of the banks, thereby creating a miss-match between assets and liquidity and force the banks to raise resources at high cost.
- **Effect on MSMEs** The disbursement of loans mainly with the large-scale firms, this made banks reluctant to issue loans to small scale industries. So MSME suffer from lack of funds from the banks and has to borrow from other sources which would increase theircost of capital.
- **Burden to Government** Since the Government is the majority shareholder in the public sector banks, it has to provide equity capital, if the banks are struggling. As Non- Performing Assets are increasing PSB's are struggling, so the government needs toprovide capital to the banks.
- **Declining productivity** Loans given by the banks are the assets to the banks. Since the Assets (NPA's) of the banks ceases to generate income for the bank there will be decrease in the income which leads to decrease in productivity of the bank's assets.

THE IMPACT OF COVID-19 ON NON-PERFORMING ASSETS

The COVID-19 pandemic has affected all facets of society and it created a truly global impact. The coronavirus pandemic is expected to have a severe impact on credit delivery and asset quality in India, with over US$30.5 billion of loans expected to turn bad over the next 12 months. However, due to the slowdown of economy, the Indian banking sector also showing signs of distress even before the pandemic. According to the study conducted by McKinsey & Co., the NPAs grew to 11 per cent of the Indian banking portfolio in 2018. Also it is anticipated that the total NPAs in the Indian financial system are expected to rise a further 7 per cent if government ends its lockdown by mid-May in India. State Bank of India expects a flat growth in its corporate loan book this fiscal due to the uncertainty triggered by the Covid-19 pandemic. The bank had registered a drop in growth in corporate credit portfolio to 2 per cent in FY20 against 14 per cent in FY19.

According to Arijit Basu, MD, Corporate Clients Group & IT, SBI, while the demand has been largely muted during the first two quarters on account of the lockdown, pick-up in demand is expected, particularly in certain sectors, from the third quarter onwards. The growth in the corporate loan book would have been higher but

for the large reduction in the non-performing assets (NPA) undertaken by the bank in the segment in both FY19 and FY20 of around Rs.60,000 crore each year. SBI Cards & Payment Services Ltd. on Thursday reported a sharp rise in bad loans for the July-September quarter due to defaults brought on by the Covid-19 crisis. The credit card NBFC, a subsidiary of India's largest lender State Bank of India, reported a gross non-performing asset ratio of 4.3% compared with 1.4% as on June 30, a rise of 290 basis points.

DATA ANALYSIS AND INTERPRETATION

The data collected are classified and tabulated and further the following statistical tools such as Ratio analysis, Comparative analysis, Correlation analysis and Growth percentage analysis are used to fulfill the objectives of the study.

RATIO ANALYSIS

i.Gross Non-Performing Assets Ratio

Gross Non-performing Assets= Gross NPA/ Gross Advances

Table showing Gross Non-Performing Assets

2015	13347.139	56,725.34	4.250
2016	15103.508	98,172.80	6.500
2017	16281.593	112,342.99	6.900
2018	20479.144	223,427.46	10.91
2019	22941.615	172,750.36	7.530

Source: Secondary Data

Interpretation: The above table exhibits that the Gross Non-Performing Assets ratio has been increasing for past 3 years that is from 2016 to 2018. An increasing Gross NPA indicates the decreasing quality of the bank's assets. There has been a decrease in Gross Non-Performing Assets during the year 2015 and 2019.

ii. Net Non-Performing Assets Ratio:

Formula of Net Non-Performing Assets Ratio = Net NPA / Net Advances

Table Showing Net Non-Performing Assets Ratio

Year	Net advances	Net NPAs	Ratio
2015	13014.425	27,590.58	2.120
2016	14647.512	55,807.02	3.810
2017	15708.189	58,277.38	3.710
2018	19346.370	110,854.70	5.730
2019	21891.940	65,894.74	3.010

Source: Secondary Data

Interpretation: The above table shows that the Net Non-Performing Assets ratio has been increasing for past 3 years that is from 2015, 2016 and 2018. An increasing Net Non-Performing Assets indicates the increase in the quantity of risky assets in the bank for which no provisions are made. During the year 2019 and 2017, the Net Non-Performing Assets has been decreased, as a result of decrease in the quantity of risky assets in the bank.

