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Dr. Satish Chand Gupta

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Comparative Evaluation of PV topologies - TCT and Sudoku under Shading Conditions

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Abstract

The aim of this paper is to investigate the performance of configurations under short narrow and short wide shading patterns. Two configurations are considered in this work – Total Cross Tied (TCT) and Sudoku at four different irradiations i.e. 300 W/m^2, 600 W/m^2, 800 W/m^2 and 1000 W/m^2. The performance parameters taken are output power and Mismatch losses (ML). The analysis has been done on software via Matlab/ Simulink. It is observed that Sudoku provides greater output in terms of power with respect to TCT.

Keywords : *Shading Patterns; Sudoku; TCT*

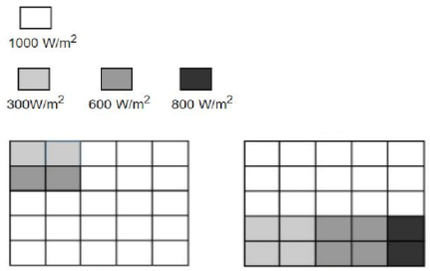
I. Introduction

The PV array consists of five panels in the series forming a string and these five strings are joined as in parallel connection. Total 25 panels formed a 5x5 matrix. The total power capacity of array is 5kw.

The authors of [1] analyze a novel method enhancing total using 3x3 Total Cross Tied (TCT) connection at eight different shading patterns. The paper [2] uses six configurations of 7x7 PV system. It is noted that triple tied topology is best among all configurations. The paper [3-4] gives impact of many shading and bypass diode on configurations. Among all configurations, TCT comes out with better performance. Mohammed Alkahtani et al [5] focusses on gene evolution algorithm on reconfiguring 2x4 PV array to uplift the overall power. The authors of [6] presents an algorithm to provide solution of reconfiguration technique under four shading patterns. The paper [7-10] investigates various configurations via MATLAB/SIMULINK and all configurations are experimentally validated. Hicham Oufettoul et al [11] provides portrait and landscape orientation in urban areas. Their performances are verified via two softwares: PSIM and MATLAB. The paper [12-15] presents novel reconfiguration method against conventional configurations under shading schemes. The paper [16-20] presents a cooling methodology for maintaining the temperature of PV modules. The experimental data has been considered for analysis and results have been verified using MATLAB software.

II. Shading Patterns And Configurations

Small shading can also have adverse effect on the performance of Photovoltaic (PV) system. Two patters are employed on 5x5 PV matrix - short narrow and short wide at irradiation level 300 W/m^2, 600 W/m^2, 800 W/m^2 and 1000 W/m^2.



A. Total Cross Tied (TCT)

TCT is basically extracted from SP topology. It has an additional feature of crossly connected Rows and columns such that total voltage and total current is equal across all Rows and all columns respectively as shown in Fig. 2. The figure also shows all shading conditions at different irradiations. This scheme works better in shading condition and reduces Mismatch losses (ML) but it has a problem that the number of ties is more which increases cable losses.

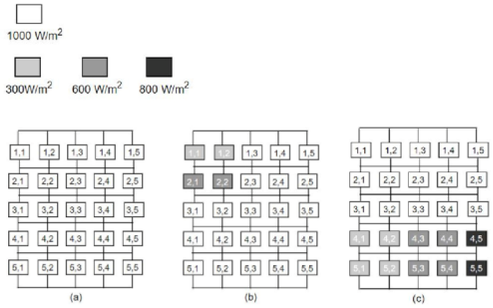


Fig. 2. (a) TCT Connection (b) Short Narrow (c) Short Wide

B. SuDoKu

This represents logical riddle pattern. A 5x5 TCT matrix is considered for SuDoKu configuration whose first digit represent row number and second digit represent column number as shown in Fig. 3. Regarding performance, this pattern is good even under shading conditions. In this configuration, the modules relocation occurs irrespective of electrical connections. The physical relocation of modules is limited by increase in the cost of wires.

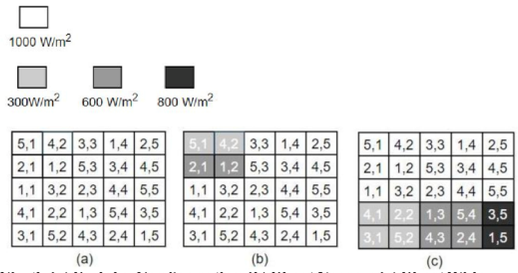


Fig. 3. (a) Sudoku Configuration (b) Short Narrow (c) Short Wide

III. Results And Analysis

To attain the performance of various configurations of a 5x5 photovoltaic system, it is subjected to short narrow and short wide shading patterns. Here, it is considered that the panels which are not shaded get 1000 W/m^2 irradiation and the panels which are shaded get 300 W/m^2, 600 W/m^2, 800 W/m^2 irradiation.

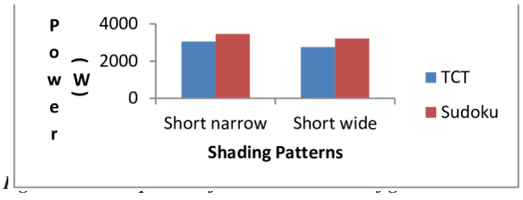
Table 1 and table 2 represents comparison between simulated values of power and mismatch losses of TCT and Sudoku under short narrow and short wide shading pattern respectively.

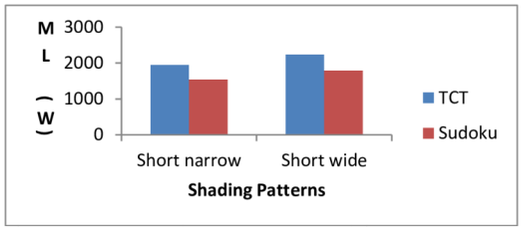
Table 1. Comparison of TCT and SuDoKu configurations undershort narrow pattern

Configurations	Power (W)	Mismatch losses (W)
TCT	3050	1950
Sudoku	3459	1541

Table 2. cc ndershort wide pattern

Configurations	Power (W)	Mismatch losses (W)
TCT	2761	2239
Sudoku	3210	1790





IV. Conclusion

This paper observes that TCT arrangement overcomes the issues of affecting the whole string under shading conditions but SuDoKu pattern works more efficiently during shading condition. Table 1 and table 2 represents comparison between simulated values of power and mismatch losses of TCT and Sudoku under short narrow and short wide shading pattern respectively which indicates that Sudoku has more output power and less mismatch losses as compared to TCT configuration. The results have been verified by Matlab / Simulink.

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Review on Reliability of Multi-State Systems

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Abstract

This paper provides an overview of research conducted on the reliability of multi-state systems. Multi-state systems refer to systems that can exist in multiple operational states, each with different levels of performance or functionality. The review focuses on the key concepts, methodologies, and advancements in analyzing and evaluating the reliability of such systems. The aim is to summarize the existing body of knowledge, identify research trends.

Keywords : *Multi state system, Reliability, Failure rate, Mean time to failures (MTTF), Availability, Markov models, Fault tree analysis (FTA).*

1. Introduction

Multi-state systems are complex systems that can exist in multiple operational states, with each state representing a different level of performance, functionality (Lisnianski and Frenkel, 2015). Unlike traditional binary systems that are either functioning or failed, multi-state systems offer a more effective perspective by allowing for various states that capture the system's condition or behavior. Multi-state systems analysis extends binary-state system analysis and is a new subject in system reliability. This extension is made mainly because i) many types of components cannot be treated as a binary state; ii) in many cases, not only the good/bad states of the system but also the performance levels should be considered; iii) any system can be modeled as a multi-state system. It applies not only to system reliability but also to measures of system performance (Janan, 1985).

1.1 Definition and Characteristics of Multi-State Systems

Here are the key definitions and characteristics of multi-state systems:

(i) Operational States: Multi-state systems have multiple operational states, which represent different levels of performance or functionality. Each state corresponds to a specific condition or behavior of the system. These states can range from fully functional to partially functional, degraded, or completely failed.

(ii) Transition Probabilities: Multi-state systems are characterized by transition probabilities, which define the probability of moving from one state to another. These probabilities reflect the system's behavior over time and can be influenced by factors such as component degradation, external events, maintenance actions, or environmental conditions.

(iii) Degradation and Repair: Multi-state systems often exhibit gradual degradation or wear-out of components over time. As components deteriorate, the system may transition to different states, reflecting the varying levels of performance or reliability. Repair or maintenance actions can also change the system's state by restoring or improving its functionality.

(iv) Performance Measures: Multi-state systems employ a range of performance measures to quantify their reliability, availability, maintainability, and other related metrics. These measures can include probabilities of being in different states, mean time to failure (MTTF), mean time to repair (MTTR), availability, and system uptime.

(v) System Complexity: Multi-state systems are typically characterized by complexity due to the presence of numerous components, subsystems, and interdependencies. The behavior of the system as a whole is influenced by the interactions and dependencies among its constituent parts, making reliability analysis and modeling challenging.

1.2 Importance of Reliability Analysis for Multi-State Systems

Reliability analysis plays a crucial role in understanding and managing the performance and dependability of multi-state systems. Many authors discussed the importance of reliability analysis for multi-state systems such as Wang and Pham (2006), Apeland et al. (2016), Ram (2013). Here are the key reasons highlighting the importance of reliability analysis for such systems:

(i) Performance Evaluation: Reliability analysis allows for a comprehensive evaluation of the performance of multi-state systems. By considering the different operational states and their probabilities, it provides insights into the system's behavior, including the frequency and duration of different states. This information aids in assessing the system's overall performance, identifying critical states, and understanding the impact of component failures or degradation on system behavior.

(ii) System Optimization: Reliability analysis helps optimize multi-state systems by providing insights into maintenance strategies and resource allocation. By quantifying the probabilities of different states and their transitions, it assists in determining the optimal timing and type of maintenance actions, such as preventive maintenance, repair, or replacement. This enables efficient utilization of resources, minimizing downtime, and maximizing system availability and performance.

(iii) Risk Assessment: Multi-state systems are subject to risks associated with different operational states and their consequences. Reliability analysis allows for the identification and assessment of these risks. By analyzing the probabilities and consequences of various states, it helps in understanding the potential impact on system performance, safety, and overall mission success. This information aids in developing risk mitigation strategies and making informed decisions to enhance system reliability and safety.

(iv) Decision Support: Reliability analysis provides decision-makers with essential information for making informed choices related to multi-state systems. By quantifying the probabilities and impacts of different states, it facilitates decision-making regarding maintenance planning, system upgrades, investments in reliability improvements, and overall system design. It helps stakeholders understand the trade-offs between system performance, costs, and other factors, supporting effective decision-making.

(v) System Design and Improvement: Reliability analysis plays a crucial role in the design and improvement of multi-state systems. By considering the probabilities of different states and their transitions, it aids in identifying weak points, vulnerabilities, and areas for improvement. Reliability analysis techniques, such as fault tree analysis and reliability growth modeling, assist in identifying critical components, failure modes, and potential design modifications to enhance system reliability and performance.

2. Types of Multi-state System Reliability Models

The analysis of the system should be conducted to develop the reliability models. The analysis has following steps:

(i) Develop a block diagram of the system based on working of the system.
(ii) Develop the logical relationships between functional component of the system.
(iii) Determine the scope in which a system can operate

in a degraded state, based on the performance assessment of the system's study.

(iv) Define the standby and repair strategies.

Based on the above analysis, a reliability block diagram is developed, which is used to estimate various reliability measures. The reliability block diagram (RBD) is a graphic method or pictographic way of demonstrating how component reliability contributes to the success or failure of a redundant. A system reliability block diagram presents a logical relationship between the system, subsystems, and components.

2.1 Series System Reliability Model

In a series configuration, the failure of any component will cause the failure of the entire system. This implies that all the components must operate successfully to make the system function or operate continuously (Ebeling, 2004). Thus, a series system is also an *n*-out-of-*n* or (*n*, *n*) system. The reliability block diagram of a series system is shown in Figure 1.

Figure 1. Reliability block diagram for the component in the series.

If there are *n* components in series and the reliability of each block is denoted by $R_i(t)$, then the resultant reliability of *n* components connected in series is given by

$$R(t)_{series} = R_1(t).\,R_2(t)\ldots\,R_n(t) = \prod_i R_i(t),\ i = 1, 2, \ldots, n \quad (1)$$

From Equation (1), it is clear that the reliability of the series system decreases as the number of subsystems or components increases.

Example of the series system are:

- The airplane electronic system consists of a sensor sub-system, a direction sub-system, a computer sub-system, and the fire controller sub-system. This system will work only if all these are functioning simultaneous.
- A simple computer consists of a processor, a bus, and a memory. The computer will operate only if all three are operate correctly.
- Deepawali or Christmas glow bulb is work when all bulb operates successfully.

2.2 Parallel System Reliability Model

In a parallel configuration, at least one component is sufficient to function or operate successfully of the system. This implies that the entire system will fail only when all components of the system failed (Ebeling, 2004). Sometimes, the parallel system is called a 1-out-of-*n* or (1, *n*) system, which means that only one (or more) out of n subsystems has to function for the system to be functional. The reliability block diagram of a parallel system is shown in Figure 2.

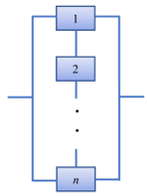

Figure 2. Reliability block diagram for the component in parallel.

The reliability of a component can be enhanced by increasing one or more similar components in parallel. If there are n component in parallel and the reliability of each block is denoted by $R_i(t)$ then the resultant reliability of n component connected in parallel is given by

$$R(t)_{parallel} = 1-\left[\{1-R_1(t)\}\times\{1-R_2(t)\}\times\{1-R_3(t)\}\times\ldots\times\{1-R_n(t)\}\right] = 1-\prod_{i=1}^{n}\{1-R_i(t)\} \quad (2)$$

Examples of the parallel system are:

- An airplane with four engines.
- A laptop with a power source or battery.

2.3 Mixed Configuration System Reliability Models

In the mixed configuration, the components are arranged both in series and parallel configuration to perform a system to be operational (Stracener, 1997). In such types of systems, the network has both the rules of series and parallel configuration. They are also divided into two types:

(i) Series-parallel Configuration

A series-parallel system is a system in which m subsystems are connected in series and each subsystem consist of n component connected in parallel. The failure in the series-parallel system occurs when all of the n components of any sub-system have failed (Stracener,

1997). To evaluate the reliability of these systems, break the network into a series of sub-systems as shown in Figure 3.

Singh et al. (2013) studied a series system with two units in which each unit is controlled by its controller, using a simple probabilistic approach and the supplementary variable technique. They found the important reliability measures and analyzed the cost-benefit of the system including the service cost. Dao et al. (2014) considered selective maintenance for the multi-state series-parallel system under different conditions.

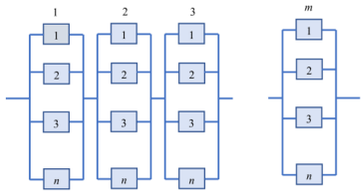

Figure 3. Reliability block diagram for a series-parallel system.

(i) Parallel-series Configuration

A parallel-series system is a system in which *m* subsystems are connected in parallel and each subsystem consist of *n* component connected in series. Redundant components are added to the parallel-series system to improve the reliability of the system. The reliability of such types of systems can be determined after breaking the network into parallel sub-systems as shown in Figure 4.

Dhillon and Rayapati (1985) discussed four newly developed Markov models for evaluating reliability and mean time to failure of non-maintained parallel system with different type of failures. Nandal et al. (2015) evaluated the reliability and mean time to system failure (MTSF) of parallel-series system systems with exponential failure laws.

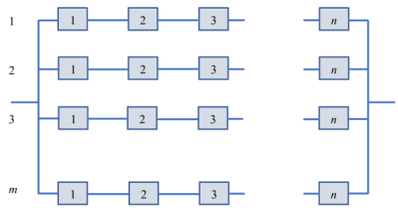

Figure 4. Reliability block diagram for a parallel-series system.

2.4 *k*-out-of-*n* Systems

A system consisting of n components is called a *k*-out-of-*n* or (*k*, *n*) system if the system only operates when at least *k* or more components are in an operating state. The *k*-out-of-*n* system is the generalization of *n*-component parallel system. The *k*-out-of-*n* system is drawn similar to the parallel system, but in this case, at least *k*-out-of-*n* identical and independent component ($1 \le k \le n$) need to be functioning for the system to be operate (O'Connor and Kleyner, 2012).

If the reliability of each identical and independent components is denoted by *R* then the reliability of (*k*, *n*) structured system is given by:

$$R_{k,n}(t) = \frac{n!}{k!(n-k)!} R^k (1-R)^{n-k}$$

k-out-of-*n* systems generally follows binomial law when one evaluates the reliability of the *k*-out-of-*n* systems. Further, when $k = 1$, *k*-out-of-*n* systems turn into a parallel system, and if $k = n$, *k*-out-of-*n* systems become a series system.

The reliability of a *k*-out-of-*n* system has turned out to be more important because of its interest in many systems to find anticipated efficiency. *k*-out-of-*n* system has an inclusive use in every sphere of the industrial sector. *A k*-out-of-*n*: *G* redundancy implies that for the proper functioning of a system at least *k* components are required to be work properly and if less than *k* components are in a good state then the system goes into the failed state. Similarly, a *k*-out-of-*n*: *F* redundancy means that if *k* component out of *n* is failed then the system is failed, i.e., to operate the system at least (*n*-*k*+1) component will work properly.

A lot of research has been done in the area of *k*-out-of-*n*: *G/F* configurations (Zuo, 1993; Cai, 1994; Hong et al., 2002; Xing et al., 2012; Kumar et al., 2013). Barlow and Heidtmann (1984) computed reliability of *k*-out-of-*n* system. Ram and Singh (2008) analyzed a system which has two subsystems, one is of 1-out-of-2: *F* and the other is 1-out-of-*n*: *F* configuration, under preemptive-resume repair policy with repair priority to the first subsystem and found the expression for system reliability, availability, MTTF and cost analysis.

Eryilmaz (2012) discussed the mean residual life function for *k*-out-of-*n*: *G* system with a cold standby unit. The mean residual life function is a famous characteristic in reliability theory and has been widely used in dynamic reliability analysis. Mishra and Agarwal (2013) studied the steady-state availability of *k*-out-of-*n*: F and secondary subsystem and discussed the different cases of repair distribution. Permila and Munday (2016) analyzed a 2-out-of-2: *G* system with a cold standby and derived some performance measures like MTTF, availability, cost analysis of the system, using semi-Markov process and regenerative point technique. Larsen et al. (2020) provided some definitions of multi-performance weighted components and proposed two multi-performance multi-state *k*-out-of-*n* system models, also authors used universal generating technique for the reliability evaluation of such systems.

2.5 Standby Redundant Systems

Redundancy is a technique that is used to enhance the performance of a system (Dhillon, 2002). Redundancy plays an important role to improve system reliability. It is the duplication of critical component or function of a system to assure high reliability of the system and decreases the risk of failure, especially during the early stages of product life. In a *n* unit standby redundant system with, only one unit is on-line at a time and when it fails, it is automatically or physically replaced by a standby unit. This process continues until all (*n*-1) standby units have been exhausted. Standby redundancy is also known as backup redundancy and the improvement effect is similar to but greater than, that of parallel redundancy (Kumar and Agarwal, 1980). Standby units are classified as follows (Li, 2016):

- **Active Redundancy or Hot Standby**: The hot standby unit is running simultaneously with the main unit and takes a load of the main unit immediately when the main unit has failed. The failure rate of the hot standby unit is the same as the main unit and switching time of the hot standby unit is negligible.