iii. Provision Ratio

Provision Ratio = Total Provision/ Net NPA Table showing Provision Ratio

Year	Total Provision	Gross NPA	Provision ratio
2015	39214.228	56,725.34	0.691
2016	59581.072	98,172.80	0.607
2017	74090.202	112,342.99	0.660
2018	147841.950	223,427.46	0.662
2019	136006.358	172,750.36	0.788

Source: Secondary Data

Interpretation: From the above table it is clear that the provision ratio has been increasing and then decreasing over the past five years. This ratio indicates that the bank has been more and less conservative in charging provisions against profit.

iv. Standard Asset Ratio

Standard Asset Ratio = Total Standard Asset/Gross Advances

Table showing Standard Asset Ratio

Year	**Standard assets**	**Gross Advance**	**Standard Asset Ratio**
2015	9,018.36	13347.139	0.676
2016	11,188.59	15103.508	0.741
2017	13,678.24	16281.593	0.840
2018	12,499.46	20479.144	0.610
2019	12,396.68	22941.615	0.540

Source: Secondary Data Interpretation: The Standard Asset Ratio has been increasing for the past three years which indicates that there have been regular returns on the loan asset. From 2018 onwards the ratio has been decreasing, this shows that there have been irregular returns on the loan asset.

COMPARITIVE ANALYSIS

Table showing Sources of funds

Year	Share Capital	Reserves and surplus	Deposits	Borrowings
2015	746.57	127,691.65	1,576,793.25	205,150.29
2016	776.28	143,498.16	1,730,722.44	323,344.59
2017	797.35	155,903.06	2,044,751.39	317,693.66
2018	892.46	193,388.12	2,706,343.29	362,142.07
2019	892.46	195,367.42	2,911,386.01	403,017.12

Source: Secondary Data

Interpretation: It is clear from the above table that the borrowings of SBI in terms of penalties, unpaid interest, prepayment charges etc are more than any other sources of funds during the year 2019. (Rs. 403,017.12 crores) All the other sources of funds are gradually increasing year by year.

Table showing Deployment of funds

Year	Cash balance with RBI	Investments	Loans and Advances	Fixed assets	Other Assets
2015	115,883.84	481,758.75	1,300,026.39	9,329.16	102,209.71
2016	129,629.33	575,651.78	1,463,700.42	10,389.28	140,408.41
2017	127,997.62	765,989.63	1,571,078.38	42,918.92	154,007.72
2018	150,397.18	1,060,986.72	1,934,880.19	39,992.25	226,994.20
2019	176,932.42	967,021.95	2,185,876.92	39,197.57	266,327.70

Source: Secondary Data

Interpretation: The above table exhibits that the bank's providing loans and advances to its customers are more than any other deployment of funds during the year 2019. (Rs. 2,185,876.92 crores) All the other deployment of funds is gradually increasing year by year.

Table showing Impact of NPA's on profitability

Year	Gross NPA	Net Profit	Net NPA
2015	56,725.34	8,857.51	27,590.58
2016	98,172.80	9,758.15	55807.02
2017	112,342.99	9,536.10	58277.38
2018	223,427.46	-,422.50	110854.70
2019	172,750.36	726.10	65894.74

Source: Secondary Data

Interpretation: The above table reveals that the impact of NPA on profitability of SBI from the year 2015 to 2019. It clearly shows that the gross NPA is more when the net profit goes in negative during the year 2018 and again increases steadily during the year 2019

CORRELATION

Table showing Correlation between mean Net NPA and mean Net Profit

Year	Net NPA (X)	Net Profit (Y)	XY	X^2	Y^2
2015	8,857.51	27,590.58	244383838.255	78455483.4001	761240104.736
2016	9,758.15	55807.02	544573272.213	95221491.4225	3114423481.28
2017	9536.10	58277.38	555738923.418	90937203.21	339653019.66
2018	-6422.50	110854.70	-711964310.75	41248506.25	12288764512
2019	726.10	65894.74	47846170.714	527221.21	4342116759.66
Σ	ΣX= 22,455.36	ΣY=3,18,424.42	ΣXY= 680577893.9	ΣX^2= 306389905.5	ΣY^2= 20846197877

N=5

$$\text{Correlation (r)} = \frac{N\Sigma XY - (\Sigma X) * (\Sigma Y)}{\text{Sqrt}\left([N\Sigma X^2 - (\Sigma X)^2]\,[N\Sigma Y^2 - (\Sigma Y)^2]\right)}$$

$$= \frac{5(680577893.9) - (22,455.36) * (3,18,424.42)}{\text{Sqrt}\left([5(306389905.5) - (22,455.36)^2]\,[5(20846197877) - (3,18,424.42)^2]\right)}$$

$$= \frac{-3747445514.39}{9669.0995}$$

r = -0.868406717

Interpretation: The above table interprets the correlation for SBI, that is -0.868. This means that the NPA is increasing every year but net profit decreases. Here SBI has shown a negative correlation, which results in the negative growth rate of the banking sector.