- **Passive Redundancy or Cold Standby**: The cold standby unit is only called when the main unit has failed. The cold standby unit takes some switching time.

- **Warm Standby**: The warm standby unit is also, only called when the main unit has failed. The changeover time of warm standby is much smaller than cold standby. The failure rate of the warm standby unit is less than the main unit.

During the last few decades, several authors (Goyal and Murari, 1984; Rander et al., 1991; Wang et al., 2006; Levitin et al., 2014) have concentrated on the analysis of standby systems. These system models are analyzed with respect to their various reliability characteristics like mean time to system failure, availability, mean time to repair (MTTR), maintainability, busy period, etc. Dhillon and Yang (1993) considered a two-unit parallel system with one standby unit under critical and non-critical human error. In this approach, the authors developed expression for steady-state availability of the system. Oliveira et al. (2005) discussed the behavior of a safety system whose components are under aging with imperfect repair.

Kumar and Ram (2016) considered the mixed configuration of standby and k-out-of-n redundancies and evaluated various reliability characteristics. Fard et al. (2017) analysed a one-unit repairable system having standby with imperfect coverage and calculated the reliability measures with the help of fuzzy parameters. Chen and Wang (2018) explored the study of repairable machining system having warm standby, with single repair and N policies. Zheng et al. (2018) analysed the sensitivity analysis of the real-time Markovian model having standby redundancy.

3. Reliability Measures for Multi-State Systems

Reliability measures are essential for assessing the performance and dependability of multi-state systems. They provide quantitative indicators that help evaluate the system's reliability, availability, maintainability, and other related characteristics. Here are some commonly used reliability measures for multi-state systems:

3.1 Reliability

Reliability is the overall uniformity of a measure. A measure is said to have high reliability if it gives similar results under consistent conditions. It is determined by dividing the total operating time of the asset by the number of failures over a given period (Balaguruswamy, 1984).

If T indicates lifetime or time till the failure, which is a random variable, then the probability that it will not fail under given operating conditions before time t is:

$$R(t) = P(T \geq t)$$

This implies that reliability is a function of time. Since $R(t)$ is a probability measure, it always satisfies the following conditions.

a) $0 \leq R(t) \leq 1$
b) $R(t) = 1$; if $t = 0$, it is expected that the system was operating at time $t = 0$.
c) $R(t) = 0$; if $t = \infty$, no system can operate without failure.

Reliability can be also obtained in term of failure density function $f(t)$:

$$R(t) = 1 - F(t) = 1 - \int_0^t f(t)dt = \int_t^\infty f(t)dt$$

where, $F(t)$ = cumulative distribution function,
$f(t)$ = failure density function.

3.2 Availability

Availability is a very important characteristic in computing the performance of repairable systems. Availability uses both reliability and maintainability properties (Dhillon, 2002). Availability is also a probability that a system is available for a specified period of time (uptime). The value of availability lies between 0 and 1 at any time t.

$$\text{Availability} = \frac{\text{uptime}}{\text{uptime} + \text{downtime}}$$

Availability can be classified as:
a) Point Availability
b) Steady-State Availability
- Inherent Availability
- Achieved Availability
- Operational Availability

c) Mean Availability

3.3 Mean Time to Failure (MTTF) or Expected Life

Mean time to failure (MTTF) is the total lifetime of the component or system. Also, MTTF represents the length of time that an item is expected to last in operation until it fails (Dhillon, 2002). It is defined as

$$\text{MTTF} = \int_0^\infty R(t)dt$$

MTTF is also equivalent to

$$E[T] = \text{MTTF} = \int_0^\infty tf(t)dt$$

$E[T]$ is also known as the mean time to failures (MTTF) when the product shows a constant failure rate; that is, the failure probability density function follows an exponential distribution. The MTTF should be used only when the failure distribution function is specific because the value of the reliability function at a given MTTF depends on the probability distribution function.

3.4 Expected Profit

If k_1 denotes revenue per unit time and k_2 is the service cost of the system per unit time, then the expected profit $E_p(t)$ during the interval $(0, t]$ is given by the following expression (Pandey and Jacob, 1995):

$$E_p(t) = k_1 \int_0^t P_{up}(t)dt - k_2 t$$

3.4.1 Revenue Cost

Revenue is defined through what amount of income that a company decides for a system sale including all types of tax, wet, and discounts during a particular time without the deduction for returned merchandise. Total revenue for a system can be calculated as the product revenue per unit uptime of the system and the probability of the upstate of the system or availability of the system within the specific time $(0, t]$.

3.4.2 Service Cost

The service cost includes repair and maintenance expenses. The cost experienced to repair or restore a failed system or component within the given time is known as repair cost while the cost of maintenance to keep the system in a perfectly operable condition is described as the maintenance cost. If a brake wire of a bike is damaged, the cost of repair to damaged brake wire is an example of repair cost or service cost.

3.5 Failure Mode

The partial or total loss in the properties of a device in such a way that its working is seriously affected or completely stopped is called failure (Balaguruswamy, 1984; Srinath, 2001). Evaluation of reliability of a system becomes easier with the concept of failures and their details. Generally, some components have well-defined failures while others do not. The more complex a system is, the more failure mode there is.

In the beginning, when the item or component is put into operation, the rate of occurrences of the failure is high, which is called infant failures or early failures. These happen due to manufacturing or processing faults. Constant failures can be seen on a component for a longer period known as catastrophic failures or service failures and characterized by a constant number of failures per unit of time. With time, the item begins to go down and the rate of failures increases rapidly due to wear and tear with the usage. These types of failures are called wear-out failures (Ebeling, 2004). These three regions of failures could be represented by a graph known as the bathtub curve as shown in Figure 5.

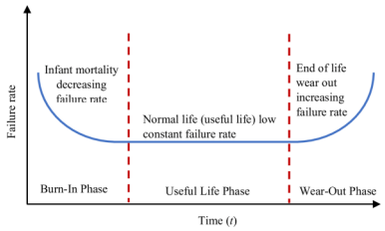

Figure 5. Bathtub failure rate curve

4. Methods and Techniques for Reliability Evaluation of Multi-state Systems

In this section, some methods which are used for reliability evaluation and the techniques that improve the reliability of the system are discussed.

4.1 Markov Process

Markov process is a very effective tool to analyze random events that depends on each other. It is the most powerful technique in the field of reliability, which helps in calculating various system's performance measures. The Markov method works well when failure and repair rates are constant but it can also deal with some systems having time-dependent failure and repair rates (Shooman, 1968). It was named after the Russian Mathematician "Andrei Andreyevich Markov" (O'Connor and Kleyner, 2012).

The properties of the Markov method are:

- It is a process in which the future state of the system depends only on the present state of the system and not at all about the states of the system had before.
- Every time, anyone is in a state, the next move is purely random to decide where to go next.

So, a "continuous-time and discrete state" stochastic process that fulfills the Markov property is called the Markov process. The Markov method is based on the following assumptions: (Dhillon, 2002; Gnedenko et al., 1969).

- The transitional probability in the time Δt from one system state to another is given by $\lambda\Delta t$, where λ is a constant failure rate and its dimensions are occurrence per unit time. If all failure rates are constant then the system is called a homogeneous system, if any failure is time-dependent, the system is known as non-homogeneous.
- The transition probability of two or more occurrences in time Δt are of higher-order and can be neglected. (e.g., $(\lambda\Delta t)(\lambda\Delta t)\rightarrow 0$).

4.2 Laplace Transform

Markov models always control the set of first-order differential equations. For a simple model, these equations are easily solved by the conventional method. But for a complex model, these equations become coupled and it is not easy to solve these equations. The easiest way to solve such type of equations is the use of Laplace transforms. Laplace transformation is a very useful mathematical tool for solving ordinary differential/partial differential equations under given initial and boundary conditions (Dhillon, 2002).

Laplace transform is used to convert the differential equation into an algebraic equation in terms of the

Laplace variable and then by taking the inverse Laplace transform, one can gets the solution of given initial/boundary value problem. Through this process, one can get the direct solution of the given initial/boundary value problem rather than finding the general solution.

If $f(t)$ be a given time function and defined for every $t \geq 0$ then the Laplace transform of the time function $f(t)$, is given by

$$L\{f(t)\} = F(s) = \int_0^\infty f(t)e^{-st}dt$$

The solution in terms of s is then converted back into a time function by taking its inverse Laplace transform as $L^{-1}\{F(s)\}$ or, $f(t)$,
where, t = time,
s = Laplace transform variable,
$F(s)$ = Laplace transform of $f(t)$.

4.3 Supplementary Variable Technique

The supplementary variable technique is applied to convert the non-Markovian character of the system to Markovian by introducing one or more supplementary variables. It was firstly used by Cox (1995) to solve the M/G/1 queening model and in the field of reliability, it was firstly used in 1963 by Gaver.

This technique can briefly describe as: consider a complex system, in order to discuss reliability measure of the complex system, our first concern is the failure and repair rates of the system. At time t, the system can be either in the operational or in the failed stage. If the system is in a failed stage at time t then the probability of the transaction to the operable stage cannot be determined unless the elapsed repair time at that time t is specified. Now, introduce a supplementary variable x representing the elapsed repair time during the time interval $(x, x+t)$. After applying the supplementary variable, this process becomes Markovian in character. It is remarkable to note that such supplementary variable automatically disappears at the solution stage.

4.4 Copula Technique

Copula is a word that comes from the Latin language, it has the meaning link or tie but it is not related to grammar. In statistics and probability theory, copulas are used to describe a relation between random variables or join or couple the multivariate distribution function and their fixed one-dimensional distribution function. The word copula was introduced by Sklar (1973). Copulas are the functions that connect multivariate distribution functions to their one-dimensional marginal distribution functions (Nelsen, 2007). If F is an m-dimensional cumulative distribution function with one-dimensional margins $F_1, F_2, \ldots\ldots\ldots, F_m$ then there exists an m-dimensional copula C such that

$$F(y_1, \ldots\ldots, y_m) = C(F_1(y_1), \ldots\ldots F_m(y_m))$$

where, An m-dimensional copula is a function such that

$$C: [0,1]^m \longrightarrow [0,1]$$

The copula approach is very natural for the complex system which is repaired by couple of ways. An important and nice property of the copula distribution is its invariance under strictly increasing transformations of the marginal (Durante and Sempi, 2010). The copula approach includes specifying the marginal distribution of each random variable along with a function that connects them. Copula function fully describes the dependence structure between two or more random variables. The use of copulas therefore splits a complicated problem (finding a multivariate distribution) into two simpler tasks. The first task is to model the univariate marginal distribution and the second task is finding a copula that summarises the dependent structure between them (Trivedi and Zimmer, 2007).

Formally, a two-dimensional copula is a function $C: [0,1]^2 \rightarrow [0,1]$ that satisfies following conditions:
a) $C(u, 0) = C(0, v) = 0$ (C is grounded)
b) $C(u, 1) = u$ and $C(1, v) = v$ (consistent with margins)
c) For any $u_1, u_2, v_1, v_2 \in [0, 1]$ with $u_1 \leq u_2$ and $v_1 \leq v_2$
$C(u_1, v_1) + C(u_2, v_2) - C(u_1, v_2) - C(u_2, v_1) \geq 0$
Intuitively, this last property ensures that the density of a copula is non-negative (Rodriguez, 2007).

Types of Copulas

There are three types of copulas given as:
a) **Archimedean Copulas** (Jaworski et al., 2010)
An m-dimensional copula C is called the Archimedean if

it follows the following expression

$$C(u_1,u_2...u_n)=\psi\left(\psi^{-1}(u_1)+\psi^{-1}(u_1)+...\psi^{-1}(u_n)\right),$$

where, ψ: [0, 1] → [0, ∞) is a decreasing and continuous function called Archimedean generator with the property $\psi(1)=0, \psi'(t)<0$.

Archimedean copula is further classified into the following three copulas-

● Gumbel-Hougaard Copula

Gumbel-Hougaard copula is defined as

$$C(u_1,u_2;\theta)=exp\left(-\left(\sum_{i=1}^{2}(-\log(u_i))^{\theta}\right)^{1/\theta}\right),$$

where, θ is the dependence parameter and $\theta\in[1,\infty)$.

The value of θ =1 corresponds to the independence copula and θ tends to +∞ correspond to the comonotonicity copula (Nelsen, 2003). Gumbel-Hougaard copula does not allow negative dependence. Gumbel-Hougaard copula came from the work of Gumbel and has further studied by Hougaard, that's why its name is Gumbel-Hougaard family of copula.

● Mardia-Takahas Clayton Copula

Clayton copula also referred to as the Cook and Johnson copula and is defined as (Nelsen, 2003):

$$C(u_1,u_2;\theta)=(u_1^{-\theta}+u_2^{-\theta}-1)^{-1/\theta}, \qquad 0<\theta<\infty$$

● Frank Copula (Nelson, 2003)

The standard expression for this family of *d*-copulas is

$$C(u_1,u_2..u_n)=-\frac{1}{\theta}\log\left(1+\frac{\prod_{i=1}^{n}(e^{-\theta u_i}-1)}{(e^{-\theta}-1)^{n-1}}\right)$$

b) Gaussian Copula

Gaussian copula is a distribution over a unit cube $[0,1]^d$. It is very helpful for the modeling of high-dimensional work because it extends to arbitrary dimension and is rich in parameters, which facilitates their fitting to data (Jaworski et al., 2010). Gaussian copula is defined as

$$C^{Ga}(u)=\phi_R\left(\phi^{-1}(u_1),...,\phi^{-1}(u_d)\right), \qquad R\in[-1,1]^{d\times d}$$

where, ϕ^{-1} is the inverse cumulative distribution function and ϕ_R is the joint cumulative distribution function.

c) Marshall-Olkin Copula

Marshall-Olkin copula distribution is a family member of the continuous multivariate probability distribution with a positive-valued component. In reliability theory, the Marshall-Olkin copula models are the dependence between random variables subjected to Poisson (external) shock (Matus et al., 2018). If X_1 and X_2 are the random variables of the replacement of two-component then the parameters of these random variables are $\lambda_1+\lambda_{12}$ and $\lambda_2+\lambda_{12}$.

Many researchers (Srinivasan and Gopalan, 1973; Gopalan, 1975; Srinivasan and Subramanian, 2006; Hu et al., 2017; Chen, 2018; Niwas and Garg, 2018) studied on multi-states system and talked about the reliability, availability, MTTF, and cost analysis of the system with various types of failures and one type of repair. But, when one type of repair is utilized to repair the failed system, it occupies more time for repair, resulting the organization suffered with a big loss. It has been seen in many systems that more than one repair is possible between two transition states. In this situation, copula distribution has been used to evaluate the reliability of the system.

In advanced research in reliability theory, many techniques improve reliability measures. Many researchers have used the copula technique to improve the reliability of the system. In the area of copula distribution, a lot of work has been done by many researchers (Nelsen, 2003; de Melo Mendes and de Souza, 2004; Hu, 2006; Genest and Favre, 2007). A special case of copula distribution is Gumbel-Hougaard copula distribution, which is used to connect bivariate distribution functions into their one-dimensional marginal distribution.

Patton (2009) presented the application of copulas in the modeling of financial and economical time-series. Ram and Singh (2012) analyzed the cost-benefit of a parallel redundant system under the first come first serve policy (head-of-line repair policy) using the Gumbel-Hougaard family copula and obtained various reliability characteristics like state transition probabilities, MTTF, and cost-benefit of the system. Ram et al. (2013) discussed the waiting for repair concept in a standby system with two types of repair policies namely general

and Gumbel-Hougaard family copula and developed the reliability characteristics using the Markov process and supplementary variable technique. Goyal et al. (2018) discussed the reliability characteristics of elevator systems with coverage and two types of repair facility by employing the copula technique. Chopra and Ram (2019) used copula distribution to calculate the availability, reliability, MTTF, and profit analysis of two non-identical units parallel system with common cause failure and human failure.

4.5 Fault Coverage Technique

Fault coverage defines the ability of the method to handle the fault in various components of a system. Failures happen in any system caused by an error while error exists due to various types of faults. So, the fault is the first stair of the chance of occurrence of the failure in the system. The performance of a system depends on the several failures of the system and the failure depends on the fault that occurred in the system (Dugan and Trivedi, 1989). Therefore, a system can be made more reliable by controlling or covering the faults of the system with the coverage probability or coverage factor c. The technique of covering the faults is called the fault coverage technique and the incorporated system is called the fault tolerance system. Arnold (1973) introduced the concept of covered fault and discussed the importance of these faults. The coverage factor is the probability of the system recovery to the fault occurs i.e., Coverage factor = probability (system recovery from fault/fault occurs in the system).

Since coverage factor is a probability, so, its value lies between 0 and 1. The coverage factor can be perfect or imperfect for different systems. Perfect coverage means a hundred percent of the detected faults in the system can be covered by the addition of some spares to attain the desired reliability of the system i.e., the value of coverage factor c is unity. Imperfect coverage means some of the detected faults can be covered in the system with probability c but some of the detected faults remain in the system as it is that cannot be covered. This technique generates a state in which the number of faults is reduced by the probability (1-c). The fault coverage that is used to measure the productivity of the system is imperfect fault coverage because the validation of the system depends on the efficiency of their fault mechanism (Powell et al., 1995). In the case of imperfect coverage, the system has a limit of maximum achievable reliability. Hence, to improve system reliability, one should not only add additional redundancy but also improve the coverage factor.

Remarkable work on fault coverage approach has been found in the literature (Levitin and Amari, 2008; Peng et al., 2013; Ram and Goyal, 2018). Pham (1992) calculated the MTTF of a high voltage (HV) system having a power supply and two transmitters under the concept of dependent failure rate and imperfect coverage. Levitin and Amari (2007) evaluated the reliability characteristics of fault tolerance systems with multi fault coverage using the universal generating function technique. Prabhudeva and Verma (2007) studied the general coverage model (GCM) based on hardware independent fault. GCM helps to perform failure mode effect analysis of a complex system.

A two-unit warm standby system has been analysed by Ke et al. (2010) to evaluate the availability with imperfect repair. Choudhary and Agarwal (2012) studied on the two-unit repairable system by incorporating the concept of coverage factor and evaluated the fuzzy availability and fuzzy mean time to failure. Ram and Goyal (2018) studied on flexible manufacturing system under a combinatorial copula-coverage approach and have shown that the mixed copula-coverage technique improves the reliability of the system. Chatterjee and Shukla (2019) presented an imperfect debugging phenomenon to model the reliability growth of software with and coverage factor and check the effect of different environmental factors on the models' parameters by sensitivity analysis.

5. Conclusion

This paper presents a comprehensive overview of research on the reliability of multi-state systems, highlighting key concepts, methodologies, and advancements in the field. By summarizing existing

knowledge and identifying research trends, this review provides valuable insights into the evolving approaches used to analyze and evaluate multi-state system reliability. Future research can build upon these findings to develop more efficient models and techniques, further enhancing the understanding and optimization of system performance across various operational states. Also, this paper explores the incorporation of the Gumbel-Hougaard copula in reliability analysis, demonstrating its effectiveness in modeling dependencies within multi-component systems. By capturing the interdependencies between system components, the Gumbel-Hougaard copula enhances the accuracy of reliability assessments compared to traditional methods.

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Hybrid Movie Recommendation System

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Abstract

Today, recommendation system is used in our daily life. However, they are far from perfect. In this project, we will try to understand various types of recommender systems by comparing their results with other datasets. We will develop a scalable model to perform statistics. We start by developing and comparing different types of prototypes on a smaller dataset of 1000 reviews. Then we try to evaluate the system so that it can handle 200 reviews using MS SQL server. We learned it to have a concise data set, the implementation of user-based collaborative filtering results with better output and efficiency. A recommendation system is an information filtering tool that wants to predict the ratings of users and articles, mainly from big data, to suggest their likes. The movie recommendation system provides a mechanism for users to rate users with similar interests. This makes the referral system a core partof e-commerce websites and apps. This article focuses on movie recommender systems with the main objective of proposing a recommender system through data clustering and computational intelligence.

Keywords : *Recommendation System, Movie Recommendation, content based, collaborative filtering*

I. Introduction

A recommender system is a type of information filtering system that assumes user preferences and makes recommendations based on their preferences. Currently, a wide range of referral system applications are available. The popularity of recommendation systems is gradually increasing day by day and is implemented on almost all online platforms. Typically, these systems can retrieve and filter information based on user preferences and can use this data to make their recommendations in the coming period. Due to the advancement of the referral system, users always expect better results. They have a low advantage over services that are incapable of making sensible recommendations. If a music streaming app can't predict and play a song based on a user's preferences, the user will simply stop using it. This has resulted in technical companies being very focused on fine-tuning their recommendation structure. But, the problem is more complicated than it looks. Every user has different preferences. In addition, even the taste of a single customer can differ depending on many aspects, such as mood, season, or type of activity the user is performing. For an instance, the type of music one would prefer to listen during exercising varies critically from the type of music he would listen to while preparing dinner. They must discover new areas to determine more about the customer, whilst still

determining almost all of what is already known about of the customer. Two critically important methods are widely used for recommender systems. One is content-based filtering, where we try to shape user preferences using retrieved data and recommend items based on that profile. The other is collaborative filtering, where we try to group similar users together and use data about the group to make recommendations to the customers. [1]

II. Related Work

MOVREC [2] is a movie recommendation system introduced by D.K. Yadav et al. based on collaborative filtering. Collaborative filtering uses user-suppliedinformation. This information is analyzed and a movie is recommended to users who are ranked with the highest rated movie first. Luis M Capos [3] et al analyzed two traditional recommendation systems, content-based filtering and collaborative filtering. Since both have their own disadvantages, he proposed a new system which is a combination of Bayesian network and collaborative filtering. A hybrid system presented by Harpreet Kaur et al. [4]

The system uses content mixing as well as a collaborative filtering algorithm. The setting of the films is also taken into account when introducing. User-to-user relationships and user-to-item relationships play a role in the recommendation.

User-specific or item-specific information grouped together to form a cluster by Utkarsh Gupta et al. [5] usingchameleon. This is an efficient technique based on hierarchical clustering for recommendation system. To predict the rating of an item, a voting system is used. The proposed system has lower error and better clustering of similar elements. Urszula Kużelewska et al. [6] group suggestions to deal with the recommender system. Two methods of calculating cluster representation have been presented and evaluated. The Centroid-based solution and the memory-based collaborative filtering method were used as the basis for comparing the performance of the two proposed methods. As a result, the accuracy of the generated suggestions has increased significantly compared to the centroid-only method. Costin Gabriel Chiru et al. [7] recommend Movie Recommender, a system that uses known user information to provide movie recommendations. This system tries to solve the problem of unique recommendations because it ignores specific user data.

The user's psychological profile, his viewing history and data related to watching movie scores from other websites are collected. They are based on an overall similarity calculation. The system is a hybrid model that uses both content-based filtering and collaborative filtering. To predictthe difficulty level of each case for each practitioner Hongli LIn et al. proposed a method known as Content Based Collaborative filtering (CBCF). The algorithm is divided into two phases, the first is content-based filtering to augment the existing trainee case review data, and the second is collaborative filtering to provide final predictions. The CBCF algorithm deals with the advantages of both CBF and CF, while overcoming their disadvantages.

III. The Proposed System

To prepare for the design of the movie recommendation system, we decided to analyze the different approaches in the literature with the aim of learning and understanding the advantages and disadvantages of each approach. After our analysis, we decided to go with a hybrid approach that combines both collaborative filtering and content-based filtering techniques. Such an approach would overcome the limitations of content-based and collaborative filtering, exploiting the advantages of both techniques.

The two-part hybrid recommendation set is quite efficient, but under certain data and domain characteristics, different hybrids can achieve different results. For our planned recommendation system, we decided to try a way to include content-based descriptors in collaborative filtering by combining content features (keywords and tags) and user ratings. More specifically, content features will be used to enhance collaborative filtering.

IV. Algorithms And Flow Chart

Algorithm we have used for recommendation system are

➢ **Content based algorithm**

The content-based system recommends items like this user has liked or suggested in the past. If articles are liked, similar articles will be featured. It rely on the properties of each element to measure similarity. Content view is based on the fact that we need to know the content of both users and items. Recommendations are based on the content of items rather than other user's opinion. [8]

➢ **Collaborative filtering**

Collaborative filtering finds a subset of users with similar experiences and interests as the target user and uses this subset to make recommendations. In this method, users with similar interests will share similar interests. If person A likes items 1, 2, 3 and B likes items 2, 3, 4 then they also have similar preferences and person A likes item 4 and person B likes item 1. It is entirely based on the past behavior and not on the present context. It is not dependent on any additional information. It is used by 'Amazon'. [8]

➢ **Item-Item collaboration**

It uses the user's item rating matrix and establishes correlations between the items. It finds items that are closely correlated and recommends the items with the highest correlation. The advantages of this method no knowledge about item features is needed. It has better stability because correlation between limited number of items instead of very large number of users. It reduces sparsely problem. [1]

➢ **K-means clustering algorithm**

K-means is one of the simple unsupervised learning algorithms that solves the well-known clustering problems. The procedure follows asimple and easy way to classify a given data set through a certain number of clusters (assume k clusters) fixed a priority. The main idea is to definek centers, one for each cluster. These centers must be placed skillfully because a different location will lead to a different outcome. So the best option is to place them as far away as possible. The next step is to take each point belonging to a given dataset and associate it with the nearest center. When there are no points pending, the first stage is completed and the group's early age is completed. At this point, we need to recalculate the new k centroids that are the centers of the resulting clusters from the previous step.

Steps:

We have provided the following steps for recommending the movies:

● Get the data of movies containing attributes title, movieid and genre.

Table 1. Get data of rating

	User_id	**Item_id**	**rating**
0	0	50	5
1	0	172	5
2	0	133	1
3	196	242	3
4	186	302	3

● Get the data from of rating containing attributes userid, movieid and rating stramp.

Table 2. Merge two datasets

	Item_id	Title
0	1	Toy story (1995)
1	2	Golden eye (1995)
2	3	Four rooms (1995)
3	4	Get shorty (1995)
4	5	Copycay (1995)

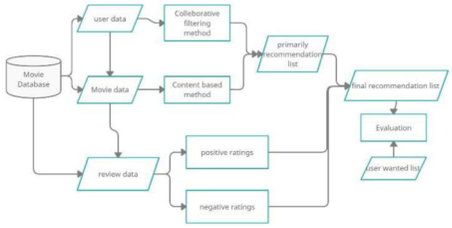
● Merge these 2 datasets together
● Create a rating data frame with average rating and number of ratings.
● Set the number of rating column with rating.

Table 3. Creating a rating data frame

title	ratings	No. of ratings
Til there was you (1997)	2.333333	9
1-900(1994)	2.600000	5
101 dalmatians	2.906257	109
12 angry man(1997)	4.344000	125
187(1997)	2.024390	41

Flow Chart:

Fig 1. Flow chart



V. Future Scope

Although this web application is well established to provide a platform for designers to comprehensively evaluate recommendation systems using different evaluation metrics, still There is much more work to be done in the 'coming' future.

● Expand to support more algorithms. The application now only supports three collaborative filtering algorithms, user-based, item-based and biased matrix-factorization.

●As the application is readily extensible for recommendation algorithms, it is expected to include more other algorithms, such as hybrid algorithms, content-based algorithms, demographic-based algorithms, etc.

●Include more evaluation criteria. In literature, there are many proposed metrics to measure the performance of recommender systems.

●In addition, there are also many different variations of a certain metric, such as multiple approaches to measuring coverage. Although a number of important metrics are available in the current system, different regions often have different requirements for evaluating performance criteria recommendation systems. Hence, it is necessary to include more evaluation metrics in the system. For example, extra metrics include serendipity, learning rate, confidence, etc.

VI. Result Analysis

Based on the proposed experimental scenarios, the following gives the results and analysis of them.

Fig 2 and Fig 3 shows the results of the proposed beyond accuracy metrics for the two algorithms, Fig 5 and Fig 5 shows the similarity of two movies which is performed on the TMDB dataset-5000 movies respectively.

1. Content Based Test Case:

In this prediction accuracy of different type movie is checked.

Fig 2. Content-based test case

```
action1      3.909247
action2      3.810282
action3      3.807445
romantic2   -2.154389
romantic1   -3.306206
romantic3   -4.376174
dtype: float64
```

2. Collaborative Filtering-Based Test Case:

In this prediction accuracy of different movie is checked based on their ratings and correlation between users and items by entering movie name.

Fig 3. Colleborative filtering based test case

```
Amazing Spider-Man, The (2012)                    3.233134
Mission: Impossible III (2006)                    2.874798
2 Fast 2 Furious (Fast and the Furious 2, The) (2003)  2.701477
Over the Hedge (2006)                             2.229721
Crank (2006)                                      2.176259
Mission: Impossible - Ghost Protocol (2011)       2.159666
Hancock (2008)                                    2.156098
The Amazing Spider-Man 2 (2014)                   2.153677
Hellboy (2004)                                    2.137518
Snakes on a Plane (2006)                          2.137396
Jumper (2008)                                     2.129716
Chronicles of Riddick, The (2004)                 2.121689
Tron: Legacy (2010)                               2.111843
Fantastic Four (2005)                             2.083022
X-Men: The Last Stand (2006)                      2.077530
Wreck-It Ralph (2012)                             2.067907
Kung Fu Hustle (Gong fu) (2004)                   2.067457
Godzilla (2014)                                   2.061653
Incredible Hulk, The (2008)                       2.050104
Quantum of Solace (2008)                          2.016189
dtype: float64
```

3. Cosine similarity:

Fig 4 and fig 5 show the similarity metrics of two movies named avatar and spectre respectively.

Fig 4. Similarity metrics of movie avatar

```
sorted(list(enumerate(similarity[0])),reverse=True,key=lambda x:x[1])[0:10]

[(0, 1.0),
 (942, 0.245071540697935 96),
 (47, 0.23675529137353302),
 (2409, 0.23190036174568118),
 (3162, 0.2231462271317343 5),
 (1216, 0.22122121613198936),
 (1444, 0.21516574145596765),
 (1920, 0.21483446221182984),
 (260, 0.21081851067789195),
 (507, 0.2099527225817517)]
```

Fig 5. Similarity metrics of movie spectre

```
sorted(list(enumerate(similarity[2])),reverse=True,key=lambda x:x[1])[0:10]

[(2, 0.9999999999999996),
 (11, 0.3921144651166975),
 (29, 0.3237996688322591),
 (1346, 0.30586777135731963),
 (277, 0.2546858159868053),
 (4077, 0.2546858159868053),
 (3166, 0.25009650646952775),
 (1134, 0.21369687880543226),
 (1723, 0.21029989116983447),
 (4343, 0.2092457497388747)]
```

Conclusion

Movie recommendation system that exists has poor performance because the recommended movie considers aspects e.g. user rated and rated movies. They have almost similar viewing tastes, by data mining and emphasis on movies based on the intersection of the three methods mentioned above, namely user-based collaborative filtering, algorithmic on content and data mining, through which users will not only get recommended movies, but this program also provides users with advanced and complex additional mentions, because movies have high scores. Poorin 'one of the movie features produced on the basis of data mining will be fine-tuned in the three-dimensional projected hybrid film recommender system large distribution platform.

A hybrid approach is applied between context-based filtering and collaborative filtering to implement the system. This approach overcomes the limitations of each individual algorithm and improves system performance. Techniques such as clustering, similarity, and classification are used to obtain better recommendations, thereby reducing MAE and increasing accuracy and precision. In the future, we may work on a combined recommendation system that uses clustering and similarity for better performance. Our approach can be extended to other domains to recommend sites for songs, videos, places, news, books, travel and e- commerce sites, etc.

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Assessment of Butanol as an Alternative Fuel Used in Diesel Engine

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Abstract

Due to rising fuel consumption and resource depletion, alternative fuels are becoming increasingly necessary. When compared to other alcoholic fuels, butanol is the most promising alternative fuel for compression ignition engines. Because of its superior physical and chemical qualities, butanol is a better option for diesel fuel mixes than other alcoholic fuels. When diesel and butanol are mixed, butanol is completely miscible in all ratios. Butanol does not absorb moisture from the surroundings since it is hygroscopic. The performance and emission characteristics of a compression ignition engine were the main focus of this investigation. Diesel and 1-butanol were used to create the combinations. Three mixes were evaluated for the experiment at 1500 rpm with different loading conditions ranging from 0% to 100% with an interval of 25%. For the experiments, a single-cylinder, four-stroke CI engine was used as test equipment. The properties of the mixtures are in the range of acceptable ASTM criteria. Performance metrics including mechanical and brake thermal efficiency are highest for the BDB10 blend at 100% BP and BSEC at 25% BP for the BDB5 blend, according to the study. There are no noticeable differences in volumetric efficiencies, and 1-Butanol concentration demonstrated a higher decrease in EGT than other substances.

Keywords : *Diesel, Butanol, Fuel blends, alternative fuels, engine performance.*

1. Introduction

One common form of alternative fuel is alcoholic chemicals. Butanol is the most widely disseminated of them, and aside from its nature, it has a low energy density and is especially hygroscopic [1]. Numerous renewable biomass sources, like the fermentation of acetone-butanol-ethanol (ABE), can be used to create butanol [2, 3]. In addition to agricultural ingredients, monomer sugars like glucose [4] and hydrolysate of wood [5] can be used to make it. Straw molasses [7] and whey permeate [6] are also used to produce butanol which provides a substantial advantage because all those resources are frequently thrown away. It involves lessening the competition between the production of food and animal feed and biofuels [8]. Butanol is superior to ethanol in terms of its chemical and physical properties. Butanol is more miscible in gasoline and diesel due to its longer alkyl chain [12]. Aside from the presence of a polar OH group, butanol is a nearly non-polar fragment. Other benefits include a higher number of cetane, a better energy density, and a lower vapor pressure. Furthermore, Because it is less corrosive and hygroscopic, it can be added to commercial fuels [13].

Table : Different characteristics of Butanol and diesel fuel [9-11]

Characteristics	Units	Butanol	Diesel
Density	g/cm^3	0.808	0.819-0.848
Specific energy	MJ/kg	34	42
Melting point	°C	-88	
Boiling point	°C	119	171-389
Auto ignition temperature	°C	324	221
Flashpoint	°C	37	>54
Cetane number	Number	27	52
Octane number	Number	95	

Few writers have examined the performance and emission characteristics of CI engines powered by 1-Butanol, despite the fact that many have studied the blending of biodiesel and diesel. The auto-ignition quality of constant volume engines using blends of n-butanol and ethanol was investigated by Magin et al. [14], who found that ethanol improves auto-ignition quality more than n-butanol does. Additionally, important properties for atomization and spray production inside the engine include surface tension and viscosity. The viscosity of butanol is about twice that of ethanol, which is quite close to the value of commercial fuels (Diesel) [15]. Additionally, butanol has a surface tension that is more similar to diesel's than ethanol's [16]. Two essential requirements must be fulfilled before combining butanol with commercial fuel: the effects of blending and the measurement methods for determining butanol content. Blending effects are important because blends can exhibit highly suboptimal physicochemical and thermodynamic properties, making it difficult to predict their behavior and engine performance.

Moreover, de-mixing inside the tank must be avoided. The ultimate objective should be to have a comprehensive understanding of the relationships between architecture and properties such that properties can be ascertained through simulations, obviating the requirement for multiple property measurements. The underlying knowledge of suitable computer models must incorporate the properties of each individual component and the molecular interactions in the mixture. These interactions impact both microscopic and macroscopic behavior because they are known as molecular mixing effects. Common solvents like dimethyl sulfoxide aqueous solutions and antifreeze are notable and conspicuous examples of these blending processes. Compared to the ideal mixture, the eutectic combination has a lower freezing point. The depression is caused by the dynamics and interactions between the mixture's molecules [17-19]. Conversely, analytical processes increase the complexity of commercial fuels but are essential for guaranteeing fuel purity and maximizing engine efficiency. [20].

The current study used diesel and 1-butanol in a Kirloskar TV-1 engine test-rig to conduct a similar type of investigation. Several physical, chemical, and thermal characteristics are examined at the initial stage, including TG and FTIR analysis. The performance parameters are assessed under various loading scenarios, with a constant speed of 1500 rpm and a compression ratio of 18:1. For blends under examination, the braking powers are plotted against the performance parameters graphs, which include brake thermal efficiency, brake mechanical efficiency, brake volumetric efficiency, brake specific energy consumption, and exhaust gas temperature.

2. Experiment

Above 99.5% purity Butanol was bought and diesel was purchased and used as received. Using a microbalance, butanol and diesel blends were generated gravimetrically. In stages of 10 weight percent, butanol/diesel mixtures were created across the mass fractions ranging from 0 to 100 percent butanol. Because of the commercial diesel chemical complexity, fractions of mass rather than mole fractions have to be adopted. Agilent Technologies Cary 630 Fourier Infrared Transform Spectrometer was utilized to collect Infrared spectra of the blends and pure compounds. An overall reflection module with ZnSe attenuation was installed on the instrument. The spectra were collected in a range between 650 and 4000 per centimeter. The current

study's experiments were conducted on a Kirloskar manufacture TV-1 engine test rig with a constant speed (1500 rpm) and compression ratio (18:1), as well as varying the loading condition in 25% stages from no load (0%) to maximum load (100%). Brake power (BP), brake thermal efficiency (BTE), mechanical efficiency (ηmech.), volumetric efficiency (ηvol.), brake-specific fuel consumption (BSFC), and exhaust gas temperatures are among the performance metrics that are measured. The blends are made using 1-butanol and diesel on a volume percentage basis as shown in table 2.

Table 2: Blends of diesel and 1-butanol

Nomenclature	Diesel	1-Butanol
D100	100	-
BDB5	95	5
BDB10	90	10

Figure 1. Diesel engine test bench

Table 3: Engine Specification

S.N.	Items	Details
1	Model	Kirloskar
2	Stroke	4 stroke
3	Bore(mm)/Stroke(mm)	88/110
4	Compression ratio	18:1
5	Speed	1500rpm
6	Cooling	Water cool

3. Result and discussions

Figures 2 to 6 show the performance characteristics of CI engines fuelled with diesel and 1-butanol.

Figure 2 shows the variations in brake thermal efficiency along with brake power. The maximum value of BTE occurs for fuel blends of BDB10 at full load conditions. BTE increases by 0.62% and 0.98% for BDB5 and BDB10 blends when compared with pure diesel, this is explained by the fact that 1-butanol blends have a greater premixed combustion ratio, a higher laminar burn velocity, and improved combustion quality as a result of the extra oxygen concentration.