MOVEMENT OF NPA

Table Showing Movement of NPA

Year	2014--2015	2015-2016	2016-2017	2017-2018	2018-2019
Opening balance	80,641.81	56,725.34	98,172.80	1,12,342.99	2,23,427.46
Add: Additions during the year	45,810.39	64,198.49	39,071.38	1,60,303.65	32,738.05
Less: Recovery during the year	51,825.57	22,751.03	24,901.19	49,219.18	83,415.15
Total	74,626.63	98,172.80	1,12,342.99	2,23,427.46	1,72,750.36

Source: Secondary Data

Interpretation: The table shows the movement of Non-performing assets during each year. According to this, the addition and recovery of NPA during each year is being fluctuated. Hence it is clear that there is a necessity of provisions, which brings down the overall profitability of bank.

FINDINGS OF THE STUDY

The following are the findings of the study gathered from the above data analysis,

- The Gross Non-Performing Assets ratio has been increasing for past 3 years that is from 2016 to 2018 and there has been a decrease in Gross Non-Performing Assets during the year 2015 and 2019.
- The Net Non-Performing Assets ratio has been increasing for past 3 years that is from 2015, 2016 and 2018. It indicates that the increase in the quantity of risky assets in the bank for which no provisions are made.
- The provision ratio has been increasing and decreasing over the past five years. The reason for changes due to the provisioning norms by RBI
- There is a increase in the problem asset ratios for the past three years indicate the chances of increasing Non-Performing Assets in future.
- The Standard Asset Ratio has been increasing for the past three years reveals that there have been regular returns on the loan asset. From 2018 onwards the ratio has been decreasing, this shows that there have been irregular returns on the loan asset.
- The sources of funds shows that the borrowings of SBI in terms of penalties, unpaid interest, prepayment charges etc are more than any other sources of funds during the year 2019. (Rs. 403,017.12 crores).
- The deployment of funds table shows that the bank's providing loans and advances to its customers is more than any other deployment of funds during the year 2019. (Rs. 2,185,876.92 crores).
- The non- performing assets are experiencing growth when compared to the net profit. This proves that the bank should go ahead with sale of assets if the repayment of loans is not made within the due date.
- The SBI has shown a negative correlation ie. -0.868. This means that the Non- Performing Assets are increasing in every year but net profit decrease. The performance of banking sector depends on how effectively the banks manage the non- performing assets and increases its net profits.
- According to the movement of NPA, the additions and recovery of NPA during each year is being fluctuated. Hence it is clear that there is a necessity of provisions, which brings down the overall profitability of bank.

SUGGESTIONS AND RECOMMENDATIONS FROM THE STUDY

- Banks should thoroughly inspect the company they are giving loans to. Loans to bad companies will lead to lack of money for good investments.
- It's better to display the defaulters' name list publicly. This will cause fear and acts as a deterrent.
- After granting loan, banks should observe the capacity of the company continuously and should be able to assess whether it is about to bankrupt
- Selection of borrowers based on CIBIL rating need be done so that good borrowers are financed.
- Some assets that are classified as Loss assets should be written off from banks books
- In case of existing loans contact regular borrower and loan notices need be sent.
- In case of natural calamity like flood and cyclone loan accounts should be restructured by the banks giving more time to the borrowers to repay.
- In case of willful defaults suits need be filed by the banks against them.

In small loan accounts compromise settlement need, be arrived at so that maximum recovery is ensured

CONCLUSION

Banking industry in India has come across major change after the first phase of economic liberalization and implementation of technology. Management of credit is very essential for all banking sector to reduce risk and increase profit. In recent years banks are very cautious in lending loans and advances to sectors of the economy, because of mounting Non-Performing Assets. This article brings out the reasons for Non-Performing Assets and suggested measures to reduce it. There are several proactive measures like Corporate Governance, Better credit information to cut down on fresh NPLs, Prudential Supervision, Well developed capital markets that can offer the mechanism and liquidity required to write off bad loans and Securitization are being implemented to reduce NPAs

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