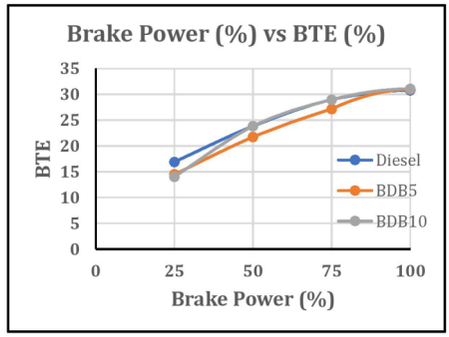

Figure 2: Variations of BTE with BP

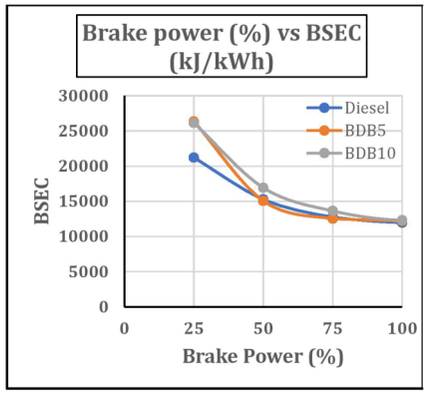

Figure 3: Variations of BSEC with BP

Figure 3 shows the variations of BSEC with brake power. Maximum value of BSEC occurs for BDB10 blend at full load condition. Increases in BSEC is 1.93% and 2.75% for BDB5 and BDB10 blends respectively compared with diesel. This is due to the greater combustion rate during diffusion combustion and the added oxygen from 1-butanol boost premixed combustion, which is primarily responsible for this. To get the same power, a relatively larger amount of fuel is injected. The increased heat absorbed from the cylinder wall during fuel vaporization is also ascribed

to1-butanol's higher latent heat of vaporization, which lowers fuel conversion efficiency for the same engine power output.

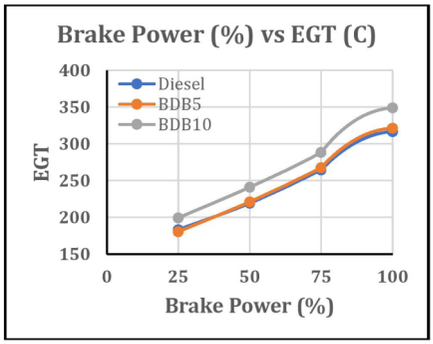

Figure 4: Variations of EGT with BP

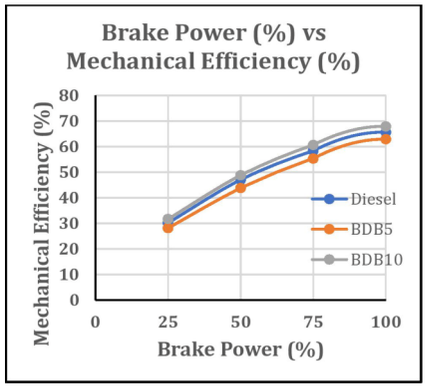

Figure 5: Variations of Mechanical Efficiency with BP

Figure 4 represent the variations of EGT along with engine load. EGT increases with increasing load. It is seen form the graph that the maximum value of EGT is for BDB10 blend at full load condition. Variations of EGT is observed as 1.5% and 10.10% for BDB5 and BDB10 blends with respect to diesel fuel. This is occurs Because of its high density and viscosity, more gasoline is injected, resulting in a greater EGT. Figure 5 and 6 shows the variations of mechanical efficiency and volumetric efficiency respectively along with engine load. Mechanical efficiency increases with increasing load whereas volumetric efficiency is decreases with increasing the load. The maximum value of mechanical efficiency is 67.9% for BDB10 blend at full load condition. The maximum value of volumetric efficiency is seen at 25% loading condition and minimum value is at full load condition for all fuel blends. It has been demonstrated that adding more 1-butanol to a fuel blend usually results in a decrease in efficiency because slower burning rates. Compared to diesel, butanol has a greater cetane number, which might enhance ignition characteristics. However, because it burns more slowly, it may result in higher heat transfer losses and decreased volumetric efficiency.

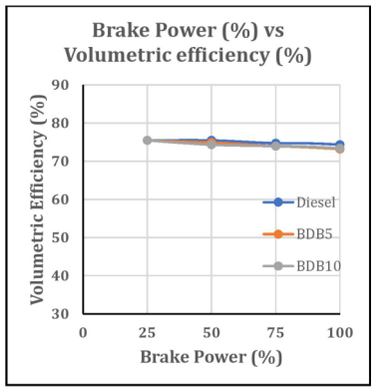

Figure 6: Variation of Volumetric efficiency with BP

4. Conclusions

The effect of adding 1-butanol to diesel fuel on the engine's performance characteristics under load situations was examined in this study. The following are the main conclusions derived from the results:

- Brake thermal (BTE) increases as brake power increases; under full load conditions, the BDB10 blend has the highest BTE.
- As the amount of 1-butanol increases, the BSEC decreases. For the majority of the investigated settings, the BDB10 blend demonstrated a higher reduction in BSEC.
- The temperature of the exhaust gas rises as brake power increases, yet 1-Butanol concentration significantly lowers EGT when compared to petroleum diesel.
- As braking power increases, mechanical (ηmech.) efficiency increases. Volumetric efficiencies for each mix under evaluation show a notable comparison.

According to the current study, the BDB10 blend

generally demonstrated improved engine performance characteristics, making it a potential fuel mix for direct replacement in diesel engines without any modifications or recalibration.

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Synthesis And Characterization Of Iron Nanoparticles Using Citrus Limetta Plant Leaf's Extract And Evaluation Of Their Antimicrobial Activity

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Abstract

Bio-inspired Iron nanoparticles were successfully synthesized by reduction of ferric or ferrous chloride using citrus limetta plant leaf extract. Liquid ammonia was used to maintain the required pH. The method was non-lethal, simple, eco-accommodating and relatively inexpensive. The resulting iron nanoparticles were characterized by FTIR. These particles show a strong magnetic character. The nanoparticles were evaluated for their antimicrobial activity against a non- pathogenic bacterium.

Keywords : *Nanoparticles, FTIR, antimicrobial activity, Liquid ammonia.*

1. Introduction

Nanotechnology - Richard Smalley first introduced the nanotechnology with the discovery of soccer ball shaped 'Buckyball' molecule and its many applications.[1-2] Nanotechnology is manipulation of matter on an atomic, molecular, and supramolecular scale. The earliest, widespread description of nanotechnology refer to the particular technology goal of precisely manipulating atoms and molecules for fabrication of macroscale products, also new referred to as molecular technology. A more generalized description of nanotechnology was subsequently established by the National Nanotechnology Initiative, which defines nanotechnogy as the manipulation of matter with at least one dimension sized from 1 to 100 nanometers. This definition reflects the fact that quantum mechanical effects are important at this quantum-realm scale, and so the definition shifted from a particular technological goal to a research category inclusive of all types of research and technologies that deal with the special properties of matter which occur below the given size threshold. It is therefore common to see the plural from "nanotechnologies" as well as 'nanoscale technologies" to refer to the broad range of research and application whose common trait is size. Because of the variety of potential applications (including industrial and military), governments have invested billions of dollars in nanotechnology reserch. Nanotechnology as defined by size is naturally very broad, including fields of science as diverse as surface science, organic chemistry, molecular biology, semiconductor physics, energy storage, microfabrication, molecular engineering, etc. [4-5]

The associated research and applications are equally diverse ranging from extensions of conventional device physics to completely new approaches based upon molecular self- assembly, from developing new materials with dimensions on the nanoscale to direct

control of matter on the atomic scale. Scientists currently debate the future implications of nanotechnology. Nanotechnology may be able to create many new materials and devices with a vast range of applications, such as in electronics, biomaterials energy production, and consumer products. On the other hand, nanotechnology raises many of the same issues as any new technology, including concerns about the toxicity and environmental impact of nanomaterials, and their potential effects on global economics, as well as speculation about various doomsday scenarios. These concerns have led to a debate among advocacy groups and governments on whether special regulations of nanotechnology is warranted.

Nanoparticles - Nanoparticles are particles that exist on a 0-100nm scale with a surrounding interfacial layer. The interfacial layer is an integral part of nanoscale matter, fundamentally affecting all of its properties. The interfacial layer typically consists of ions, inorganic and organic molecules. Organic molecules coating inorganic nanoparticles are known as stabilizers, capping and surface ligands, or passivating agents. In nanotechnology, a particle is defined as a small object that behaves as a whole unit with respect to its transport and properties. Particles are further classified according to diameter. [6-8]

Types of Nanoparticles

Most current nanoparticles are organized into four types:

- Carbon Based Particles
- Metal Based Particles
- Dendrimers
- Composites

Carbon Based Particles: These nanomaterials are composed mostly of carbon, most commonly taking the form of hollow spheres, ellipsoids, or tubes. Spherical and ellipsoidal carbon nanomaterials are referred to as fullerenes, while cylindrical ones are called nanotubes. These particles have many potential applications, including improved films and coatings, stronger and lighter materials, and applications in electronics [9-10].

Metal Based Particles: These nanomaterials include quantum dots, nanogold, nanosilver and metal oxides, such as titanium dioxide. A quantum dot is a closely packed semiconductor crystal comprised of hundreds or thousands of atoms, and whose size is on the order of a few nanometers to a few hundred nanometers. Changing the size of quantum dots changes their optical properties. [11]

Dendrimers: These nanomaterials are nanosized polymers built from branched units. The surface of a dendrimer has numerous chain ends, which can be tailored to perform specific chemical functions. This property could also be useful for catalysis. Also, because three-dimensional dendrimers contain interior cavities into which other molecules could be placed, they may be useful drug delivery. [12]

Composites: Composites combine nanoparticles with other nanoparticles or with larger, bulk-type materials. Nanoparticles, such as nanosized clays, are already being added to products ranging from auto parts to packaging materials, to enhance mechanical, thermal, barrier, and flame- retardant properties. [13]

● Iron Nanoparticles

Iron nanoparticles have been found to be an effective measure to treat several types of ground contamination and are easily transportable through ground water for in situ treatment. These factors combined make this method cheaper than most methods currently being used. Nanoparticles can easily be reduced to magnetite and maghemite which preffered in biomedical in vivo application because they are biocompatible and potentially non-toxic to humans. They also show magnetic and paramagnetic properties which make them a potentially useful drug delivery system. Recent advancements in the field of nanotechnology have led to the development of metal nanoparitcles. Green Technology designing chemical products and processes in a way that reduces or eliminates hazardous substance from the beginning to end of a chemical products life cycle. It involves using of bio-extracts as reducing or oxidizing agents, thus making new products less toxic. [14-15]

Literature Review

Iron nanoparticles (FeNPs)

Iron is a Block D, Period 4 element. It is the fourth

most abundant element found in the earth's crust. It is found in minerals such as Hematite and Magnetite. It is a strong, ductile and malleable metal. Iron nanoparticles are sub-micrometer particles of iron metal. Iron is highly reactive to both air (oxygen) and water, and in nanoparticles the reactivity is even more rapid than the bulk material. This characteristic limit its use in inert environments. Iron nanoprticles are not toxic. Iron nanoparticles can be manufactured using several methods. They can be prepared using wetchemical processes such as colloid chemical or sol-gel methods; or by dry processes such as vapor deposition method. Another method is to synthesize the nanopartles by the reduction of Fe_2 or Fe_3 salt with liquid ammonia in an aqueous medium. Iron nanoparticles are inorganic nanoparticles and are classified based on the size of the iron oxide, i.e., (1) standard size of superparamagnetic iron oxide is 60-150nm, (2) ultrasmall size of superparamagnetic iron oxide is 5-40nm, (3) subset size of momocrystalline iron oxide is 10-30nm. Iron nanoparticles are used for treating industrial sites contaminated with chlorinated organic compounds, and can treat many types of ground contamination such as chlorinated organic solvents. Iron nanoparticles are used as a primary colorant in glass and ceramics and are used as a catalyst. And the magnetic properties of the nanoparticles allow them to be used in memory tape, medical and laboratory magnetic data storage and in resonance imaging (MRI), and as plastics, nanowires, coatings, nanofibres. [16]

Methods of FeNPs synthesis

Two general methods of nanoparticles synthesis are bottom-up and top-down. Top-down method start with a bulk material and then break it into smaller pieces using mechanical, chemical or other forms of energy (top-down). An opposite method bottom-up synthesize the material from atomic or molecular species via chemical reactions, allowing for the precursor particles to grow (bottom-up). Both approaches can be done in either gas, liquid, supercritical fluids, solid states, or in a vacuum. Most of the manufacturers are interested in the ability to control a) particle size b) particle shape c) size distribution d) particle composition e) degree of particle agglomeration. [17-19]

I. Value Of Plant Extracts In FeNPs Synthesis

The use of plants as the production assembly of iron nanoparticles has drawn attention, because of its rapid, eco- friendly, non-pathogenic, economical protocol and providing a single step technique for the biosynthetic processes. The reduction and stabilization of iron by combination of biomolecules such as proteins, amino acids enzymes, polysaccharides, alkaloids, tannins, phenolics, saponins, terpinoids and vitamins which are already established in the plant extracts having medicinal values and are environmental benign, yet chemically complex structures.[20-21]

Synthesis of Iron nanoparticles using plant extracts

A simple, low-cost and eco-friendly approach of preparing of Fe_3O_4 nanoparticles using plants extract is simple. Reduction of ferric chloride and ferrous chloride at 2:1 solution is achieved by using any plant extract as the reducing agent. In producing nanoparticles, the plant extract concentrates is mixed with metal salt solution at ambient conditions. Nature of the plant extract, temperature at which the reaction is carried out, its concentration and that of the metal salt pH, reaction time are known to affect the rate of production of nanoparticles in terms of their quantity and characteristics. The pH of the plant extract is measured using the pH meter and the results are recorded. Then plant extract is added in salt solution. The volume of added plant extract is usually 5% v/v. The pH of the mixture is maintained towards alkalinity using liquid ammonia/NaOH. Utilization of plant concentrates is entirely respectable prompting really green science which gives progression over synthetic and physical strategy as it is inexpensive, environmentally practical, easily topped up for bulky synthesis and does not require usage of high pressure, energy and temperature.

II. Why Was Citrus Limetta Plant Chosen For This Study

Citrus limetta is commonly known as sweet lime, sweet lemon and sweet limetta. It is called by different names in different parts of the world. Natural products are chemical compounds found in nature, and they possess multiple pharmacological activities.

Anticancer Activity

Animal studies have set the stage for further investigation into the chemoprotective activity of d-limonene for several types of cancer. Several studies suggested that inhibition of chemically induced mammary cancer in rodents administered either orange peel oil or pure d-limonene caused inhibition in the initiation depending on the chemically induced medium used [26-28]. One experimental study suggested that increased survival in lymphoma-bearing mice placed on a high d- limonene diet. These mice also demonstrated increased phagocytosis, microbicidal activity, and nitric oxide production. [22]

Pharmacological Properties

Citrus flavonoids have a large spectrum of biological activity including antibacterial, antifungal, antidiabetic, anticancer and antiviral activities. Flavonoids can function as direct antioxidants and free radical scavengers and have the capacity to modulate enzymatic activities and inhibit cell proliferation. In plants, they appear to play a defensive role against invading pathogens, including bacteria, viruses and fungi.[23]

Antibacterial And Antifungal Effects

Even though pharmacological industries have produced a number of new antibiotics in the last three decades, resistance to these drugs by microorganisms has increased. In general, bacteria have the genetic ability to transmit and acquire resistance to drugs, which are utilized as therapeutic agents. [24]

Antioxidant Activity

Antiradical activity was evaluated by measuring the scavenging activity of the examined C. limetta oil on the 2, 2- diphenyl-1-picrylhydrazil (DPPH) radical. The DPPH assay was performed as described by. The samples (100 µl each) were mixed by 3 ml of DPPH solution. The absorbance of the resulting solution and the blanK were recorded after an incubation time of 30 min at room temperature against ascorbic acid as a positive control. For each sample, three replicates were recorded. The disappearance of DPPH was measured spectrophotometrically at 517nm. The percentage of radical scavenging activity was calculated. It is the ability of essential oils to act as a donor for hydrogen atoms or electrons in the transformation of DPPH-H (which is measured spectrophotometrically) gives them an antioxidant activity characteristic. The results of DPPH scavenging activity of C. limetta oil compared with ascorbic acid as a reference standard indicating that it has slightly lower antioxidant activity comparative to reference standard, ascorbic acid, being a strong antioxidant reagent. [25-27]

Antihyperglycaemic Activity

Citrus limetta fruit peel contains the flavonoids hesperidin and naringin. Hesperidin and naringin both are proven to be potent hypoglycaemic agents and their hypoglycaemic activity is postulated to be partly mediated by hepatic glucose regulations enzymes in C57BL/KsJ-db/db mice. Dietary hesperidin also exerts hypoglycemic and hypolipidemic effects in streptozotocin-induced diabetic rats. Naringin provided a significant amelioration of hypoglycaemic and antioxidant activity in STZ-induced diabetic rats [28]. Therefore, it can be postulated that the presence of flavonoids in the extract might be the reason of the antihyperglycemic action.

Antitumor Potential of Citrus Limetta Peel

Methanolic extract of Citrus limetta peel at the dose level of 200 and 400 mg/kg body weight increased the life span, non- viable tumor cell counts and decreased the cell count compared to the Ehrlich ascites carcinoma (EAC) control mice. In a study reported acute response of blood pressure to angiotensin II administration was measured in mice. Also, the acute oral toxicity profiles were determined. Investigations showed that different concentrations of the aqueous extract prevented the rise of systolic blood pressure, diastolic blood pressure and mean blood pressure with a dose dependent effect for diastolic pressures at 125-500 mg/kg dosages. The 500 and 1000 mg/kg doses inhibited the action of Ang II in similar extent to telmisartan. Toxic signs or deaths were not observed in mice treated at 2000 mg/kg of Citruslimetta extract. All doses of C. limetta aqueous extract, used in this assay, were safe and effective. [29]

Traditional Uses of Citrus Limetta

In the treatment of scurvy, as digestive aid,

antidiabetic benefits, antiulcer effects, immunity booster, weight reduction, beneficial in pregnancy, treatment of urinary disorders, ophthalmic benefits, remedy for common cold and antihyperlipidemic effects. Drinking mosambi juice reduces cholesterol and lowers blood pressure.

Syntheis of FeNPs using Liquid Ammonia

Green synthesis of nanoparticles by using liquid ammonia has recently attracted considerable attention due to their biodegradability, non-toxicity, and cost effectiveness. Fe_3O_4 nanoparticles and were synthesized by using liquid ammonia under alkaline Condition. Fe_3O_4 nanoparticles were synthesized according to the modification procedure. Briefly $FeCl_3$ and $FeCl_2$ solution on a 2:1 and add 5% plant extract which was then heated at 75°C under room temprature, then NH_3 was added drop wise to reach pH 8. After 1 h, the synthesized nanoparticles were separated from the supernatant by an external magnetic field and were washed several times by deionized water. Hydrodynamic diameter of liquid ammonia and liquid ammonia coated Iron nanoparticles were determined under heat treatment and different pH. This data also displays absorbance peak of Iron nanoparticles synthesized by plant extract under different pH conditions (8, and 10) using liquid ammonia. [30-35]

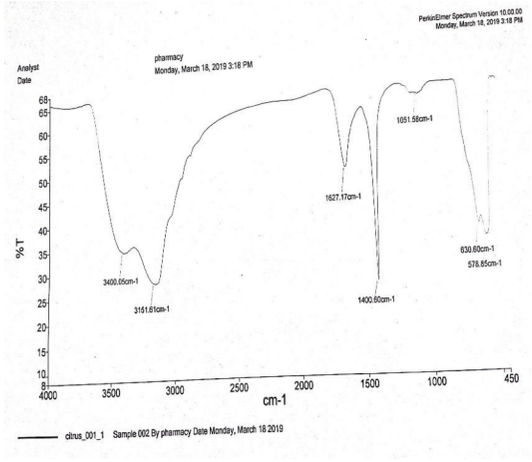
Synthesis of Iron Nanoparticles

Using 2:1 0.3M $FeCl_3$ and $FeCl_2$ solution and aqueous citrus limetta leaves extract (95ML Salt Solution + 5ML Plant Extract) in a 250 mL beaker, iron nanoparticles were prepared. The mixture was then handshake well and add drop wise liquid ammonia solution(10%) to increase the pH to make the solution basic. Measure the pH at pH 8 using liquid ammonia on pH meter. Heat mixture on a magnetic hot plate without stirring. After 10 minutes, the change in colour of the solution from brown to black was noted and recorded. The iron NPs gets settled on the bottom of the beaker remove the liquid part by simple decantation process. The mixture was centrifused for 10 minutes and the supernatant poured out. The black paste obtained was re dispersed in acetone followed by ultra-purified water to remove exess biological molecules. The process of centrifugation and re-dispersed in acetone and ultra-purified water was repeated 3 times to completely purify the nanoparticles. The light black paste collected was then oven dried at 60-degree celcius overnight, after dried light black paste are change in light brown colour, packed and stored in eppendorf for characterization.

III. Characterixation and Analysis of The Bio-synthesized Iron Nanoparticles (CTE-FeNPs)

IV. FTIR Analysis

FTIR measurements were done using a Perkin Elmer spectrum with a resolution of 4cm-1. FTIR analysis of the dried FeNPs was carried out through the potassium bromide (KBr) pellet (FTIR grade) method in 2:98 ratio and spectrum were recorded. FTIR analysis was carried out in the transmission mode range of 450-400cm^{-1}.



V. Evaluation of Antimicrobial Activity Of FeNPs Using Mic Process (minimum Inhibitory Concentration)

Minimum inhibitory concentration (MICs) are defined as the lowest concentration of the antimicrobial that will inhibit the visible growth of microorganism after overnight incubation, and minimum bactericidal concentrations as the lowest concentration of antimicrobial that will prevent the growth of an organism after subculture on to anti-biotic free media. The disc diffusion method has been selected in the present work.

Preparation of agar medium

1. The medium was prepared from the dehydrated medium in distilled water according to the manufacturer's instructions.
2. It was sterilized by autoclaving at 121°C for 15 min.
3. After cooling the agar medium, it was poured into sterile glass or plastic petridish on a flat surface to a uniform depth of 4 mm. It was then allowed to solidify.
4. Prior to use, plates with lids partly ajar were dried at 30-37°C in an incubator for not more than 30 minutes or until excess surface moisture was evaporated. Media was prepared in such a way that it was moist but free of water droplets on the surface. Presence of water droplets may result to swarming bacterial growth, which could give inaccurate results.
5. INOCULUM

Preparation

1. Transfer colonies to 5 ml of trypticase soy broth or 0.9% saline.
2. Incubate the broth at 30°c or at an optimum growth temperature until it achieves or exceeds the turbidity of 0.5 macfarland standard.
3. Compare the turbidity of the test bacterial suspension with that of 0.5 MacFarland (vigorously shaken before use) against a white background with contrasting black line under adequate light. Arrow points to tube with correct turbidity.
4. Reduce turbidity by adding sterile saline or broth.

VI. Control Disc

Include one disc inoculated with a control strain for every set of plates and incubate together.

VII. Incubation

1. Incubate plates in an inverted position at 30°C or at an optimum growth temperature.
2. Observe for the zone of inhibition after 16 to 18 hours. Slow growing organisms may require longer incubation period.

Reading and measurement of zones of inhibition

1. The zone of inhibition (arrow) is the point at which no growth is visible to the unaided eye.
2. Record the presence of individual colonies (arrows) within zones of inhibition.
3. Record occurrence of fuzzy zones (arrow). In measuring the zone diameter, the fuzzy portion of the zone should be ignored as much as possible. The zone limit is the inner limit of the zone of normal growth.
4. Read and record the diameter of the zones of inhibition using a ruler that graduated to 0.5 mm. Round up the zone measurement to the nearest millimeter.

Conclusions

The development of biologically inspired experimental processes for the synthesis of nanoparticles is evolving into an important branch of nanotechnology (Ahmad et al., 2003 and Shankar et al., 2004). Nanoparticles are usually 1 to 100nm in each spatial dimension considered as building blocks of the next generation of optoelectronics, electronics and various chemical and biochemical sensors. Synthesis of nanoparticles with different compositions, sizes, shapes and controlled dispersity is an important aspect of nanotechnology. In order to synthesize noble metal nanoparticles specific methodologies have been formulated (Narayanan et al., 2010). Despite the physical and chemical techniques being able to produce large quantities of nanoparticles with defined size andshape in a relatively short time they are complicated, outdated, costly and inefficient and produce hazardous toxic waste that is harmful. Biosynthesis is considered better than chemical and physical synthesis because use of expensive and toxic chemicals is eliminated (Riddina et al., 2010) and it is a clean, eco-friendly and commercially viable method (Rajendran, 2007 and Moghaddam, 2010). Iron nanoparticles are undoubtedly the most widely used nanomaterials among all nanoparticles with several applications in antimicrobial agents, textile industries, water treatment etc. Biosynthetic methods can be categorized into intracellular and extracellular synthesis according to the place where nanoparticles are formed (Simkiss et al., 1989 and Mann., 1996). Extracellular synthesis has advantages, since retrieval of nanoparticles is easy compared with intracellular synthesis where additional recovery steps are required. Further, these biologically synthesized nanoparticles used to analyze antimicrobial, antioxidant and cytotoxic efficacy and are summarized. The reaction

due to the reduction of iron ions is evidenced by the change in colour from pale yellow to blak. The reduction of iron ions was monitored FTIR spectroscopy. The iron nanoparticles thus formed were Characterized by FTIR spectroscopy. The synthesized iron nanoparticles were checked for its antibacterial (gram positive and gram negative) and antifungal activity by disc diffusion method. FeNPs exhibited high antibacterial activity against non-pathogenic bacteria.

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Pharmacological Activity of Argemone Mexicana: A Review

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Abstract

Argemone mexicana (Mexican poppy), commonly known as "Satyanasi or Bhatkatiya" in India. This is used as Medicine in the treatment of Various Diseases, like Treatment diuretics, inflammation, malarial fever, leprosy, scorpion stings, warts, cold sores, wound healing, skin diseases, itches, jaundice and an antidote to various poisons. The whole plant is used as medicine, leaves, stems, latex, roots, and seeds have several pharmacological activities of A. Mexicana like an Anti-oxidant, anti-bacteria, anti-helminitic, anti-cancer, anti-inflammatory, anti-hypertensive, anti-fungal, anti-protozoal, anti-ulcer, anti-viral, anti-vemon, anti-diabetic, etc. The pharmacological activity of A. Mexicana due to the presence of photochemicals like Dehydrocorydalmine, columbamine, argemexirine, quercetin, quercetrin, rutin, mextin, etc. This review article aims to provide various medicinal uses of Argemone Mexicana proved by various modern researches.

Keywords : *Argemone Mexicana, medicinal use, anticancer, antibacterial, anti-inflammation.*

I. Introduction

Argemone Mexicana L. (Papaveraceae), native to Mexico, is also known as Premathandu in Tamil and Prickly Poppy in English. It also known as vernacular names: **English**: Mexican prickly poppy, flowering thistle, cardo or cardosanto; **French**: Argemone; **German**: Doppelklappen; **Sanskrit**: Swarna ksheeri, Kanchani, Karshani, Hemadugdha, Tikta Dugdha; **Hindi**: Satyanasi, Kataila; **Urdu**: Baramdaandi; **Bengali**: Siyal-Kanta; Bharband; **Kannada**: Datturigidda; **Konkani**: Phirangi dhutro; **Malayalam**: Ponnummattu; **Manipuri**: Khomthongpee; **Marathi**: Firangi dhotra; **Punjabi**: Bhataiktheya; **Tamil**: Kudiyotti; **Telugu**: pichi kusuma. It found in the United States, India, Bangladesh, and Ethiopia. It grows as a wasteland weed all over almost every region of India [1]. The plant grows most effectively in light, sandy soils with good drainage; it can also thrive in low-nutrient soils that are acidic, neutral, or basic (alkaline) [2]. In India, A. Mexicana is considered as a significant medicinal plant. The yellow juice that the plant releases when it is injured has long been used in traditional medicine to treat conditions like dropsy, jaundice, ophthalmia, scabies, and cutaneous diseases [3-5]. A. mexicana offers sedative, analgesic, narcotic, and antispasmodic properties. The freshly yellow, milky seed extract has ingredients that break down proteins that are useful in treating a variety of skin conditions, including dropsy and jaundice, as well as warts, cold sores, dermatitis infections, and itches. Mexicana seeds are also used in snake poisoning as antidote [6-7]. It was further reported that seeds and leaves can help keep the human body's cholesterol and blood circulation at normal levels [8] and also contain anti-venom properties [9-10].

II. Taxonomy

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnliopsida
Subclass: Magnoliidae
Order: Ranunculales
Family: Papaveraceae
Genus: Argemone
Species: Argemone Mexicana
Other name: Mexican Poppy, Satyanashi, barashi-kantal.

Fig. 1: Argemone Mexicana plant and its uses

III. Composition of Argemone Mexicana:

Ashine, 2022 et al, reported that the percentage yield of oli Argemone Mexicana seed was found 48.62% by using chloform as solvent. The AM seed oil contains: Saturated FAs (Palmitic acid- 12.73% and Stearic acid-2.25) and Unsaturated FAs (Oleic acid- 25.92% and Linoleic acid -58.75%) [11].

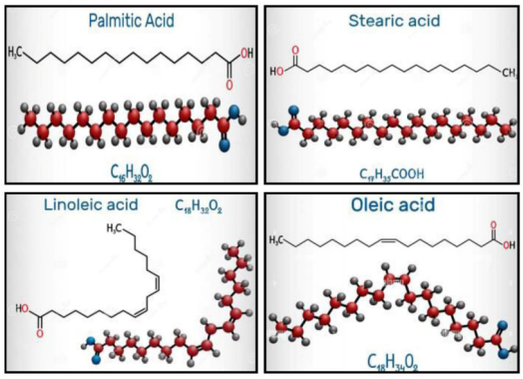

Table 1: Chemical composition of A. Mexicana

Source /Part	Chemical constituents
Whole Plant	Dehydrocorydalmine [12-13]
Whole Plant	Columbamine [12]
Whole Plant	Jatrorrhizine [12]
Whole Plant	13- oxoprotopine [14]
Whole Plant	Protomexicine [14]
Whole Plant	Argemexirine [15]
Whole Plant	± - tetrahydrocoptisine [16]
Aerial Part	8- methoxy dihydrosanguiranine [14]
Flower	Hentricontane-3,20-diol [16]
Whole plant	Quercetin [17]
Aerial part	Quercetrin [14]
Whole plant, aerial part	Rutin [14,17]
Aerial part	Mexitin [14]
Whole plant	Argemexirine [15]
Whole plant	Dihydrocoptisine[15]

IV. Pharmacological Activities of Argmone Mexicana:

A. Antimicrobial Activity:

Osha A. et al (2010) reported that Argmone mexicana essential oils are an exciting alternative compound for the development of a new indigenous antimicrobial agent against Candida albicans, Candida stellatoidea, Candida torulopsis, S. aureus, B. subtilis, P. aeruginosa, and K. pnuemoniae due to their observable inhibition of specific bacteria and fungi [18]. Rahman et al (2009) report that A. Mexicana plant prevents the growth of several microorganisms, including bacteria, viruses, and harmful fungus. The most adaptable unicellular pathogens are bacteria, which can cause a wide range of infectious diseases in both humans and animals. They are typically spread by food, drink, air, and soil. Numerous natural compounds derived from medicinal plants can be used to treat these kinds of illnesses. Many research studies describe the function of A. mexicana in inhibiting the growth of microorganisms. It investigated the antibacterial activity of several extracts (hexane, chloroform, ethyl acetate, and ethanol) of A. mexicana stems in vitro by using the minimum inhibitory concentration (MIC) determination method and agar diffusion against ten (five Gram-positive and five Gram-negative) food-borne pathogenic [19]. Kumar Santosh et al (2009) reported that Argemone mexicana L. (Papaveraceae) seed extracts were evaluated for their

antibacterial effectiveness against a variety of harmful bacterial strains. The antibacterial activity of seed chloroform extract varied, with minimum inhibitory concentrations (MIC) ranging from 2.0 to 5.0 mg/ml against both Gram-positive and Gram-negative bacteria. Compared to the other extracts, the chloroform extract showed greater efficacy against every test bacterium [20]. G. Shyam Prasad et al (2010) reported that A. mexicana leaves extract by using methanolic solvent shows antibacterial and antifungal activity. At 40 µl showed no activity, At 100 µl showed maximum inhibition and at 70 µl showed activity against Staphylococcus Aureus, E. coli, and proteus vulgaris [21].

B. Antidote Activity:

Bhattacharjee et al (2006) reported that the seeds have been utilized as a snake-poisoning remedy in Mexico [22]. Inder Kumar Makhija et al (2010) reported that Decoction of leaf seed is useful against snake-poisoning if taking orally for seven days [23].

C. Anti-Inflammatory Activity:

Prusti and Misra et al (2004), Alagesaboopathi et al (2009) found that, In India, toothaches are treated with the smoke from the seeds. Fresh yellow, milky seed extract has anti-inflammatory and anti-diuretic properties that are useful in treating leprosy, warts, cold sores, wound healing, skin conditions, itching, jaundice, and malaria. It also includes chemicals that dissolve proteins [24, 25].

D. Anti-urolithiatic and anti-ulcer Activity:

Das et al (2011) reported that the Ulcers and related conditions have long been treated with the plant A. mexicana. They examined the impact of oral administration of A. mexicana methanolic and aqueous extract against rats' duodenal ulcers caused by cysteamine hydrochloride. The results of the investigation showed that both plant extracts significantly inhibited the growth of rats' artificially caused duodenal ulcers. Compared to the methanolic extract, the aqueous extract exhibited more powerful action in a dose-dependent manner. Nevertheless, this study does not explain the precise components or processes by which the plant A. mexicana decreased the production of duodenal ulcers [26].

E. Anti-diabetic Activity:

Nayak, et al 2011., reported that, an aqueous extract of A. mexicana aerial parts at doses of 200 and 400 mg/kg body weight was found to have hypoglycemic efficacy; significant reductions in blood glucose levels, plasma urea, creatinine, triacylglyceride, cholesterol values, and recovery in body weight were found when treated with the aqueous extract at a dose of 400 mg/kg body weight compared to diabetic control rats and the standard drug-treated rats [27]. Rout, et al 2011, A. Mexicana hydro-alcoholic extraction can prevent normal and diabetic rats' serum cholesterol and triglyceride levels from rising and can lower blood glucose levels in normoglycemic and diabetic rats. Effect of A. mexicana is more effective at higher dose [28].

Table 2: Pharmacological activity of A. Mexicana

S.NO	Plant Parts	Pharmacological Activity
1.	Leaf	Wound healing activity [1]
2.	Leaf	Anti-malerial activity [31]
3.	Leaf	Anti-bacterial and anti-fungal activity [21]
4.	Leaf	Anti-oxidant activity [32]
5.	Leaf	Anti-ulcer activity [33]
6.	Leaf	Anti-viral activity [34]
7.	Flower	Larvicidal activity [35]
8.	Aerial part	Anti-ulcer activity [[36]
9.	Flower	Anti-cancer [37]
10.	Plant	Anti-venom [9]
11.	Aerial part	Hypoglycemia activity [38]
12.	Aerial part	Anti-diabetic activity [39]
13.	Aerial part	Anti-oxidant [36]
14.	Plant	Asthma [40]
s15.	Root	Anti-oxidant activity [41]
16.	Seed	Anti-bacterial activity [20]
17.	Plant	Skin disorder [42]
18.	Plant	Anti-venom [43]
19.	Leaf	Anti-inflametry and analgesic activity [44]
20.	Seed	Anti-bacterial activity [45]

F. Wound Healing Property:

Mengie Ayele T, et al 2022, reported that the efficacy of wound healing and anti-inflammatory of A. mexicana was more active in ethyl acetate [29]. Patil MB, et al 2001., reported that the excision, incision, and dead space wound models in Wistar albino rats were used to test the healing properties of different Argemone Mexicana leaf extracts. The results showed that treating rats with an Argemone Mexicana leaf methanol extract expedited the healing of wounds. Significantly effective at healing wounds, petroleum ether and butanol fractions of argemone ethanol extract [30].

Conclusion

This review article contains up-to-date information on Argemone maxica, its medicinal use, and its pharmacological activity of this. A. Mexican is used to treat wounds, diabetes, inflammation, skin disorder, skin-poisoning, asthma, bacterial viral, and malarial, also gives antioxidant, anti-cancer, anti-inflammatory, and anti-ulcer pharmacological activity. A. Mexicana was also known as Satyanashi and Pickly Poppy. It found in India, US, Bangladesh, etc.

Conflict of Interest

The authors have no conflicts of Interest, financial or otherwise.

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Wavelet Methods for Inverse Problem associated with Conformable Fractional Black-Scholes model of one and two assets

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Abstract

This paper presents a novel technique for conformable black Scholes model for option pricing. There are various classical methods for solving the economical assets but the method used here uses a lot of fundamental research which solves the problem of time consumption. The mathematical modeling of the black Scholes model has been performed with the extensive simulation which has been done on the MATLAB. The novel method is more practical than the classical model. The advantage of the explicit solution form is easy and efficient for determining the European call option which rely on the two-stock price. Additionally, the numerical examples of the solution have been illustrated to find the explicit solution.

Keywords : *Asset, Black-Scholes model, Volatility, Conformable fractional derivative, Wavelet Based Numerical Method, Multiresolution Analysis, American option, European option.*

1. Introduction

Traditional calculus invented independently by Newton (a renowned Physicist from U.K) and Leibniz (German Mathematician and Philosopher) is well established and is an essential ingredient of under graduate courses in Science, Engineering as well as Medical and Social sciences. One cannot imagine study of any branch of human knowledge without traditional calculus; especially integral derivatives like derivative of order 1, order 2 of any positive integral order. The concept of fractional order derivative was discussed as back as in 1695 during exchange of ideas between L'Hospital's Rule and Leibniz. Fractional calculus involving derivatives like $\frac{df^{1/2}}{dx^{1/2}}, \frac{df^{1/3}}{dx^{1/3}}, \ldots, \frac{df^{5/2}}{dx^{5/2}}$, $D^{\propto}[f(x)]$ For $\propto \in [n-1, n]$.

Attention of a fairly large number of well-known mathematicians and Physicists in different parts of the world [1- 12, 16-22, 30, 35, 42] has been drawn on this topic. Several Mathematicians of Indian origin settled in U.S. such as HM Srivastava, V. Lakhmikanthan and R.P. Agarwal are also working in this field besides two strong research groups based in King Fahad University of Petroleum and Minerals, Saudi Arabia and Sultan Qaboos University, Muscat Oman. Bhartiar University, Coimbatore, India is actively engaged in this theme; see Manchanda, Lozi and Siddiqi [23]. A fairly large number of fractional derivatives have been reviewed by Olveira and Machado [28]. In the last 5 years a notion of fractional derivative known as conformable fractional derivative has been studied, see Khalil etal [18], Abdul Jawed [2], Abdelhakim etal [1], Anderson etal

[4], Zhao and Luo [41], Zhou etal [42] and Meng and Cai [24]. Applications of fractional derivatives to real world problems have been examined in references [4, 5, 24, 29, 30, 35, and 36].

As we see most of the research work in fractional calculus including fractional differential equations are related to direct problems but inverse problems in this field is not reasonably explored. One reason could be that direct problems are easier to solve while solutions of inverse problems are tedious. In direct problems we are interested in finding solutions of given equation (matrix equations, differential equations, partial differential equations with or without initial and boundary conditions) while an inverse problem deals with finding unknown parameter in an initial or boundary value problem while solution of the problem is given. An interesting introduction of Inverse Problems for traditional derivative and associated differential and partial differential equations is given by Groetsch [15], fairly good number of updated references can be found in Amita Garg [13] and Siddiqi, Al-Lawati, Boulbrachene [33,623-625].

The main objective of this paper is to study inverse problems related to conformable fractional differential equation. In section 2 a resume of basic properties of conformable fractional derivative is presented. Inverse problem of finance involving conformable fractional derivative.

2. Conformable Fractional Derivatives

The concept of conformable fractional derivative has been studied by Khalil etal [18], Abdeljawad [2], Abdelhakim etal [1], Anderson and Ulness [4]; Modeling of heat distribution in the form of conformable fractional differential equation has been studied by Hammad, Khalil [16, 17]. The solutions of time and space comfortable fractional heat equation with conformable Fourier transform have been studied by Cenesiz and Kurt [7]. Analysis of projectile motion involving conformable derivative has been presented by Contreras etal [10].

Definition 2.1 [18] Conformable fractional derivative denoted by $T_{\propto}f, for\ 0 <\propto< 1\ of\ a\ function\ f: [0,\infty] \to R, is\ defined\ as$:

$$T_{\propto}f(x) = \lim_{\epsilon\to 0}\frac{f(x+\epsilon\, x^{1-\propto})}{\epsilon} - f(x), x > 0 \quad (1)$$

provided the limit exists, in this case f is called $\propto$ - differentiable on (0, a) for some $\alpha > 0$. Also

$$T_{\propto}f(0) = \lim_{x\to 0+} T_{\propto}f(x) \quad (2)$$

It has been observed by Abdelhakim and Machado [1] that if f is $\propto$- differentiable in the conformable sense at x>0, then it must be differentiable in the classical sense at x and

$$T_{\propto}f(x) = x^{1-\alpha}f^{1}\, x \quad (3)$$

is satisfied.

Various analogous properties of classical derivative including Rolle's Theorem, Mean value theorem hold true.

The concept of fractional integral is derived in the following manner.

Definition 2.2 [18]. Fractional Integral associated with conformable fractional derivative (α − derivative) is defined as $I_{\propto}^{a}(f)(t) = I_{t}^{a}(t^{\propto-1}f)$

$$\int_{a}^{t}\frac{f(x)}{x^{1-\alpha}}\,dx, \quad (4)$$

where it has been proved by Khalil et.al [18] that $T_{\propto}$ and $I_{\propto}^{\alpha}$ are inverse of each other, namely $T_{\alpha}(I_{\propto}^{a}(f))\,(t) = f(t)$,

For $t \geq \alpha$ where f is continuous in the domain of $T_{\propto}$. It may be observed that $\alpha \in (0,1]$ and the integral is a usual Riemann improper integral.

Definition 2.3 [18] Let $\alpha \in (n, n+1)$ and f be an n-differential at t, where t>0. Then the conformable fractional derivative of f of order $\propto$ is defined as

$$T_{\propto}(f)(t) = \lim_{\epsilon\to 0}\frac{f^{(\lceil\alpha\rceil-1)}\left(t+\epsilon t^{\lceil\alpha\rceil-\alpha}\right)-f(t)}{\epsilon} \quad (5)$$

Where $\lceil\alpha\rceil$ is the smallest integer greater than or equal to α.

Abdeljawad [2] has studied the chain rule, Gronwall inequality and integration of parts formula and Laplace transform corresponding to conformable

fractional derivative and integral. An interesting question could be "how conformable fractional derivative of a function f: $[0, \infty] \rightarrow R$ is related to minima and maxima of f over $[0,\infty]$.

A definition similar to conformable fractional derivative which is based on the concept of limit rather than a fractional integral has been introduced by Katugampola and studied in detail by Anderson and Ulness [4].

3. Mathematical Modeling of Time Inverse Parabolic Problem: Option Price Forecasting

The Black-Scholes model is a way of deriving a fair price of an option today given a future expiration date T. The main idea to reverse the time t and calculate i.e., forecast a future option price given today's market data. First, we show why this inverse problem is ill-posed in the sense of Hadamard using the analogy to the heat equation as an accessible example. Monica et. al [51] has given the novel approach for clock recovery in MPEG -2 transport streams in DVB-IPTV environment. Next, the full model including new boundary and initial conditions is presented. Thereafter, we present the most common numerical solution approaches and reproduce convergence results which are based on Carleman estimates for one such class of procedures from Klibanov et.al (Klibanov and Kuzhuger , profitable forecast of prices of stock options on real market data via the solution for the Black-Scholes equation pp.1-13]. The regularization technique treating this ill-posed problem is the famous Tikhonov regularization approach for the solution of ill-posed inverse problems. Monica et. al [52] has illustrated the digital Video Broadcasting for large jitters due to multipaths and other losses. Some remarks on the role of data errors and the inevitability of having estimates on the input data error for the successful construction of regularization algorithms are made. Finally, some numerical experiments are carried out to determine optimal regularization parameter, influence of different boundary criteria and preferable numerical solution techniques. Recalling that Black-Scholes is of the parabolic type let us consider the heat equation for a moment. In its simplest form the heat equation can be written as:

$$u_t - u_{xx} = 0 \qquad in\ \Omega \subset \mathbb{R} \times (0,\infty), \quad (6)$$

$$u\,(x,0) = f(x)\ for\ x \epsilon\ \Omega, \quad (7)$$

For simplicity, let us consider the one-dimensional case and let the domain be bounded such that $x \in \Omega = (0, x)$ and let the terminal time $T > 0$ be chosen such that $t \in (0, T) \cap (0, \infty)$. It is well known that there exists a unique solution to this initial boundary value problem which can be represented by Fourier series.

The concept of option pricing technology is comparatively new. In 1973, Fisher Black and Myron Scholes [5] and R.C. Merton [34] published two fundamental papers which laid foundation of this technology. Black passed away in 1995 but other two founding fathers of this theory Merton and Scholes were awarded Nobel prize of economics in 1997 Sveringes Riksbank (Bank of Sweden) prize in economics in memory of Alfred Nobel]. As mentioned in the citation of the Nobel prize award, the model of Black- Scholes was new but the concept of option type contract existed even during the period of Aristotle in ancient Greece and was employed in Amsterdam, the financial center of Europe in the seventeenth century. Their work has direct impact also on other areas outside financial markets, such as investment alternatives, selecting one type of energy to another, the value of insurance and economic guarantees, government grant of offshore drilling rights, and various legal and tax issues involving policy and behavior. A systematic account of this theory and practice may be found in references Wilmott [51], Willmott, Dewynne and Howison [49], Willmott, Howison and Dewynne [50]. Updated information about this technology, specially numerical methods can be found in references Siddiqi, Manchanda [42], Siddiqi,Manchanda and Kocvara[43], Wang, Al-Lawatia and Wang [48]and references therein. The main goal here is to replace classical derivative by conformable fractional derivative.

We consider the standard Black-Scholes partial differential equation with two assets for European-style option, efficient markets, perfect liquidity and no dividends during the option's life. Throughout this paper, we assume that σ1, σ2, ρ and rare constants.

The solution of the partial differential equation:

$$\frac{\partial u}{\partial t}+\frac{1}{2}x^2\sigma^2(x,t)\frac{\partial^\alpha u}{\partial x^\alpha}+rx\frac{\partial^\alpha u}{\partial x^\alpha}-ru=0 \quad (8)$$

Direction problem of option pricing:
The local volatility function $\varepsilon\sigma(x,t)$

$$u(x,T;K)=\max(x-K,0)(9)$$

$$u(0,T,K)=0$$

Inverse Problem:

$$u(x^*,t^*,K,T)=u^*(k,T)\ (10)$$

$$G(x,t;K,T)=\delta(x-K)(11)$$

$$\frac{\partial G}{\partial T}=\frac{1}{2}\frac{\partial^{1-\alpha}(K^2\sigma(K,T)G)}{\partial K^\alpha(\alpha+1)}-\frac{\partial(KG)}{\partial^\alpha K}-rG(12)$$

$$\frac{\partial u}{\partial T}=\frac{1}{2}K^2\sigma^2(K,T)\frac{\partial^\alpha u}{\partial K^\alpha(\alpha-1)}-rK\frac{\partial u}{\partial^\alpha K}-ru(13)$$

$$y=ln\frac{K}{x^*}\ ,\ J=T-t(14)$$

The Function,

$$U(y,J)=u(K,T)(15)$$

$$a(y)=\sigma(K)(16)$$

$$\sigma(s,t)=\sigma(s),\sigma(t)\ (17)$$

$$U(y,0)=x^*(1-e^y)^*y\epsilon R(18)$$

$$U(y,J^*)=U^*(1-e^y)^*y\epsilon W(19)$$

$$\frac{1}{2}a^2(y)=\sigma_0+f(y)\ (20)$$

$$\frac{\partial V}{\partial\tau}=\sigma_0\frac{\partial^{1-\alpha}V}{\partial y(\alpha+1)}-\sigma_0\frac{\partial V}{\partial y^\alpha}-r(21)$$

$$V(y,0)=y\epsilon R(22)$$

$$V(y,\tau^*)=V^*(y)y\in W(23)$$

$$z_0(t,\tau)=\frac{\partial^{1-\alpha}U_0}{\partial y^\alpha{}_{(\alpha+1)}}-\frac{\partial U}{\partial y}(24)$$

$$V^*(y)=U^*(y)-U_0(y)(25)$$

$$\frac{\partial w}{\partial\tau}=\sigma_0\frac{\partial^\alpha w}{\partial y^\alpha}=\sigma_0\frac{\partial w}{\partial y^\alpha}\ (26)$$

$$w(y,0).\ y\in R(27)$$

$$w(y,\tau^*)=w(y);y\in w(28)$$

$$u(x^*,T_0,K,T_1)=(x^*-K)+\frac{K^\iota\sigma^\iota(K,T_1)}{2}\lim_{\epsilon\to0}\frac{f(x+\epsilon x^{1-u})}{\epsilon}-f(x)(29)$$

4. Wavelet Based Numerical methods for Black – Scholes Model

The mathematical modeling for wavelet based numerical methods for black-Scholes model is as follows:

$$\frac{\partial u}{\partial\tau}=\frac{\partial^{1-\alpha}}{\partial x^\alpha{}_{(1+\alpha)}}\ for\ 0<x\le1/2(30)$$

U plot on different $\propto$ value of >0.

With $u(x,0)=\max\left(e^{\frac{1}{0}}(K+1)\right)^\alpha x^{\frac{1}{2}}_{-e}(K-1)x,0$

$$t=T-\frac{\tau}{\frac{1}{2}\sigma^x}$$

$$v(x,\tau)=Ee^{-1/2(k-1)(k-1)2\tau u(x,\tau)}(31)$$

$$\text{Where,}K=\frac{r}{1/2\sigma^\alpha}$$

Method based on scaling function expansion:

$$u_t^n=\frac{u^{n+1}-u^n}{\partial t}=u^nxx(32)$$

$$uj\in V_j^{j,1}2^{j-1}$$

$$u(x)=\sum_{K=0}c_{j,K}(x)$$

Cj,K are unknown coefficient of scaling function expansion of $u_j(x)$.

$$H=\begin{bmatrix}(r-\sigma_1^2-(1/2)\rho\sigma_1\sigma_2)S_1\\(r-\sigma_2-1/2)\rho\sigma_2\sigma_2)S_2\end{bmatrix}$$

$$\int \frac{\partial V}{\partial \tau}\varphi d\Omega = \int \nabla.(G\nabla V)\phi d\Omega + \int H^T \nabla V \varphi d - \int rV\varphi d\Omega$$

$$\int \frac{\partial V}{\partial \tau}\varphi d\Omega = \int (G\nabla V).\vec{n}\,\varphi(d\Omega) - \int (G\nabla V)\nabla\varphi d\Omega +$$

$$\int H^T \nabla V \varphi d\Omega - \int rV\varphi d\Omega + \int H^T \nabla V \varphi d\Omega - \int rV\varphi d\Omega \quad (33)$$

$$V(S, m, S_2, \tau) = 0 \qquad \sigma = 1,2,3$$

$$V(S_1, S_2 m, \tau) = 0 \qquad r = 5.25$$

$S_1 = S_1 m$ and $S_2 = S_2 m$

$S_1 = 0$, $S_2 = 0$

$$\frac{\partial V}{\partial t} = \frac{1}{2}\sigma_1^2 S_1^2 \frac{\partial^{1-\alpha}}{\partial^{\alpha(\alpha+1)} S_1} + r\frac{S_1 \partial V}{\partial^{\alpha} S_1} - rV \quad (34)$$

$$(c_u^{n+1} - c_u^n) = \partial t D^{(2)} c u^n$$

$$AC_n = F$$

$WAW^T WC_u = WF$

$du = Wc_u$ and $d_f = Wc_f$

$WAW^T Wdu = dF$

Black Scholes with two assets

$$V = \frac{1}{2}\sigma_1^2 S_1^2 \frac{\partial^{1-\alpha} V}{\partial^{\alpha} S_1 (\alpha+1)} + \rho\sigma_1\sigma_2 S_1 S_2 \frac{\partial^{1-\alpha} V}{\partial^{\alpha} S_1 \partial^{\alpha} S_2} + \frac{1}{2}\sigma_2^2 S_2^2 \frac{\partial^{1-\alpha} V}{\partial^{\alpha} S_2} + rS_1 \frac{\partial V}{\partial^{\alpha} S_1} + rS_2 \frac{\partial V}{2^{\alpha} S_2} - rV \quad (35)$$

$$\frac{\partial V}{\partial \tau} = \nabla.(G\nabla V) + H^T \nabla V - rV$$

∇ is the gradient operator,

$$[\partial S_1, \partial S_2]T$$

$$G = \frac{1}{2}\begin{bmatrix} \sigma_1^2 & \rho\sigma_1\sigma_2 S_1 S_2 \\ \rho\sigma_1\sigma_2 S_1 S_2 & \sigma_2^2 S_2^2 \end{bmatrix}$$

& S_2 plot

&S_1& V & S_2

$$\frac{\partial V}{\partial \tau}\frac{1}{2}\sigma_2^2 S_2^2 \frac{\partial^{1-\alpha} V}{2^{\alpha(1+\alpha)} S_2} + rS_2 \frac{\partial V}{\partial^{\alpha} S 2_2} - rV_{ab} \quad (36)$$

$$\frac{\partial V}{\partial T}\varphi d\Omega = -\int (G\nabla V).\nabla\varphi d\Omega + \int H^T \nabla\varphi d$$

Let the method of two assets

$$\frac{\partial^{1-\alpha}}{\partial x^{\alpha(\alpha+1)}} + f \text{ for t > 0}$$

$$x\epsilon(-\infty, \infty)$$

$$0 < \infty < 1/2$$

$$u(0,t) = u(1,t)$$

$$\partial u(t) = \frac{\partial^{1-\alpha} u}{\partial x^{\alpha}(\alpha+1)} 1, t$$

$$u(x,0) = u_0 x$$

$$\left(\frac{\partial u}{\partial x}, v\right)^t \int_0^{u_0} \frac{\partial u}{\partial t}\frac{\partial v}{\partial v} dx = (f, v)$$

$\varphi \in H_0^1(\Omega)$, where O indicates that φ is homogenous at any Dirichlet boundaries and $d\Omega = dS_1 S_2$

5. Numerical Examples

In this section, a series solution of European call option based on Black-Scholes model with two assets as in Equation (25) is computed by using MATLAB programming. The simulations are carried out using the financial parameters given in Table 1.

Table 1. Parameters of the numerical solution

Parameters	Symbol	Value
Strike Price	K (Dollars)	70
Risk-Free interest (per year)	r	5%
Maturity time	T (year)	1
Volatility of the underlying first assets	S1	10%
Volatility of the underlying second assets	S2	20%
Correlation	r	0.5

The graphs of the transformed explicit solution v and original explicit solution c in the case of call option are plotted in Figures 1–5. In Figure 1, the solutions v and c are plotted at a day before an expiration date over a range of 0 _ S1_ 200 and 0 _ S2 _ 200

surrounding at the strike price with order a = 0.9. The results show that the option values increase significantly when the stock prices increase. By setting S2 = 10, the solutions v and c with order a = 0.9 are plotted in Figure 2a, b.With increasing S1 from 0 to 50, the option price c reaches to zero. It is similar to c, v also reaches to zero when x increases from 2 to 4. The option price c increases linearly when the stock price is greater than 50. The solution v increases exponentially when x is greater than 4.

Figure 3 shows the surface plot of call option with S1 = 10 over a range of stock price 0 _ S2 _ 200 and time 0 $\leq t \leq$ 1. With increasing S2 from 0 to 40, the option price c reaches to zero. v also reachesto zero when x increases from 2 to 3.8. After that the option price c increases linearly when stock priceis greater than 40. The solution v increases exponentially when x is greater than 3.8.

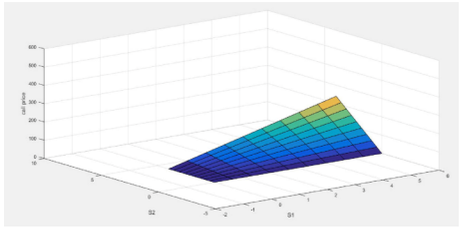

Fig. 1 (a) Transformed explicit solution, v

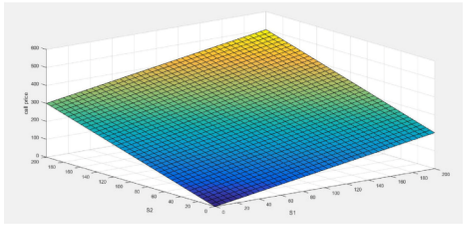

Fig. 1 (b) call option price, c, for a = 0.9 at a day before an expiration date.

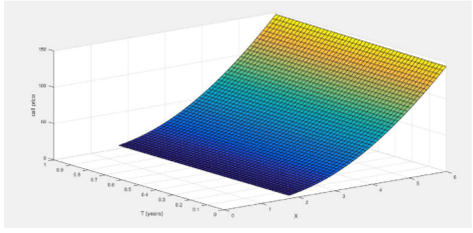

Fig. 2 (a) Transformed explicit solution, v

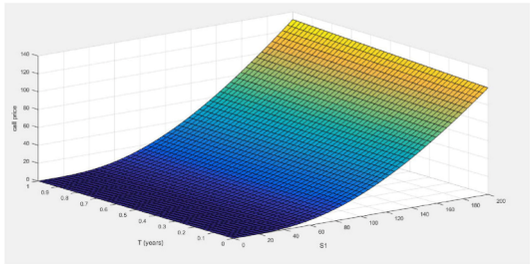

Fig.2 (b) call option price, c, for all time of order a = 0.9 with S2 = 10.

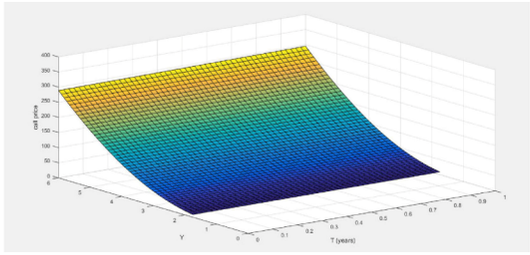

Fig. 3 (a) Transformed explicit solution, v

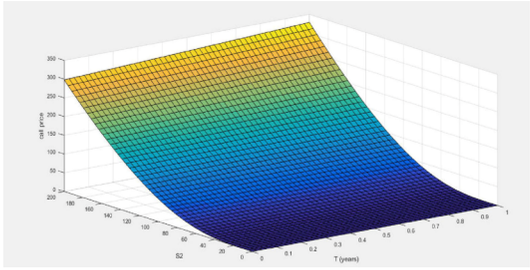

Fig.3 (b) call option price, c, for all time of order a = 0.9 with S1 = 10.

At a day before an expiration date, the European call option price over the stock price S1 and S2 for various order a = 0.5, 0.7 and 0.9 is investigate. Effects of fractional order a on c for different orders when S2 = 5 and S1 = 10 are shown in Figure 4a, b, respectively. The comparison indicates that a higher order a gives a lower call option price. In Figure 5, the solution plot of v is similar trend to c. It is noted that a higher order a gives a lower option price v. Moreover, the option prices v increases rapidly after x = 4.2452 and y = 3.4589 as shown in Figure 5a,b, respectively. Consequently, we can conclude that the effect of time derivative order a has a small effect on the option price.

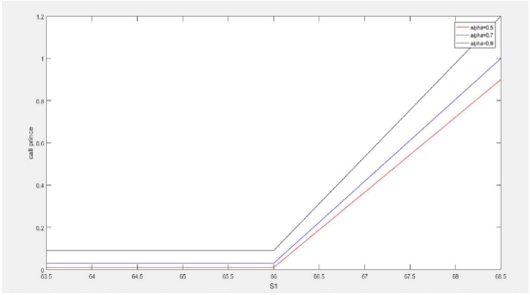

Fig. 4 (a) Solution plots of European call option obtained from the model with different orders a = 0.5, 0.7, 0.9 at a day before an expiration date at S2 = 5.

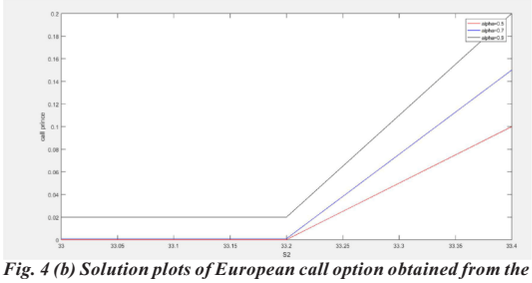

Fig. 4 (b) Solution plots of European call option obtained from the model with different orders a = 0.5, 0.7, 0.9 at a day before an expiration date at S1 = 10.

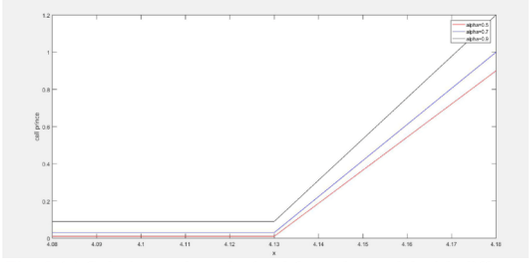

Fig. 5 (a) Solution v plots obtained from the model with different orders a = 0.5, 0.7, 0.9 at a day before an expiration date at y = 1.6093

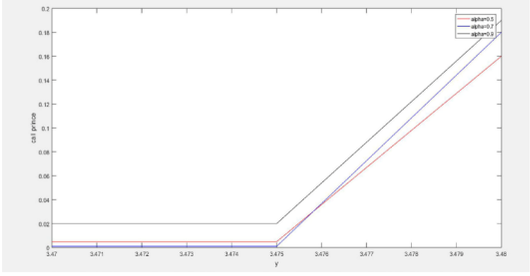

Fig. 5 (b) Solution v plots obtained from the model with different orders a = 0.5, 0.7, 0.9 at a day before an expiration date at x = 2.3024.

The values of European call option with the correlation varying from -1 to 1 is presented in Figure 6 at a day before an expiration date. The effects of stock price S2 with some fixed stock prices S1 and y with some fixed value x are investigated. Three values of S1 including 50, 80 and 100 and three values of x including 3.8671, 4.3371 and 4.6556 are chosen for S2 = 5 and y = 1.6093. The result shows that the relationship between the European call option and the correlation is the increasing linear pattern. In addition, the rate of change of European call options v and c with respect to rare also similar to each other as shown in Figure 6 a, b.

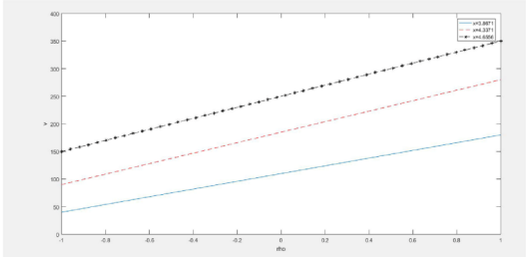

Fig. 6 (a) Relationship between the European call option and the correlation r for time derivative order a = 0.9 at a day before the expiration date v for y = 1.6093.

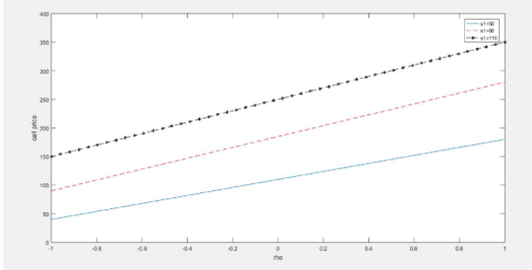

Fig. 6 (b) Relationship between the European call option and the correlation r for time derivative order a = 0.9 at a day before the expiration date: (a) v for y = 1.6093 and (b) c for S2 = 5.

6. Conclusion

Here in this paper the classical derivative is replaced by conformable fractional derivative in Black-Scholes Model. The explicit method is used for finding the numerical solution for the visualization of the standard parameters. As shown in the result, we can see that if parameters were not changed in the model, we obtain the difference value of option price with the different order. As a result, the Conformable

fractional Black-Scholes model is more practical than the classical black Scholes model. The benefit of the explicit solution form is easy to use for finding the European call option which depends on two stock prices. Moreover, the numerical examples of the solution are presented to illustrate the explicit solution.

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Advancements in Gastrointestinal Drug Delivery: Tailoring Dosage Forms for Optimal Release

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Abstract

Considering the entry and exit of gastrointestinal physiology is essential for designing a sustained release dosage form. The environment of a dosage form is defined by a combination of pH and transit time; for example, a tablet's transit time in the stomach during a fast can last anywhere between 0.5-2 hours. Hence, a dose form, such as a tablet, will experience a pH below 2 for a period of 0.5-2 hours. Transit time and pH are very significant for the release of active substances because they are highly variable for different people and the same person at different times, especially when using a modified release dosage form. The use of porous networks for drug delivery, commonly referred to as matrix or monolithic systems, is another common practice. These systems employ both swellable (also known as "hydrogel") and non-swellable matrices. Monolithic devices have a cheaper cost of manufacturing with a lower risk of dosage dumping since they require less quality control throughout the fabrication process than reservoir systems do. A controlled release method that could be processed in a single step and still have a high drug loading and no burst release would be ideal. The first burst has been reduced using several relatively simple techniques, such as extracting the drug formulations short in vitro before using them in an in vivo application.

The microstructure of the polymer and interactions between hydrophilic and hydrophobic groups play a significant role in the determination of drug distribution profiles and release characteristics. Nowadays, polymers are being used to revolutionise the way that medications are delivered. Innovative drug delivery techniques enable the system to change the rate of drug distribution while preserving the duration of therapeutic action. Following partial separation or even complete dissociation of the ion pairs, electrostatic intra- and intermolecular interactions may diverge from "normal" polymer behaviour in a variety of ways. Many properties, such as chain conformation, diffusion coefficients, solution viscosity, polarizability, miscibility, etc. are significantly influenced by ionic groups. Both in the solid and solution, low molar mass counter ions (LMMC) are tightly bound to the polymer ion group.

Keywords : *Burst release, microspheres, complexation sustained release.*

I. Introduction

The benefits of oral sustained release dosage forms are well known and highly significant in the pharmaceutical industry. These dosage forms are made to have larger concentrations of an active ingredient and are manufactured in a way that allows the active ingredient to be released gradually over an extended period of time

into the human gastrointestinal tract. Compared to conventional, immediate release dosage forms, well-absorbed oraly, sustained dosage forms have several inherent advantages. These benefits include less recurrent dosing of an active compound, higher patient regimen adherence, increased sustained drug blood level response, and therapeutic action with less drug intake, thereby minimising many potential side effects. Spikes in the absorption of a drug's concentration are reduced by causing a smoother and longer-lasting blood level response by delivering a slow and steady release of an active ingredient over time. [1]

The design of a sustained release dosage form necessitates a thorough knowledge of gastrointestinal physiology. A natural pH gradient runs from the stomach's acidity through the duodenum's mild acidity and into the small intestine's neutral environment. Furthermore, pH alterations brought on by changes in nutrition are possible. The transit time of the dose form is a further crucial element.

The length of time a dosage form stays in a certain area of the gastrointestinal tract is measured by its transit time. The dosage form itself, gastrointestinal motility, the presence of food, etc. all affect the transit duration. A dosage form's environment is determined by a combination of pH and transit time; for instance, a tablet's transit duration in the stomach during a fast may range from 0.5-2 hours. A dose form, like a pill, will therefore experience a pH below 2 for a duration of 0.5-2 hours. Transit time and pH are very variable for various people and the same person at different times, making them extremely important for the release of active chemicals, especially from a modified release dosage form. It is usually preferable for the drug product to be independent of these variabilities and avoid the associated issues with bioavailability fluctuation in order to be used as effectively as possible. [2]

II. The most popular formulation techniques for giving an orally administered dosage form a sustained release characteristic are as follows:

1. Coating tablets or microspheres with a coating that allows for slow release of the active ingredient through either gradual permeation through or gradual breakdown,
2. Mixing the active ingredient with a sustained release matrix made of a fat, wax, or polymeric material. A tablet with the medicine embedded in an excipient that forms a non-disintegrating core is referred to as a matrix. Through its centre, drugs diffuse. [3]

Regardless of the technique used to create sustained release in the pharmaceutical formulation, burst release of the active ingredient is a common formulation issue with sustained release dosage forms. "Higher initial medication delivery is a result of burst release, additionally shortens a sustained release dosage form's effective life span (internally). Burst release in monolithic polymeric materials has been linked to a number of different physical, chemical, and processing-related underlying mechanisms. The burst release has been experimentally seen by several researchers, [9, 11, 13, 20, 23] and some have proposed ideas to explain it in various technologies, but for the most part, no conclusive results have been demonstrated [4–11, 12–29]. Processing conditions, host material surface properties, sample geometry, host/drug interactions (surface adsorption), and the morphology and porous structure of dry material are a few of the possible causes.

a. Burst release in reservoir drug delivery systems: The burst release has been experimentally seen by several researchers, and some have proposed ideas to explain it in various technologies, but for the most part, no conclusive results have been demonstrated. Processing conditions, host material surface properties, sample geometry, host/drug interactions (surface adsorption), and the morphology and porous structure of dry material are a few of the possible causes.[11] The agent saturates the entire membrane enclosing the drug reservoir when reservoir systems are stored for a while before use. The agent that has diffused to the membrane's surface is instantly released when it is placed in a release medium, leading to a burst effect.

b. Burst release in matrix drug delivery systems: Drug delivery methods that use a porous network to

distribute the drug, often known as matrix or monolithic systems, are also quite popular. Both swellable (sometimes referred to as "hydrogel") and non-swellable matrices are used in these systems. Monolithic devices require less quality control throughout the fabrication process than reservoir systems do, which lowers the cost of fabrication with a lesser risk of dosage dumping. [11, 12] Similar explanations for burst from reservoir devices, such as synthesis and manufacturing circumstances, the heterogeneity of polymer matrices, drug characteristics, and percolation-limited diffusion, can also be utilised to explain burst release from monolithic, or matrix, formulations. One theory put out to explain the burst effect in monolithic systems is that during manufacture,[13] particularly in the event of excessive drug loading, [5] some drugs become trapped on the polymer matrix's surface and, upon activation in a release solution, are promptly released. This issue may arise when pharmaceuticals are placed onto polymeric devices via equilibrium partitioning in extremely concentrated drug solutions. When polymeric devices are loaded with drugs by equilibrium partitioning in highly concentration drug solutions, this problem may happen. Migration of drugs during drying and storage steps may result in a heterogeneous distribution of drug in the polymer matrix and lead to burst release. [7,10]

Drugs must first be dissolved before they can diffuse through an expanding porous structure and reach the release media, which is often water or a pH buffer solution for in vitro experiments. The same way, as water flows to the gel surfaces and evaporates during the drying process, drug diffusion and migration may take place. Drug concentrations may be unevenly distributed throughout the gel due to drug convection with the water, with larger concentrations towards the surface.

The circumstances employed for synthesis, particularly the ratios of polymer to medication and polymer to solvent, are another crucial element in burst release. Shah et al. was seeing the burst.[16] For the release of bovine serum albumin (BSA) from microspheres made of poly-D,L-lactic acid (PLGA) and lactide-glycolide (75:25) (PLA). Although the experimental design did not hold the drug:polymer ratio constant, burst was more noticeable as the overall number of polymers utilised to make microspheres dropped. According to the researchers, a smaller ratio of polymer to suspending phase resulted in microparticles with a less compact polymer phase. As a result, bigger pores may emerge where the polymer does not regulate diffusion, allowing BSA to move towards the surface of microspheres after drying.

The heterogeneity of some hydrogels is another theory put out for burst release in swellable monolithic systems. To verify the notion of drug migration during drying. [9] employed crosslinked poly(sucrose acrylate) hydrogels immediately after synthesis (i.e., without drying). However, the initial burst of protein was discovered even without drying the samples. The hydro gels in this study were described as having a structure made up of continuous low-density matrix and high-density microgel domains.

The burst effect in controlled release systems can also be significantly influenced by the chemical and physical structure of different medication or active agent molecules. Both systems for the delivery of peptides and proteins as well as those with small molecular weight solutes have been observed to experience the burst effect. As small molecular weight solutes are frequently extremely soluble in aqueous systems and can quickly pass through the porous structure of hydrogels even before swelling, the precise mechanisms for burst release in these systems may be drastically different. Surface adhesion and desorption are frequently blamed for the observed burst release of proteins from controlled delivery devices. The driving forces for release are influenced by a drug's solubility and partition coefficients, which might result in a rapid release due to thermodynamic imbalances.

Another explanation for the sudden release of small molecular weight active chemicals from bulk disintegrating non-swelling polymer devices is provided by Tzafriri [23]. Theoretically, the initial active agent loading consists of two distinct pools: a pool of mobile active agent that is free to diffuse upon matrix hydration and a pool of immobilised active agent that

can diffuse only once the matrix's pore diameters have widened due to hydrolytic breakdown. Similar to the percolation principle, solitary solute is confined or immobilised by the matrix whereas molecules linked by holes may disperse.

The employment of environmentally sensitive materials to achieve pulsatile release, where fast (burst) release is triggered by changes in the device's chemical environment, is one instance where burst release is desirable. Anionic or cationic hydro gels have the capacity to control diffusion in an on/off pattern and pH-sensitive swelling. Temperature sensitivity is present in polymer gels with lower critical solution temperatures (LCST). These gels are extremely swollen at low temperatures and rapidly de-swell as the temperature rises over the LCST, leading to fast burst release [23]. Comparable burst release has been seen in macro porous gels built on polymers that are sensitive to pH. Researchers looking to improve cardiovascular targeting have explored the release of heparin from thermo sensitive hydro gels. [20]

It would be excellent if a system for controlled release could be processed in a single step while yet having high drug loading and no burst release. Some fairly straightforward methods, including extracting the drug formulations briefly in vitro before employing them in an in vivo application, have been used to lessen the first burst. [4] When the drug is taken out of the outer layers of the controlled release devices, this method effectively reduces burst. But, there is still a serious issue with the cost of extraction and the decreased effectiveness of the (sometimes expensive) medications.

Surface extraction by briefly washing the sample before doing the release experiment has been demonstrated to be effective for systems with higher drug concentrations on the surface, however the fraction of drug eliminated in the extraction stage may be considerable. [10,15] When opposed to microsphere formulations, where extraction may remove a sizable amount of the active ingredient, bigger release devices with a smaller surface area to volume ratio may be more suitable for this approach.

Surface modification by extra coating stages to give an outer layer without drugs is another widely utilised technique to avoid burst release. In order to avoid the initial burst release, Wheatley et al. [19] employed alginate beads coated three times with either poly (L-lysine HBr) or poly(vinyl amine) in a study on the delivery of biomacromolecules such as proteins and dextrans. It was discovered that lowering the burst effect and increasing the polycation content resulted in a more sustained release profile. It was also believed that a significant element affecting the release profiles was the molecular weight of the species that had been encapsulated. Findings indicated that higher molecular weight dextrans might be employed to achieve a prolonged release with a lesser burst effect, which was related to a greater impediment due to solute molecular size.

One technique that has proven successful in decreasing the burst effect in monolithic systems is non-uniform drug loading, although being challenging to implement in practical systems. An initial sigmoid drug distribution with the highest concentrations at the centre of a gel slab was capable of introducing a distinctive inflection point, resulting in close to zero-order sustained release behaviour, as demonstrated by Lee [15]'s mathematical and experimental analysis of the impact of initial drug distribution on the kinetics of drug release from polymer matrices. The expanding rubbery gel layer was overcome by the increased concentrations distant from the surfaces. With uniformly loaded gels, this gel layer often results in release rates that gradually decrease over time.

Determining drug distribution profiles and release characteristics also heavily relies on the microstructure of the polymer and interactions between hydrophilic and hydrophobic groups. By lowering the early entry of water into polymer films and increasing the hydrophobicity of biodegradable poly(-glutamic acid) matrices. [7]

Certain polymers are also capable of crystallising, allowing the annealing conditions to regulate the pore sizes and shape. Mallapragada et alresearch.'s [10]

demonstrated that semi-crystalline samples that were annealed at higher temperatures for longer periods of time had less burst release of metronidazole. Release kinetics can be changed by using swellable excipients properly since the rate of water uptake in hydrogel devices, which is controlled by PVA, determines release rate. Catellani and others [23] The medication demonstrated that by adding swellable and soluble polymers, like HPMC (hydroxy propyl methylcellulose) and PVA, to the inert base matrix, release rate variability could be decreased, resulting in a nearly constant rate.

Moreover, by combining polymers with various swelling and erosion characteristics, such as sodium carboxy methylcellulose and HPMC, improved zero-order release can be achieved [21].

Several approaches have been tried to stop burst release from porous polymer structures brought on by solvent evaporation during processing [20, 21, 23] the majority of which are focused on altering the surfaces of the devices. Two techniques were utilized in one study [20] to create PLA gels. In the first approach, a second coating was added by dipping the film into a poly (vinyl alcohol)-dioxane solution, moving it to distilled water, and then allowing PVA to precipitate on the film's surface while dioxane was dissolved in the water. An alternative method suggested was to use compression moulding to coat PLA polymer powder tablets on both sides above the temperature at which PLA turns glass. These two techniques both contributed to some reduction in burst. Another strategy [21] involved altering the polymer's morphology by combining it with non-ionic polymeric surfactants to create a matrix in which the surfactants were entangled with the PLA's amorphous area. An extra liquid-crystalline phase that was embedded between the PLA crystalline phases was added to the blends during hydration, creating an overall intact surface morphology that led to a smaller initial protein burst and a prolonged release time. [21] Later, it was revealed that when the aforementioned blend matrices were treated with an aqueous solution of polyethyleneimine (PEI), the protein burst was significantly reduced and the release was much prolonged. The theory behind this method was that PEI chains adhere to or diffuse into the polymer matrix, ironically cross linking protein molecules that are present close to the surface.

The above discussion on the importance of burst release to the development of sustained release dosage forms started with compounds (10 mg/ml at 20ºC) that have a tendency to enter solution quickly in an aqueous environment. It became clear that burst release can be a particular issue with water soluble active physiological environment. An active substance that is only marginally or sparingly soluble (1–10 mg/ml at 20°C) may likewise be susceptible to burst release. Therefore, there is a clear and growing need for a superior sustained release dosage form that is simple but still highly effective. This dosage form must also show a substantially constant dissolution rate over a long period of time and for the majority of its dissolution time when exposed to the subject's gastrointestinal fluids to whom or to which administered.

Polymers have been employed to revolutionise the medicine delivery mechanism in the current situation. The system can adjust the pace of drug distribution while maintaining the duration of therapeutic action thanks to innovative drug delivery mechanisms. Particularly those that react in a desired manner to changes in the temperature, pH, electric field, or magnetic field, polymers have become increasingly important in the delivery of new drugs. Because of this, they are frequently and widely employed as excipients in the development of products with regulated and/or prolonged releases. Polymers are often used as coating materials, film-forming agents, drug carriers, granulating agents, tablet excipients, and solubilizing agents due to their physiochemical characteristics.

In nature, polyelectrolytes are all around us. Polyelectrolyte complexes have attracted attention as a potential new method of drug delivery because they can modulate the pace of drug release by serving as carriers, thereby extending the therapeutic effect. Every repeating unit of a polyelectrolyte, which are charged polymers, is capable of carrying an electrical charge.

Together, these polyelectrolyte complexes form a biocompatible polymer system called an association complex as a result of electrostatic contact between polyanions with opposing charges (e.g. polymer-polymer, polymer-drug and polymer-drug-polymer). An approach that can be used to improve burst release prevention and sustained drug release is the employment of the polyelectrolyte complex building technique between macromolecular units of oppositely charged polymers. The complex created is typically used in various dose forms to create stable aggregated molecules.[22]

Strong polyelectrolyte are polymers that are typically made up of monomers that are strong acids, bases, or the salts of strong acids, bases, or both. Weak polyelectrolyte are typically formed by monomers that are themselves weak bases or acids. Polyelectrolytes contain the counter ions of the poly ion. The polymeric backbone carries charges, however due to electro neutrality all polymeric charges must be balanced by a counter ion. Due to the dissociation of the electronic group, the polyelectrolytes acquire a high number of elementary charges scattered along the macromolecular chain when they are dissolved in a suitably polar solvent (often water).

There are many ways whereby electrostatic intra- and intermolecular interactions might deviate from "normal" polymer behaviour following partial separation or even complete dissociation of the ion pairs. Ionic groups have a significant impact on a number of properties, including chain conformation, diffusion coefficients, solution viscosity, polarizability, miscibility, etc. Low molar mass counter ions (LMMC) are strongly bonded to the polymer ion group both in the solid state and in polar liquids, and the chain has no net charge. Similar to how a straightforward low molar mass salt dissolves, the ionic moieties are solvated and the LMMC become mobile in aqueous solution. The electrostatic attraction of the polyelectrolyte prevents the remaining LMMC from moving much outside of the polymer domain.

If polymer complexation is to take place, the loss of conformational and transational entropy of the polymer chain must be balanced. Complexation and formation must take place.

Polyelectrolyte complex formation and stability are influenced by a variety of factors, including:

a) Position of ionic group on polymer chain
b) Charge distribution on polymer chain
c) Temperature of the reaction medium
d) Ionic strength of the reaction medium
e) Molecular weight of polyelectrolyte
f) Concentration of polyelectrolyte
g) Polymer chain flexibility
h) Duration of interaction
I) Nature of ionic group
j) pH of the medium
k) Mixing Order
l) Mixing ratio

The complexes that are created when these characteristics are combined are anticipated to have a variety of useful qualities. Polymer complexes are regarded as unique compounds because of their specific makeup. The three types of polymer complexes include hydrogen bonded complexes, inter polyelectrolyte complexes, and stereo complexes. Polyelectrolyte complexes are created when two polymers with opposing charges interact. As polymer chains with ionizable monomer units, they are referred to. Since many bio macromolecules, including DNA, RNA, and enzymes, are polyelectrolytes, they play a significant role in biological systems. Coagulants, sorbents, polymer catalysts, drug delivery systems, artificial vaccines, and other uses for polymer complexes are numerous. [23]

Conclusion

In summary, when creating sustained release dosage forms—especially for tablets—the complex interactions among gastrointestinal physiology, transit duration, and pH fluctuations must be taken into consideration. The intricacy of accomplishing regulated drug release is highlighted by the variations across

people and even within the same person at different points in time. Reservoir systems are more expensive than monolithic devices, which are comprised of porous network systems that can accommodate both swellable and non-swellable matrices. The search for the optimal controlled release technique highlights how crucial it is to use a single-step procedure with high drug loading and low burst release. Several methods have been investigated to lessen the initial burst, including pre-extraction of drug formulations in vitro. Drug distribution profiles are greatly influenced by the microstructure of polymers and the interactions between hydrophilic and hydrophobic groups.

Drug delivery is changing, and polymers are being used to transform medicine administration. This allows for dynamic changes in drug distribution rates without compromising therapeutic efficacy. It is impossible to overestimate the influence of ionic groups on changes in polymer behavior, such as chain conformation, diffusion coefficients, solution viscosity, and miscibility. Both the solid and solution phases are further impacted by the strong binding of low molar mass counter ions to polymer ion groups.

Essentially, a new era in medicine administration is being shaped by the convergence of gastrointestinal physiology, polymer science, and drug delivery technology, which promises more efficient and patient-specific therapeutic interventions. Further developments in this area could improve the general effectiveness and safety of medicinal therapies.

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Communication Skills: A Back Bone of Organizational Structure

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Abstract

Man has been blessed with the divine gift of speaking. Speaking means one major constituent of communication, Writing, Reading & Listening are other significant elements of communication. Language serves as a very effective device of communication. Hence speaking, writing, reading & listening (SWRL) are the four communication skills. Out of these four communication skills, i.e., Speaking & Writing are known as encoding devices. If these two devices are not in proper order, the basic purpose of communication is defeated. Sender, Message, Channel, Receiver & Feedback (SMCRF) are the process of communication. Language comes under the category of channel.

Communication skills are paramountly needed for every professional particularly for a who doggedly aspires for significant achievements in life. Conversely, those who lack efficacious communicative skills do really fail in their professional careers. It was said of Oliver Goldsmith, the noted litterateur, that he wrote like an angel but he talked like a poor poll. Charles Darwin, the famous Evolutionist, lacked aesthetic sense, an offshoot of Reading Skills, and that's why he failed to appreciate Shakespeare's plays. M. K. Gandhi, the father of the nation, started his legal career rather shakily for want of strong communication skills. In an age of global communication, communicative skills have now become all the more important. One can't, of course, face international competition of the modern milieu wholesomely spawned on newer breakthroughs of technologies without the meticulous use of communicative skills.

Keywords: *Encoding, Paramountly, Doggedly, Aesthetic, Spawned*

I. Introduction

Effective communication in an organization serves as the life blood that sustains every facet of operations. From disseminating critical information to fostering collaboration and driving innovation, organizational success hinges upon the ability to communicate effectively at every level. But what exactly constitutes an organizational communication strategy, and why is it crucial for businesses today?

An organizational communication strategy encompasses a structured approach to managing and enhancing communication within an organization. It involves the deliberate planning, implementation, and evaluation of communication processes to ensure alignment with organizational objectives and foster a culture of transparency, engagement, and productivity. At its core, strategic organizational communication aims to optimize the flow of information, both internally among employees and externally with stakeholders, to support decision-making, problem-solving, and goal attainment.

In the dynamic landscape of the contemporary workplace, effective communication strategies in the workplace have emerged as a linchpin for success. Research underscores the significant impact of communication on organizational outcomes, with studies indicating that companies with strong communication practices are more likely to outperform their peers in key areas such as employee retention, customer satisfaction, and financial performance. Indeed, effective organizational communication in an organization is not merely a desirable trait but a strategic imperative that directly influences competitiveness and sustainability.

As organizations grapple with evolving challenges such as globalization, digital transformation, and remote work, the need for robust communication strategies has never been more pronounced. In this context, organizational communication strategy assumes paramount importance, guiding leaders in navigating complexities, fostering resilience, and driving positive change. By embracing communication as a strategic asset and implementing tailored strategies that address the unique needs and dynamics of their workforce, organizations can unlock new opportunities for growth, innovation, and success in today's interconnected world.

We explore the top 15 proven strategies for effective organizational communication, drawing on insights from industry experts, empirical research, and real-world examples. From leveraging technology to enhance virtual collaboration to nurturing a culture of constructive feedback and inclusivity, each strategy offers practical guidance for organizations seeking to harness the power of communication to achieve their goals and thrive in an ever-evolving business landscape.

Effective organizational communication refers to the seamless exchange of information, ideas, and feedback within an organization to achieve shared goals and foster a positive work environment. It involves the timely dissemination of relevant information, clear articulation of expectations, active listening, and open dialogue among all stakeholders. Effective organizational communication goes beyond mere transmission of messages; it cultivates trust, enhances collaboration, promotes innovation, and drives organizational success. In essence, it is the cornerstone of a thriving workplace culture where employees feel valued, engaged, and empowered to contribute their best.

Organizational communication is vital for the smooth functioning of any business as it facilitates the exchange of information, ideas, and feedback among employees, teams, and leadership. Effective communication fosters transparency, clarity, and alignment of goals, reducing misunderstandings, conflicts, and errors. It enhances employee engagement, morale, and productivity, leading to higher job satisfaction and retention. Additionally, strong communication practices enable organizations to adapt to change, respond to challenges, and innovate more effectively. Ultimately, organizational communication plays a crucial role in building trust, fostering collaboration, and driving overall success in the workplace.

II. Types of organizational communication

Organizational communication can be broadly classified into several types, which help facilitate the exchange of information within and outside an organization. Here are the main types:

1. Internal Communication

(a) Vertical Communication: This type occurs between different levels of the organizational hierarchy. It can be further divided into:

- **Upward Communication**: Information flows from subordinates to superiors, such as feedback, reports, or suggestions.
- **Downward Communication**: Information flows from superiors to subordinates, including instructions, announcements, or feedback.

(b) Horizontal (Lateral) Communication: This type takes place between employees or departments on the same level of hierarchy. It fosters collaboration and coordination across departments, like project teams or interdepartmental meetings.

(c) Diagonal Communication: Occurring across different levels and departments, this type

facilitates quick problem-solving and collaboration outside of traditional hierarchical lines.

2. External Communication

This type involves communication between the organization and external entities, such as customers, suppliers, regulatory bodies, or the public. It includes:

- **Formal External Communication**: Official announcements, press releases, and corporate communications that reflect the organization's public image.
- **Informal External Communication**: Social media interactions, customer service chats, and networking events that may not follow official formats but still represent the organization.

3. Formal Communication

This involves structured, official communication channels, such as memos, reports, and documented meetings. It typically follows the organization's established protocols and is used for official purposes.

4. Informal Communication (Grapevine)

Informal communication flows freely and spontaneously among employees. This may include casual conversations, rumors, or social interactions. While less structured, it plays a vital role in building relationships and sharing information that might not be formally addressed.

Each type plays a crucial role in ensuring that information flows effectively, enabling better decision-making, employee engagement, and overall organizational efficiency.

III. Benefits of organizational communication

Effective organizational communication offers numerous benefits that contribute to the overall success and productivity of an organization. Here are some key benefits:

1. Improves Employee Engagement

When employees are well-informed about company goals, changes, and their role within the organization, they are more likely to feel valued and engaged. Engagement leads to higher job satisfaction and motivation, which can increase productivity and reduce turnover rates.

2. Enhances Decision-Making

Efficient organizational communication ensures that decision-makers have access to accurate, timely information, which is crucial for making informed decisions. Clear communication channels also enable feedback and suggestions, allowing for well-rounded decisions that consider multiple perspectives.

3. Boosts Productivity

Clear communication reduces misunderstandings, streamlines processes, and minimizes the need for repetitive clarification. Employees can work more efficiently, knowing exactly what is expected of them and how their tasks contribute to the organization's objectives.

4. Facilitates Collaboration

Effective organizational communication fosters collaboration across departments and teams. When information is shared openly and transparently, employees can coordinate their efforts, work towards common goals, and share knowledge and resources, which enhance teamwork and innovation.

5. Strengthens Organizational Culture

Open and honest communication contributes to a positive organizational culture. When employees feel heard and respected, trust and loyalty develop. A strong culture based on trust and respect can enhance employee morale and attract top talent.

6. Improves Conflict Resolution

Good organizational communication practices help prevent misunderstandings and provide a framework for resolving conflicts when they arise. By addressing issues openly and directly, organizations can foster a

collaborative approach to problem-solving and maintain a harmonious work environment.

7. Supports Change Management

During periods of change, effective communication is crucial for minimizing resistance and ensuring a smooth transition. Keeping employees informed about changes, their reasons, and their implications helps in gaining employee buy-in and reduces uncertainty.

IV. 15 Best Organizational communication strategies in the Workplace

1. Use unified communication tool like Clarity

Clarity uses artificial intelligence in communication to combine emails, chats, documents, calendar events and feeds on the same topic, in rich, context-based "conversations" to ensure team communication stays focused and organized. Clarity AI continuously mines data to add more contexts to conversations, automatically.

Clarity unique machine learning algorithm identifies, collects, and makes deep connections with relevant contexts from all communication, to make work easier. Teams can navigate discussions effectively; see the full context before making decisions and increase productivity.

2. Encourage feedback

Encouraging feed back from employees shows that their opinions are valued, which can boost engagement and promote a culture of open communication. According to Office vibe, regular feedback improves employee engagement by 83%. When employees feel heard, they're more likely to feel invested in the organization's success.

3. Set clear expectations

When communication expectations are clear, employees know what's expected of them and what they can expect from others. This can increase engagement and productivity by 50%, according to Gallup. By setting clear expectations, employees can spend less time wondering what's expected of them and more time focused on their work.

4. Train employees on communication skills

Communication skills are not innate; they can be taught and improved. By investing in communication training for employees, you can improve overall organizational communication effectiveness by 75%, according to a study by Training Industry. By improving communication skills, employees can more effectively share their ideas, collaborate with others, and avoid misunderstandings.

5. Use visual aids

Using visual aids like graphs, charts, and images can help convey complex information more effectively. Visual aids can improve communication effectiveness by up to 400%, according to a study by 3M Corporation. They help to simplify complex information, making it easier for employees to understand and remember.

6. Use plain language

Using jargon and technical terms can make organizational communication difficult for some employees. Using plain language can make communication more accessible to everyone. According to a study by Nielsen Norman Group, using plain language can improve comprehension by up to 70%.

7. Foster a culture of open communication

In a culture of open communication, employees feel comfortable sharing their thoughts and ideas. This can improve engagement, creativity, and innovation. According to a study by TINY pulse, organizations with high employee engagement have a 21% higher profitability than those with low engagement.

8. Use active listening

Active listening involves fully engaging with the person you're communicating with, asking questions, and reflecting on what they're saying. Active listening can

improve understanding, reduce misunderstandings, and build trust. According to a study by Dale Carnegie Training, active listening can improve productivity by up to 30%.

9. Make communication a two-way street

Effective organizational communication involves not only transmitting information but also receiving it. Encouraging employees to share their thoughts, ideas, and feedback can improve communication effectiveness and help build trust.

10. Celebrate successes

Celebrating successes and milestones can improve employee morale and promote a sense of accomplishment. According to a study by Harvard Business Review, employees who feel recognized and valued are 23% more likely to be engaged.

11. Keep communication concise

Long-winded messages can be difficult to follow and can lose the attention of employees. Keeping organizational communication concise and to the point can improve understanding and engagement. According to a study by the University of Southern California, shorter messages are more likely to be remembered than longer messages.

12. Provide context

Providing context for communication can help employees understand why certain information is important and how it relates to their work. Context can improve understanding and engagement. According to a study by the Center for Talent Innovation, employees who understand the purpose of their work are more engaged and productive.

13. Use technology to facilitate communication

Technology can facilitate effective communication in an organization by making it easier to connect with employees, share information, and collaborate.

14. Be transparent

Being transparent and honest with employees can build trust and improve communication effectiveness. According to a study by Edelman, employees are 91% more likely to trust their employer if they perceive them as transparent.

15. Provide regular updates

Regular updates can keep employees informed and engaged. According to a study by The Creative Group, 43% of employees feel that communication about company news and updates is the most important aspect of effective communication in an organization.

V. How does Clarity improve Effective organizational communication?

Clarity enhances effective organizational communication by providing a unified platform that integrates various communication channels such as email, chat, and file sharing into one contextual hybrid Conversation. This integration ensures that all relevant information and conversations are easily accessible and organized, reducing the risk of miscommunication or lost data. Additionally, Clariti's context-driven approach allows users to maintain continuity in discussions by linking related messages and files, enabling teams to stay aligned and informed.

Furthermore, Clarity's advanced search and sort capabilities enable users to quickly retrieve specific information or past conversations, further streamlining communication and decision-making processes.

Clarity significantly enhances effective organizational communication through its innovative utilization of artificial intelligence (AI). By harnessing AI technology, Clarity transforms the way teams communicate and collaborate within organizations.

Clarity's AI algorithms analyze and identify contextual relationships between different communication elements, enabling users to navigate discussions with ease and clarity. By providing insights into the underlying context of hybrid Conversations, Clarity empowers teams to make informed decisions and take decisive actions.

Conclusion

Effective organizational communication is a critical component of any successful business or organization. By implementing the 15 organizational communication strategies, organizations can improve their communication practices and ultimately achieve their goals. From using a variety of communication channels to fostering a culture of open communication, organizations can improve communication effectiveness, reduce misunderstandings and confusion, increase collaboration, and improve overall transparency.

Effective organizational communication is not a one-time fix but requires a continuous effort from all stakeholders. It involves ongoing feedback, training, and adjustments to ensure that communication practices remain effective and relevant.

By prioritizing effective communication and implementing the strategies outlined in this blog, organizations can improve employee engagement, foster a positive work environment, and ultimately drive business success. Effective organizational communication can lead to higher employee satisfaction, increased productivity, and improved organizational performance.

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